GOVERNMENT OF PUERTO RICO

Comprehensive Action Plan to Control the Green Iguana's population

A Systematic Approach to Reduce the Impacts of the Ongoing Invasion of the Green Iguana in Puerto Rico

Department of Natural and Environmental Resources

Department of Agriculture

Department of Health

Department of Economic Development and Commerce

The Interagency Committee for the Population Control of the Green Iguana

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Prepared by: THE INTERAGENCY COMMITTEE FOR THE POPULATION CONTROL OF THE GREEN IGUANA

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In compliance with: MOU 2012-000111 (Registration No. 28-2-12)

For (Cooperators):
Secretary of the PR Department of Natural and Environmental Resources (DNER),
Secretary of the PR Department of Agriculture (DA),
Secretary of the PR Department of Health (DH), and
Secretary of the PR Department of Economic Development and Commerce (DEDC)

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1. JUSTIFICATION

1.1. Background summary and current situation

The green iguana or common iguana (gallina de palo, *Iguana iguana*, hereinafter iguana) is an arboreal herbivorous (plant-eating) lizard that can grow up to 6 ft. in length, from head to tail tip, and may reach a body weight of 20 pounds. It is native to Central and South America, and considered an invasive species in the United States (Florida, Hawaii, Texas, Virgin Islands, and Puerto Rico). Most likely, beginning in the 1970s, this species was introduced on multiple occasions to the wild and became an island-wide pest (in detriment to the quality of life of many residents in Puerto Rico). The exact year for its effective establishment in mainland as a growing population in the wildlife of Puerto Rico is unknown, but probably occurred during the 1990s. Since then, the population of iguanas has increased exponentially. In a conservative projection, for this plan, Dr. López-Ortiz estimated a wild population of approximately one million iguanas in 2010 and over four million in 2012. In many ways, the invasion of the iguana is an unprecedented situation in Puerto Rico, exceeding the scale of possible damages of previous invasions, such as the cane toad (common toad, *Bufo marinus*), and recent invasions, such as the lionfish (lionfish, *Pterois*).

A basking male of *I. iguana*, age ~ 7 years, weight ~20 pounds, total length ~6 ft (1.3m).

Due to the effects of the overpopulation and habits of this iguana, DNER Secretary requested the preparation of a comprehensive plan to establish a systematic approach to reduce the impacts of the current invasion of the Iguana in Puerto Rico.

The purpose of the plan is to provide specialized technical support to the Secretaries of DA, DH, DEDC and DNER. Those Secretaries are cooperators concerned with the following situations:

1. Natural Resources:

    a. Damage to vegetation - In the reproductive season, this iguana may damage plant root systems during digging activities for nesting. Extensive herbivory may cause physical damage to the vegetation and promote plant diseases, especially in wetland habitat systems. Damage to branches due to excessive weight applied by large iguanas will occur. The iguanas' consumption of flowers directly decreases fruit and seed production, thus inhibiting natural processes of plant recruitment and potentially altering the structure of entire ecosystems.

    b. Damage to fauna – High rates of herbivory on foliage, fruits and flowers is likely to cause indirect damage to native wildlife, especially to frugivores and nectarivorous animals (e.g. bats and hummingbirds). On the other hand, predation by iguanas, on eggs of birds and small animals is rare, but could increase as their population grows. In relation to competition for nesting sites, this iguana can damage nests of native turtles (*Trachemys stejnegeri stejnegeri*) and sea turtles (e.g. *Eretmochelys imbricata*). Due to the high volume of eggs laid by iguanas (about 50 eggs annually per mature female), an increase in the population of potential predators of eggs and hatchlings should be expected. In particular, a population increase of opportunistic exotic predators should be of concern.

Size and number of eggs found in a single clutch of a young *I. iguana* near the outlet of the Guanajibo River, Cabo Rojo, PR.

2. Public Health - Iguanas can bite, injure and puncture the epidermis, dermis and muscle tissue of humans, especially during handling, or if the iguana is defending itself from a threat. They may also provoke a psychological challenge when confronted (Herpetophobia). Hygiene concerns are already ongoing due to: the diving of iguanas into swimming pools and water cisterns, iguana roadkills, and consumption of undercooked or contaminated iguana meat (e.g. Salmonellosis and other zoonotic diseases carried by reptiles). Iguana eggs and hatchlings may also supplement the diet of carnivores terrestrial mammals (e.g. *Herpestes javanicus auropunctatus*, small Indian mongoose, mangosta), some of which are known to be vectors of rabies and other zoonotic diseases.


More and more iguanas are run over on roads and bridges, especially near water sources (e.g. rivers and lagoons).

3. Agriculture - As mentioned under Natural Resources, crop damage is expected due to the herbivory of the iguana, above all: to flowers, seedlings and fruits. Similarly, damage to root systems, is expected from excavations, mostly during the nesting season. As mentioned under Public Health, an increase in the population of rabies vectors can have a negative effect on domestic mammals.


A breeding female of *I. iguana*, age ~2 years, weight ~3 pounds, total lenth ~3 ft (1m), laid 33 eggs near the outlet of the Guanajibo river, Cabo Rojo, PR.

4. Infrastructure - Iguanas seek heat sources to maintain optimal metabolism, especially in the morning and during digestion. They frequently use manmade structures, such as roads and airports, electrical poles to serve as these heat sources. This contact leads to accidents, including collision and power outages. Separately, iguanas weaken structures, such as those used for flood control, when digging their caves for nesting.

Females of *I. iguana* nest every year in a net of small caves dug into loose soil at a small mound in Cabo Rojo, PR.

5. Domestic - Iguanas adversely affect the landscape, gardens, pools and ponds. This species has devoured expensive horticultural projects and fouled water intended for recreational purposes.

6. Economy - All the damages mentioned before have an economic impact. During the creation of this document, there was no estimation of the projected cost of the damages caused by the invasion of iguanas in PR. However, some farmers reported to have lost several tons of pumpkins (*Cucurbita* spp.), because iguanas ate the flowers and buds. Annually, in Las Cabezas de San Juan Nature Reserve, the Puerto Rico Conservation Trust spends about $10,000 to mitigate the damage caused by the iguanas on the roads and plant nursery. In the Luis Muñoz Marín international Airport, these iguanas are considered an air-strike risk on runways, causing the suspension of flights six times in a one two-month study. Over $80,000 are annually invested to avoid delays and accidents caused by iguanas in the runway of this airport.

A female *I. iguana* dug a nest in the surroundings of Rio Blanco Reservoir in Naguabo, PR.

1.2. Authorized course of action

The Constitution of the Commonwealth of Puerto Rico, Art. VI, § 19 establish, inter alia, that: "it will be public policy of the Commonwealth, the most effective conservation of its natural resources, as well as further development and use of them for the general benefit of the community".

The Organic Law of the DNER, Act No. 23 of June 20, 1972, (3 L.P.R.A. 156), as amended, provides that this agency will be the entity responsible for implementing, in relation to the operational phase, the public policy of the Commonwealth of Puerto Rico contained in Article VI, Section 19 of the Constitution.

The Organic Law of the DNER, Act No. 23, supra, proclaims as a ministerial duty of the Secretary of DNER, to advise and make recommendations to the Governor, the Legislature and other government agencies in relation to public policy on natural resources.

Environmental Public Policy Act No. 416 of September 22, 2004,(12 L.P.R.A § 8001 *et seq.*), as amended, has among its objectives to ensure all Puerto Rican landscapes safe, healthy, productive and aesthetically and culturally pleasing and preserve important historical, cultural and natural heritage.

The Law of Public Policy on Wetlands in Puerto Rico, Act. No. 314 of December 24, 1998, (12 L.P.R.A. sec. 5001 *et seq.*) as amended, declares the public policy of the Commonwealth of Puerto Rico, the protection of wetlands, including marshes and swamps by promoting its preservation, restoration conservation and management.

The New Wildlife Law, Act. No. 241 of August 15, 1999, (12 L.P.R.A. sec. 107 *et seq.*) as amended, establishes as public policy the protection of wildlife and, in particular, the habitat of these species.

Executive Order No. 13112 directs federal agencies whose actions may affect the status of invasive species to reduce invasion of those species and the associated damages to the extent practicable and permitted by law. The DNER and DA have regulatory authority over wildlife species in Puerto Rico and regulate activities related to wildlife damage management within the Commonwealth under that authority.

Therefore, DNER Secretary, Mr. Daniel J. Galán-Kercadó, by virtue of the above laws requested the collaboration of the DA, DH and DEDC Secretaries as Cooperators in the establishment of an interagency committee of experts in different areas related to the subject. Due to the urgency of this situation, the Cooperators rapidly established an ad hoc interagency committee for the population control of the green iguana.

