



From Pets to Threats: Invasive Iguanas and Other Species Cause Significant Harm to Native Iguanas

Gad Perry¹, Charles R. Knapp^{2,3}, Tandora D. Grant^{3,4}, Stesha A. Pasachnik^{3,5}, and Ioana Coman⁶

¹Department of Natural Resource Management, Texas Tech University, Lubbock, Texas 79409, USA (gad.perry@ttu.edu [corresponding author]).

²Daniel P. Haerther Center for Conservation and Research, John G. Shedd Aquarium, Chicago, Illinois 60605, USA (cknapp@sheddaquarium.org)

³IUCN SSC Iguana Specialist Group, Gland, Switzerland

⁴San Diego Zoo Wildlife Alliance, San Diego, California 92101, USA

⁵Fort Worth Zoo, Fort Worth, Texas 76110, USA (SAPasachnik@iguanafoundation.org)

⁶College of Media and Communication, Texas Tech University, Lubbock, Texas 79409, USA (ioana.coman@ttu.edu)

Compared to fictional voracious cinematic sharks or the every real crises of climate change and COVID-19, the genuine threat of Common Green Iguanas (*Iguana iguana*; Figs. 1–2) and Spiny-tailed Iguanas (*Ctenosaura similis* and *C. pectinata*; Fig. 3) seems quite innocuous. Originating in the Neotropics, they are at risk in parts of their native range because their habitats are being degraded and animals are captured for human consumption. Being intentionally moved, primarily via the pet trade, and unintentionally hitchhiking with horticultural and construction materials has allowed these lizards to spread widely, especially Common Green Iguanas. Knapp et al. (2020) discussed the dismaying establishment of non-native iguanas in more than 25 countries.



Fig. 1. A Common Green Iguana (*Iguana iguana*) (on rock, center) on Saba, Caribbean Netherlands. The iguanas are common in some habitats on the island, but whether they are native or introduced, and if so when and by whom, is unclear (Powell et al. 2005). Photograph by Gad Perry.



Fig. 2. A local Puerto Rican Racer (*Borikenophis portoricensis*) feeding on a juvenile Common Green Iguana (*Iguana iguana*) introduced to Tortola, British Virgin Islands. Photograph by Richard Land.

As with many other invasive species, the impacts of invasive iguanas are especially large on island ecosystems (IUCN SSC Iguana Specialist Group 2017). Although other lizards such as tegus and monitors can be problematic in places like Florida, Common Green Iguanas stand out because of the scale of their spread and reported impacts (Perry et al. 2020a). Indeed, Common Green Iguana invasions have been get-



Fig. 3. An adult Common Spiny-tailed Iguana (*Ctenosaura similis*) in northern Costa Rica, where they are native. The species inhabits a wide range of habitats and is often seen near human habitations. Photograph by Gad Perry.

ting coverage in the popular media, ranging from local press (Kay and Associated Press 2017) to international news (e.g., Knight 2020). However, these stories generally focus on the nuisance created by invasive iguanas, rather than the more complex situations that professional conservation biologists are documenting and attempting to address. For example, van den Burg et al. (2020) discussed damage to infrastructure, agricultural losses and other economic impacts, and threats to biodiversity caused by the spread of Common Green Iguanas in mainland Asia. Further, Moss et al. (2018) reported the alarming intergeneric hybridization with endangered native iguanas in the Caribbean. Interbreeding is a relatively common outcome of human-caused species invasions (Ottenburghs 2021). These and other devastating impacts are commonly the result of invasive species in general but often remain unnoticed by the public until the damages reach large scales (e.g., Pyšek et al. 2020). Knapp et al. (2020) and others have documented the impacts of invasive iguanas on ecosystems. These include altering seed dispersal patterns, enabling secondary invasions by parasites, and more. James Lazell (pers. comm.) often worried about dispersing Common Green Iguanas in the British Virgin Islands dominating habitats that the native Stout Iguanas (*Cyclura pinguis*) could use as part of a restoration effort.

