

Chagos News

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Cover photo: Hawksbill turtle © Jon Slayer; photo p2: Coral and fish, Barton Point, Diego Garcia © Jon Slayer
photo p3: Sunset over Salomon Atoll © Jon Slayer; photo p4: Fairy terns, Nelson Island © Jon Slayer
photo back cover: Peros Banhos lagoon knolls © Jon Slayer

This year marks 30 years since John Topp’s ‘Friends of the Chagos’ was registered as a UK-based charity intent on realising his vision of preserving the precious and unique environment of the Chagos Archipelago. Since then, the now-named Chagos Conservation Trust has assisted in motivating for a no-take Marine Protection Area, has partnered with numerous scientific organisations to document the biodiversity of the archipelago, and is now aiming to rewild degraded islands to restore balance to the terrestrial and marine environments.

The three articles by Dr Pete Carr in this anniversary issue summarises the progress of our signature *Healthy Islands, Healthy Reefs* programme, with the final information gathering phase completed by the expedition in June last year, and the integration of the Vegetation Management Plan with another expedition in April this year.

Our aim to increase the coral reefs’ resilience through guano runoff is mirrored by Dr Tom B Letesier’s discovery that dolphins’ excreta also improve reef health. Our conservation efforts will hopefully

allow the endemic brain coral nurseries documented by Dr Bryan Wilson to flourish, and invasive species eradication to improve the viability of turtle eggs detailed in Holly Stokes upcoming PhD.

Jodey Peyton details how biosecurity, i.e. limiting the spread of invasive species, is being monitored and improved on Diego Garcia. Her and Danielle Frohlich’s article detail how data from the islands is cataloged into iNaturalist for researchers and the public to share. The fascinating story of the discovery and identification of a historic wreck off Eagle Island is told by Bridget Buxton, Caroline Durville, Gary Philbrick, John and Casper Potter. The man and motivation behind the stunning images of the Chagos featuring throughout this issue is revealed in Jon Slayer’s article. And our sister organisation in the US provides a brief summary of their founding and conservation efforts over the past three decades.

This bumper edition of *Chagos News* is the first part of our anniversary celebrations, and in the coming months we will host an enlarged AGM with public interest talks after the formalities, launch a series of online talks for members, hold a year-end function, and unveil our new strategy, Board of Trustees changes, a website revamp, and (hopefully) news of a patron.

Next year, we will start a concerted drive for new members, with new fundraising activities, and enlarged membership benefits. Interest in CCT has blossomed thanks to our new director’s Sarah Puntan-Galea’s posts on social media – so in addition to encouraging your friends to join the Trust, please also follow and like us on [Facebook](#), [Instagram](#), [Twitter](#), and [LinkedIn](#)!



Dr Natasha Gibson



Director's Report

It has been an honour to edit my first ever [Chagos News](#), after [becoming the director of the Trust just seven months ago](#). Having been a journalist and editor in a former life, I could not resist putting together a bumper anniversary issue of 11 fascinating articles, making *Chagos News* an annual publication for our members, social media followers, friends, staff and Trustees.

It has been a (busy) year since the last issue. One of the first things I did after starting the role, was to apply for the Chagos Conservation Trust to be an 'Actor for the [United Nations Decade on Ecosystem Restoration](#)', and we were successful! And now the Trust joins a [global movement](#) of like-minded organisations helping to prevent, halt, and reverse the degradation of ecosystems worldwide. It is only by working together can we successfully fight against catastrophic climate change, protect the one million species currently threatened with extinction, and revive hundreds of millions of hectares across terrestrial and marine ecosystems – our work will play its part in this. Plus, being a partner in this network will no doubt help raise the profile and reputation of the Trust and its work, public diplomacy being a vital part of my role.

Engagement with the Chagossian community – who share our passion in protecting and conserving the unique and precious environment of the Chagos Archipelago – has been able to increase, since the world opened up post-lockdown. We managed to obtain funding to partner with diaspora group *Chagossian Voices* to launch a website featuring news and information for and about the global Chagossian community.

Found at [chagossianvoices.org](#), a member of the Chagossian community who is fluent in both English and Kreol has been selected to be a 'community website officer'. They have received training, and will

be funded to ensure the website is updated weekly. This is also a fantastic resource for anyone wanting to learn more about the Chagossian community, its culture, and the Chagos Archipelago's environment.