The committee members consisted of specialists in wildlife, agriculture (plant and animal health), public health, food processes and strategic marketing. They began their meetings in May 19, 2011 and during the subsequent near monthly meetings, they simultaneously analyzed the possible solutions and prepared a memorandum of understanding (MOU) which purpose was to formalize the Cooperators commitment and the committee goals and effort. Meetings and/or communications with other related agencies as the U.S. Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA) were attained and an MOU was delivered to the DNER Secretary Office on November 23, 2011.

1.3. MOU outcome summary

In MOU 2012-000111 (Registration No. 28-2-12), the Cooperators authenticated the recognition and acceptance of the following:

1. Overpopulation of iguanas is a serious hazard to wildlife, agriculture, public health and local economy.

2. Only an aggressive and comprehensive plan will provide the scale of eradication needed to reduce the current rapid invasion of iguanas in Puerto Rico, especially in sensitive areas.

3. Encouraging a safe exploitation of products derived from iguanas removed from the wildlife of Puerto Rico has the potential to benefit the local economy and public health. In the long term, this is almost certainly the only activity that could control the population growth and may reduce local invasion of this species.

4. The creation and support of a Management Committee is fundamental to prepare a comprehensive plan to control and, if possible, reduce the population growth rate of the iguanas that invade Puerto Rico. It was established that the purpose of the meetings of the Committee would be the development of such a plan, considering different methods of management, relevant scientific research, local culture, wildlife, agriculture, public health and the economy.

1.4. Research findings

1. The following is a summary of the relevant and available biological facts of captive and wild iguanas mostly from Costa Rica, Panama and Puerto Rico:

   a. Reproductive biology and growth:

      i. Sexes and sizes

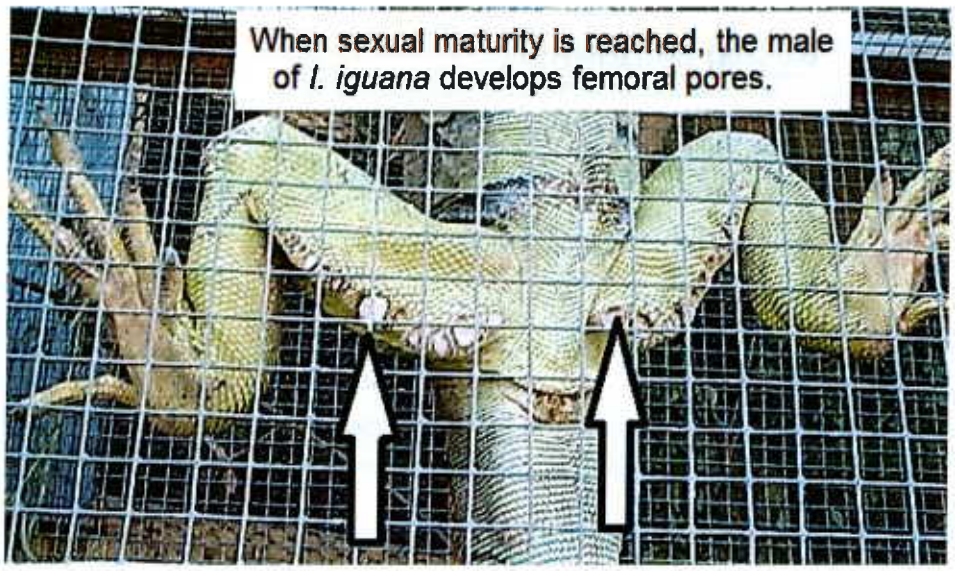
         1. Normal sizes and weights ranges between six inches or 0.2 pounds to 72 inches or 20 lb depending on age and diet. The iguana tail is about 2.5-3 times the snout-vent length.

         2. Hatching size is about 15 to 23 cm (6 to 9 inches) in total length.

Age (years)	Hatchling	1	2	3	4	5	6	7	Adult relative size
Aprox. total length (inches)	6-9	20-27	28-36	30-42	35-48	45-60	50-66	50-72	
Aprox. weight (pounds)	~0.2	1-1.5	2-4	4-6	5-8	10-15	14-18	15-20	

         3. Females attain sexual maturity at age of 2.5 to 5 years and males at age of 3 to 5 years.

         4. Visually, the iguana sex can be determined in specimens over one year old, the age at which the femoral pores begin to expand in males. The male has a larger dewlap and is bigger than the female. The male may develop a dorsal crest as high as three inches (8 cm). Another characteristic of the male is a broader jowl and a soft bulge in the base of the tail on the ventral (bottom) surface. The bi-lobed reproductive organs called hemipenes shape the bulge that begins to develop around age 16-18 months. They are located in the tail, just south of the vent, and turned inside out during copulation and sometimes during defecation and dominance displays. During copulation, only one lobe is used at a time.



ii. Breeding

1. Iguanas breed annually in the dry season (December to June).
2. Males perform reproductive displays between December and March.
3. Courtship and mating occur between January and February.
4. Females aggregate in the mating territories of the largest males and preferentially mate with them.
5. Females can save viable sperm for up to 5 years, allowing them to fertilize eggs later without the new involvement of a male.
6. The gestation period is 59 to 84 days, averaging 65 days.
7. Nesting occurs between February and April.
8. Nest average 35 cm in depth.
9. False and real burrow nests, can reach up to 25 m of tunnels in a few generations.
10. Egg lying occurs between March and May.
11. Females use straight terrestrial paths to move from their home site to the nest. After seven days spent at the nest site, nearly the identical path is used to travel back to the home site. Females

may migrate as far as 1.8 miles (3 km) to find a suitable nesting site.

12. Iguanas lay 3 to 75 eggs, averaging 24 eggs/year.
13. Egg viability is high (~87%).
14. The incubation period occurs between March and June.
15. The hatchlings emerge from the nest between May and June, after 8 to 15 weeks of incubation, coincident with the new leaf growth of the year.
16. Sex ratio of hatchlings is usually close to 1:1.
17. In Panama, hatching success average 27% but the number of offspring could be as high as 65 per nest, averaging 20, but only 3 to 10 hatchlings (~46%) survive to maturity.
18. Longest known lifespan in captivity is about 20 years.
19. Average lifespan in captivity is about ten years.
20. Average lifespan in the wild in Panama is about 8 years.

b. Ecology and Diet:

i. Habitat

1. Green iguanas are generally found in lower altitudes in areas near water sources. These iguanas are excellent swimmers and can dive from trees and hold their breath underwater for up to 40 minutes. Iguanas spend most of their time well camouflaged in the forest canopy, about 12 to 15 meters above the ground (40 to 50 ft.).
2. Prefer about 75% humidity and temperatures between 85-90°F, will bask at 100°F, and the nighttime preferred temperature is about 77°F. The iguanas invading the state of Florida fall into a deep sleep when the temperature drops to 40 °F. Their bodies turn gray, and they lose their grip.
3. Need a full-spectrum light.

ii. Diet

1. Free-ranging iguanas tend to select plants that contain not only high protein but also relatively high fiber, although very high fiber diets may suppress growth of juvenile iguanas.

2. Diet in captivity is recommended to be 80% calcium rich vegetables and 20% fruit and flowers.

iii. Population

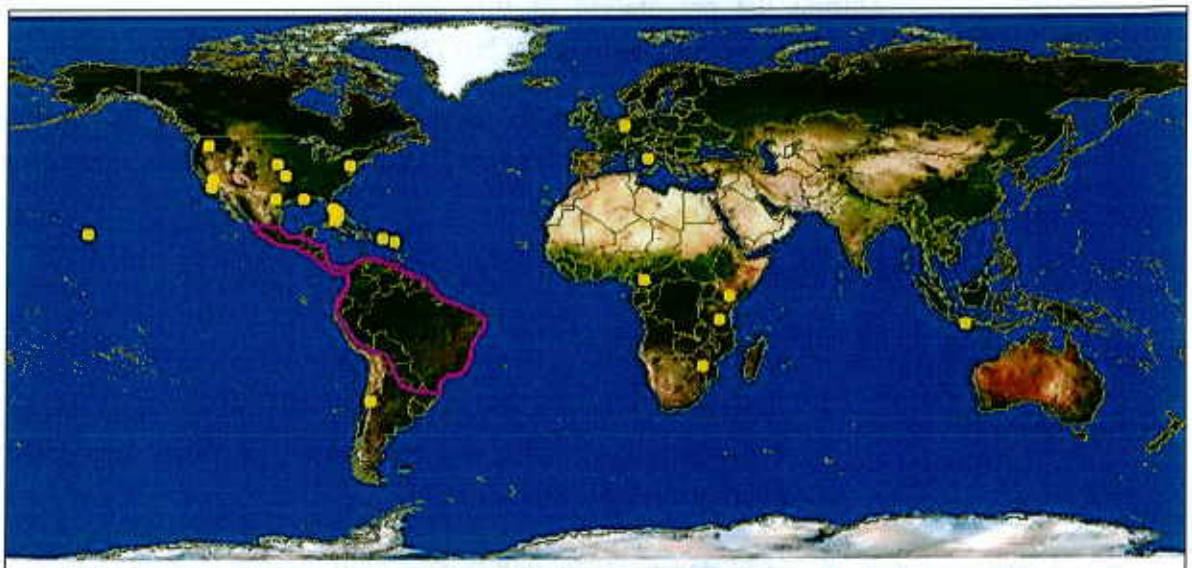
1. Green iguanas are native to Central and South America. Their range stretches from southern Brazil, Paraguay and Bolivia to southern Mexico and the Caribbean Islands (Grenada, Curacao, Trinidad and Tobago, Saint Lucia, and Saint Vincent).

