

Final Project Evaluation Report

We ask all grant recipients to complete a project evaluation that helps us to gauge the success of your project. This must be sent in **MS Word and not PDF format**. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Complete the form in English and be as concise as you can. Note that the information may be edited before posting on our website.

Please email this report to jane@rufford.org.

Your Details	
Full Name	Jeanette Moss
Project Title	Natal ecology of the Sister Islands Rock Iguana (SIRI): radio-tracking and long-term monitoring of juveniles on Little Cayman and Cayman Brac
Application ID	23086-В
Grant Amount	£10,000
Email Address	Jbm650@msstate.edu
Date of this Report	December 7, 2017



1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Evaluate population recruitment on Little Cayman based on recapture success of neonates tagged in 2015 and 2016				Low recapture rates; maximum-likelihood estimate of cohort size calculated to be 3,722 in 2016
Investigate natal dispersal, survivorship, and habitat associations using radio- tracking methods				A total 28 hatchlings tracked from natal sites; positively confirmed fates of 18 (77% survivorship) by end of 4 weeks
Evaluate impact of inbreeding on recruitment in highly reduced Cayman Brac subpopulation by sampling and genotyping hatchlings and comparing levels of heterozygosity to adult cohort				A total 65 hatchlings sampled on Cayman Brac in August 2017; genotyping and laboratory analyses are on- going to evaluate severity of inbreeding depression
Cultivate working partnership with the Little Cayman District of the National Trust's "Green Iguana B'Gonna" (GIBG) program to facilitate the removal of invasive green iguanas and hybrids				One hybrid and six green iguana hatchlings removed by our team between August and September 2017; collaborative efforts of our team, GIBG, and Cayman Islands Department of Environment (DoE) yielded six more hatchling captures in October, generation of green iguana database and high- quality maps, construction of secure hybrid enclosures, genetic analysis of hybrids and green iguana clutch, and inception of DoE internship position to assess biosecurity protocols on Little Cayman and facilitate continued collaboration between DoE and National Trust



2. Please explain any unforeseen difficulties that arose during the project and how these were tackled.

Over the course of our radio-tracking season, some challenges arose which were not altogether unexpected given the nature of radio-tracking but nonetheless affected data collection. Given that about 30% of Little Cayman's land area is comprised of mangrove wetlands and lagoons, we anticipated difficulties with tracking subjects on foot once they dispersed into the island's interior. To address this challenae, we enlisted a custom unmanned aerial vehicle (UAV) tracking system developed by University of California San Diego Engineers for Exploration. While the system performed very well for the first several weeks of field-testing, need for replacement parts became limiting about halfway through the season and several hatchlings migrated too far into impenetrable terrain to be tracked on foot, resulting in lost signals. In addition, Hurricane Irma rendered tracking efforts hazardous for a period of 2 days, and upon resuming the study, several more transmitter signals had been lost. We made daily efforts to recover lost signals by triangulating along accessible roadsides, and a handful of tracking subjects eventually emerged on the opposite side of the island. Ultimately, 10 of 28 tracking subjects had unknown fates as a result of lost signals.

Another challenge that we faced this season involved one of our major project objectives, which was to begin the process of expanding nesting surveys to include Cayman Brac – the other island within the range of SIRI. We approached this objective as a trial run, where sampling was concurrently conducted on Little Cayman and Cayman Brac for about 3 weeks at the peak of hatching season. Overall, this was very successful and SIRI nests were sampled for the first time on Cayman Brac. Moreover, data collection on Little Cayman was allowed to continue for the most part uninterrupted. The major challenge faced was in stretching personnel across two islands in an effective manner that both maintained consistency of methodologies and ensured a sufficient workforce was present on either island at all times. In the future, we hope iguana monitoring efforts will continue to expand on Cayman Brac but this task should be approached with greater division of leadership roles and minimal exchange of volunteers.