This is not the first Chagossian community project the Trust has run – and it will not be the last. It also worked together with the Zoological Society of London on *Chagos Connect*, which trained community members how to contribute to the conservation of the archipelago, and hopes to welcome some 'graduates' on future expeditions. Trustee Jean-Francois Nellan, a third generation Chagossian who represents the community on our Board, will also be consulted on our rewilding project, [Healthy Islands, Healthy Reefs](#), to identify heritage sites of importance to the community which need to be restored.

Another completed project is the imminent launch of a Chagos Conservation Trust published short book by Nigel Wenban-Smith, the co-author

Photo: CCT secretary Alistair Gammell with author Nigel Wenban-Smith



We give every Chagossian a chance to express their views and have their voice heard by the international community.

For the Chagossian Community

[UK Citizenship Route for Chagossians >](#)

[£40 million support package >](#)

of [Chagos: A History](#), and a founding member of the Trust. Called *The Sad Story of the Conceição*, it will provide the first ever English translation of a Portuguese survivor's account of being shipwrecked in 1555, supposedly in the Chagos. As well as giving Ullattil Manmadhan, an American engineer of Malabar descent, the opportunity to share his unrivalled knowledge of the societies and history of the part of India invaded and taken over by Portugal at the start of the 16th century.

The earlier *Chagos: A History* explained: "Unfortunately, Jesuit records shed no light whatsoever on where exactly the *Conceição* went aground, how the survivors found their way to India, or how many perished". The new book brings new clarity to those far-off events. And the survivor Manoel Rangel's hardships and courage in tackling them provide a fascinating read in their own right – his account also offers clues as to the wreck site.

However, as in all good detective stories, his clues point in different directions, while learned commentators disagree with one another on practically every point. To thicken the plot, modern experts, deeply familiar with the seas concerned, pounce on each solution the authors propose. As if this were not enough, Rangel's numbers challenge Manmadhan and Wenban-Smith's attempt to provide an accurate body count. In the end, the book provides only one really firm and important conclusion – but

you will have to read it to find out what it is! We will be announcing the publication date soon.

The Trust will also be publishing another book this anniversary year, the second edition of *A Guide to the Birds of the Chagos Archipelago*, written by our *Healthy Islands, Healthy Reefs* project manager Dr Pete Carr. All publications – and at a later stage when the website is revamped, photos and merchandise – will be available to purchase from the Chagos Conservation Trust [website shop](#).

Whether it is our current [website](#), or the new and improved version which will be launched later this year, or across our social media platforms – [Facebook](#), [Twitter](#), [Instagram](#), [LinkedIn](#), [YouTube](#) – make sure to stay updated on the Trust's activities, because it's going to be an eventful year.

Sarah Puntan-Galea



30 Years of CCT, and CCT-US

By Ted Morris (CCT-US chair) and Lotte Purkis (CCT-US secretary)

The Chagos Archipelago and its waters constitute one of the largest no-take marine reserves, covering an area the size of France. Commercial activities of all kinds are prohibited – everything from shark and tuna fishing, to seabed trawling, and harvesting of sea cucumbers. With the exception of Diego Garcia Atoll, the Chagos islands have been uninhabited for 50 years. Save for extensive stands of coconut, the islands have largely reverted to a near-precolonial condition, including a much-reduced population of invasive rats. Continuing this status, both on the islands and the seas of the archipelago, is due in great part to 30 years of tireless effort by the Chagos Conservation Trust (CCT), based in the United

Kingdom, to study and document the natural environment of the region and pass on this knowledge freely to the public. Over the decades, CCT scientists and their colleagues have shown how irrefutably important it is to protect large swaths of the ocean from direct human impacts.

CCT and its sister organisation across the Atlantic, the Chagos Conservation Trust US (CCT-US), have funded and participated in many expeditions to the Chagos, both to determine the ecological baseline for the archipelago, and research its ecological trajectory. For example, it was the CCT expedition in the mid-1990s that raised the alarm of warming seawater temperatures and the disastrous effect that has on hard corals.