2. The density of iguanas in a wildlife refuge in Costa Rica, where they are considered endangered, is estimated at 0.1 to 0.4 individuals per hectare. In this site, a minimum population density of 1.52 individuals was estimated as necessary for their long-term persistence.

3. The density of iguanas in Colombia, where the species was overexploited as a food source, was estimated to be 13.7 individuals per hectare. In Panama, where it was protected, density was estimated to be 36–50 adults per hectare.

4. In Puerto Rico, the density of adult iguanas in Parque Lineal and Canal Blasina was estimated to be 119 and 223 individuals per hectare, respectively.

5. Additional introduced populations exist in the U.S. (California, southern Florida, Hawaii, the Rio Grande Valley in Texas, Puerto Rico, and the Virgin Islands), in the Caribbean (Anguilla, Grand Cayman, Guadeloupe, Martinique, the Netherlands Antilles, St. Martin, and Turks and Caicos), in Israel, and in Fiji (islands of Laucala, Matagi, Qamea and Taveuni).



2012 Global distribution of the *I. iguana*. Native range is delineated in purple. Yellow dots represent introduction sites reported to the Global Biodiversity Information Facility database (Adapted from GBIFD).

6. In Florida and Texas, the invasion of green iguanas to the north is limited by the cold weather. The impacts of iguanas in Hawaii and elsewhere are poorly described. In Guadeloupe, green iguanas have almost, if not totally, replaced the native *Iguana delicatissima* through interbreeding and competition for food and nesting sites. In Fiji, scientists are concerned because the green iguana may compete with two native iguana species and may infect them with a fungus.

c. Survival and mortality in Puerto Rico:

i. Over 41 predator species can be found in its native range, but there are no significant predators of adult iguanas in PR. There are few predators of iguana eggs in PR. However, predators are expected to increase in numbers, especially exotic opportunist species. Some predators of eggs and juvenile iguanas could be land crabs, snakes, hawks, herons, egrets, rats, mongooses, and stray cats and dogs. Caimans (*Caiman crocodilus*) and common boas (*Boa constrictor*) could most likely depredate adult iguanas and juveniles. Both are established exotic species. Dr. Puente-Rolón reported to the committee, observations of the Virgin Islands Tree Boa (*Epicrates monensis granti*) preying iguanas at Cayo Ratones. Similarly, Wildlife Biologist Miguel Canals reported the Puerto Rican racer (*Alsophis portoricensis*) preying iguanas at Guánica State Forest.

During the preparation of this document, there was no evidence of predation by the Puerto Rican boa (*Epicrates inornatus*).

ii. On the roads, is common to see adult iguanas accidentally run over by motor vehicles. In fact, this species is among the most common roadkill in Puerto Rico.

d. Potential effects on the wildlife of Puerto Rico:

i. By consuming flowers:

1. Iguanas may have a negative effect on fruit and seed production, consequently affecting the recruitment of flora, and potentially altering an entire landscape.

2. Iguanas can create a drastic drop in the available nectar for native nectivores such as hummingbirds, warblers, bats and arthropods.

ii. By consuming fruits, iguanas may have a negative effect on the available supply of fruits and/or seeds for native fauna. In fact, Dr. Puente-Rolón reported to the committee dispersion of exotic seeds by iguanas in the municipality of Humacao.

iii. By consuming leaves, iguanas may have a negative effect on the flora by affecting plant respiration, transpiration, photosynthesis, and response to disease.

iv. By digging their dens, iguanas may interfere with nesting activities of the native turtle (*T. s. stejnegeri*) and sea turtles.

v. By laying eggs in their dens, iguanas provide protein to other pests (e.g. mongooses and rodents).

vi. By climbing trees and shrubs, iguanas will damage vegetative tissue, and they may cause nest failures for native birds.

e. Potential effects on manmade structures:

i. By digging dens, iguanas may break down pavement.

ii. By seeking heat, iguanas may cause electrical and mechanical failures.

iii. By crossing roads and airport landing fields, iguanas may create moving vehicle accidents and hygiene issues.

f. Potential effects on agriculture:

   i. By digging dens, they may cause damage to vegetable roots.

   ii. By consuming flowers and fruits, iguanas may reduce fruit production.

   iii. By consuming seedlings, iguanas may destroy entire crops.

g. Potential effects on public health:

   i. They have sharp teeth capable of shredding human skin.

   ii. Their tail can deliver a painful blow.

   iii. They may trigger an anxiety attack known as Herpetophobia.

   iv. Like most reptiles, iguanas can carry *salmonella*.

      1. The fecal matter of many reptiles can carry large amounts of *Salmonella* bacteria.

      2. As reptiles drag their bodies during locomotion, *Salmonella* bacteria can easily be spread from the guts, by defecation, to the hind legs and/or tail.

h. History and Population Growth:

   i. Green iguanas are the second most traded vertebrate species in world commerce. According to the World Conservation Monitoring Center, 800,000 iguanas were imported into the U.S. in 1995 alone, primarily originating from captive farming operations based in their native countries (Honduras, El Salvador, Colombia, and Panama).

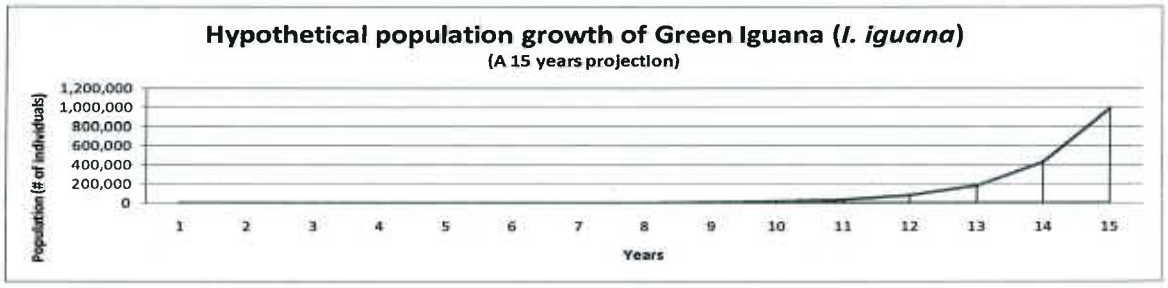
   ii. The top reptiles imported into the U.S. for pet purposes during 1998-2002 were house gecko *(Hemidactylus* spp.), ball python *(Python regius*), red-eared slider *(Trachemys scripta*), water monitor *(Varanus salvator*), and green iguana. All of these species became invasive, locally reaching high population densities.

   iii. In some parts of the U.S. (e.g. New York and Hawaii), iguanas are considered exotic pets, and are prohibited from being owned. Due to the potential impact of an introduced species on Hawaii's ecosystem, the state has strict regulations regarding the import and possession of green

iguanas; violators can spend three years in jail and be fined up to $200,000.

iv. The exact year of the effective establishment of iguanas in Puerto Rico is unknown. Most probably, the introduction was carried out at multiple times and sites during several years. However, by 1994-1995, Dr. López-Ortiz counted over 50 adult individual in Las Cabezas de San Juan while surveying yellow-shouldered blackbirds (*Agelaius xanthomus*) by navigating upstream the main water canal. Similar anecdotic citations reported wild adult iguanas since the 1970s.

v. In a projection, beginning with only one successful nest, the population could be close to 1 million individuals in 15 years. Using data reported in Panama and elsewhere, the projection assumes that 50 eggs per female are laid annually with a hatching success of 27% and a 46% survival rate from hatchlings to maturity; which is attained at two years of age. Also assumes a sex ratio of 50% and an adult lifespan of 8 years. In other words, if 1995 is assumed as the starting year, the population of iguanas could be over four million by 2012.



2. Wildlife scientists, who study alien species, use a statistical parameter known as the "rule of ten": One of ten exotic animals escape to the wild, one of ten of the escapees survives to establish a breeding population, and one of these established species becomes a pest.