3. Briefly describe the three most important outcomes of your project.

a). The first major outcome of this project was to identify age classes at which attrition may be outpacing recruitment in wild populations of SIRI and gauge the urgency of mitigation measures. In a broader sense, this project contributes to a deeper understanding of the life history of SIRI and rock iguanas in general, in particular of expected levels of fecundity and neonate survivorship. In long-lived species such as rock iguanas, examining viability across individual life history stages is critically important to projecting population trends, since high attrition in younger age classes may be masked by longevity and high fecundity in older age classes. Through a combination of long-term monitoring and radio-tracking approaches, we found that SIRI's annual fecundity is quite high (annual cohort size is estimated to be close to 4,000, if accounting for large margins of error (2,000-20,000)) and that neonates experience surprisingly high survivorship over the first 4 weeks compared to



some similar taxa (77% based on known fates alone; 50-86% extrapolated from worst and best case scenarios for hatchlings with unknown fates). These data set important baseline expectations for particular age classes in the population under natural circumstances. While very low recapture rates suggest that attrition expectedly increases over the first year, our population database shows all age classes including juveniles and first-time breeders are well represented, abating deliberation of conservation measures such as captive breeding and head-start programmes to boost successful recruitment. On the other hand, high annual road mortalities and steadily declining nest counts over the past 3 years of survey effort suggest likely ongoing reductions in the adult breeding cohort. Our data warns that unnatural attrition in older age classes could begin to outpace recruitment if sources of unnatural mortality such as roadkill are not mitigated.

b). A second major outcome of this project was to inform habitat protection measures on Little Cayman by generating new data on the habitat use patterns of disparate life history stages in the population. Through our hatchling radio-tracking efforts this summer, we contributed the first characterisation of natal ecology for this taxon, including patterns of dispersal and habitat associations. We found by comparing juvenile and adult capture histories that dispersal is most pronounced during the natal life stage. The hatchlings in our tracking study migrated distances of over half the length of the island in just a few weeks, and a few averaged as much as 1 km a day (quite the feat for a 50 g animal). We also examined the final locations of tracking subjects after their movements ceased and found that the habitat that serves as valuable sanctuary habitat for hatchlings (i.e. interior dry shrubland, manarove forest, and the edge habitat between) also serves as foraging and home territory habitat for many of the adult females that we radio-tracked last summer. However associations with microhabitat types (i.e. arboreal in hatchlings) suggest that different age classes utilise similar habitats in different ways. This contrasts with the results of a radio-tracking study on Andros Island that identified manarove – a habitat type that is not preferred by adult iguanas – as critical sanctuary habitat for hatchlings. Our finding is important because conservation actions currently prioritise the protection of coastal shrubland (i.e. nesting habitat for iguanas) and wetland (i.e. important breeding and foraging areas for seabirds), but afford less attention to the protection of interior habitat types such as dry shrubland. Because this pristine habitat is critically important for both the year-round foraging of adults as well as the survival of neonates, we have recommended the establishment of large protected reserves in the island's interior as a medium- to long-term goal (depending on the rate at which island development accelerates) to forestall the impacts of encroaching development and safeguard the long-term viability of SIRI.

c). A third contribution of this project was to assess the urgency of action required to address possible threats to recruitment. By collecting environmental and genetic data upon hatching and monitoring a representative sample of hatchlings over their first weeks of life, we were able to identify major threats during this vulnerable period. Overall high hatching success (90%) in over 100 nests sampled on Little Cayman over the past 3 years suggests that environmental variables affecting the nesting stage are not massively limiting to successful recruitment in the population. Surprisingly, our radio-tracking dataset also did not reveal a large impact of natural predators such



as snakes and birds on the survival of hatchlings in their first 4 weeks (11% of confirmed fates; up to 42% assuming worst-case-scenario for unconfirmed fates). However, we did record at least two instances of predation by feral cats, accounting for half of all confirmed mortalities in our tracking dataset. While our sample sizes are small, the fact that we observed as many predation events by introduced as native predators is very concerning. Due to a rapidly increasing feral cat population on Little Cayman, we anticipate that alien predators are likely to become a major recruitment-limiting factor in the future if not controlled. Combined with evidence linking feral cats to mortalities in fledgling sea birds, the predation events we recorded this season have hastened the organisation of a major feral cat cull on Little Cayman (expected 2018) to mitigate the threat to native fauna. On Cayman Brac, we are in the process of investigating a more subtle threat to recruitment, which could have a major impact on population viability over the longterm. While we did not detect any genetic signals of severe inbreeding depression in the population of Little Cayman, we suspect that genetic factors could be limiting recruitment in the Cayman Brac population due to the relatively recent, dramatic size reductions which may have exacerbated inbreeding depression. While we are not able to influence mate choice or increase natural population sizes, these analyses will help us gauge the probability of population persistence following reductions in population size.