Since that time, CCT has played a pivotal role in examining the ecological baseline against which the scientific community, including citizen scientists, can accurately assess the differences between anthropogenic degradation and global environmental change – and, in turn, how those degradations may be mitigated and managed. Indeed, the vast ocean wilderness of Chagos

provides one of the last places on Earth where it may be possible to decouple the influence of direct human impact and global environmental change.

As the CCT built upon its earlier successes, it became clear that providing a forum and tax-free donor opportunity for Americans to participate in the study and appreciation of the Chagos would help the CCT achieve its aims. Following an invitation from the late William Marsden, British diplomat, and a previous chair of UK-based CCT, CCT-US was formed in 2008 by Carol Garner, Steve Snell, and Sam Purkis.

Upon becoming a fully registered US 501(c)(3) not-for-profit organisation in 2009, the CCT-US set out with the mission to extend the goals of the CCT to the United States by promoting conservation, science, education, and historical research in relation to the Chagos Archipelago.

William Marsden was instrumental in the creation of CCT-US, driven by his passion for nature conservation, which he developed during his time as British ambassador to the Americas. Marsden was motivated by the National Park System in the United States and the desire to preserve places of natural beauty. He also played a central role in establishing the Costa Rican National Park System, created in 1970. Throughout his life, he brought people together, shared ideas, and was the catalyst for bold environmental policies that have shaped countries in a positive way for years

to come. CCT-US is one of many incredible legacies that Marsden leaves to future generations.

The CCT-US team is currently chaired by Ted Morris, with Dave Snell as vice chair and treasurer, and Lotte Purkis serving as secretary. Morris's career as a U.S. Air Force officer included a tour of duty on Diego Garcia, where he developed a lifelong interest in the Chagos Archipelago. Dave Snell's father, Steve Snell, a founding member of CCT-US, was assigned to Diego Garcia as an executive officer of the US Naval Communication Station. He served together with Royal Navy Commander John Topp OBE from 1983 to 1984 in Diego Garcia. John Topp was the founder of the Friends of Chagos, which in 1992 officially became CCT.

CCT-US strives to raise awareness about the Chagos Archipelago and its unique role in defining and preserving planet Earth's biodiversity. Over the years, CCT-US has attracted those who have served on the Diego Garcia base, or otherwise had the opportunity to experience first-hand this special environment. Our membership is open to interested people of all nationalities, as we hope to expand our outreach efforts to communicate the global environmental importance of the Chagos. In that regard, it is the CCT-US's pleasure and privilege to continue to work alongside the CCT as they mark their 30th anniversary.

More information on CCT-US can be found on their [website](#).

Photo below left: John Topp (CCT founder), Carl Lundin (then International Union for Conservation of Nature global marine director), Charles Sheppard (Warwick University), William Marsden (former CCT chairman) and botanist David Bellamy.

Photo below right: Research work, Blenheim Reef.



Photo © Dick Goodwin



Photo © Jon Slaver

Healthy Islands, Healthy Reefs

A Project Manager's Report – Part One The Background and Science

By Dr Peter Carr



Photo © Dr Peter Carr



Photo © Dr Peter Carr

The genesis of the Chagos Conservation Trust's (CCT) *Healthy Islands, Healthy Reefs* (HIHR) programme predates even the Friends of the Chagos, the forerunner of CCT. In 1976, three eminent scientists and conservationists, Professor Charles Sheppard (a former Chair of CCT) and the late botanist David Bellamy, along with the (polymath and) ornithologist, the late Montague Hiron, in a letter published in the journal *Nature*¹, sounded the first call to arms for the HIHR project. After conducting research as part of a joint services' expeditions to the Chagos Archipelago in the early 1970s, they recognised the link between

Photo above: Assisted by the British Forces stationed on Diego Garcia and the crew of the BIOT Patrol Vessel, stores and equipment are being unloaded to commence the Chagos Conservation Trust led Vache Marine Rat Eradication Operation in 2014.

invasive rats and islands devoid of breeding seabirds, in particular on the Egmont Islands atoll and Eagle Island on the western Great Chagos Bank.