3. Because, few individuals of any given species escape and even fewer survive in the wild, the population increases very little at first. However, for those species that manage to escape, survive and thrive, the population gradually increases, and eventually increases exponentially, as the numbers of breeding pairs increases in each generation. For this reason, most people did not even notice that iguanas were already established. Now they are virtually everywhere. Experts in this topic recognize the seriousness of the potential effects of the iguana invasion, but the public, due to unawareness on the topic, underrates those effects.

4. Few scientific studies on green iguanas have been carried out in Puerto Rico (e.g. Díaz-Maldonado 2002, Engeman et al. 2005, Guzmán-Ramírez 2007, Carlo and García-Quijano 2008, Figueiredo-de-Andrade et al. 2011, and López-Torres et al. 2011). These studies provided regional information on population density and distribution; described habits and/or damage caused by iguanas; and suggested the need to study/control the iguana population in Puerto Rico. Also provided some of the facts presented in the background summary.

5. In 2009, wildlife biologist and herpetologist Dr. Puente-Rolón designed for DNER a method to estimate population densities and a procedure to control iguanas through iguana nest destruction and iguana removal from aggregation sites. This valuable methodology will be included in this plan as a way to control iguanas regionally by skilled personnel (e.g. wildlife managers, farmers, anglers and pest control service providers).

6. In order to neutralize the population growth rate of iguanas in Puerto Rico, the committee estimated that approximately 80% of the population must be removed from the wild every year, a difficult goal to be achieved by natural forces alone (e.g. diseases, flooding, fires, storms, predators). These forces might control eggs, hatchlings and juveniles but adults are hard to obliterate, even by the strongest native predators.

7. New techniques for effective population control are still under development, but none of the preliminary results appears to be having the potential to solve the iguana overpopulation (USDA, National Wildlife Research Center).

8. The Government of PR already allows the removal of green iguanas from the wild. Even so, the amount of iguanas removed from the wild is currently insignificant.

9. Feasibility of eradication:

    a. Once an iguana population is established, eradication is predicted to be very difficult. The eradication of small populations on two islands in Fiji is currently underway (the species was first detected in 2000). Up to 2011, the authorities had spent over $250,000. In addition, an unsuccessful eradication effort was reported in the Lesser Antilles (Anguilla) in 1999, where green iguanas posed a threat to the locally native *Iguana delicatissima*.

    b. However, iguanas have several traits that make them particularly susceptible to over-exploitation by humans. For example, they are conspicuous during the mating season and have predictable nesting habits, both factors that make them easy targets for hunters and collectors. In fact, within its natural range, where the iguana is an important source of food, this species has been hunted almost to

extinction. In those places, iguana meat is highly prized, and eggs are considered a delicacy. Then, because the iguanas often nest in groups, their local population has been significantly reduced just by removing the eggs at their nesting sites.

10. The Committee agreed that only a comprehensive plan could provide the basis for:

    a. An aggressive educational campaign to avoid subsequent health issues related to unregulated consumption of iguana-derived products.

    b. The eradication strategies to produce the removal rate needed to reduce the current rapid invasion of iguanas in Puerto Rico, especially in sensitive areas.

11. The Committee also stressed that the drive of the private sector to generate income through the commercialization of products derived from wild-caught iguanas, will be the catalyst to add these products in the popular diet, which ultimately is likely to provide the only safe and healthy way to achieve the eradication rate needed to control the invasion.

12. The increasing demand of products derived from reptiles has resulted in the development of national breeding programs in more than 30 countries in North, Central and South America, Africa, Asia and Australia (e.g. crocodiles, caimans, alligators, turtles and iguanas).

13. Due to its high consumption rate as "aphrodisiac" and nutritional food, and for leather accessories, this iguana is endangered in some of its native habitats; paradoxically, it is considered a pest out of its native range.

14. The consumption of iguana meat and eggs supports an important market in Central and South America. As food, it is gaining popularity in the continental U.S. and is becoming a profitable industry. A pound of cooked iguana meat sells online for $12 to $60. The distributor is paying approximately $6 per pound of iguana. The retail price of a can of iguana meat with a net weight of 10.8 oz. is about $7. Iguana eggs are sold as an "aphrodisiac" food, at more than twice the price of chicken eggs by weight.

15. The USDA Food Safety and Inspection Service do not have jurisdiction in the processes related to reptile meat. Therefore, they do not regulate inspections, tagging procedures or fitness of the reptile's meat for human consumption unless it is voluntarily requested to the Division of Inspection (Dr. Carlos Diaz, DVM, and Front Line Supervisor: carlos.diaz@fsis.usda.gov or Xiomara Vázquez, Front Line Supervisor: xiomara.vaquez@fsis.usda.gov).

16. The iguana meat industry needs to comply with regulatory requirements of the FDA in order to manufacture and distribute iguana products in interstate commerce. FDA

officers are willing to provide guidance to interested entrepreneurs and agencies regarding these regulatory requirements (Lieutenant Commander Frances de Jesus, Supervisory Investigator: Frances.DeJesus@fda.hhs.gov and Rafael Nevárez, Compliance Officer: Rafael.Nevarez@fda.hhs.gov).

17. In the United States, since 1975, it became illegal to sell turtles whose shells measure less than four inches in diameter, according to the CDC. One of the reasons behind this ban was that small children often confuse small turtles with toys, putting them in their mouths, which may promote an outbreak of Salmonellosis. However:

    a. According to the CDC, there is no clear way to determine which reptiles carry *Salmonella* and which do not.

    b. Salmonella is mainly transmitted from eating undercooked foods including chicken, rabbits, and cows.

    c. There is no scientific evidence of Salmonellosis transmitted through well-prepared reptile consumption.

    d. Caimans, crocodiles and other reptiles are sold for food in southern U.S. and elsewhere.

    e. Iguanas are an important human food source throughout its natural range.

    f. There is no CDC publication about banning the consumption of well-prepared reptile meat.

    g. In the state of Florida, Florida Museum of Natural History herpetologist Kenneth Krysko is promoting iguana consumption as a way to control the population growth of iguanas.

18. Although they may appear healthy, most reptiles and birds are carriers of *Salmonella.* Therefore, there is a risk of reptile-associated Salmonellosis in the preparation and consumption of products derived from iguana. Due to the risk of Salmonellosis, the DH does not promote the management of reptiles without proper hygiene practices, especially if the management is to prepare food. If the management of reptiles complies with the good manufacturing practices issued by the DH and the FDA, consumption of products derived from farm-raised reptiles would present a negligible risk to public health. In fact, domestic consumption of iguana food (meat and eggs) is lawful. However, sales of food products derived from iguana are illegal if the DH and the FDA do not approve the process. To carry out an operation of iguana meat production, the processing plant must meet the auditing requirements set by the DH and the FDA.

19. The trade of iguana meat as food is illegally ongoing. The negative effect of this practice is the lack of a way to secure tax revenues. Lieutenant Angel Atienza, DNER Rangers Corps, reported local prices ranging between $6 and $12 per iguana, with no tax collected (aatienza@drna.gobierno.pr).

20. Due to the urgency of managing the iguana overpopulation, the Committee decided that some of the recommendations that will be presented in this plan could be executed simultaneously to the preparation of this document; and so it was done.

21. Before this document was completed, about four companies were coordinating efforts with government agencies to market products derived from wild-caught iguanas.

22. The government's emergency fund was used in 2007 to begin a project to control two invasive species in southwest PR; the rhesus macaque (*Macaca mulatta*) and the patas monkey (*Erythrocebus patas*). That project is now subsidized by state and federal funds, and has been very successful in reducing the population of both species. However, before considering the use of emergency funds to begin controlling the iguana population it is recommended to consider the strategy proposed in this plan.

1.5. PLAN OBJECTIVES

In recognition of the serious threat posed by the invasion of iguanas, the Committee developed a systematic approach to reduce the impacts of their ongoing invasion, through actions targeted to decrease their population growth rate. The objectives are the following:

1. Remove breeders: Adult iguanas defend themselves effectively and have no major predators; therefore, skilled personnel must perform large-scale removal.

2. Reduce recruitment: High volume of iguana eggs must be removed from the wild.

3. Prevent spreading: The invasion of iguanas to sensitive areas must be avoided.

4. Enforce completion: The tasks identified in the plan must be monitored and reviewed periodically, in order to overcome changes in the iguana population.

Emphasis should be given to the following areas:

1. Reduce accidents, stress and disease related to human-iguana interactions.

2. Protect agriculture, endangered species and other wildlife from damages caused by iguanas.

3. Prevent electrical power failures and damages to infrastructures caused by iguanas.

2. WORK PLAN

2.1. Action tasks

In order to achieve the objectives adequately, the Committee discussed various tasks and endeavored to identify all possible scenarios and difficulties. The Committee agreed that the most parsimonious and practical way to accomplish the objectives and cause a significant decline to the growing population trend of iguanas in Puerto Rico is by encouraging the exportation, marketing and local safe consumption of products derived from wild iguana specimens captured in Puerto Rico. This strategy should also provide positive economic opportunities to the private sector. This option, complemented with actions to reduce the population in specific sensitive areas, turned out to be the most effective/promising plan.

