Assessment of Control Methods for Invasive Alien Iguanas in Saint Lucia.

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Abstract

The Saint Lucian Iguana is the largest native terrestrial animal on Saint Lucia. It gave the island its Arawak name: Iyanola *- Land of the Iguana - and has become a valuable flagship species that represents a globally threatened habitat type in the insular Caribbean. DNA and morphological studies suggest that the iguanas on Saint Lucia are a unique population, found only on this island. In 2008 a threat to the uniqueness of the Saint Lucia iguana and ecosystem was identified: an exotic iguana was reported in the wild near Soufrière, presumably originating from escaped pets that were smuggled into the country illegally. The spread of the alien iguana within the Soufrière basin is considered invasive. Several mechanisms are feared: hybridization with the Saint Lucia iguana, competition for food and habitat, vectoring pests and diseases, and upsetting the local ecosystems and agriculture. Thus the alien iguana needs to be effectively controlled, preferably eradicated. The current geographical separation of Saint Lucian and alien iguanas could provide an opportunity for eradicating the aliens if a cost-effective method is identified in time.*

Genetic (mitochondrial DNA and microsatellites) and morphological analyses carried out by MTIASIC partners suggest that the Saint Lucia iguana is unique and is an endemic, warranting subspecies status, and that no hybridization with the alien iguana has occurred to date, which has been confirmed as being of Central American origin.

Population viability modelling using VORTEX suggest that extinction probability of the alien depends on when it first established, on juvenile mortality and hunting pressure applied. Reasonable assumptions lead to eradication likelihoods of 30% to 90%. Thus, alien iguana eradication in the Soufrière area is probably feasible if moderate removal rates can be achieved before estimated current populations explode. Currently available methods do not achieve the required rates. All scenarios predict explosive population growth if unchecked by aggressive management interventions.

Detection of alien iguanas is key to any management. However, visual searches alone were not very effective. Over the entire project duration, the capture rate of detected iguanas was 60%. Capture success, following residents' prompt reports of sightings, were 100%, but most reports were not prompt; a community mobilization campaign probably needs to target residents who

stay largely at home and/or at the relevant field sites, in order to increase timely calls. An Iguana Alert Network was set up in a strive for post-project sustainability.

Attempts to attract iguanas to bait, traps or nest sites were unsuccessful. A single season trial with a detector dog suggests that this approach could be effective in locating iguanas in difficult terrain, even if they rest in the tree canopy.

The iguana team has benefited from volunteering schemes, training visits and exchanges of ideas via telecommunication. Both local staff and overseas trainees gained valuable capacity in the control of alien iguanas as well as the conservation of the Saint Lucia iguana, which must accompany alien control. To this end, Saint Lucia Forestry Department and Durrell have drafted a 5-year Species Action Plan for the native iguana in 2013, through a participatory process.

Introduction

Saint Lucia was known to the original Arawak inhabitants *Iyanola* - the Land of the Iguana. The Saint Lucian Iguana is the largest native terrestrial animal, striking in its appearance, and a cultural signifier of long standing. The name Iyanola suggests Saint Lucian iguanas were more widespread in the past but their past distribution has not been documented. Population estimates from 2002 suggest that probably fewer than one thousand remain. They are found in the dry coastal woodlands of the NE coast, often near streams, stretching from Grand Anse in the North to Fond d'Or, and Louvet seems to be the area with the most native iguanas on the island. Populations levels have been decimated due to a combination of habitat loss, predation by invasive alien species (IAS), and hunting (Morton, 2009). Given the low population estimate and the unique genetic signature of these animals, the Saint Lucia Iguana would meet Red List criteria for Critically Endangered (IUCN 2001), if Saint Lucia were to produce its own Red List at a national level (Morton & Krauss 2011). Thus, the Component 5 pilot's goal was preserving this unique heritage and genetic resource.

The Saint Lucian iguana is referred to as *Iguana* cf. *iguana*, i.e. similar to, but not confirmed as the common green iguana (*Iguana iguana*) (Daltry 2009, Morton 2009). Recent DNA studies are suggesting that the iguanas on Saint Lucia are a unique population, quite distinct from all other green iguanas and found only on this island. One objective on this pilot project was to further elucidate the taxonomic status of the Saint Lucia iguana.

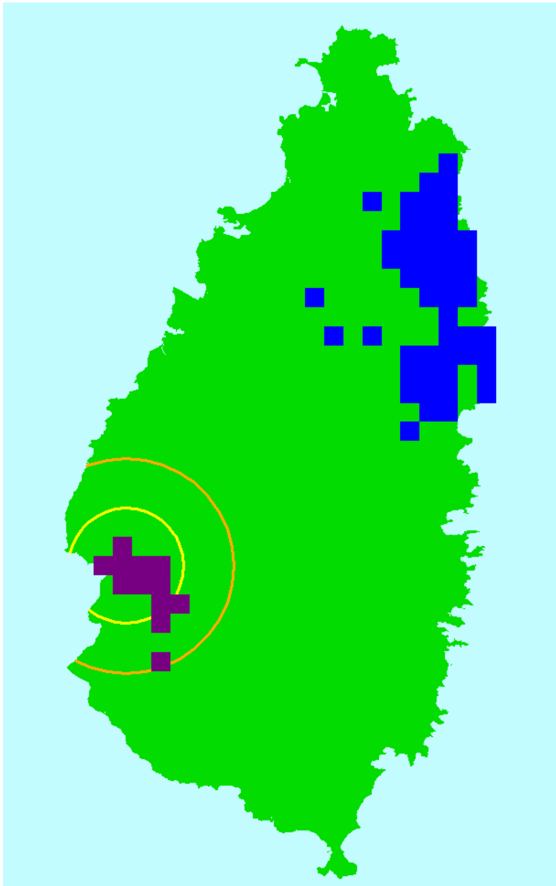
Concerns about the survival of the Saint Lucia Iguana in the 1990s prompted both initial work (in the 2000s) by the Durrell Wildlife Conservation Trust (Durrell) and Saint Lucia Forestry Department (SLFD) to evaluate the status of the population and the threats facing it (Morton 2007; Morton & Krauss 2011). More recently, SLFD and Rare Animal Relief Effort (RARE) built upon earlier awareness-raising efforts (Bendon, 2003) by means of a "pride" campaign (Narcisse-Gaston 2009, RARE 2010). This campaign promoted the Saint Lucia Iguana as a flagship species for the island's endangered deciduous seasonal forest habitat, and in particular the deciduous seasonal forests of Saint Lucia's NE corridor. Both the pride campaign's iguana mascot and the NE corridor were given the name Iyanola. In this respect, the importance of the Saint Lucia Iguana to conservation efforts on the island would remain unchanged regardless of its future taxonomic status. As such, it is a valuable flagship species that represents a globally threatened habitat type in the insular Caribbean (WWF and McGinley 2007) and an area that appears to be the last remaining stronghold of a number of species and subspecies endemic to Saint Lucia, particularly birds and reptiles (Morton & Krauss 2011 and referenced therein).

Another avenue to preserve the Saint Lucian iguana is to control its IAS predators. Durrell and Forestry Department conducted mongoose control research at sensitive iguana nesting site, as mongooses prey on iguana hatchlings. The researchers found that live-trapping and euthanasia, even at a relatively low trapping and removal effort around nest areas, can effect a sharp decline in numbers of mongooses that persisted for several months, essentially the entire window of hatchling emergence. This work was funded by the Balcombe Trust prior to the current Global Environment Facility (GEF)-funded project and has not been included in MTIASIC's mandate.

The Alien Invasive Iguana in Saint Lucia

Observations of the exotic iguana in the wild were first reported to the Forestry Department in 2008 (Morton 2008). Its country of origin is unknown, because these specimen are believed to have been bought from a pet shop in Canada and smuggled into Saint Lucia for a mini zoo at a hotel, The Still, in Soufrière, but the species was identified as green iguana, *Iguana iguana*. At least two, but possibly more individuals, escaped and subsequently bred outside of captivity. In the light of local observations collated by a recent awareness survey under this project (Krauss, 2010), it seems likely that first escapes occurred before 2000 and that there were possibly several escapes from one or more source(s). A wealth of evidence from around the world suggests it will quickly become invasive, causing negative impacts (Morton & Krauss 2013). The alien iguana has a high reproductive potential. Its clutch size is 40 to 60, possibly 80, eggs, whereas the clutch size of the native iguana is only 20 to 25 (Morton 2007). The alien iguana is also very mobile locally and adaptable to semi-urban and agricultural areas, as well as forest environments. The population is cryptic, making detection difficult in the early stages of invasion, but has the capacity to expand rapidly, both by large increases in numbers and by widely dispersing. Especially on the mountains surrounding Soufrière, its control will become increasingly difficult (Morton & Krauss 2011), while eradication is only considered feasible if *every last* individual can be targeted. Several factors contribute to its predicted damaging impact:

- It can compete with indigenous species for food and habitat, causing a reduction in numbers or even extinction of the local species
- It may vector pests and diseases to the local iguana populations, especially if imported illegally without veterinary certification or inspection
- It may cause an imbalance to local ecosystems
- It could become an agricultural pest that would cause a direct economic loss
- The most worrying impact for conservationists is the threat of interbreeding with native Saint Lucia iguanas. Its genetic uniqueness, resulting from a long period of genetic isolation, would be lost forever if the two populations (the Saint Lucia iguanas in the north east of the



(a) Native and alien ranges

(b) Native iguana

(c) Alien invasive iguana

(d)

Topography of range of alien iguana in the Soufrière area

Figure 1: (a) Distribution of the Saint Lucian native iguana (blue on map; b) and the alien invasive iguana (purple on map; c). Purple squares represent actual observations, yellow and orange rings the predicted natural spread in two years. The topography of the Soufrière area (d) poses a challenge to control efforts. The yellow boundary is a radius based on the furthest known dispersal from The Still, and the orange one is a 3 km radius, equivalent to approximately the maximum juvenile dispersal distance (based on radiotracking dispersing Saint Lucia iguanas.

island and the alien iguanas in the south west; Figure 1) should make contact and interbreed. This, in turn, would destroy the Iyanola concept, with negative consequences for national pride as well as marketing it to tourists. The current geographical separation of Saint Lucia and alien iguanas on the island and the apparently restricted distribution of the alien population could provide an opportunity for eradicating the aliens. It might also offer an opportunity to mitigate some of the risks of mixed messages in public awareness campaigns that could arise from simultaneously trying to protect one iguana population while attempting to eradicate another. Efforts to eradicate the alien iguana population must include strategies for preserving the Saint Lucia Iguana in the face ongoing threats emanating from the possibility of contact with the alien iguana population.

