Cyclura collei Gray 1845
Jamaican Rock Iguana

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Status:
IUCN Critically Endangered B1ab(iii)+2ab(iii) (assessed 2010). CITES Appendix I.

Although suitable vegetation still exists, extensive recent surveying has not located iguanas far from the central core protected zone (<10 km^2). Habitat in the Hellshire Hills continues to be degraded by human encroachment from the periphery. The Jamaican Iguana is therefore listed as Critically Endangered, given its small population size (~200 adults), extremely small range in a single location, and where there is a continuing decline in habitat.

Taxonomy:
First described as C*yclura Collei* by Gray in 1845 with a type locality of "Jamaica". The holotype record is: BMNH 1936.12.3.108.

The Jamaican Iguana is one of ten living species of rock iguanas (*Cyclura*) occurring in the Greater Antilles of the Caribbean. This species is sister to the clade comprising *Cyclura cychlura*, *Cyclura nubila*, *Cyclura lewisi*, and *Cyclura rileyi* (Malone *et al.* 2000).

Description:
The Jamaican Iguana is a moderate-sized rock iguana, with a snout-to-vent length reaching 500 mm in males and 410 mm in females. Overall body color is greenish to bluish grey. Schwartz and Henderson (1991) describe oblique lines of dark olive-green on the shoulder, three broad triangular patches extending from dorsal crest scales to venter, with dark olive-brown zigzag spots. The dorsal crest scales are somewhat brighter bluish-green than the body. The top of the head is washed green and the dorsal and lateral body surfaces are blotched with straw, with the blotches breaking up into small groups of spots. Juveniles are generally lighter overall, with more pronounced striping. Wild individuals, particularly nesting females, often appear deep reddish-brown in color after digging in the coarse ferralic soils of the Hellshire Hills region.

Distribution:
According to Sloane (1725), who visited the island in 1688, iguanas were once common in Jamaica although their distribution seems to have been restricted to the drier sections of the south coast. The Jamaican Iguana declined dramatically during the second half of the 19th century, probably due to the introduction of the Indian Mongoose (*Herpestes javanicus* [=*auropunctatus*]) in 1872, changing land use patterns, and human population growth. Thought to be extinct since the 1940s, a

report of a living iguana was documented in the 1970s and then confirmed in 1990 from the Hellshire Hills, a rugged limestone area totaling 114 km^2. However, extensive surveying has shown that iguanas are only found near the central core area (< 10 km^2) where intense conservation efforts are now focused, including protection from the mongoose in a small area containing the primary communal nesting sites (~ 3km^2). Despite the proximity to Jamaica's densely populated capital Kingston, the Hellshire Hills has persisted as a wilderness area because of its ruggedness and lack of surface water, making the area unsuitable for agriculture and large-scale settlement. The species was recorded to occur from sea level up to 200 meters.

Habitat and Ecology:
Rugged limestone outcroppings comprise much of the Hellshire Hills, with coarse red ferralic soil accumulating in crevices and depressions. Soil suitable for nesting is comparatively scarce. The vegetation of the Hellshire Hills consists of tropical dry forest, one of the world's most threatened ecosystems. The area supports about 300 species of higher plants, including 53 endemics. Jamaican Iguanas are found only in the remotest sections of the Hellshire Hills where the forest remains in good condition. The Jamaican Iguana feeds on leaves, fruits, and flowers of a wide variety of plant species, supplemented occasionally by animal matter, including snails and insects. Diet composition changes seasonally according to the flowering and fruiting cycles of local plant species.

Since 1991 the known communal nest sites have been observed intensively (Vogel 1994, Wilson *et al.* 2004) and individuals have been marked. Nesting occurs in underground burrows that are filled with loose soil, and gravid iguanas often begin digging trial holes long before egg laying. Females deposit their eggs from late May to June, and hatchlings emerge after approximately 85-87 days of incubation. Following oviposition, females guard their nests from other laying females for several days up to two weeks, including aggressive interactions such as threat displays, biting, and chasing. Clutch sizes range from 6-20 eggs depending on the size and age of the female (R. van Veen and B. Wilson pers. comm.). Hatching success varies from 0 to 100%, and appears to be related to maternal body size and seasonal rainfall extremes.