Invasive iguana populations can grow explosively and persist in a broad range of habitats, perhaps because they often comprise multiple introductions and genetic lineages. Common Green Iguanas in particular are highly prolific (Fig. 4). As is the case with many invasive species, the response of policymakers has often been insufficient or even negligent, at least initially (Perry et al. 2020c; Pyšek et al. 2020). In places where the Common Green Iguana population has become so out of control that denial is no longer an option, millions of US dollars must be spent in an effort to control well-established or nascent populations (e.g., Kraus 2019). However, to date, no eradication effort has succeeded, even when thousands of iguanas were removed (Knapp et al.

2020). Where more aggressive efforts to regulate the trade of pet iguanas and other dangerous species were made, as with the July 2020 changes to Florida statutes, public pushback and legal challenges prevailed, once again setting back an attempt at protective measures against these invasions (Knapp et al. 2020). To the best of our knowledge, the market-based approach suggested by Perry and Farmer (2011), in which risk-adjusted fees on the pet trade are used for education and quick response at the local level, has yet to be implemented anywhere. However, the recent implementation of regulations that require pet iguanas and tegus to be microchipped in Florida (Luscombe 2021) does represent an effort to place responsibility for feral animals on the individuals that allowed them to get loose or, worse, let them go.

Perhaps detection using drones (e.g., Aota et al. 2021), possibly even application of control measures (e.g., Song et al. 2020) will eventually offer an effective and rapid response methodology. However, as important as they are in addressing novel invasions (Reaser et al. 2019), rapid detection and response are reactive approaches. The Florida Fish and Wildlife Conservation Commission is set to proactively ban the breeding and trade in ecologically damaging invasive herps, including several constrictors, all tegus and some monitors, and Common Green Iguanas (Florida Fish and Wildlife Conservation Commission 2021). Of course, with these species already established in many locations and chances of eradication unclear, this may be a case of closing the terrarium door after the iguanas have bolted. Experience has shown that pre-invasion, proactive prevention is more effective than post-invasion control efforts, although remarkable progress in eradication of invasives, primarily small mammals on small islands, has been seen in recent years (Capizzi 2020). Prevention requires not only policy-maker engagement, but first and foremost, public support (Perry et al.



Fig. 4. A pile of Common Green Iguanas (*Iguana iguana*), culled during an attempt to control their spread on Grand Cayman, clearly shows the magnitude of the invasion. Photograph by Jane Haakonsson.



Fig. 5. A feral cat (*Felis catus*) threatens a Mona Rock Iguana (*Cyclura stejnegeri*), which has assumed a defensive position (left). An adult iguana is safe from this invasive predator, but feral cats readily consume hatchlings of all iguana species, as shown by this feral cat carrying a juvenile rock iguana it killed on Little Cayman (center). Even at low concentrations, the feral cat population makes a significant impact on the survival of hatchling and juvenile Sister Isles Rock Iguanas (*Cyclura nubila caymanensis*). Mongooses (*Urva auro-punctata*) have been introduced to many Caribbean islands and are voracious predators with broad conservation impacts. In this camera-trap image, taken in Jamaica in August 2019, a mongoose is taking a hatchling Jamaican Iguana (*Cyclura collei*) from a nest in a rock crevice (right). Photographs by Alberto Alvarez, Mark Pothier, and Stesha Pasachnik.

2020b). For example, recent public engagement and mobilization on Little Cayman, following government and partnership initiatives, resulted in a rapid response to sightings and an enhanced chance of controlling the spread of Common Green Iguanas (Knapp et al. 2020). Such public support can only be obtained where objections by animal rights enthusiasts, those with a strong financial interest, and invasion denials (Russell and Blackburn 2017) are effectively addressed. However, different stakeholders hold diverse views and beliefs on a range of issues. For example, residents of Little Cayman supported efforts to control Common Green Iguanas but objected to killing feral cats that threaten native species (Knapp et al. 2020). To effectively protect unique native iguanas, a range of approaches is required.

One of the main groups working to further iguana conservation is the International Union for Conservation of Nature Species Survival Commission Iguana Specialist Group (IUCN SSC ISG). The ISG is an international cadre of conservation practitioners, academics, zoo professionals, and others focused on guiding and globally implementing conservation measures for native iguanas. Members of the ISG assess iguana species for inclusion in the IUCN Red List of Threatened Species™, develop conservation action plans for species of concern, provide guidance for iguana conservation, implement outreach programs, and conduct research on iguanas across the globe. Each year members meet, usually in a country with native iguanas. These annual meetings allow attendees to understand the opportunities and challenges facing other iguana conservationists, learn about novel conservation techniques, forge collaborative partnerships, and draft policy statements and conservation action plans. COVID-19 prevented the ISG from meeting in person in 2020 so the meeting was virtual for the first time, allowing for greater attendance from a wider audience.