Control of the Alien Invasive Iguana

Alien iguana mapping and control was initiated in 2009[1] as collaboration between Durrell and the SLFD, prior to the main phase of the GEF project, with support by the Balcombe Trust. The main approach was the removal (by field teams) and euthanasia (by a veterinarian) of the alien invasive iguana from SW Saint Lucia. In 2010 the alliance was expanded by establishing a four-year collaborative partnership under the GEF-funded project "Mitigating the Threats of Invasive Alien Species in the Insular Caribbean" (MTIASIC). The initial goal was to eradicate the alien population of *I. iguana*. However, despite intensive visual searches and interviews, alien iguana removal rates that were achieved by Mid Term Review (MTR) fell clearly short of even the relatively modest hunting pressures used in simulations models (see below) that predicted realistic eradication chances. Low capture rates are likely due to a combination of the cryptic nature of iguanas at rest in trees and an iguana population putatively at low densities, a phenomenon expected to have an even larger impact as eradication progresses. Thus, the pilot focus was shifted to evaluate the cost-effectiveness of different search and capture approaches in order to choose the most suitable method(s) for possible future eradication attempts, after MTIASIC expired.

PATHWAY INTERCEPTION is essentially a preventative technique and thus regarded particularly cost-effective. To this end, the pet trade, which has also given rise to incipient invasions by other exotic species, e.g. black-tufted capuchin (*Sapajus paella*), has been targeted during this project. A Voluntary Code of Conduct for the Pet Sector (PS VCoC)[2] was developed at a series of participatory workshops with public and private stakeholders. The PS VCoC collates current best practices on managing the pet trade in relation to invasive alien species (IAS), as applicable in Saint Lucia and is the third of three public-private VCoCs developed under this project[3]. The main target groups are pet stores, breeders and dealers; pet owners; and

[1] A prelim report alerting Ministry of Agriculture to the problem (incl. a preliminary map) was submitted in Feb 2008 (Morton 2008)

[2] http://www.ciasnet.org/wp-content/uploads/2014/03/Voluntary-Code-of-Conduct-for-Pet-Sector-final.pdf

3 The others being the Voluntary Code of Conduct for the Ornamental Plant Sector (OPS VCoC) and the Voluntary Code of Conduct for the Tourism Sector (TS VCoC), both of which are available at www.ciasnet.org too.

veterinarians. The document also stipulates support the private sector requires from Saint Lucia public agencies to effectively adopt the PS VCoC.

As with many other invasive species, reptilian invasions are often characterized by an extended lag period, sometimes lasting decades, which precedes an explosion in numbers and range. Thus, for the control of the alien invasive iguana, EARLY DETECTION AND RAPID RESPONSE is very important, as control is only realistically possible as long as the ranges of the two types of iguanas remain separate (Figure 1). Since early 2008, first reports of free-living iguanas in the area were collated and mapped. Questionnaire returns from 2009 and 2010 (unpubl.) suggest a possible switch of the alien iguana population in Saint Lucia from lag period into a period of rapid growth. Population monitoring is a prerequisite for informed decision-making. While presence/absence data are relatively easily gathered via interviews/questionnaires and serve to monitor changes in geographic range, quantitative population estimates for such an elusive species in extremely mountainous terrain are almost impossible to obtain with any degree of accuracy. Thus, POPULATION MODELLING was employed to at least estimate likely population levels and predict the outcome of possible management scenarios.

Negotiations with Michel Breuil (*Laboratoire des Amphibiens et Reptiles, Musée National d'Histoire Naturelle de Paris*, Paris, France) were initiated in late 2010 in order to conduct a GENETIC ANALYSES to compare of the two iguanas on Saint Lucia and the two iguanas species and their hybrids on the French Caribbean overseas departments and territories, in comparison to South- and Central American iguanas. This complimentary study was entirely financed by the French Government.

The LEGAL FRAMEWORK for euthanizing the alien iguana has one major weakness, which has not affected control efforts to date, but nevertheless needs to be resolved. *Iguana iguana* is listed on Schedule 1 of the Wildlife Protection Act and Appendix II of the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES). As long as the native and alien iguanas are not taxonomically distinguished, control effort of the alien iguana could be misinterpreted. SAINT LUCIA'S NATIONAL INVASIVE SPECIES STRATEGY (NISS) 2012-2021[4], prepared under MTIASIC, addresses this issue by stipulating that any *populations* declared *invasive* - based on the damage it actually or potentially inflicts - by an authorized Invasive Species Entity, this particular population (in space and time) should qualify for control, independent of the species' definition as alien or native, its status under the Wildlife Protection Act or CITES. An INVASIVE SPECIES BILL was drafted to create the necessary legislative backing. However, the NISS is yet to be endorsed by Cabinet and the IS Bill to be enacted.

Pilot Results

[4] Chase V, Felix M-L, Mathurin G, John L, Andrew MG, Lewis D, Krauss U (2011a) Saint Lucia National Invasive Species Strategy 2011-2021. Ministry of Agriculture, Lands, Forestry and Fisheries, Castries, Saint Lucia, pp 72, http://www.ciasnet.org/wp-content/uploads/2013/05/NISS-SLU-final-reformat-v6.pdf

Genetic Analyses

Given the allopatric distribution of the two iguana populations on Saint Lucia, we believe that no hybridization has yet occurred. Tissue samples from both populations were collected before the launch of MTIASIC, in order to quantify the genetic uniqueness of the native population and allow the search for alleles unique to the alien population. This approach will allow us to survey the native population for evidence of introgression. Although the alien iguana population currently appears restricted to a relatively small part of Saint Lucia, it is reproducing and will presumably increase its range.

Catherine Stephen (*nee* Malone) sampled Saint Lucian iguanas prior to the invasion for her Ph.D. thesis[5]. While her results are probably based on small sample sizes, her results suggest the Saint Lucia iguana is an endemic lineage, with a sister group of (Saba + Montserrat) + Venezuela. In 2011 nearly all genetic sequences were established with co-finance from the French Government. For 15 samples, both mitochondrial and nuclear DNA could be sequenced. Additional information of the exact geographic and chronological origin of the samples in 2012 and a more detailed analysis with more samples covering both the Saint Lucia iguana and the alien green iguana included samples from Saba, Saint Martin, Saint Barthélemy, Martinique, Guadeloupe, Les Saintes, and Saint Lucia (indigenous and alien iguana). Attempts to obtain samples from Montserrat, Saint Vincent and the Grenadines and Grenada were unsuccessful within the lifespan of this project. Whereas much technical detail remains confidential until its publication (in preparation), the main points of the analyses contributed by the French to this project were:

- Assessment of morphological parameters allowed to differentiate *Iguana iguana* from South America from individuals of the same species from Central America, which was corroborated by genetic differences (Breuil, 2013).
- Results furthermore confirmed the hypothesis that the iguana in Soufrière is alien, specifically of Central American origin.
- The Saint Lucia iguana, with remarkable stripes, is morphologically unique and is an endemic (Breuil, 2013)
- Even more relevant, it can be distinguished from those of Montserrat + Saba. The French team has submitted a paper with the morphological descriptions of *Iguana delicatissima, Iguana iguana* and hybrids from South America, Central America, Saint Lucia[6].

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[5] Malone, C.L. (2000): *Phylogenetics, biogeography, and conservation of Caribbean iguanas (Cyclura and Iguana)*. Texas A&M University, UMI #9994289.