The call to arms by Hiron and colleagues was the catalyst for the failed 2006 rat eradication attempt on the 252-hectare Eagle Island, the second largest island in the archipelago (see *Chagos News* No 28 for an account of this epic undertaking). The Eagle Island failure was followed by the successful eradication of introduced black rats *Rattus rattus* (the only mammal species in the archipelago) from the less ambitious and much smaller (12.4-hectare) island of Vache Marine in southern Peros Banhos in 2014². Led by the author, on behalf of CCT and funded by the Darwin Initiative scheme, this was CCT's first foray into rodent eradication.

It has now been proven that on oceanic islands that had their native forest cut down and replaced by monospecific stands of coconut *Cocos nucifera*, as happened in both the Chagos Archipelago

in the Indian Ocean and Palmyra Atoll in the Pacific Ocean, that abandoned coconut plantations are also invasive and physical barriers to seabirds returning in numbers to breed when rats are removed^{3/4}. Yet, before this scientific evidence was available, CCT were co-funding vegetation management on Diego Garcia. The author, with a mainly volunteer force, successfully converted three 10-hectare plots of abandoned coconut plantation back to native forest, of which the southernmost plot on the eastern arm of the island now has information boards along a trail explaining this work. Along with the on-island volunteers, several visiting Chagossians, scientists, conservationists and CCT members, bent their backs for this project. (see *Chagos News* No 35, January 2010 for fuller accounts of the forest rehabilitation work on Diego Garcia).

Perhaps the lightbulb moment concerning the benefits of restoring seabird islands was the publication, again in *Nature*, of the work emanating from

Photo above: Volunteers landing at Barton Point, Diego Garcia, in 2009 to work on the forest rehabilitation project co-funded by CCT.

the Chagos Archipelago led by Professor Nick Graham⁵ that identified the link between seabirds, nutrient transfer between ecosystems and 'healthy islands, healthy reefs'⁵. The tenet that seabirds are ecosystem engineers of healthy, undisturbed tropical oceanic islands, that they transfer nutrients from the open oceans onto islands where they roost and breed and that these nutrients are extremely beneficial to surrounding coral reef and near shore environs, is a foundation of the *Healthy Reefs, Healthy Islands* project.^{6/7}

Governments of oceanic islands, atolls and archipelagos globally are now realising the environmental and economic benefits of restoring the health of environmentally degraded islands,



Photo above: Visiting Chagossian delegation in 2011 with the British Representative (far left), Dr Peter Carr (second left) and Ian Robinson (second right, RSPB advisor to the project).

Photo left: Professor Charles Sheppard (the then BIOT chief scientific advisor and former CCT chair) and Anne Sheppard with Dr Pete Carr.

Photo top right: Dr Colin Clubbe (CCT trustee, head of conservation science at the Royal Botanic Gardens Kew, and project advisor) with Dr Pete Carr in 2010.



especially those that have been impacted by invasive species introduced either accidentally or deliberately by man. The British Indian Ocean Territory Administration (BIOTA) that govern the Chagos Archipelago as a UK Overseas Territory have in their 11 conservation and [environmental priorities](#) five that directly relate to rehabilitating the islands that are rat-infested and overrun by abandoned coconut plantations:

- ♦ Eradicating invasive rats which threaten native seabird populations, and impact the delicate balance of BIOT's ecosystem.
- ♦ Protecting BIOT from invasive flora and fauna.
- ♦ Understanding and mitigating against the effects of global climate change where possible.
- ♦ Understanding more about BIOT's unique terrestrial environment.
- ♦ Studying our key species and habitats to ensure we are providing the best protection and stewardship.

Research by scientists and conservationists working in the Chagos Archipelago since the 1970s has supported and informed the five BIOTA conservation and environmental priorities by publishing papers demonstrating the importance of eradicating rats from oceanic islands and restoring native vegetation^{1/5/3}. This research has been funded and sponsored over the past 50 years by BIOTA, the UK military, generous grants from Darwin schemes and latterly by the Bertarelli Foundation through the Bertarelli Programme of Marine Science. In the latter decades since the formation of the Friends of Chagos, this research and associated practical conservation activities have also been supported, funded and often led by CCT.