The northeastern portion of the Hellshire Hills has been totally degraded, and much of the land in this section is now virtually barren. Along the north-central border, charcoal burners have moved 2-3 km into the forest and are approaching the two major iguana nesting sites. Along the south coast, charcoal burners have cut some of the coastal forest, although they have not yet expanded their activities far northwards into the limestone karstland. The central and most of the western sections of the Hellshire Hills are still covered with little-disturbed, primary tropical dry forest (McLaren *et al.* 2011). However, even in intact forest, iguanas are vulnerable to pressure from invasive alien predators, particularly dogs, cats, and mongooses.

The most promising site for establishing a new subpopulation in the wild appears to be Great Goat Island, where a population of iguanas had survived until at least the late 1940s. However, the numerous goats on the island would have to be removed and the ground vegetation given an opportunity to recover before iguanas could be reintroduced. At the same time, the island must be rendered mongoose- and cat-free. Removing the goats will involve negotiations with the goat owners who live in a nearby fishing village. Other potential release sites include Little Goat Island and the Portland Ridge area, which retains the island's only other tracts of relatively undisturbed dry forest aside from the Hellshire Hills.

Threats:
One of the most significant pressures on the remaining population in areas of intact forest are invasive alien predators, including mongooses, cats, stray dogs, and feral pigs. Mongooses are common throughout the Hellshire Hills and have been observed depredating 100% of the iguana nests monitored by camera traps that were located outside the conservation zone receiving removal-trapping effort. Radio-tracking results have also demonstrated that mongooses prey heavily on hatchlings and on juveniles up to 900 grams. Cats occur throughout the area, including nesting areas, and are also known predators of hatchling and juvenile iguanas. The dogs used to hunt feral pigs are of particular concern, as they are able to kill adult iguanas (Woodley 1980). Although feral pigs have not been observed disturbing iguana nests in the Hellshire Hills, evidence from Mona Island suggests that they are potentially important egg predators (Wiewandt 1977).

The overriding threat to the iguana's persistence in Hellshire is the continued destruction of their remaining habitat. Roughly one-half of the Hellshire Hills has been badly degraded from uncontrolled illegal tree cutting, primarily to support the charcoal industry. Previously a local industry to supply local demand, a recent (2012) development to create an export market for tree-based charcoal in Jamaica poses a further threat to the forest. Tropical dry forest, particularly over a limestone base, cannot regenerate from the level of deforestation associated with charcoal burning. Once damaged, the forest is unable to regenerate to a natural state, and is essentially lost as habitat for dry forest-dependent species. Continued destruction of the forest threatens both the persistence of the iguana and the on-going conservation efforts in the area. Development proposals for large-scale limestone mining, human settlements, and tourism also threaten much of the northern and eastern portions of the Hellshire Hills. Although a few localized limestone quarries might have only limited impact on the iguanas and their habitat, the new roads that would be constructed to facilitate the mining process would undoubtedly allow charcoal burners, pig hunters, and other forest users to migrate further into the forest.

Conservation Measures:
Although most of Jamaica's remaining ecologically important forests, including the Hellshire Hills, are owned by the government and protected by law under the Forest Act of 1996, the Act has received little enforcement. Burning of wood to produce

charcoal, slash and burn agriculture, and other destructive uses of the forest still progress. The Hellshire Hills is currently part of the Portland Bight Protected Area (PBPA). Declared in 1999, the PBPA is Jamaica's largest protected area and includes both of the Goat Islands. Designation as a protected area provides a promising legal instrument to prevent the expansion of large-scale development projects in the Hellshire Hills.

Following the rediscovery of the species in 1990, a local Jamaican Iguana Research and Conservation Group (JIRCG) was formed, comprising representatives from the University of the West Indies, the Natural Resources Conservation Authority, Hope Zoological Gardens, and the Institute of Jamaica. Together with a group of international iguana specialists, the JIRCG held an IUCN-sponsored workshop in Kingston in 1993, which developed a Population and Habitat Viability Assessment and a comprehensive plan for recovering this species in the wild (CBSG 1993). The goals of the workshop were to use computer-modeling techniques to systematically evaluate threats to the iguana population and determine how those threats might be mitigated through management activities, as well as heighten awareness about the importance of conserving the biodiversity of the Hellshire Hills. During the workshop, it became clear that the current mortality level of juvenile iguanas in the wild was too high to permit survival of the population. This led to recommendations for a captive headstarting program at the Hope Zoo, in which a portion of the young from wild nests were collected and raised in captivity until they attained large enough body size to avoid mongoose predation. Headstarting has resulted in the release of 175 iguanas back into the Hellshire Hills from 1996 through 2012.