[6] Breuil, M. *et al.* Hybridization between the native species *Iguana delicatissima* and the invasive *Iguana iguana* **(**Reptilia, Iguanidae) in the Lesser Antilles as a consequence of the decline of the native species.. Submitted to *Biological Conservation* (2013)

- The Saint Lucia iguana is genetically unique based on both, mitochondrial sequences and microsatellites
- While the Saint Lucia iguana is clearly different from those on Saba, in South and Central America, we currently have insufficient data on the iguanas south of Saint Lucia. Thus, we cannot determine how Saint Lucian iguanas differ from iguanas on Saint-Vincent and Granada.
- Typically, two separate species exhibit a difference of ca 10 My, as is the case with *Iguana iguana* and *Iguana delicatissima.* Published work indicates a divergence of about 5 My for the Saint Lucia iguana, meaning the first human settlers, reaching Saint Lucia by about AD 420-690 (Fitzpatrick 2006) could not be responsible for the arrival of the Saint Lucia iguana on the island.
- This magnitude of genomic divergence and a divergence of 10% on the mitochondrial genome, warrant subspecies status for the Saint Lucia iguanas

Population Modelling

The population viability analysis software VORTEX has previously been used for simulations of population growth (Lacy 1993, Lacy et al. 2009) and has led to predictions regarding the potential success of eradication efforts. In an attempt to model the eradication probability of the alien iguana, a range of plausible conditions and manageable intervention scenarios were fed to the model and likely outcome analysed.

Simulating a worst-case scenario of 60% juvenile mortality (i.e., the same as that estimated for adult Green Iguanas in Panama; Rand and Bock 1992) and an alien population established since 1990 predicted that extinction probabilities greater than about 30% are very unlikely, regardless of any hunting pressure we could feasibly apply (Morton & Krauss 2011). By contrast, a relatively modest hunting pressure (60–180 adults or 600–1,000 juveniles removed per year) could raise extinction probabilities to almost 100% in a best-case scenario of 90% juvenile mortality and a population established for only four years. This best-case juvenile mortality is slightly lower than that reported by Harris (1982) and van Devender (1982), but those studies could not distinguish loss of juveniles through emigration (dispersal) and death. The same hunting pressure is predicted to increase extinction probabilities to about 80–90% for intermediate scenarios (75% juvenile mortality and/or a population established since 2002, the last year when all the known founder iguanas were confirmed to be in captivity). Thus, alien iguana eradication in the Soufrière area is possibly feasible if moderate removal rates can be achieved before estimated current populations explode. The VORTEX simulations also predicted that the most likely current alien iguana population size under the worst-case scenario to be in the tens of thousands, which is inconsistent with the difficulty of finding alien iguanas around Soufrière, suggesting, at least for the moment, that the worst-case scenario is not the most accurate representation of reality. All scenarios predict explosive population growth if unchecked by aggressive management interventions (Figs. 2 & 3).

Effect of time period alien iguanas established prior to being hunted on likely eradication success

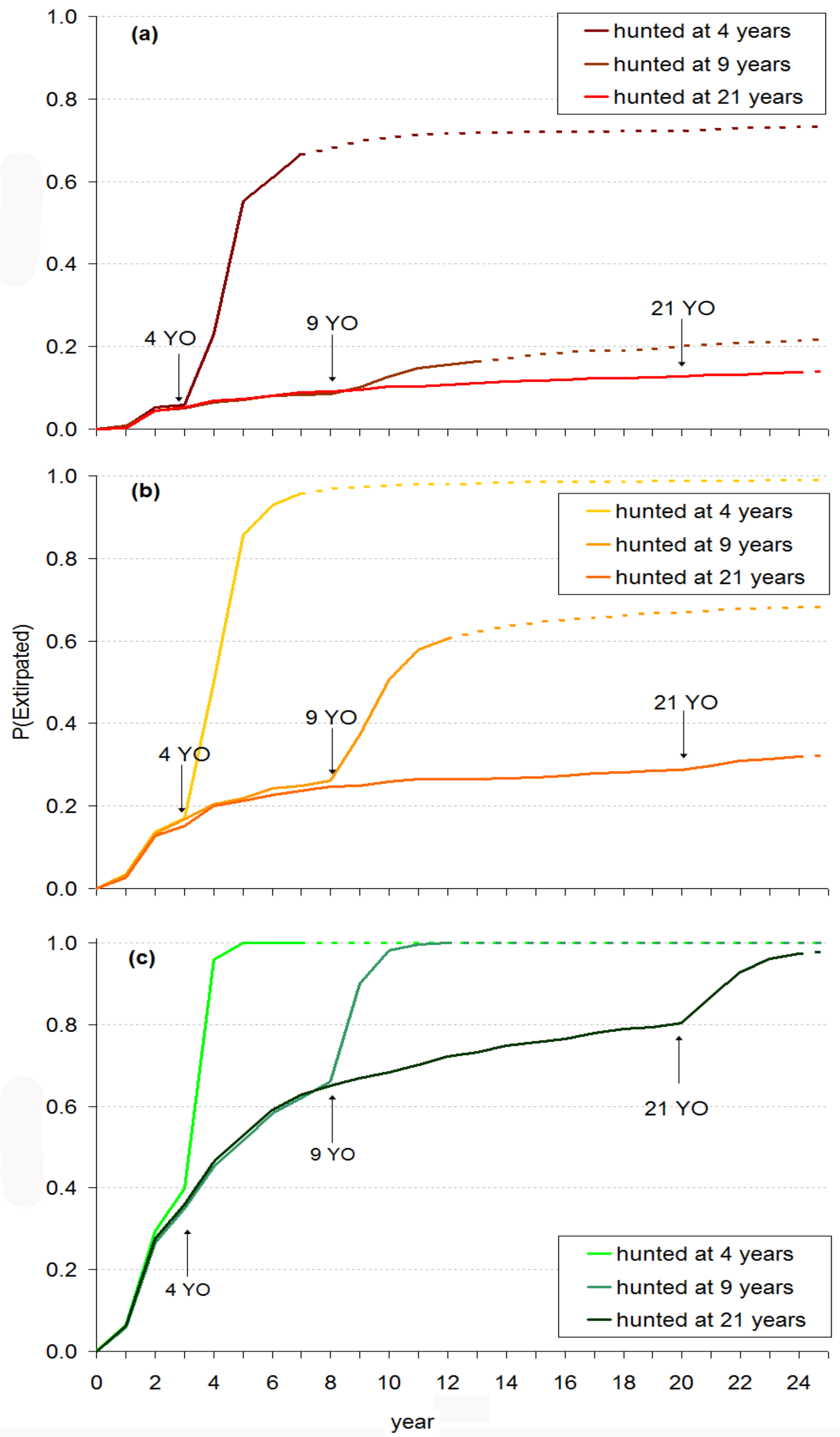

Fig 2: Predicted effect of hunting pressure applied to juvenile and adult alien iguana populations in Saint Lucia, using Vortex simulations (Lacy et al. 2009). Graphs show the predicted probability that the population will be extirpated if it is experiencing: (a) Low (60%), (b) moderate (75%), or (c) high (90%) juvenile mortality, in addition to the hunting pressure. The three lines in each graph illustrate uncertainty over how long this population has been establishing before hunting is initiated; i.e. four (4 YO), nine (9 YO) or 21 years (21 YO). For a population experiencing high juvenile mortality in addition to hunting (c), the probability of extirpation is high, regardless of how long the population has been establishing. For moderate or low juvenile mortality in addition to hunting (b, a), a high probability of extirpation exists only for the younger populations (first hunted at 4 YO or 9 YO). Figure reproduced from Morton & Krauss (2011).*

Effect of severity of hunting pressure on likely eradication success of alien iguana populations