Because the taking, possession, sale and domestic consumption of iguanas in Puerto Rico is allowed, but remain poorly executed, the Committee suggests encouraging these activities by executing three tasks. All are essential parts a short- and long-term strategy. Both terms are needed to reduce the iguana population growth rate. These tasks are interrelated and listed in order of priority, which are the following:

1. A compelling motivation for the sale of iguana products must be developed. Guiding and incentivizing entrepreneurs to enter the industry to market, both locally and for export, products derived from PR-caught iguanas, could achieve this.

2. An educational strategy must be developed to achieve the following:

    a. Encourage potential harvesters to participate in the removal of iguanas from the wild: This includes requesting and preparing the personnel with the skills to manage wildlife, to remove and manage iguanas correctly and without damaging other species (e.g. Wildlife Officers, DNER Rangers, farmers, anglers, and pest control service providers).

        i. Lands administered by DNER - An iguana control plan should be part of the management plan of each reserve, forest or refuge of DNER. The control could be performed by DNER personnel, contracted personnel or by concessions as accorded with the land manager.
        ii. Other public lands and private sectors - As with any other pest control problem, the property owner is allowed by law to remove and destroy the iguanas or could hire a pest control service provider to do so.

    b. Aware residents and visitors about the iguana issue and control plan. The community needs to know more about the damages caused by iguanas; the benefits of consuming products derived from PR-caught wild iguanas; the

guidelines to avoid zoonotic diseases associated with iguanas; the laws that regulate the human interactions with iguanas; and ways to avoid hazardous interactions with iguanas.

c. Encourage landowners or land managers to be part of the control plan (e.g. Wildlife Officers, DNER Rangers and farmers).

3. Create a way to evaluate the effectiveness and viability of the control actions, including both operational and research components of the plan. In addition, to improve the probability of success, develop a periodic review and updating of this plan within the first four years after the implementation of the plan. The evaluation of the effectiveness of the control actions and the review and updating of the plan should also provide feedback to the cooperators to continue or change the actions.

It is important to promote the consumption of iguanas in an assertive and educational way to lower the chances of an outbreak of reptile-associated Salmonellosis and other zoonotic diseases.

2.2. Action plan route

1. Establish an official Government Public Policy Statement, which could be the following: "To promote the local consumption and exportation of products derived from green iguanas (*Iguana iguana*) that are removed from PR's wildlife."
2. Identify entrepreneurs of the private sector that could be interested in the marketing of products derived from iguanas.
3. Encourage entrepreneurs to invest in the marketing of products derived from iguana, by doing the following:
    a. Present small business incentives
    b. Facilitate related permits
    c. Provide related guidance
4. Support those groups from the private sector that would be most likely to profit immediately from the removal of iguanas (e.g. farmers, fishermen, pest control service providers), by doing the following:
    a. Provide training to exclude, trap and keep iguanas in a safe and humane way
    b. Facilitate related permits
    c. Provide related guidance
5. Promote the safe consumption of products derived from iguanas, by doing the following:
    a. Provide guidance in proper handling and nutritional facts of those products.
6. Provide information on how to avoid damages due to iguanas' behavior and how to avoid hazardous interactions with iguanas.

2.3. An industry to market products derived from iguana

2.3.1. Supporting statutes

The encouraging for the creation of an industry to market products derived from iguanas will comply with the following statutes:

1. Under Public Law (PL) No. 416 enacted on September 22, 2004.
    a. "To establish public policy that encourages a desirable and convenient harmony between man and his environment";
    b. "To promote efforts to prevent or eliminate damage to the environment and biosphere, and stimulate the health and welfare";
    c. "To enrich the understanding of ecological systems and natural sources important for Puerto Rico."
2. Under PL No. 241 enacted on August 15, 1999, as amended.
    a. "For the protection of native wildlife, especially habitat and natural range of such species".
3. Under PL No. 81 of March 14, 1912, as amended.
    a. "To establish health goals of the population of Puerto Rico and develop strategies to protect people's health."
4. Under PL No. 164 of August 29, 2006.
    a. "To support the growth, development and strengthening of the Puerto Rican industry, through all available mechanisms, and feasible within constitutional, governmental and economical parameters available, in order to achieve maximum job creation for the country."

2.3.2. Traditional and modern use of products derived from iguana

The idea of mitigating invasive species' impacts on the environment and economy by turning them into commodity foods and other products is gaining strength throughout the U.S. Other invasive animals and plants that are making appearances on dinner plates are Asian carps, (*Hypophthalmichthys* spp.), Asian shore crab (*Hemigrapsus sanguineus*), kudzu (*Pueraria lobata*), northern snakehead (*Channa argus*), lionfish (*Pterois* spp.) and signal grayfish (*Pacifastacus leniusculus*).

The uses of iguana skin, eggs, meat, oil and fat are diverse and vary according to culture. These customs and traditions serve as the basis for an industry to market products derived from iguana. Some possible uses are the following:

1. Food - Throughout the world, people rely on reptiles as an important protein source. Iguanas have been part of the Central American diet for over 7,000 years and are now

widely consumed by all levels of society. Iguanas have symbolic importance in many cultures. While some cultures ascribe medicinal and/or aphrodisiac qualities to the meat and/or eggs, others simply consume iguanas as an additional protein source. Iguana dishes, particularly those with gravid females, are especially popular during the Catholic period of Lent or "Cuaresma", which coincides with the iguana-breeding season.

2. Oil - Iguana oil is used to treat rheumatism, brittle bones, bruises, and swelling in humans and cattle.
3. Hunting - Iguanas are also hunted solely for sport.
4. Leather - In Central America, particularly in Nicaragua and Costa Rica, iguana skin is used for the manufacture of leather handicrafts, purses, wallets, shoes, belts, and mounted specimens that are sold in local markets. However, the trade in leather products made from iguana skin is insignificant, if compared to the scale of trade in iguanas for food and pets.

Local market, hunting and the international pet trade are clearly the drivers of iguana exploitation in Central America. Nevertheless, the special benefits that are attributed to the consumption of iguana, makes consumers of certain cultures willing to pay more for its meat and eggs, when compared with other commercially available options of domestic animals. In fact, the attributes properties to the iguana meat and eggs appear to drive the majority of modern-day iguana consumption. Marketers and consumers of iguana meat and eggs promote such activities, by emphasizing that these products have a high nutritional and/or medicinal value.

2.3.3. Regional variations in the use of products derived from iguana

There is regional variation in traditional use of iguana products and in preferences for iguana meat and eggs.

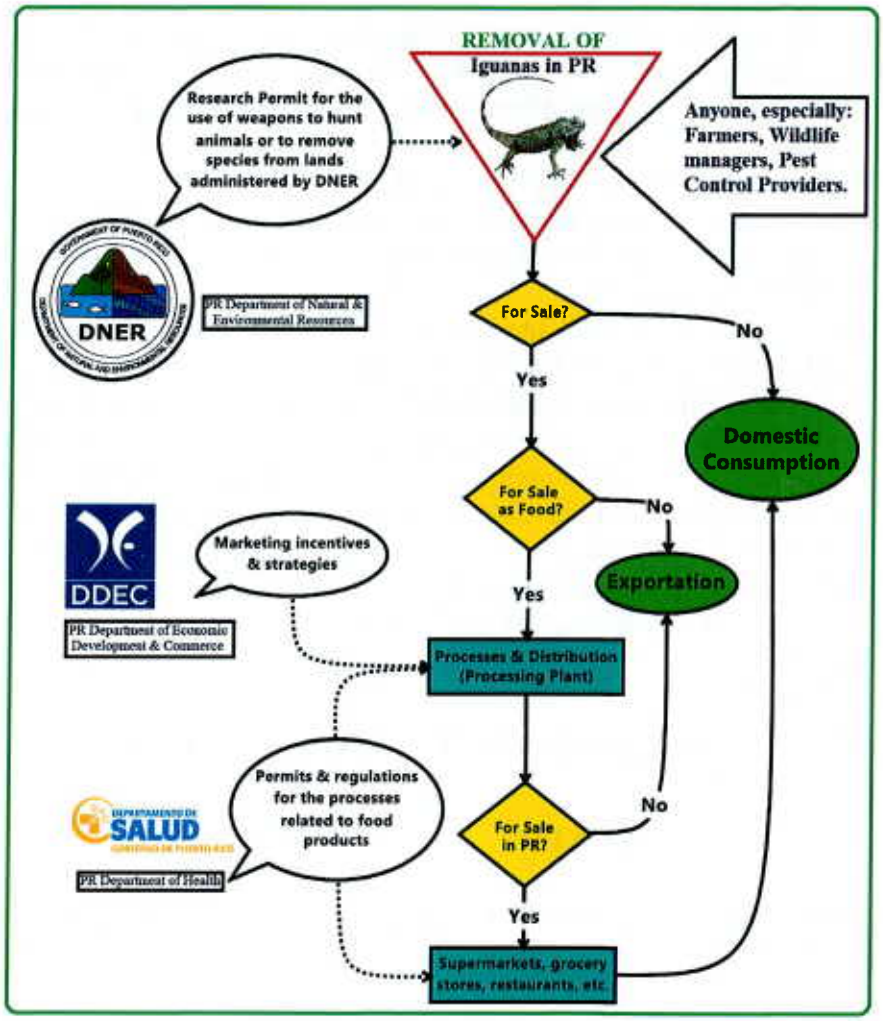
1. In Guatemala, the iguana is widely hunted along rivers of both the east and west coasts. Thus, it is commonly found in the markets of major population centers.
2. In Honduras, iguana hunting and consumption are quite common along with other species such as the white-tailed deer and the peccary. It is also the subject of the yearly Jamo Festival, which takes place in late April or early May. This festival celebrates the "jamo" by offering several different ways to eat the animals and is highlighted by an iguana-themed parade. The parade features people dressed in lizard costumes, vehicles decorated with slogans like "come jamo 100%", or iguanas tied up and placed on vehicles. Advertisements for the festival feature photos and cartoons of the iguanas.
3. In El Salvador, although illegal, iguanas are served openly at restaurants in San Salvador and at farmer's markets in many places around the country. Additionally, the yellow fat of iguanas is used to treat sprains, and a broth of this species is thought to cure young children of illness.
4. In Nicaragua, eggs are considered a delicacy. The consumption of products derived from iguanas increases during the dry season. In this country, the iguana harvest is banned during the breeding season, from January 1 to April 30. The policy is designed to protect gravid females. However, the policy is not effective because the closed season is in direct conflict with local traditional uses and demand for iguana eggs.