The foundation stone of the late Commander John Topp's Friends of Chagos organisation was to protect this incredible area of open ocean and its miniscule amount of terrestrial landmass. The butterfly organisation of CCT that emerged from John's early vision has grown and enhanced his original idea, to the extent that BIOTA in 2019 requested of CCT that they lead on the production of plans to ecologically rehabilitate the environmentally degraded islands of the northern atolls. The Part Two and Three articles detail how CCT have answered the call from BIOTA.



Photo © Dr Peter Carr

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Healthy Islands, Healthy Reefs

Project Manager's Report – Part Two

The Chagos Archipelago Rat Eradication Operational Plan (REOP)

By Dr Peter Carr

The production of the REOP entailed producing three separate, but interlinked documents including a Feasibility Study (FS) and Ecological Impact Assessment (EIA), that both led to the REOP itself. Chagos Conservation Trust (CCT) commissioned a global leader in invasive species management to produce these documents – Biodiversity Restoration Specialists Limited (BRS). This was the same company employed by CCT to be the technical experts in the successful 2014 Vache Marine rat eradication operation.

The director of this New Zealand based company, Dr Grant Harper, produced all three documents for CCT in 2019. These documents were passed out to international experts in tropical island restoration for peer review and the FS and EIA were accepted as complete.

The REOP itself was found to have knowledge gaps and the reviewers recommended a limited number of sections of it to be revisited and strengthened. Most of the knowledge gaps identified at peer review were unavoidable, for example, details such as the port of departure, shipping company and bait suppliers were not known. These gaps will remain until such times as the plan has been approved by the BIOT Administration and funders have been identified. Other knowledge gaps could be addressed and in 2020 CCT set out to fill them.

The four areas of the REOP identified that could be worked upon were:

1. Are rats present on Manoel in Peros Banhos?

Crucial information to any rat eradication operation is whether rats are present or absent on an island. The first published record of what islands in the Chagos Archipelago were rat infested was produced by Peter Symens, an ornithologist who visited several islands on a scientific expedition in 1996¹. Over the following decades this author updated and corrected Symens' work, reaching the point in 2019 whereby the rat status of only

one island, Manoel in northeast Peros Banhos, remained uncertain. Trials were needed to ascertain the status of rats on this island.

2. Are house mice (*Mus musculus*) present in the Chagos Archipelago?

It is possible that when man colonised the Chagos Archipelago in addition to accidentally introducing black rats, house mice could also have been introduced. Mice can go unnoticed on islands where larger, more aggressive rats are present. However, if rats are eradicated, mice can then become a similar invasive problem and potentially a second eradication operation is required to restore conditions suitable for breeding seabirds. Research and trials were required to ascertain if mice were present in the Chagos Archipelago.

3. How much rodenticide should be distributed per hectare on an island to ensure every rat receives a dose?

This is a critical calculation in any rodent eradication plan. Administratively, it impacts the cost of the operation as it dictates how much bait has to be bought and transported. Operationally, every rat on an island has to take the bait for the eradication to be successful. On tropical islands there are several factors that must be taken into consideration when making the bait per hectare calculation. Prime amongst these is the amount of bait consumed by land crabs (the rodenticide used does not have any effect on crabs). To answer this question trials had to be conducted.

4. How should rodenticide be delivered in the two stands of mangrove forest present in the Chagos Archipelago?

There are two stands of mangrove forest in the Chagos Archipelago both found on rat-infested islands. One is on Eagle Island on the western rim of the Great Chagos Bank and the second on Moresby in Peros Banhos. Both of the stands are composed of a single mangrove species, white-flowered black mangrove *Lumnitzera*



Photo © Dr Peter Carr

racemosa, and both stands are now cut off from the open sea. Beneath both stands of mangroves lies brackish water. Aerially delivered rat bait into the mangroves would simply disappear beneath the water and decompose and arboreal rats living in them may survive. An effective method of delivering bait into the mangroves was required. This is a challenge to eradication projects globally and is not restricted to the two islands of the archipelago. To assist in answering this question research and trials were required.