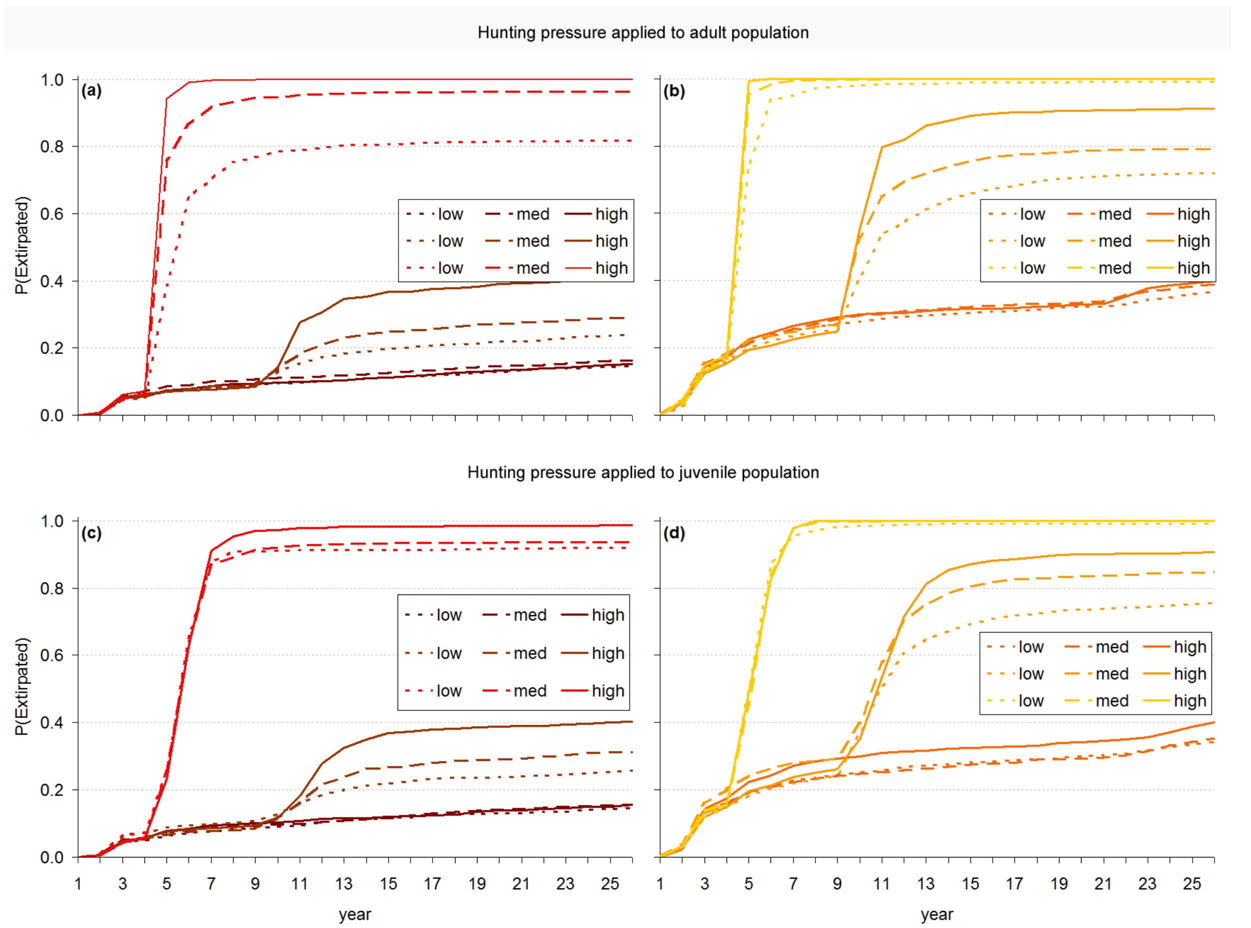

Fig 3: Predicted sensitivity to extirpation of the alien iguana population establishing in Saint Lucia depending on whether hunting pressure is applied to the adult population (a, b) or the juvenile population (c, d). Populations experiencing low juvenile mortality in addition to hunting (a, c) and moderate juvenile mortality (b, d) are shown. For populations with high juvenile mortality, the probability of extirpation under hunting is high in all cases. Figure reproduced from Morton & Krauss (2011).

For the scenarios presented here, parameter estimates were taken from literature on *I. iguana*:

- Age of first reproduction was estimated at two years, i.e. pessimistic compared with Zug & Rand's 1987 estimates;
- Reproduction was assumed to be polygynous (references reviewed by Rodda 2003)
- Adult mortality was set at 60% (using Rand & Bock's 1992 estimates)
- Juvenile mortality was set at (as a worst case, and presumably pessimistic) the same 60%; as best case (and probably optimistic) it was set to 90%.

Two parameters were based on our own results, collected in 2010, albeit using small samples:

- Sex-ratio at birth was assumed 1:1 based on a sex ratio of 48:52 from a sample of 77 hatchlings.

- Mean clutch size was estimated at 40 ± 12.18 from a sample of 4 gravid females in 2010.

One parameter was guessed:

- Percent of adult breeding was guessed for males at 62.7% (given polygyny), and for females at 100% (which may be pessimistic).
- Environmental variation was set to have no effect on breeding; i.e. no variation in reproductive success due to 'bad years' (pessimistic). Carrying capacity was set as high (60,000), to model unchecked growth in an expanding population.
- Although all these parameter values are uncertain, we believe they are biologically plausible (and more likely to err on the side of pessimism). They allowed us to model different management scenarios and thereby demonstrate the potential utility of this tool and allowed us to simulate responses of a population whose size is beyond our means to reliably estimate at this point.

Search Methods

Visual detection of alien iguanas is key to any management. A total of 368 alien iguanas were sighted during this pilot project by visual search on its own or complemented with supporting methods. Most iguanas were seen in Cressland (35), followed by Toraille (31), Jerusalem/Toraille and Jerusalem (17 each), and Saphire (10) (Fig. 4). Counts were analyzed by Chi-square, continuous data by analysis of variance (ANOVA) using InfoStat (Di Rienzo *et al.*, 2013). Readers should bear in mind, however, that adult, juvenile and hatchling counts were pooled for this paper. Hatchlings are typically found in clusters, so that a single nest detection has a relatively large influence on the overall outcome of the analysis. Separate analyses of adult & juvenile versus hatchling data could overcome this bias and is expected to change some of the effects reported below.

Visual Searches

The likelihood of spotting an iguana differed significantly between areas within the known range of the alien iguana ($P = 0.049$; Fig. 4), the supervisor of the field team ($P = 0.046$), but not the number of staff conducting the search ($P = 0.145$). When senior staff visited the pilot site, detection was significantly higher than if either of the two pilot supervisors or nobody supervised the team. Furthermore, areas differed significantly in terms of sighting rates per team-day invested ($P < 0.001$): the Beemans/Saphire transect yielded higher sighting rates than any other route. If the effort invested was analyzed per person-day, however, area, month (both $P < 0.001$) and day time $P = 0.046$) mattered. Again, Beeman/Saphire had higher sighting rates per person day than any other area. The supervisor had no significant effect ($P = 0.716$). Mid day searches were most productive.

Weather significantly affected iguana sightings ($P = 0.003$). Light rain and light cloud cover were most conducive for sightings, followed by overcast skies. Both sunny days and heavy rain were associated with low sighting rates.

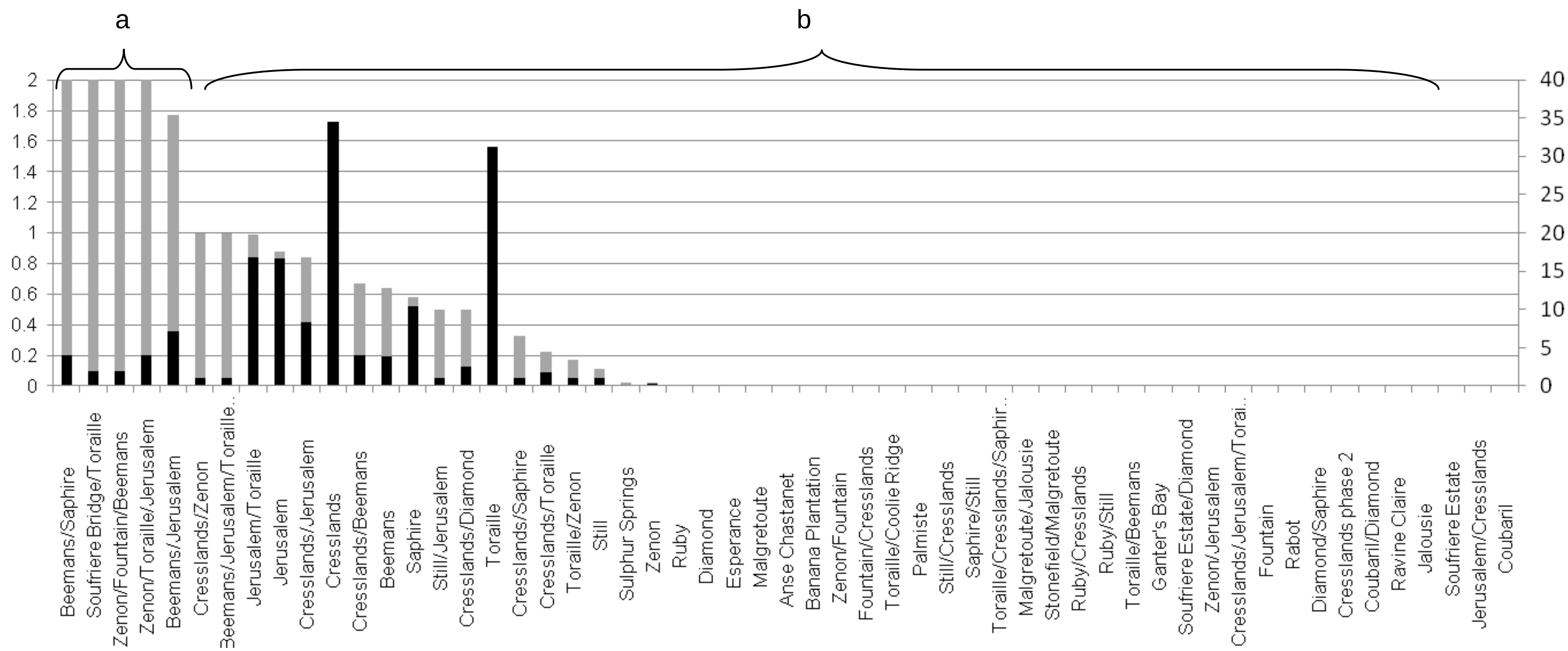

Figure 4: High sighting rates were found only on five transects (grey bars, left y-axis).
Overall, the most iguanas were spotted in Cressland, followed by Toraille (black bars; right y-axis). Counts include adults and hatchling; the latter have a markedly clustered distribution and account for most sightings at Touraille.

The time of day ($P = 0.043$), month ($P = 0.002$), but not year ($P = 0.097$) influenced sighting rates per unit team effort. More iguanas per group day were seen in 2011 than 2012. August was the most productive month, followed by July and December; June, September, October and November had the lowest sighting rates per group effort. Again, most iguanas were seen around mid day. The same trends were true when data were analyzed per person day.

A highly significant ($P < 0.001$) association was found between a new iguana being sighted where another iguanas was present. Not surprisingly, visual searches were most effective when they focussed on an area known or suspected to harbour iguanas ($P < 0.001$).