One well-known traditional dish is called "Pinol de iguana", a soup made of iguana eggs taken from the gravid female. Other traditional dishes are the soup called "Consomé de garrobo", considered a medicine and aphrodisiac, and the iguana barbecue. Seasonal increase in the consumption of these species also occurs due to the tradition to use iguana meat during Lent or "Cuaresma", as a substitute for other types of meat that may be given up.

5. In Costa Rica, among the east coast natives, iguana consumption has long been part of the culture. As in other Central American countries, consumption of meat and eggs increases during the Christian holiday week of "Semana Santa", coinciding with the nesting season, exactly when females with eggs are most desired.

2.3.4. The suggested path of commercialization of iguanas

The marketing of PR-caught wild iguanas, in compliance with federal and state laws, may be carried out as described by the following flowchart.



2.3.5. Requirement for sanitary license

All food establishments must comply with the Food Code of the FDA. To carry out an operation of iguana meat production, the processing plant must meet the inspection requirements set by the DH and the FDA, as part of a sanitary license. These requirements are the following:

1. A service request form must be completed at the DH Food Hygiene Division.
2. A proposal explaining the project must be presented with the service request form. The proposal must comply with all applicable Food Regulations parts under Title 21 of the Code of Federal Regulations (e.g. Parts 101 for "Food labeling", 110 for "Current good manufacturing practice in manufacturing, packing, or holding human food", and 113 for "Thermally processed low-acid foods packaged in hermetically sealed containers"). In addition, the proposal should include the following information:
   a) A description of the source of iguanas and the capture methods.
   b) Address and description of the iguanas' holding area and processing factory including the following:
      1) Iguana management, care and quarantine (holding time) processes and protocols.
      2) A factory diagram with a process flowchart and map of equipment location.
      3) Protocols for waste disposal and bacteriological sampling (e.g. for *Salmonella* spp.).
      4) Evidence of water supplies compliance.
      5) Evidence of completion of the course of good manufacturing practice and/or sanitation standard operating procedures for all supervisors or persons in charge of the meat process.
      6) Samples of the package and the nutritional value labels for each food article, prepared in compliance with the FDA.
      7) Evidence of the hiring of the services of a Doctor in Veterinary Medicine with an internship in exotic animal medicine. The duty of this veterinarian is to evaluate, *antemortem* and *postmortem,* gross pathological lesions during the process of slaughtering, and be able to make good judgment on the condition of the carcasses of iguanas.
      8) Registration with the Food and Drug Administration under the Bioterrorism Act.
      9) Other aspects determined after the initial evaluation.

2.3.6. The suggested roles for each Department

2.3.6.1. <u>DNER's role</u>

DNER could encourage, in safe and humane ways, the removal of iguanas from the wild by doing the following:

1. **Facilitating DNER's permits to capture, possess and sell iguanas:**

All the activities related to the capture of wild green iguanas are in fact rules by Regulation 6765 of the New Wildlife Law, No. 241 of August 15, 1999, as amended. For such reason, the regulation allows any person to capture, buy, sell, keep and export green iguanas removed from the wild without a DNER permit. In other words, this regulation allows the removal of iguanas, simultaneously with the establishment of the plan for its control.

DNER requires a permit for scientific research in order to remove iguanas from its lands or by using firearms or pneumatic guns. The application for this permit requires a short proposal stating that the use of the weapon will be part of the methodology. To facilitate the permit application, DNER could keep them available at its Regional Offices and digitally through its website.

2. **Facilitating the removal of iguanas in DNER's Natural Protected Areas**:

DNER manage about 3.5% of Puerto Rico's land. The management plan of each of the DNER's natural protected areas should promote the removal of eggs and iguanas from all age classes, with emphasis on removing adult females and destroying nests. This guiding principle should control population growth of iguanas in DNER's protected areas, without endangering the native wildlife and operations of each protected area. Therefore, the management plan of each natural protected area should include:

a. An iguana population control strategy. While each area's management plan will account for different circumstances, each area should include its own control strategy to comply with the current plan.
b. A site description and identification of the iguanas' nesting and congregation areas (for both basking and breeding).
c. A nest destruction schedule and protocol. Destruction could be done by digging and removing content or by inundation.
d. Description of the traps and hunting techniques to be used in the removal of young and adult iguanas, as allowed by law.
e. Description of the euthanasia methods. Any euthanasia method used to destroy wild iguanas should produce a quick and painless death. The use of euthanasia is by definition consistent with humanitarian goals and conservation and appreciation of animals.
f. An appropriate disposal and handling protocol should also be considered, including first aid and personal protection equipment.
g. Possible effects to wildlife: In compliance with the U.S. Corp of engineers and U.S. Fish and Wildlife Service, the manager must provide a detailed description of the possible effects of the iguana population control strategy to wetlands and wildlife, especially to the species of concern.

h. Budget for iguana control. As each management plan considers different circumstances, the manager should determine the goal, objectives, costs, and identify the available funding sources in accordance to the established goal. The funding sources could be consulted and coordinated with the Bureau of Fisheries and Wildlife of DNER.

i. All these requirements can be managed through a concessionaire, who could be allowed to remove iguanas in a specific area, according to the needs identified by the management officer of each natural protected area.

3. **Providing virtual education and training:**

DNER could provide online resources for the public and training for wildlife handlers.

a. Education for Internet users: DNER could provide information about the challenges and problems posed by the overpopulation of iguanas. To do so, DNER must include the following on its website:

   i. A section of frequently asked questions (and answers) that can provide guidance to citizens. This section should include questions about the iguana's biology, its invasion in PR and other related topics. DNER should provide the space and guidance to prepare this document. All collaborators should be invited to participate in the preparation of this document.

   ii. Similarly, this same information can be transmitted through interviews with officials that are experts on the topic and press release for newspapers and newsletters.

b. Training to wildlife handlers: DNER could provide training about different techniques to exclude, remove and handle wild iguanas by safe and humane ways. The training could be offered to pest control services providers, *bona fide* farmers and DNER wildlife staff.

4. **Developing a project to monitor this plan**:

DNER could develop a project that encompasses the following:

a. Monitor the implementation of the iguana population comprehensive control plan,
b. Monitor iguana population fluctuations,
c. Train wildlife handlers,
d. Maintain DNER online page on iguana information and resources.

2.3.6.2. DA's plan role

DA could encourage safe and humane ways of removing iguanas by doing the following:

1. **Facilitating DA's technical assistance:**

The DA will facilitate agronomist personnel in each of the agricultural regions that will assist farmers in the processes related to the removal of iguanas.

2. **Facilitating DA's permits for the removal of iguanas:**

The DA will provide authorization for the removal of iguanas in those properties of the Land Authority which are not leased.

3. **Considering proposals for the following:**
   a. The control of iguanas in Puerto Rico as a continuing-education course for exterminators.
   b. The acquisition of traps, for facilitating the removal of iguanas on agricultural lands.