Presentations at the 2020 ISG meeting underscored the devastating impacts of invasive species on native iguanas,

nearly all of which are threatened by invasive species. Cats (*Felis catus*) and rats (*Rattus* spp.) are the most common culprits, as is the Small Indian Mongoose (*Urva auro-punctata*; Fig. 5), but the meeting also highlighted the effect that Common Green Iguanas have on native iguanas when they invade. For example, non-native populations are now the greatest existential threat to the Lesser Antillean Iguana (*Iguana delicatissima*), which they displace by hybridization (Vuillaume et al. 2015; Knapp et al. 2020; Fig. 6).

A special session was reserved to discuss the threats to the Lesser Antillean Iguana and opportunities for collaborative conservation planning, including biosecurity, regulation, and mitigation strategies. In general, regional conservation planning can be challenging, and this species inhabits islands representing several jurisdictions and languages. In 2009, the ISG facilitated development of the first conservation plan for the Lesser Antillean Iguana (Knapp et al. 2014), but the meeting was only able to bring together some of the range countries at the time. The 2020 ISG meeting provided a platform for representatives from across the region to participate and allowed the process of developing a comprehensive revision of the Lesser Antillean Iguana conservation plan to include all range countries. Several stakeholder regions have started the process by vetting older, more geographically limited plans to collate overlapping threats, identify gaps and needed action items, and assign people to spearhead the work. The collaborative, regional approach will provide a better chance to combat the ever-growing threats from invasive Common Green Iguanas and save the Lesser Antillean Iguana from extinction.

In order to effectively combat the crisis of invasive species, we need more collaborative, coordinated, and strategic efforts to communicate with those who can push regional and broad conservation agendas forward on all levels, from public awareness to political action. We need to better engage with decision makers, stakeholders, media, and the public, as is increasingly happening around other important issues such



Fig. 6. Hybridization of Common Green Iguanas (*Iguana iguana*) with highly endangered Caribbean rock iguanas increases their risk of extinction. Shown here are a hatchling Common Green Iguana (*Iguana iguana*, left), a Sister Isles Rock Iguana (*Cyclura caymanensis*, right), and a hybrid, which displays an intermediate overall coloration. Character differences include (top): (1) enlarged nasal scales that are in contact for pure *C. caymanensis* and separate and small in *I. iguana* and hybrids; (2) a prominent midline frontal scale for pure *C. caymanensis* and intermediate in *I. iguana* and hybrids. Bottom: (3) complete yellowish dorsolateral stripes on hybrids versus black stripes with yellow spots on pure *C. caymanensis*. Montage by Tandra Grant of photographs by Jeanette Moss, Jane Haakonsson, and Tanja Laaser.

as climate change (Gardner et al. 2020). Increasing and maintaining public trust (Wald et al. 2019; Warner and Kinslow 2013), while sharing information, educating, and learning from local communities is crucial to successful long-term action and change. Many ISG projects heavily involve and actively engage the general public through formal and informal settings that teach by appealing to both emotions and facts (Besley et al. 2018), ultimately bringing communities together to see conservation actions realized. As recent events surrounding COVID-19 and vaccination illustrate, we need to remember that merely providing information will often be insufficient to sway opinions.

We would be remiss not to include the impacts of other invasive species, such as cats and rats, on native iguanas. More needs to be done on a broader scale to effectively reduce the impacts of all invasive species, including iguanas, transported (wittingly or not) by humans. Just as it is critical for us to share the plight of native species and the work to save them, we must communicate the message of the massive destruction that can result from invasions, even by species that may need protection in their native range. Often, the problem begins with the pet trade's "supply and demand" approach or other

careless economic activity (Perry and Farmer 2011). Ideally, stakeholders from around the world can agree on the need to use commonsense precautions such as pre-invasion screening and preventative activities such as locally-driven rapid responses when new invasions are identified. Unfortunately, the willful myopia of policymakers (Perry et al. 2020c), more concerned with markets than with the wellbeing of people and the environment, stands in the way.

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