The presence of what is believed to be iguana scat had no influence on sighting an iguana ($P = 0.759$). But where iguana scratches were found on trees, frequently an iguana was subsequently spotted ($P < 0.001$). Tail drags and iguana holes were not observed during this trial. Other signs, such as sloughed skin, failed to reach significance ($P = 0.759$); thus no conclusion can be drawn from this data set on these aspects.

The presence of lyenn dous (*Ipomoea tiliacea*) ($P < 0.042$) was associated with decreased chances of seeing an iguana, especially near mattered vines ($P = 0.001$). However, signs of vines being eaten indicated good chances for spotting the animal ($P < 0.001$). The presence of mango ($P < 0.001$), coconut ($P = 0.002$), pwa dou (*Inga laurina*, $P = 0.001$), glory cedar (*Gliricidia sepium*, $P = 0.004$), and savonet (*Lonchocarpus* spp., P = 0.012) reduced the likelihood of iguana sightings. Bwi (*Chrysophyllum argenteum*, P = 0.279), bamboo (P = 0.471), kakoli (*Inga ingoides*, P = 0.372), patat (*Ipomoea batatas*, P = 0.674), godmo (*Cissus verticillata*, P = 0.765) and other species (P = 0.331) had no significant effect in this dataset. Branches over water ($P = 0.305$), vegetation on cliff sides ($P = 0.204$), the presence of sandy spots ($P = 0.227$) were unrelated to sighting frequency. The presence of holes under rocks narrowly failed to yield a benefit to detection ($P = 0.083$).

The failure to detect an iguana does not imply no iguanas are present. The species is very cryptic and difficult to spot. Iguanas like basking in the sun high on the canopy of trees or on rocks, except in the heat of the middle of the day. Often dense foliage or dense mats of vine mask their presence, especially when searching from below.

Males may be more conspicuous during mating (when they make territorial displays), usually around October to December. During that time, iguanas often occur in clusters (polygynous 'harems'). Females were expected to be more conspicuous during nesting, roughly the three months dry period February to April. Having to come to the ground to dig nests, this may be a window of opportunity to detect and capture females, but too few data were generated by this pilot to support or reject this hypothesis.

Residents' Reports Tied to Bounty

Twenty iguanas were reported by residents promptly calling the field team and subsequently captured. The capture rate following prompt calls was 100%. Questionnaires, however, indicated that residents see iguanas more frequently and do not call, or not promptly enough, the capture teams. One reason for the low call-in rate could be that the campaign was poorly targeted. It was announced on small business cards (Fig. 5), which were handed out in Soufrière, e.g. to passers-by, at supermarket check-outs and at petrol stations. This was done in response to repeated requests from members of the public in the Soufriére area to have the hotline phone numbers to hand in an easy-to-carry format. Our approach reached mostly those who were going from one place to another. This audience is less likely to have the time to wait for a capture team to arrive than stationary residents, such as stay-at-home mothers, the elderly, farmers attending to their crops, etc.

Fig 5: Two versions of the business card used to announce the bounty. The second version was modified based on public opinions of the first. These were used sequentially and responses were too few to compare the effectiveness of the designs.

During the second round of the bounty awareness, increased efforts were made to reach those who remain most of the day at one rural location and thus can more easily await the arrival of the capture team. Unfortunately, calls were too few for meaningful statistical analysis. Furthermore, a broader iguana awareness campaign, which included the bounty, was on-going throughout the same period on the media. While broad awareness was desirable, the overlapping awareness drives rendered a statistical comparison of the two drives aiming to increase interest in the bounty system, impossible.

Radio Tracking

A total of six iguanas were radio-tracked during the pilot project (Table 1). All were adults, two males and four females. Two females had to be recaptured and euthanized when they were rightly believed to be gravid. One female and one male died due to external factors. IG210 is either dead or had shed its radio collar; to date, the collar could not be retrieved from an inaccessible hole high in a tall tree. IG215 could not be re-captured in time for rather hasty pilot closure, but was successfully recovered subsequently.

Radio-tagged iguanas were sighted successfully in 68% of attempts. Successful sightings were once more associated with cloud cover and light rain (P = 0.004) and not in the sun (P = 0.031). But for radio-tagged iguanas, sightings were more successful in scrubland and urban settings than in forest and cultivated land (P = 0.014). Popular plant species were blue mahoe (*Talipariti* *elatum*), bwa koko kawet (*Casearia decandra*), bwa mil bwanch (*Margaritaria nobilis*), cocoa (*Theobroma cacao*), isabel, kakoli (*Inga* sp.), mapu (*Guapira fragrans*), mortele-bon (*Erythrina* sp.), different types of beans, savonet (*Lonchocarpus* sp.), shack shack (*Albizia lebbeck*) and sip (*Cordia reticulata*) (P < 0.001). Another iguana nearby, surprisingly, had no significant effect (P = 0.985). Lack of significance, however, does not proof the opposite to be true, i.e. it only mean that no conclusion can be drawn from this dataset regarding these research questions.

Table 1: Alien Iguanas radio-tagged during this pilot.

Code	***Sex***	***Weight (g)***	***Comment***
IG172	F	2,100	caught 13 July 2011, euthanized 10 Dec 2011, gravid
IG173	F	1,200	caught 21 July 2011, euthanized 10 Dec 2011, gravid
IG196	F	3,700	02 Nov 2011, found dead 09 Dec 2012
IG210	F	1,700	caught 13 June 2012, stationary signal from March 2013
IG215	M	1,300	caught 26 Sept 2012, re-captured after project closure
IG216	M	4,000	caught 30 Sept 2012, re-caught at sea Dec 2012, died from injuries sustained during capture by members of the public later

If only successful sightings were taken into consideration, few differences between sexes were detected. Male iguanas were more frequently seen on savonet or mortele-bon, whereas females were spotted on a wide range of other plants. Females were seen inside the tree crown, as well as inside or on top of other vegetation, whereas males were commonly seen on top of trees or on extended branches (P = 0.007). Although not statistically significant, there were mild tendencies of females to be seen preferentially near running water (P = 0.099), on cliff tops (P = 0.089) or near motorable roads (P = 0.062).

With the low numbers of radio-tagged iguanas and a gender bias, it is difficult to decide to what extent any observed preferences are due to an individual's choice and to what extent they apply to the gender generally. Analyses by individuals showed that females IG172 and IG196 were notably fond of scrub and vines on trees, particularly lyenn dous (all at P < 0.001), while male IG215 was only found on tree tops (P < 0.026). Plant species preferences of individuals were highly significant (P < 0.001). Preference for running water by females (P = 0.050) may also stem from individual partiality.

One very active male covered over 3.6 km from its release site and was spotted swimming in the sea near Jalousie Plantation (now: Sugar Beach Resort). When it got scared, it dove deeper into the water. Fishers retrieved the live iguana from a depth of 30 feet with a net (see more below under Iguana Alert Network).

Detector Dogs

Detector dogs have been used previously to locate another alien invasive arboreal reptile, the Brown Tree Snake (*Boiga irregularis*) on Guam, both in airport cargo (Vice and Engeman 2000) and free-living in trees (Savidge et al. 2008). This prompted us to evaluate the feasibility of this approach for detection of the green iguana. On Guam, researchers released radio transmitted snakes into specific areas for the dog and handler teams to survey; however, only one free-ranging snake was found over a four month study with two dog/handler teams (Savidge *et al.,* 2008). So careful fine-tuning will be required. Detector dogs have, however, been used successfully to find a variety of other reptile species (e.g. Iampietro, 2013; McCormick, 2010; Nussear *et al.,* 2007)

A conservation dog, Tucker, and handler were contracted from the Center for Conservation Biology (CCB), Conservation Canine (CK9) program at the University of Washington. Conservation Canines adopts dogs from rescue shelters that cannot be placed in homes. Dogs that make it into the program must have an intense desire to play fetch. They are happy to work all day long in the field scenting for scat or other olfactory cues just for the opportunity to obtain their play reward upon locating each sample. Conservation Canines traverse plains, climb mountains, clamber over rocks and fallen trees, splash through rivers and trek through snow all over the world, helping to monitor and study wildlife.

Use of detection dogs to locate wildlife (via their scat) over large areas was pioneered in 1997 by Samuel Wasser, Director of the CCB. Since then, the CK9 has been non-invasively monitoring a diverse array of threatened and endangered species around the world. Elizabeth (Liz) Seely, the handler, has been working on and off with Tucker as a team searching the ocean for resident killer whale scat in an effort to help researchers determine the potential causes of the recent population declines. Tucker and Liz worked on the iguana pilot study in Soufrière, Saint Lucia, to locate the alien arboreal iguanas, because detection of individuals at very low population densities is a major bottle neck to success.

On Saint Lucia, Tucker and Liz faced the significant challenges of locating an arboreal reptile in thick vegetation in a tropical climate and mountainous relief. They utilized multiple training tools in order to optimize Tucker's chance of locating the iguanas. Body swabs taken from previously captured iguanas were originally used to introduce Tucker to their scent. Preserved iguana eggs were placed in holes and under sand to teach Tucker to dig when he detects the odour of potential nest sites. As the study progressed, the team collected native and alien iguana scat to help determine specific areas within the forests where iguanas are living. At the final stage, captive native and alien iguanas were included in the training to be certain that Tucker was alerting to the scent of live iguanas. The cages used to hold these iguanas were varied to ensure that Tucker was truly detecting iguanas rather than cueing on the scent of plastic or metal (Seely & Wasser, 2012).