2.3.6.3. DH's plan role

DH could encourage safe and hygienic ways of processing green iguanas by doing the following:

1. **Facilitating DH's permits for the processing of iguanas to be used as food:**

In order to process food products derived from iguanas, a Service Request Form must be completed with payment to the Food Division Office. The Service Request Form should be supplemented with a proposal explaining the project. To facilitate the Service Request Form, the DH could keep it available at the offices of DH and digitally through its website.

2. **Providing personal guidance to assist entrepreneurs in the fulfillment of the requirements of the DH, and the FDA:**

Entrepreneurs interested in willing to establish processing plants to develop iguana products may request guidance with proposals and DH/FDA compliance from the Auxiliary Secretary Mayra Toro at mtoro@salud.gov.pr.

4. **Facilitating technical assistance for the raising of iguanas intended for consumption:**

The veterinary staff of the DH could also provide consulting services for the processing of meat and eggs of iguanas, intended for public consumption as food. Similarly, the DH could revise applications for compliance with federal and state regulations governing the processing of iguana eggs for human consumption.

2.3.6.4. DEDC's plan role

DEDC, through the Puerto Rico Industrial Company (PRIDCO), a key economic development agency in Puerto Rico, could promote the exportation and marketing of iguana products by doing the following:

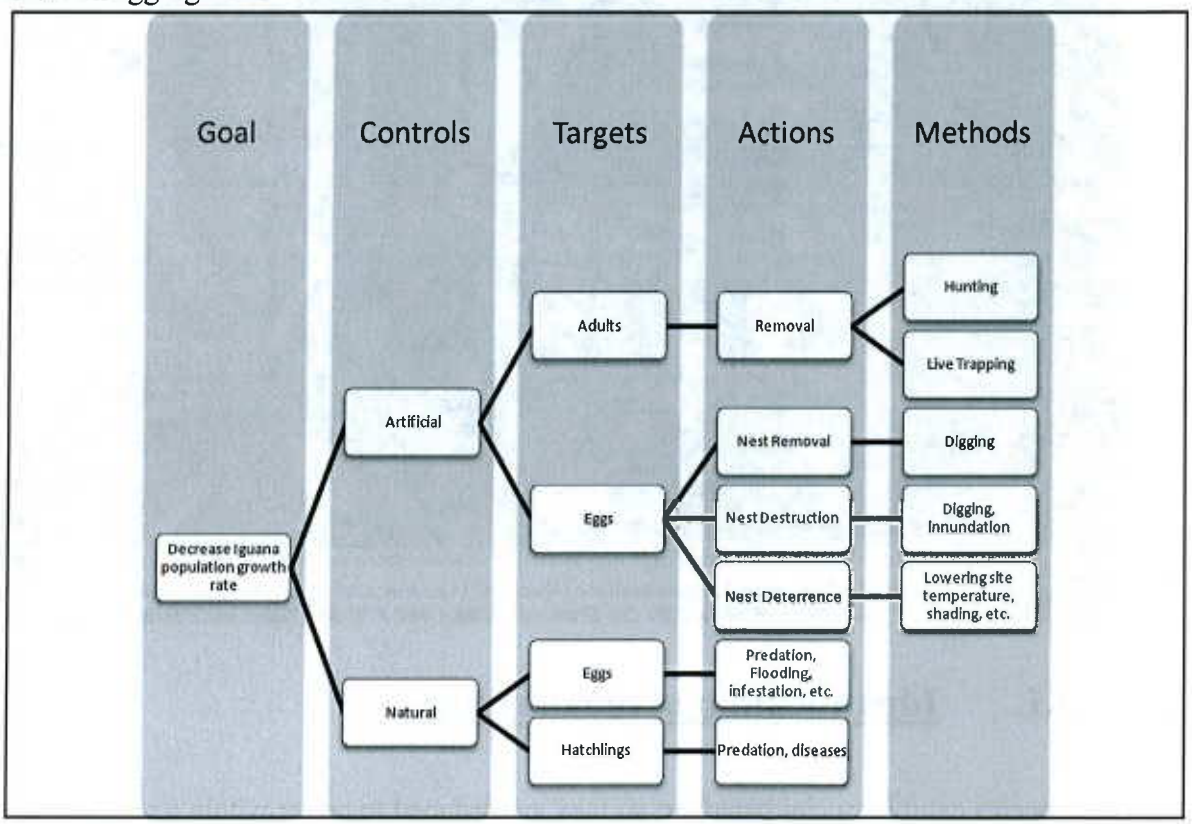
Making available the incentives and programs to promote the exportation and marketing of iguana-derived products:

To provide economic incentives to companies that will be devoted to the process, marketing and exportation of products derived from iguanas, PRIDCO could assist by:

1. Facilitating the process to apply for Industrial Tax Exemption,
2. Giving access to a vast array of industrial buildings through the island at accessible costs,
3. Providing infrastructure incentives for PRIDCO's buildings,
4. Providing marketing incentives for the exportation of the products,
5. Providing the services by referral from the "Small Business Technology and Development Center" for assistance in preparing the Business Plan with financial projections, and
6. Assisting in completing the Application for Services.

3. PROCEDURE TO CONTROL THE IGUANA'S AGGREGATIONS

In 2009 former DNER wildlife biologist and herpetologist Dr. Puente-Rolón, now Biology Professor at the Inter-American University, Arecibo Campus, submitted to DNER a method to evaluate iguana population density and a procedure to control iguanas through nest destruction and removal of individuals from aggregation sites. The methodology to estimate the population density was designed to be used by DNER wildlife staff. However, the procedure to control iguanas regionally can be adapted to be used by skilled personnel (e.g. wildlife managers, farmers, anglers and pest control service providers). The adapted three-step procedure is the following: 1) identification of iguana clusters, 2) identification of nesting areas and destruction of nests and their contents, and 3) removal of iguanas in the areas of aggregation.



Summary of the main methods to control iguanas and their potential uses.

Methods	Uses			
	Land management	Domestic consumption	Marketing	
			As textile	As food*
Hunting (adults)	X	X	X	
Live Trapping (adults)	X	X	X	X
Digging (nests)	X	X	X	X
Digging, flooding (nests)	X			
Lowering site temperature, shading, etc. (nests)	X			

* = In accordance with FDA, and DH regulations

Adult female captured in a non-lethal cage trap by DNER wildlife biologists in the Boquerón State Forest, within the critical habitat of the Yellow-shouldered Blackbird (*Agelaius xanthomus*), an endangered species.

3.1. Identification of iguana clusters

The species exhibits social behavior, so they are grouped together within its habitat in areas limited by the characteristics required by iguanas. Iguanas are grouped together for the following:

1. For thermoregulation, they bask in sun-exposed sites, which are limited.
2. To escape predators and move with little energy consumption, they prefer to jump into the water and swim, so they are grouped together at the edges of water bodies.

3. To nest, they need soils where they can dig their caves. These soils are usually not compacted, not floodable and have little or no shade.
4. To mate, they take advantage of the places mentioned above.

The characteristics of these limited sites might be used to identify the best locations for the most cost-effective removal of iguanas.

3.2. Identification of iguana nesting areas and destruction of content of nests

Iguana nest sites are easily recognizable. Iguana nesting areas are usually places devoid of vegetation and near water bodies. The cavities used by nesting iguanas can be identified in these places. To lay their eggs, iguanas often dig deep burrows in the sand and soil. At the bottom of these burrows, the female will create a small cave in which she can lay eggs. The tunnels can connect multiple holes, so that more than one entrance leads to the same cavern. Such shared caves are generally deeper and better protected than the nest used by a single female.

Female iguanas leave the nest after the eggs are deposited, covering it with sand or dirt. Different iguanas can use the same nest sequentially. The iguanas return to the same nest site season after season. Sometimes females fight for a nesting site. Unless that kind of competition is occurring, the female iguanas do not stay close to their nests to protect their eggs.

Creating artificial nesting sites or mounds to attract the females during the breeding season can be effective for collecting or destroying adults and eggs thus, controlling iguana populations. Care must be taken not to destroy nests of native species that are also attracted to these sites.

Once a nesting cave is identified, it can be excavated and the eggs removed intact. Iguana eggs may carry *Salmonella* bacteria. Therefore, the handler should wear gloves when handling iguana eggs. After handling eggs or soil, hands should be washed with antibacterial soap. If the goal is the elimination of eggs, the most sympathetic method is to freeze them to stop development and then discard them. Another option is to fill the iguana burrows with cement, if the burrows are found in a dam or a foundation. Otherwise, the burrows can be filled with gravel. For animal welfare reasons, burrows occupied with live iguanas should not be filled. To dig their burrows, the iguanas choose sunny places with soils that are not too compacted. When these burrows become flooded with rainwater, the eggs do not hatch, and they rot instead.