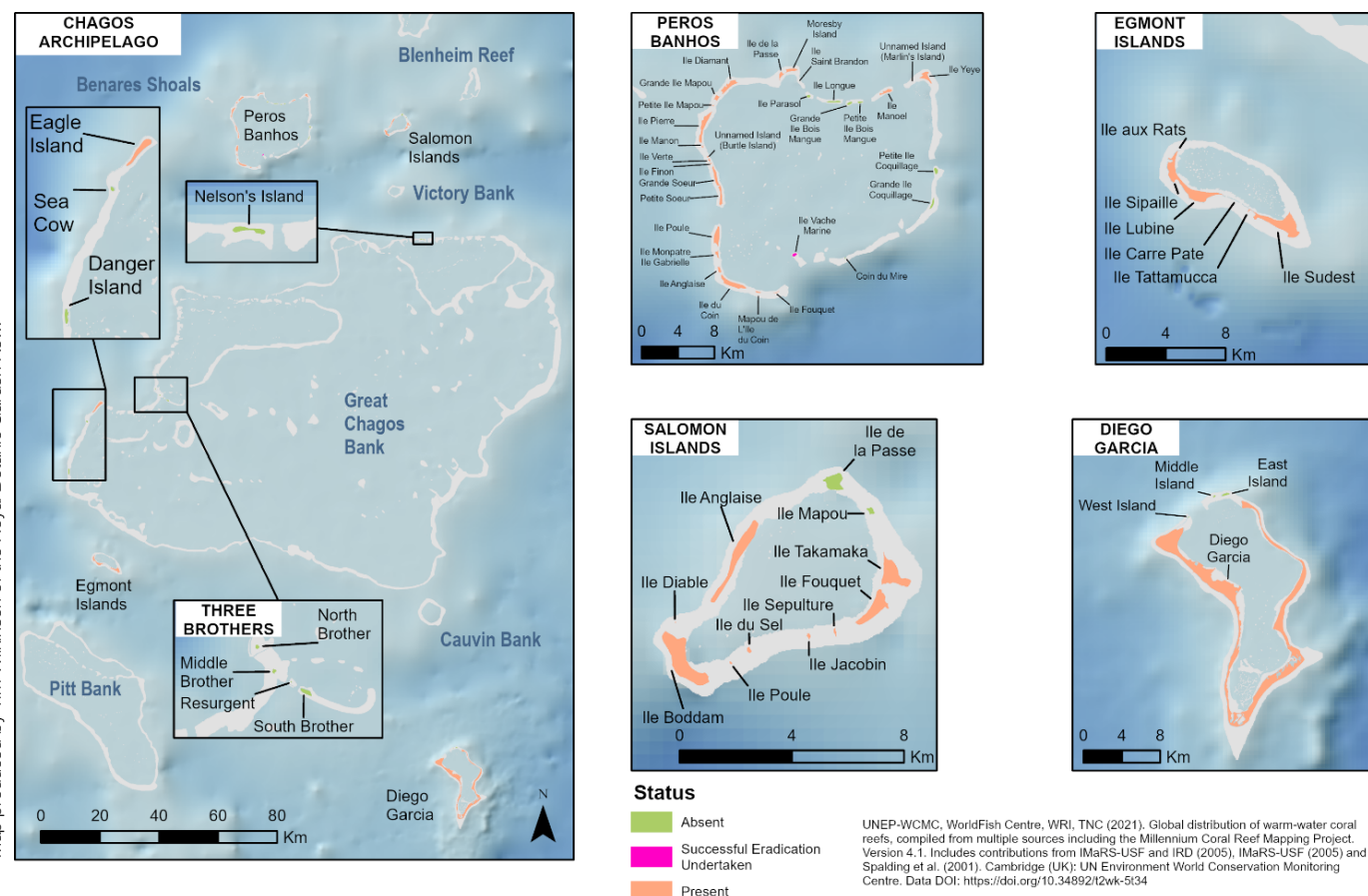
To address the four knowledge gaps above, a small team of rat eradication experts needed to visit the archipelago to conduct research and trials. Being remote and isolated with no facilities, a vessel is needed to operate in the northern atolls. Initially it was planned that CCT could share vessel time with other scientists working in the archipelago but for good reasons this option proved unworkable. The decision was made that

Photo above: CCT REOP expedition members Dr Grant Harper (rodent expert) and Darryl Birch (forestry expert).

CCT would charter its own vessel and it would sponsor its own expedition.