Taking the training out to the field proved to be a whole new challenge. Saint Lucia was struck by Hurricane Tomas in October of 2010, causing severe damage to our study location in Soufrière from landslides and floods. The damage made hiking extremely difficult at times. Surveys had to be restricted to mornings to avoid the oppressive hot, humid afternoon weather. Liz spent the afternoons surveying with the Durrell volunteers, hoping to find areas likely to contain iguanas that Tucker could search for in detail the following morning.

Soufrière received heavy rain for weeks in late April and early May 2012, which caused more flooding and some small landslides in our study area. The new rainfall further complicated hiking conditions in likely iguana habitat to be surveyed, and particularly along ridge tops, ravines and river beds.

Tucker and his handler were always accompanied by a member of the Forestry Department and/or a Durrell volunteer during our surveys. As Tucker's training progressed, he became better in locating iguana signs in the field. However, he still had not been able to find a wild iguana.

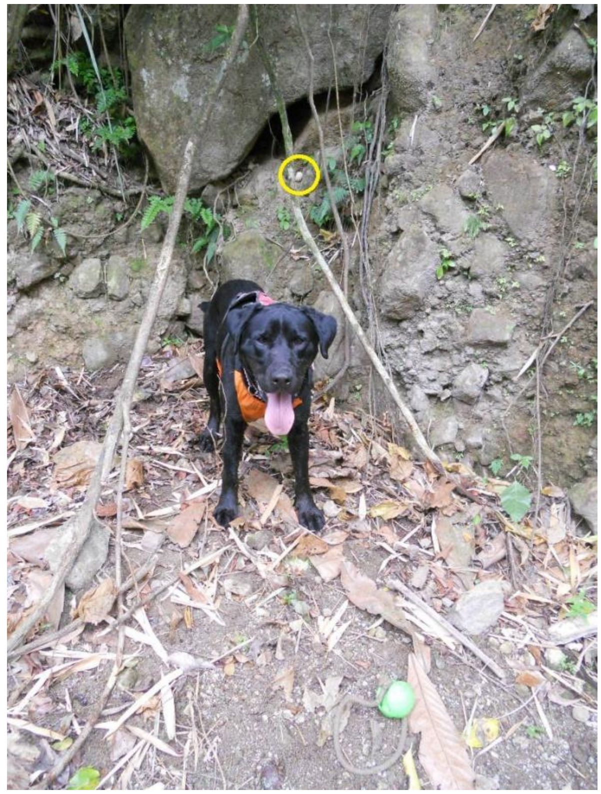

Figure 6: Tucker waiting patiently for his reward after finding an iguana egg in the opening of a hole by the river (circled yellow)

Thus, we decided to set up blind exercises as a proof-of-concept. Forestry personnel or Durrell volunteers hid a live iguana or iguana scat in the forest without the K9 team's knowledge, which Tucker and Liz then set out to find. Tucker found every sample, without fail (Figure 6). He has an incredible nose and is capable of smelling iguanas in the trees, even though he cannot climb them. During training, Liz noticed that Tucker would circle an area of interest, leave the area, circle back into the area, and repeat the process. Even though he was unable to locate the specific area, he was able to show his handler that he found and alerted to the proper smell! These alerts provided the Forestry Department and Durrell volunteers with specific areas to focus their searches. However, since these iguanas live 10-40 meters up trees in dense vegetation, locating them remains a formidable challenge; only one iguana has been located by Forestry personnel over the relevant three months, including the duration of this pilot study, as opposed to over 150 in 2010. As eradication efforts progress, this difficulty will increase.

At completion of the pilot study, the SLFD and Durrell were provided with digital (GIS) locations of areas where Tucker had alerted to iguanas or located iguana scat. Those locations are were subsequently being used to conduct further investigations with hope that authorities will find an increased number of iguanas in the specific areas where Tucker alerted to the scent. However, successes were too rare for meaningful analysis. The high cost of an overseas detector dog and handler team visiting did not permit a second trial season to consolidate preliminary data.

Capture Methods

All iguana removals have been the result of intensive visual searches supplemented by reports from local residents and other clues, which led to captures by hand or pole-noose. As is to be expected, a focussed search, while beneficial to detection (see above), had no influence on the capture success rate (P = 0.747).

By MTR even relatively modest hunting pressures used in simulations models above, for which realistic eradication chances were predicted, exceeded the actual alien iguana removal rates that we were able to achieve in the first two years of this project, despite intensive efforts. After one year (late 2010), only 21 adults (including sub-adults) and 132 hatchlings had been removed. Thus, the focus of the pilot moved from an attempt to eradicate towards a quantitative assessment of the cost-effectiveness of detection and capture methods in order to take an informed decision on future eradication attempts. By the end of the four-year project, just over 60% (221 of the 368) of sighted iguanas were successfully caught; the remainder escaped by running, jumping and/or swimming. Occasionally the tail was shed.

All 221 iguanas captured under this project were euthanized by lethal injection administered by the Veterinary Division of the Ministry of Agriculture, Food Production, Fisheries and Rural Development (or its predecessor, Ministry of Agriculture, Lands, Forestry and Fisheries. Morphological data were recorded and tissue sample for DNA analysis taken from the carcass. Some iguanas were maintained in captivity for testing of feeding preferences/baiting for some time or radio-tagged and released. After completion of these additional studies, they were also euthanized.

Iguana Attracting Methods

The rationale behind this series of experiments was to assess whether it is possible and cost-effective to attract iguanas towards their prospective captors. This was suggested in the MTR and also by J. Duquesnel and A. Lopez (in litt.). Two approaches were chosen: baiting to eventually lure iguanas into traps and artificial nests to attract gravid females during nesting season, when capture impact is largest, as a breeding adult and year's off-spring can be destroyed.

Trapping and Baiting

Prior to the launch of MTIASIC, in September 2009, a pilot study conducted by Durrell and SLFD deployed 50 Tomahawk live traps and 20 releasing-lock snares in about 0.5 km^2 within the core area of iguana sightings, but no iguanas were captured by either method over a four-week period. Traps and snare enclosures were baited with aromatic fruit (mango, banana) plus fragments of red fabric as green iguanas are reported to show a preference for red foods such as hibiscus flowers (G. Besne-Garcia, pers. comm.). This could be attributable to the arboreality of the iguanas, the putative low population density, and/or an apparent super-abundance of food (foliage), which would render the baited traps less attractive.

Further trapping assessments were carried out under this project in the 2011 nesting season. During this period, female iguanas presumably spend a greater proportion of their time on the ground and, post-nesting, were likely to be more motivated to feed after having suspended feeding while gravid (Rodda 2003). Prior to field trapping, bait preferences were tested with captive iguanas, i.e. alien iguanas caught via visuals search and manual or noose capture, in order to optimize trapping and baiting chances. Following disappointing trapping results, this exercise was repeated and expanded in 2012.

Initial experiments involved a wide range of purchased fruit (including watermelon, strawberries and cocktail cherries). When these tests yielded only negligible results, freely available fruit, i.e. bananas, mangos and papayas, were tested more extensively on captive iguanas. Only mangoes were taken. However, captive iguanas preferred lyenn dous, a vine that is readily available throughout most of the alien iguana's range, rendering any bait relatively unattractive. It should be noted, however, that (1) captive iguanas may feed on foodstuff they would not voluntarily chose in nature and (2) recently captured iguanas may be too stressed to practice their normal feeding habits. In the wild, iguanas spend only a small part of the day, i.e. less than an hour, feeding (typically on leaves). This is a fundamental limitation to baiting them, though this approach has resulted in iguana captures in, for example, Florida (J. Duquesnel, pers. comm.).

Ten bait stations were constructed and installed in a range of habitats. Resources and time taken was recorded. Three stations were installed between 2.5m and 13 m above the ground (Fig. 7). It took an average of 5 minutes to construct each bait board (excluding travel time to site).

Fig 7: Highest of the iguana bait stations was placed in canopy of tree.

Artificial Nests

In other countries, female iguanas may nest in or close to their home range or migrate up to 3km to nest sites and return afterwards. Eggs are laid ca. 0.5-1m underground, in a chamber at the end of a tunnel that may be up to 2-3m long. Some females reportedly guard freshly dug tunnels for a few days after having dug them, supposedly to prevent other females using them and from destroying eggs already deposited. This is the only reported egg guarding; iguanas show no parental care.

Twelve artificial nest sites were constructed to simulate 11 natural potential nesting sites. The effort involved was quantified. In practice, the artificial and natural nest sites did not differ in length (*t*-test, $P = 0.269$), but the former were slightly wider ($P = 0.011$). The 23 sites were monitored for the presence of eggs, visitation by iguanas and tail drag marks, again measuring the effort necessary. Meteorological data were also recorded.

None of the selected signs were observed during the trial period form 23 March to 11 April 2012. Thus, any cost-efficacy analysis would have been futile.

Manual Capture, Noosing and Nets

The likelihood of successfully catching a sighted iguana was independent from the search area ($P = 0.543$), the supervisor of the field team ($P = 0.308$) and the number of staff on the search party ($P = 0.819$). Similarly, a focused search was no indicator of a subsequent successful capture ($P = 0.747$).

Highly significant differences ($P < 0.001$) existed between capture methods (Fig. 8). Whenever attempted, manual capture was most effective, with a 90% success rate. This was followed by using a hoop net (eight out of 10 attempts successful). Noosing was frequently the only applicable method, because of its farther reach. The success rate was a respectable 74%. Few attempts (seven each) were made for the free net and gun; five attempts each led to capture.