3.3. Removal of iguanas in the areas of aggregation

The removal of iguanas can be carried out using several techniques, among which are: the use of live traps, pneumatic guns and nets. The capture and removal of individuals should be more cost-effective between May and December, during which a greater number of aggregated individuals can be observed. Particularly during the courtship period, when males are in reproductive displays and more females are found near them. Aggregation patterns on the island seem to be similar to those observed in Central America.

To catch iguanas without injury, experts usually use non-lethal cage traps or catchpoles. Non-lethal cage traps are sold commercially with a cost between $65 and $125. With the catchpoles, the handler ties the iguana by the neck and one foreleg, or by the waist (cost between $70 and $145).

Traps should be placed where the iguanas are active. The trapper can use fresh ripe fruits such as chopped mango and banana to attract iguanas. The roof of the trap should provide shade and the trap must be checked daily. It is inhumane to leave these animals in the sun or in a trap for long periods.

Once an iguana is caught, the trapper automatically becomes the owner and is therefore responsible for this animal. It is illegal to release iguanas in the wild. In PR, the iguana can be taken or given away as a pet, but it is illegal to sell it as pet. The person who has an iguana should care for and feed it daily, according to Act No. 154 of 2008 or Act "for the Welfare and Protection of Animals".

To capture iguanas within areas managed by the DNER, or to use a weapon to capture them, it is necessary to obtain permission from the DNER. The permit is for Scientific Research in order to control the population only. This permit should be submitted with a proposal that must indicate the use of a weapon as part of the methodology. The permit application can be obtained in the Regional Offices of DNER or digitally through the DNER website at: http://www.drna.gobierno.pr/permisos/index.php?module=pagemaster&PAGE_user_op=view_page&PAGE_id=23&MMN_position=35:3. The application must be delivered to the Regional Offices or Central Office of DNER.

4. CONSIDERATIONS

4.1. Useful research

The Committee acknowledges lack of information on the green iguana, especially within the economical, biological and social aspects of its status as an invasive species in Puerto Rico. This information could be important to enhance or complement the population control techniques presented in this document. Therefore, some research that could complement our knowledge on the iguanas could be based on the following topics: population dynamics/monitoring, behavior, reproduction, sensory perception, genetic variation, diet, foraging, locomotion, displacement, climatic tolerance/thermal biology, habitat use, cultural perspectives/conflicts, and human health/safety.

In order to be more effective in the eradication of iguanas, research must be done in basic control technology such as: trap enhancement, attractant identification/verification, toxic bait delivery/stations, toxic screening/testing/registration, repellent identification/verification, fumigants development/registration, detection/eradication of low-density populations, barrier development, canine detection verification/training aids, and integrated control plan further development. In addition, biological control technology with parasites, disease, and other infectious agents or through reproductive inhibitors, genetic control mechanisms, and fertility control, should be considered for research.

4.2. Puerto Rican cultural and culinary practices

The short-term objectives of this plan are to educate the country about the issues with iguanas, provide guidance in controlling iguanas and facilitate export of iguana. These short-term objectives for themselves, though has great potential to control local populations, probably will not control the population of iguanas island-wide. Only domestic consumption could control the population island-wide, which is the long-term objective of this plan. The outlook should be optimistic considering the good acceptance that Puerto Ricans have for delicacies (e.g. blue land crab, red lionfish, sharks, etc.).

Although in Puerto Rico more and more people are including the iguana in the local menu, yet the general perception is that the iguana is not acceptable as food. In part, the reluctance to add the iguana in the home menu is due to the lack of a proper broadcast of the iguana facts (e.g. the benefits of consuming PR-caught iguana products). The short-term goals mentioned above, should reduce the problem of information-broadcast about the iguana as a food source.

Although the paradigm will shift naturally to one of good acceptance of the iguana as an excellent food, this may take several years. To speed up the change of this paradigm is the

ultimate objective of this plan. To do so, the main strategy is to take advantage of the supply/demand rate presented by the exportation market of iguana-derived products. Once the exportation is in its climax, instinctively business owners will want to sell the product locally; it will probably begin with the Oriental and Central American restaurants. Those local businesses gradually will change the current paradigm of iguana in the culinary and cultural practices of PR. With the change in paradigm, the iguana population could be controlled through domestic consumption, as has happened in countries where it is native. Then, the change in the perspective of local cuisine, albeit gradual, is the key to control the population of iguanas.

Possible obstacles that must be overcome in order to include the iguana in the domestic menu are the following:

a. To gain acceptance of the iguana as a good source of food is necessary to change the paradigm in culinary and cultural practices of Puerto Ricans.
    i. This was a concern when the campaign for the consumption of lionfish was implemented as part of the solution to control the population growth of that invasive species. Nowadays, the lionfish is sold by several restaurants and frequently consumed by local anglers.
    ii. With appropriate publicity campaign alluding to the health, ecological, aesthetical and agro-economic benefits of consuming PR-caught iguanas, a greater awareness of the potential of the iguana as a food source could be achieved. The government and the private sector could consider the endorsement of a cultural activity, like a festival. This could be used to trigger and promote the "the first tasting", the local marketing and consumption of products derived from iguanas. Products like dog or cat food made from iguana, different plates of iguana meat, and arts on iguanas designed by local artisans or "artisans", could be presented in public activities sponsored by any of the government agencies, perhaps taking advantage of campaigns of other products or services (e.g. promotion of fresh milk, influenza vaccination, education on invasive species, etc.).
b. The lack of knowledge or misconception of the New Wildlife Law, among potential iguana harvesters and providers, discourages the activities related to the removal of iguanas.
    i. Many potential iguana harvesters and providers wrongly believe that this species of iguana is protected as an endemic species. This could be solved by correcting this misbelieve and advertising the possible economical profits and the DNER Regulation 6765 under PL No. 241.

c. The rate of consumption of iguana products may be low in PR, because it is widely believed that such activity may generate an outbreak of Salmonellosis.
    i. As with any animal-derived food, an outbreak of Salmonellosis can occur if the food is consumed undercooked and contaminated with bacteria. This can be greatly reduced by advertising the importance of good handling techniques throughout the preparation and consumption of iguana-derived products. The DH could provide inspections and guidance as necessary or as requested in compliance with the DH and FDA laws and regulations.
d. Entrepreneurs, concerned about the marketing risks, might hesitate to invest in the iguana industry.
    i. This concern could be solved by providing DEDC incentives and guidance to the entrepreneurs willing to take advantage of this opportunity.
e. Iguana breeders could argue that the alternative solution of importing and breeding iguanas in captivity is essential to save the industry or improve their economies.
    i. Importation and breeding of iguanas is currently illegal.
    ii. Importation and breeding of iguanas is counterproductive if the government goal is to remove iguanas from PR's wildlife.
    iii. DNER special permits to breed iguanas should not be given until the wild population density of iguanas averages less than 0.1 individual per hectare of riparian and lacustrine edge habitat.
f. The illegal market of products derived from iguana could try to take advantage of commercialization to conceal their illicit activities.
    i. This possible scenario should be abridged by the certification provided by the iguana slaughterhouse and holding centers, which in turn have to be certified and inspected by the FDA and DH.

Summary of main paradigms to be changed to promote the consumption of iguanas.

Current paradigm	Fact	Wanted Paradigm
The Green Iguana is protected as an endangered species.	This iguana is an exotic invasive species considered a nuisance by the Government of PR.	This iguana can be captured and destroyed at any time as permitted by law.
The Green Iguana is not edible.	This iguana is an important food source where it is native.	This iguana is an available healthy food source.
The Green Iguana is a dirty animal.	This iguana is a vegetarian arboreal reptile that likes to dive in water.	This iguana is as "clean" as any other animal.
The Green Iguana carries diseases.	As poultry and many other animals, this iguana can carry potential pathogens.	If managed properly, it is unlikely that an iguana will infect a person.
The Green Iguana produces food poisoning.	There is no evidence of foodborne illness due to eating a properly handled, well cooked, and properly stored reptile.	If prepared as conscientiously as other meats, iguana meat does not cause gastrointestinal illness.
Many permits are needed to catch an iguana.	Other than a permit from the landowner or land manager, no permits are needed to capture an iguana, unless the activity uses a firearm.	The Government of PR promotes the removal of iguanas from the wildlife.
To eat products derived from Green Iguana is unhealthy.	Iguana meat is rich in protein and low in fat.	To eat products derived from iguana is healthy.

4.3. A task force to tackle invasions at their early stages

In Puerto Rico, most management efforts to control invasive species are focused on preventative restrictions on import (border restrictions) combined with post-border restrictions on possession and sale. However, once an invasive species evades these management efforts, outcompetes native species, and becomes established as a pest, the time it takes to implement control actions makes the difference between a cost-effective successful mitigation and a challenging expensive eradication program. Therefore, it is critical to create a task force with sufficient independence and power to tackle invasions at their early stages.

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