Jocara, a privately-owned 18-metre sailboat, had recently completed (January 2022) a successful expedition to the Chagos Archipelago supporting a marine archaeological expedition. As part of the archaeological research rat DNA was being collected from throughout the archipelago – the collection of which was to be CCT's and Dr Carr's contribution to the expedition. As well as supporting the archaeological research, the rat DNA read outs are being donated to CCT and the HIHR project. This is because if, after the eradication phase rats are found on an island, by comparing this 'historic DNA' with the rats' present DNA, a comparison can be made to ascertain if the eradication failed or there has been a second introduction.

The technical expertise required on the CCT rat research expedition to fill the knowledge gaps was again provided by BRS, who were contracted for the expedition and to update the REOP with the expedition findings. Dr Grant Harper again provided the technical lead supported by Darryl Birch, the



Map above: The status of black rats *Rattus rattus* in the Chagos Archipelago. This definitive map of which islands are rat infested in the archipelago has taken over 25 years to complete. The final island to have its rat status determined, Manoel in Peros Banhos, was confirmed as being ratinfested on a CCT-sponsored expedition assisted by funding from the Darwin Initiative scheme.

Photo above right: Dr Harper with a coconut crab.

latter being one of the hardy souls who conducted the Eagle Island rat eradication operation in 2006. Birch is a commercial forester as well as a rodent eradication specialist and features again in Part Three of this report. The funding required to contract BRS, and to meet their expedition expenses, was generously provided by a grant from the UK Government's Darwin Initiative scheme.

Birch and Harper were signed onboard *Jocara* in Malé in the Maldives in June 2022, where they joined Dr John Potter and Caroline Durville who crewed the vessel throughout the expedition. There were problems getting the bait that was sent from New Zealand (both toxic and

non-toxic) released from Maldivian Customs, and this delayed the sailing from the Maldives by a number of days and concertinaed the research programme. With slack built into the expedition programme, the reduced time available only marginally impacted the research programme. Customs problems were overcome, and *Jocara* headed south at the end of the second week of June, arriving in northeast Peros Banhos after a smooth sail ready for work.

The technical report detailing the research expedition results has been forwarded to the BIOT Administration and is available from the author. The salient points from the research expedition have been incorporated into the Chagos Archipelago REOP, and this is now back with CCT. A précis of the non-technical results follows:

1. Are rats present on Manoel in Peros Banhos?

Rats were confirmed as present on Manoel. There is no consensus on how many islands and islets are present in the Chagos Archipelago and the answer strongly depends on what is considered a single island. For example, the 'Six Islands' as Egmont Islands atoll is sometimes called, is now two islands through accretion. With Manoel's rat status now known, this author believes there are 21 rat-free islands and 34 that are rat infested. (See map, above for details).



Photo © Dr Peter Carr

2. Are there house mice (*Mus musculus*) present in the Chagos Archipelago?

This important question has been answered by research and proxy. Logic suggests that if mice were ever accidentally introduced it would have been to one of the inhabited islands that were regularly serviced by boat – the source of any introduction. This leads to Diego Garcia, Sudest in the Egmonts, Eagle on the Great Chagos Bank, Coin in Peros Banhos and Boddam in the Solomons being the most likely islands to have mice, Diego Garcia being the likeliest due to it receiving far more visiting vessels than any other. Research reveals that despite there being an extensive pest control programme on Diego Garcia for decades (that this author headed between 2011-2013) there has never been a mouse recorded on this island.

Eagle Island had a team of rodent experts living on it for several weeks in 2006 who were daily servicing rodent traps; Eagle Island has never had a mouse recorded on it. On the June CCT-sponsored rodent research expedition, internationally

recognised rodent expert Harper conducted a series of trials on Coin in Peros Banhos and concluded that mice were not present on this former plantation headquarters island. By proxy, it is assumed that if mice were not introduced on to the three islands of Diego Garcia, Eagle and Coin, they were not introduced to any island in the archipelago.

Along with the new information on rat and mice status in the archipelago, the technical data gleaned on the expedition concerning bait delivery systems and amounts has now been included in the REOP, 'filling the knowledge gaps'. The REOP is now back with the HIHR project manager being reviewed, before being submitted for approval and execution.