Iguana hatchlings were more easily captured ($P < 0.001$) than juveniles or adults (Fig. 9). It would be worthwhile to analyse a larger dataset as a crossed contingency table, for method and iguana development stage (adults & juveniles versus hatchlings) simultaneously.

Environmental Factors Influencing Capture Success

Neither the area ($P = 0.411$), year (2011 or 2012; $P = 0.872$), month ($P = 0.132$), nor time of day ($P = 0.741$) influenced overall capture rates significantly. Similarly, capture rates per group day ($P = 0.981$) and man day ($P = 0.906$) were also independent from area, year (2011 or 2012; $P = 0.979$ and $P = 0.999$, respectively), month ($P = 0.121$ and $P = 0.219$, respectively), and time of day ($P = 0.435$ and $P = 0.493$, respectively). Similarly, if data were analyzed per man day invested, there were no significant differences between areas ($P = 0.906$), years ($P = 0.999$), months ($P = 0.219$) or time of day ($P = 0.493$).

The weather influenced overall capture success ($P < 0.001$; Fig. 10); this however pools adult and hatchling captures. Again, future analyses should separate adults and juveniles from hatchlings. On normal rainy days, capture success was highest with 93%. When rain was heavy, this rate dropped to 50%. The second highest capture rate was observed overcast days: 72%. Sunny days, with 53% success, were less favourable. The lowest success rate (17%) was recorded in light rain.

Running water in the vicinity ($P = 0.370$) and the exact iguana location (on plant or rock; $P = 0.103$) had no significant influence on capture success. However, the habitat had a significant influence ($P = 0.003$; Fig. 11). A large proportion of sighted iguanas was captured in most disturbed sites, whereas in scrubland, forests and shrubs an increasing proportion of the sighted iguanas escaped capture. There were relatively few sightings in highly disturbed areas, such as backyards, farmland, roadsides and residential areas, but all 16 iguanas detected there were also caught. In fact, the proximity of a motorable road ($P < 0.001$), and crop cultivation ($P = 0.001$), was associated with high capture rates. But again, raw data were biased towards hatchlings from one area (Touraille), so that these probabilities should be interpreted with caution.

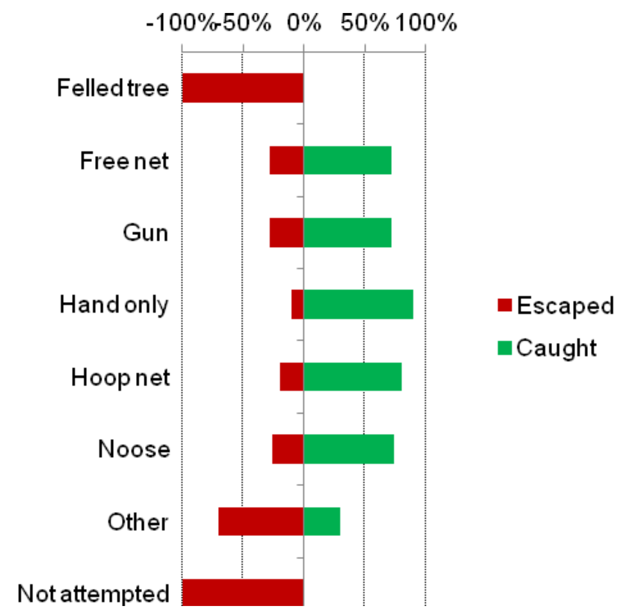

Fig 8: Capture methods for alien iguanas in Soufrière (% success)

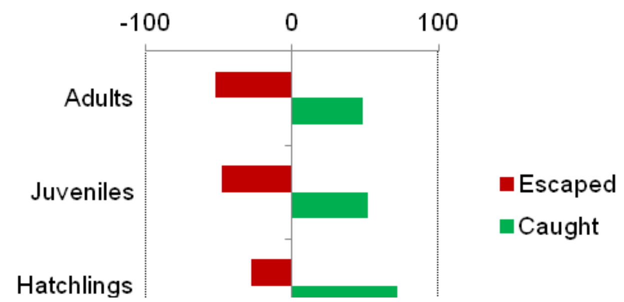

Fig 9: Iguana development stage: influence on capture rate (% success)

A sun-exposed site ($P = 0.001$) or cliff sides roost ($P < 0.001$) reduced capture efficacy. The presence of savonet ($P = 0.039$) and lyenn dous (*Ipomoea tiliacea*; $P = 0.050$) increased capture chances, especially when vine had been eaten ($P = 0.043$). The presence of mango ($P = 0.494$), coconut ($P = 0.561$), pwa dou ($P = 0.944$), bwi ($P = 0.317$), bamboo ($P = 0.429$), glory cedar ($P = 0.791$), kakoli ($P = 0.116$), patat ($P = 0.768$), godmo ($P = 0.699$) had no significant effect on capture rates (Fig. 12). However, there were too few observations for most plant species (single observation for some) to interpret results for the other plants shown in Fig. 12.

A closed canopy ($P = 0.075$), cliff top roosts ($P = 0.397$), soil texture ($P = 0.095$), rocky ground ($P = 0.129$), the position on/within vegetation ($P = 0.103$), the presence of another iguana ($P = 0.521$) or iguana scratch marks ($P = 0.695$) had no significant influence on capture success.

Human Resource Considerations

Overall capture rates ($P = 0.657$) and those per group days invested ($P = 0.789$) were independent of the team supervisor. The number of staff on the day (range 1 to 12) had no influence on the capture success rate of the group ($P = 0.984$). If the effort invested was analyzed per man day invested, similarly, neither supervisor ($P = 0.814$) nor number of team members (P = 0.997) mattered. However, most teams were of intermediate size so that the extremes that would be of interest for management decisions did little more than add uncertainty. It should also be born in mind that some capture methods, such as free net, require a minimum number of people.

As already mentioned in the section on radio-tagging above, sighting successes were more common with cloud cover and light rain than in the sun. Capture rates, as just seen, were higher in moderate than in light rain. It is conceivable that more diligent search efforts are being made in more pleasant weather, as opposed to heavy rain or hit sun. This would be consistent with the (non-significant) tendency of more sightings near motorable roads, noted above.

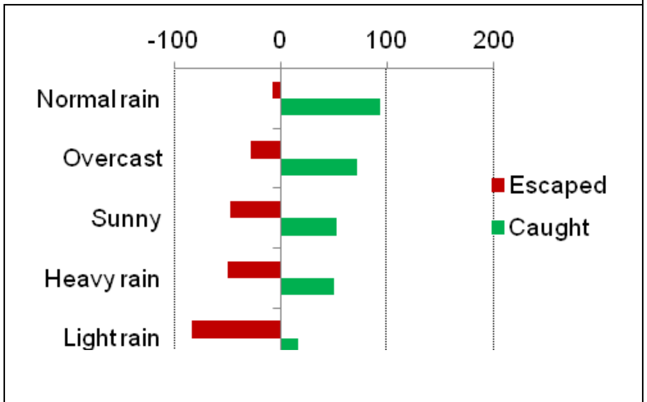

Fig 10: Weather: influence on capture success of alien iguanas in Soufrière (%)

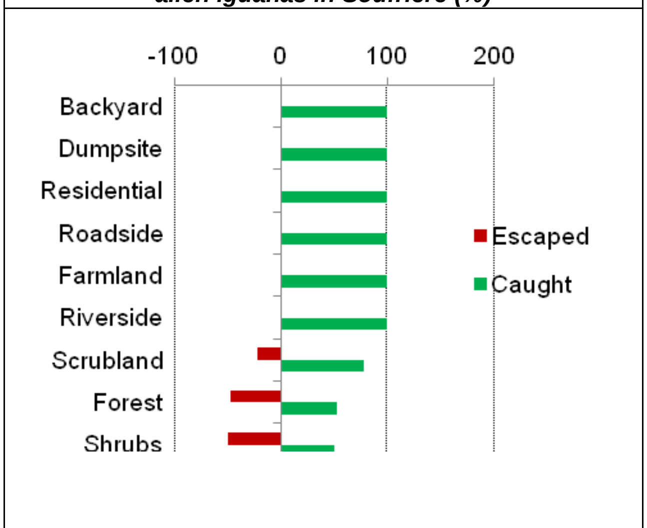

Fig 11: Habitat: influence of on capture success of alien iguanas in Soufrière (%)