4. Briefly describe the involvement of local communities and how they have benefitted from the project.

From its conception, this project has represented the collaboration of many institutions, including local government. The Cayman Islands Department of Environment (DoE) has played an integral role in field efforts by providing housing, vehicles, and a large amount of equipment, in addition to overseeing research planning, permits, and the exportation of samples. This season, DoE Terrestrial Research Unit officers, Jane Haakonsson and Sophie O'Hehir assisted our research team on the ground for several weeks. This experience facilitated exchange of invaluable expertise between scientists and management personnel. For example, while Jane and Sophie became versed in protocols for handling, tagging, and tracking rock iguanas, our team was trained in the official protocols employed by DoE staff on Grand Cayman for the culling of invasive green iguanas. We expect this exchange has been critical to facilitating future monitoring efforts led by local government, as well as encouraging the incorporation of biosecurity training into long-term terrestrial research projects.

In addition to our enduring relationship with the DoE, we spent the better part of this summer working to cultivate a working partnership with the Little Cayman District of the National Trust's "Green Iguana B'Gonna" (GIBG) programme. This effort, started by Trust members Mike Vallee and Ed Houlcroft, has been successfully removing invasive iguanas from Little Cayman since the first individuals were recorded on the island in 2007. Our team has had the opportunity to contribute in a greater capacity to monitoring the green iguana situation on Little Cayman in recent years because of funding organisations, like the Rufford Foundation, that support long-term terrestrial research projects. Unfortunately, the problem has escalated in recent



years with the discovery of hybrid hatchlings in 2016 and the number of sightings increasing dramatically over the past two years. Recognising the need for more onthe-ground biosecurity personnel to address the growing problem, the DoE and partnering institutions backed our research team in partnering with GIBG and taking a more active daily role in searching for and capturing green iguanas on Little Cayman. Between August and September 2017, our team apprehended one hybrid and six green iguana hatchlings representing the first green iguana nest confirmed on Little Cayman since 2012. We also assisted with the construction of biosecure enclosures for housing hybrids, which will eventually enter breeding trials to assess fertility status. By exchanging GPS locations and generating a detailed log of all green iguana hatchlings by Mike and Ed in October 2017. Funds raised by GIBG will support genetic analyses at Mississippi State University to confirm hybrid status of newly captured individuals as well as the relatedness of presumed clutch-mates.

This year, our team was especially committed to the inclusion of Caymanian youth in field research. Three Caymanian university students, TayVanis Oyog, Vaughn Bodden, and Kelsey Bodden participated in fieldwork on Little Cayman or Cayman Brac between August and September 2017. The students participated in activities fulltime and developed critical research skills ranging from animal handling and processing, nest excavation, and radio-tracking to equipment care and maintenance and data integrity. We expect that this real world experience will not only prove invaluable to the students, who are each pursuing careers in environmental science and conservation, but will also benefit future employers within the Cayman Islands and help to stimulate interest in terrestrial conservation research.

5. Are there any plans to continue this work?

At the conclusion of this project, a committee of scientists, management personnel, and informed citizens assembled at the 2017 SIRI Action Plan Updating Workshop to review conservation actions and new threats since the last update of the plan in 2014 and to formulate objectives for the future. One important outcome of the workshop was to outline targeted research and monitoring priorities up to 2020, which include following up on tagging efforts and nesting surveys on both islands, with a special emphasis on identifying new nesting areas and reassessing population trends on Cayman Brac. Invasive green iguanas and feral mammals were both identified as urgent threats requiring concerted and immediate intervention, including the establishment of biosecurity measures and the implementation of a periodic feral cat-culling programme on Little Cayman beginning in 2018. As these management actions are implemented, there will be need to monitor the impact on native iguana populations to evaluate success. For example, genetic sampling will be incorporated into future green iguana culling efforts in the Sister Islands to evaluate relatedness of presumed clutch-mates and investigate sources of introduction, and a cat cull in 2018 may involve sampling aut contents to quantify the impact of feral cat predation on iguanas and other native fauna. The workshop also involved the discussion of larger, long-term management goals, including the



protection of more coastal nesting habitat on Little Cayman and Cayman Brac, the establishment of protected reserves in the interior of Little Cayman, and investigation into the use of artificial substrate for nesting to facilitate the production of new habitat. Reducing the rates of road mortality continues to be a high priority in the Sister Islands, demanding new solutions and heightened enforcement to improve upon actions that have been taken to date (i.e. well-distributed "Iguana Crossing" signs, strict island-wide speed limits).