The JIRCG is now known as the Jamaican Iguana Recovery Group (JIRG) and includes international collaborators. In addition to captive headstarting and release, the group continues to survey the wider Hellshire Hills, monitors individuals in the core area centered around the known nesting sites, and is detailing a complete natural history of the species (Wilson *et al.* 2004; Wilson and van Veen 2005, 2008). Repatriated animals have demonstrated high survivorship and are now integrated into the breeding population. Complementary predator control in the core area has resulted in improved recruitment attributable to enhanced survival among younger age classes. The group also focuses on education, international awareness, and habitat protection and improvement.

In 1994, an *ex situ* captive population was initiated with the importation of 12 iguanas to three U.S. institutions (Indianapolis Zoo, Fort Worth Zoo, and Gladys Porter Zoo). In 1996, this group was supplemented by a second importation of 12 iguanas to the San Diego Zoo, Central Florida Zoo, and Sedgwick County Zoo. After successful breeding in the U.S., the program has expanded to the Fresno, Miami, and St. Louis zoos. The primary purpose of the U.S. captive population is to promote education and awareness, and to provide support for the ongoing recovery effort of the wild population. Additionally, the captive colony is managed for long-term

maintenance of genetic diversity in the event of catastrophic loss in the wild population (Grant 2010).

As a further safeguard against extinction, captive-reared juvenile iguanas may also be used to establish satellite populations on the Goat Islands, provided the islands can be rendered free of non-native predators and goats. A priority goal, highlighted in the 2006 Jamaican Iguana Species Recovery Plan, outlines the establishment of a dry forest biodiversity reserve on these offshore islets - arguably the single most critical conservation activity that could ensure the long-term persistence of the Jamaican Iguana.

The Jamaican Iguana is listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); however, humans have probably not exploited the Jamaican Iguana since well before the late 1800s.

Current Research and Needs:
Current research conducted by the laboratory of Dr. Byron Wilson (University of West Indies) in the Hellshire Hills includes: nesting ecology, population size and dynamics, distribution, life history, and ecology. Survival of juvenile iguanas is dependent on a large network of mongoose traps that is operated daily by the field team. Overall terrestrial biodiversity is also assessed in the area using pitfall traps, and Dr. Kurt McLaren's laboratory (UWI) conducts research on the ecology and regeneration dynamics of the Hellshire forest. Continuing research is needed to monitor the iguana population, sustain *in situ* management strategies (especially invasive alien predator control), and monitor habitat trends. Additional work will be needed when iguanas are reintroduced to the Goat Islands (government support is pending).

The laboratory of Dr. Mark Welch, Mississippi State University, is determining genetic structure and variability within the iguana population since headstart repatriations began. The goals of this research are to determine how much variation has been maintained from the original remnant population, how it might fluctuate in the near future, and to devise a strategy for future monitoring or management efforts. Additionally, genetic data will be used to select individuals representing the greatest genetic diversity possible for future translocations and to guide future meta-population management within Hellshire, the Goat Islands, and the captive populations.

Although the Jamaican Iguana Recovery Group developed a Species Recovery Plan, implementation of many of the critical action items is sorely needed, particularly for enforcement preventing illegal forest uses. The Top Six Priorities outlined in the SRP are:

Priority 1 - Protect recovering iguana population in the Hellshire Hills.
Priority 2 - Establish healthy iguana population on the Goat Islands.
Priority 3 - Management plans and agreements with all parties to be put in place and acted upon.

Priority 4 - Continue the headstart program at Hope Zoo.
Priority 5 - Communicate key elements of the plan to the Prime Minister.
Priority 6 - Prepare for Byron Wilson's departure from leading the JIRG by January 2014.

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Left: Female *Cyclura collei*. Photo by Rick van Veen. Right: Repatriated headstarted Cyclura collei. Photo by Tandora Grant.

Left: Jamaican Iguana at Hellshire's South Camp. Photo by Rick van Veen. Right: Female Cyclura collei at nesting site. Photo by Glenn Gerber.