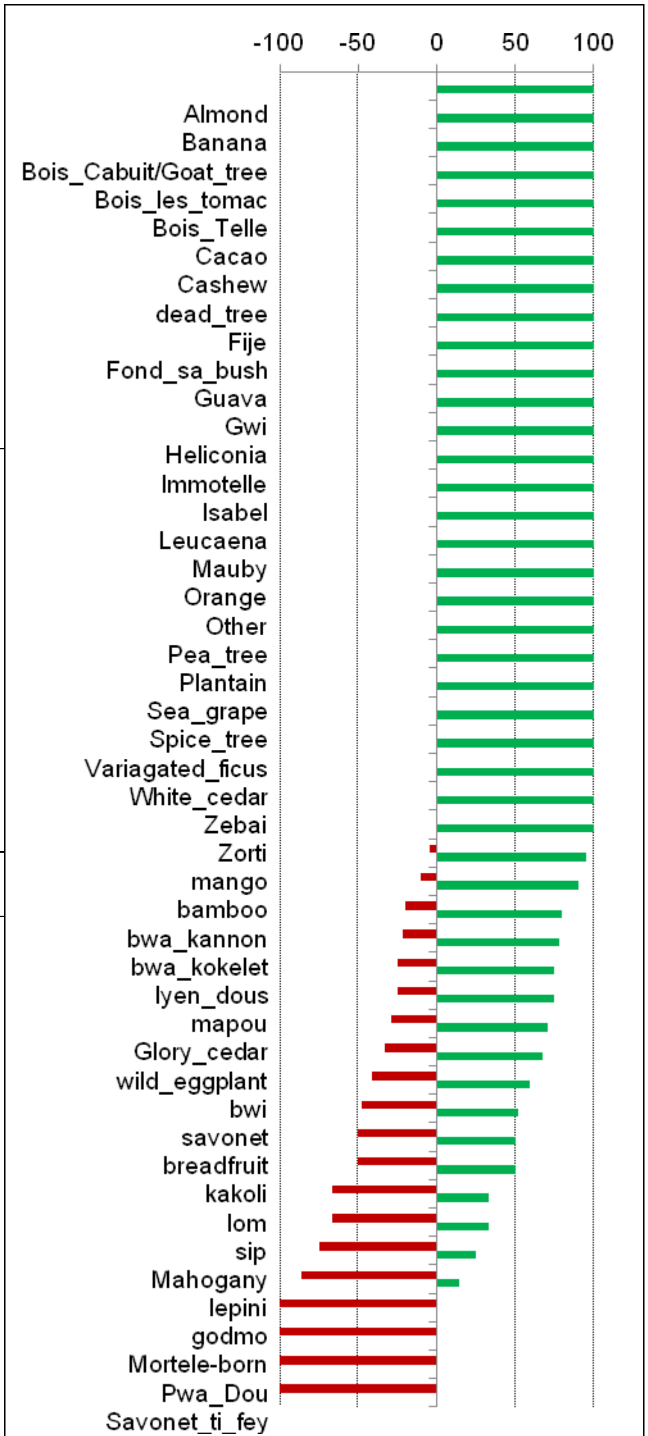

Fig 12: Plant species: influence of on capture success of alien iguanas in Soufrière (%)

Capture Following Residents' Reports Tied to Bounty

While only relatively few calls were received from residents, for the likely reasons discussed above, the capture rate following prompt residents' reports was 100%. Thus all who made the effort of calling and awaiting Forestry staff were rewarded. This method, if better targeted to the most responsible segment of the population, has the potential of boosting detection and capture rates. Therefore, a iguana reporting network of 30 persons in three general locations in the vicinity of Soufrière was established. After the project-funded bounty was phased out, these individuals agreed to be regularly consulted about alien iguana sightings in their neighbourhood.

Iguana Alert Network (IAN)

The Iguana Alert Network is a action taken towards both sustainability of alien iguana management and social marketing, as several members were previously not aware of the implication of importing and/or keeping iguanas as pet. They have since recognized the importance of preventing further imports as well as the spread of the alien iguana beyond its current distribution in the wider Soufrière area and support the SLFD's alien iguana control efforts.

During the establishment of the IAN, the team focused on areas at the margins, but still outside, the current distribution of the alien iguana. The rationale behind this is that reporting a sighting in a new area is more critical than in the existing range. Therefore, 21 of the 30 members reside in the Piaye/Choiseul area to the South-East and Bouton/Canaries to the North.

The wider public has grown more responsive: the National Coordinator received about a half dozen reports of the sighting of a large iguana on or near the Dennery Road at Fond D'Or. Pictures and personal reports consistently led to a particularly active male specimen of the indigenous Saint Lucia iguana. In September, 2012, the SLFD was notified of an iguana hatchling at the Sandals Saint Lucia Dive Center at Ganters Bay, Castries. Officers responded and captured the alien reptile. A subsequent press release explicitly solicited the assistance of the general public to note and report any iguana sightings outside of the north east corridor. The notice also stressed that the unauthorized capture and keeping of wildlife is an offense under the Saint Lucia Wildlife Act. Three months later, the Soufrière Marine Management Association (SMMA) was alerted to an alien iguana caught at sea by fishermen. It turned out to be one of the radio-tracked iguanas (IG216 in Table 1). Once more, a press release was issued that not only explained the alien iguana control programme but also the radio-tracking approach in a language for the general public. The fact that the alien iguana seemed comfortable and adept at swimming in and below sea water underlined the invasive behaviour of the species in the public eye. For the IAN to fulfil its purpose, the SLFD needs to prioritize the regularly communication with the informers. At the time of writing, no up-date had been collated.

Regional Exchange of Experiences

A number of possible approaches to increase detection and capture probabilities were considered and investigated initially by literature research, followed by focussed knowledge exchange with international experts. These included poisoning, falconry, attractants and baiting. A summary of discussions is presented in Table 2.

Table 2: Key matters arising from the conversation were:

International experts' recommendation	***Saint Lucia's action or response***
Test Harris's hawks, which are specialized in reptiles and hunt within tree canopies	Contacts were explored for raptors that could be leased for this purpose. We were unable to find anyone working Harris's hawks on international projects. However, the Canadian company Predator Bird Services Inc. (www.predatorbirdservices.com) uses using birds of prey to control problem species. A meeting was arranged in Nov 2011 to discuss whether falconry is an option for controlling the problem of bird strikes at the airports and/or for the alien iguanas in Soufrière. Their raptor species can be used against birds, but not arboreal reptiles. The simplest consultancy involving a leased raptor would cost in excess of US$25,000.
Test different leaves and fruit choices on a small captive population of alien iguanas. Determine what specific baits are more attractive than their observed feeding on *lyenn dous*.	This was done (see above), albeit without success.
Exploring attractants other than baits, e.g. pheromones, basking stations, etc.	These options were researched in the literature and reviewed in M. Morton's report. No suitable attractant could be identified for field testing.
Given the terrain and lush vegetation it may be more productive/ more expensive saturating the area with traps and determining proper trap placement areas.	Without successful baiting, no trapping density is going to be productive. This the expense cannot be justified. Traps are also items of attraction to poachers in the area.
Exchange of methodological approaches and experiences with French National Hunting and Wildlife Agency (NHWA), who are a member of the Caribbean Iguana Delicatissima Conservation Network (CIDCN) and the IUCN Iguana Specialist Group. All direct costs were covered by the *Office National de la Chasse et de la Faune Sauvage* (ONCFS), with the help of FEDER funding. The aims of the mark-recapture sessions were to: ➢ to assess the population size using a standardized protocol that is suitable for collating population dynamics data, when repeated ➢ collect data on morphometry, behaviour, pathology and physiology of Iguana delicatissima, I order to estimate the population health ➢ obtain tissue samples for genetic analysis ➢ gain an insight into population structure and dynamic by repeating those Mark-recapture	Two exchange visits to Chancel Island, Martinique were arranged for two field team members on 2012 and three C5 staff in 2013. This represented a great opportunity to reinforce a functioning network to work on iguanas' conservation in the Caribbean by sharing valuable information, provide training and support to each other. Though Saint Lucia and French West Indies do not have the same iguana species to protect, they both face some similar problems. Achievements were: ➢ 165 *I. delicatissima* caught for the first time during this session, plus 28 recaptures from this session (193 total captured), which corresponds to a rate of 5-8 Iguanas per team per day. This represented an increased in capture efficiency, but a decrease in detection. Females are suspected to be less detectable, due to behaviour ➢ 81 Iguanas caught for the very first time (considering previous capture sessions too) and Pit-tagged, bringing the total population of

studies.	Pit-tagged iguanas to nearly 600. ➢ Very few mistakes in data taking were recorded ➢ A detailed report was prepared by Chloé Rodrigues of ONCFS and shared with partners While the experience was very valuable in terms of networking and iguana conservation methodology, the approaches are probably more applicable to Iyanola conservation interventions, or even off-shore island work, than to the control of the alien invasive iguanas, due to marked differences in terrain; vegetation cover; iguana appearance, behaviour and density.

Acknowledgements

This project has received significant help from within and outside Saint Lucia. Local field assistance and supervision was provided by Pius Haynes, Gilbert Pierre, Timotheus Jn Baptiste, and Lester Jn Baptiste, who perished in flood waters in Fond St Jacques during Hurricane Tomas. The Veterinary Division of the Ministry of Agriculture euthanized captured alien iguanas.

Durrell regularly assigned volunteers, who made various contributions: Rachel Barwick, Rob Williams, Amy Clack, Lenni Griffiths, Benji Barca, Mike Ball, Nick Condie, Nate Wood, Barbara Schaeffer, Twyla Holland, April Tyror, Karin Crofts, Tristan Chan, Imogene Aylwin, Carola Dallmeier, Alex Blackman, Alex Fleming, Lucy Williams, Kate Entwistle, George Downing, Stanley Leonard, Abhijeet "AJ" Saran, and Charlotte Crummack.

We are grateful for ideas contributed by Jim Duquesnel, Rick Engeman, A. Lopez, and Jamie Reaser. Training on Chancel Island would not have been possible without the efforts of Chloé Rodrigues. Samuel Wasser, Heath Smith and, last not least, black Labrador Tucker made the CK9 pilot what is was.

Images

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