6. How do you plan to share the results of your work with others?

Some results of this research have already been formally presented to a range of audiences, including private citizens (at a public talk sponsored by the National Trust on Little Cayman, May 2017), management (at the 2017 SIRI Action Plan Updating Workshop on Grand Cayman, September 2017), and the scientific community (at the Joint Meeting of Ichthyologists and Herpetologists in Austin, TX, July 2017, and the Iguana Specialist Group Meeting in Veradero, Cuba, October 2017). Additionally, evidence for the discovery of hybrids on Little Cayman was published in *Biological Invasions* in an article entitled "First evidence for crossbreeding between invasive Iguana iguana and the native rock iguana (Genus Cyclura) on Little Cayman Island" (DOI 10.1007/s10530-017-1602-2). The next issue of *Flicker*, the bimonthly bulletin of the Cayman Islands DoE's Terrestrial Resources Unit will feature an article about SIRI and our on-going research in the Sister Islands. We plan to continue presenting our research at future meetings, publishing results in academic journals, and communicating findings to the public.

7. Timescale: Over what period was the grant used? How does this compare to the anticipated or actual length of the project?

This grant was used over a period from July through October 2017, adhering to the proposed length of the project (August 1-September 30, 2017).

8. Budget: Provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in \pounds sterling, indicating the local exchange rate used. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion.

Item	Budgeted Amount	Actual Amount	Difference	Comments
1 Airfare to Little Cayman (JM)	720	720	0	
1 Airfare to Little Cayman (GG)	800	760	40	
4 Airfare to Cayman Brac	580	470	110	
Rental Car on Cayman Brac (2	0	585	-585	This unforeseen expense
weeks)				arose because the in-kind



				vehicle that was to be provided by the DoE broke down on short notice.
Capture & Processing Supplies (noose poles, PIT tags, etc.)	520	730	-210	One piece of in-kind equipment (a receiver) needed to be replaced following the completion of this project due to damage $(\pounds500)$.
Radio transmitters and antennas	3600	3430	170	
Blood sampling supplies (needles, syringes, and cryovials)	520	500	20	
Food for 10 weeks @320/wk	3200	2800	700	
Total	9940	9994	-55	

9. Looking ahead, what do you feel are the important next steps?

Looking ahead, the first important next step for this project is to finish analysing the genetic samples collected on Cayman Brac to evaluate the severity of inbreeding depression, as well as samples collected from green iguanas and hybrids on Little Cayman. Publishing our results is a critical short-term goal to ensure that SIRI remains relevant within the academic community. Over the coming months and year, we will continue to develop the collaboration between Mississippi State University, San Diego Zoo Institute for Conservation Research, DoE, and the Cayman Islands National Trust to acquire funds and direct existing resources and personnel towards monitoring, biosecurity, and feral mammal eradication in the Sister Islands.

10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

The Rufford Foundation logo was used in all presentations by our team in 2017 or was acknowledged in writing in all publications and articles (See #6).

11. Please provide a full list of all the members of your team and briefly what was their role in the project.

Jen Moss, a Ph.D. student at Mississippi State University, was the Principal Investigator and prepared all proposals and reports related to this project.

Dr Mark Welch (Mississippi State University) and **Dr Glenn Gerber** (San Diego Zoo Institute for Conservation Research) served as major advisers on the project and assisted with study design and report-writing.



We collaborated with the University of California San Diego Engineers for Exploration on a project led by **Nathan Hui**, with advising and assistance by **Ryan Kastner**, **Curt Schurgers**, **Eric Lo**, and **Matthew Epperson**.

Jane Haakonsson and Sophie O'Hehir, Terrestrial Research Officers of the Cayman Islands DoE, were involved in approving, planning, and assisting with research efforts in the Sister Islands.

Additional field assistants between August and September 2017 included **Tanja** Laaser, TayVanis Oyog, Jill Jollay, Bonnie Scott-Edwards, Gene Edwards, Chelsea Richardson, Ruth Smith, Vaughn Bodden, Kelsey Bodden, George Waters, and Katie Correia.

12. Any other comments?

N/A





