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Healthy Islands, Healthy Reefs

Project Manager's Report – Part Three The Chagos Archipelago Vegetation Management Plan (VMP)

By Dr Peter Carr

On many temperate islands that have been ecologically altered by invasive species, removing the invasive species is often all that is needed to rehabilitate the island. Recent research in Palmyra Atoll in the Pacific Ocean¹, and in the Chagos Archipelago in the central Indian Ocean², has proven this is not always the case on tropical islands. Human colonisation of both Palmyra and the Chagos Archipelago brought two events that severely impacted the delicate eco-systems of these remote, oceanic island groups.

The first was the introduction of invasive species, in both cases rats have been the lasting legacy that have had the greatest impact, especially on the breeding seabirds. The second event was the clearing of native habitat, particularly native forest and open, savannah grassland-type habitats. These were mostly replaced with monospecific stands of coconut *Cocos nucifera*, grown as a cash crop.

Research in the Chagos Archipelago has proven that breeding seabirds very strongly prefer native forest and savannah as a breeding habitat over abandoned coconut plantations³. It has also shown that converting the abandoned plantations to habitat conducive to breeding seabirds following the eradication of rats could, theoretically, increase the number of breeding seabirds by orders of magnitudes³.

Put simply, for breeding seabirds to return in numbers sufficient to produce a 'healthy island healthy reefs' scenario in the Chagos Archipelago, a dual conservation intervention needs to happen: the eradication of invasive rats and the conversion of invasive abandoned coconut plantations to habitat attractive to breeding seabirds.

The Chagos Conservation Trust (CCT) were very quick to accept and act on this conservation concept. To continue and complete the *Healthy*

Image bottom left: The VMP expedition will search for culturally sensitive sites, such as this graveyard on Boddam in the Solomon Atoll – with advice and guidance from the Chagossian community to ensure they are protected.

Image bottom right: White-leaved black mangrove (*Lumnitzera racemosa*) forest on Moresby in Peros Banhos – a habitat that will be protected in the CCT VMP.

Islands, Healthy Reefs (HIHR) project, in late 2022 the Trustees of CCT expanded the original (rat eradication focussed) HIHR programme by contracting a project manager to produce a Chagos Archipelago Vegetation Management Plan (VMP). This author, who had been contracted to fill the knowledge gaps in the Chagos Archipelago Rat Eradication Operational Plan (REOP) was further contracted to produce the VMP. As briefly mentioned in Part One of this report, this author led the successful rehabilitation of three 10-hectare plots of abandoned coconut plantations on Diego Garcia (2008-2013). With colleagues he has been highlighting the requirement for vegetation management as a necessary tool for the ecological rehabilitation of tropical islands that were farmed for coconuts^{2/3}.

There has been tropical island rehabilitation work occurring in the western Indian Ocean involving invasive species' eradications and vegetation management for at least three decades. Unfortunately, much of this work has gone undocumented. Realising the value of the experience contained in these historic ventures, this author, along with a colleague involved in some of these undocumented projects, is writing a 'lessons learnt' paper.

This work, sponsored by the UK Department for the Environment, Food, and Rural Affairs and the Bertarelli Foundation is endeavouring to collate the management experiences of 30 years of tropical island rehabilitation. It is envisaged that this paper will strongly influence the Chagos Archipelago VMP.

Even with the 'lessons learnt after 30 years' paper, there will still be knowledge gaps in any Chagos Archipelago VMP. Similar to the REOP, a 'filling the knowledge gaps' expedition is required during which specialists who are to contribute to the VMP can conduct research to complete their input. Again, similar to the REOP, the VMP will consist of a Feasibility Study (FS), an Ecological Impact Assessment (EIA) and the Operational VMP. At present (December 2022), planning is well underway for an expedition in early 2023. Some of the questions and tasks to be answered and completed during this expedition are as follows.

Photo © Dr Peter Carr



Photo © Dr Peter Carr



1. Can an island have its vegetation managed mechanically or will it require manual work?

During the June 2022 REOP ‘filling the knowledge gaps expedition’ commercial forester Daryll Birch undertook some rough-and-ready calculations into the time needed to convert the abandoned coconut plantations to native habitats. His calculation was that it would take years to manually clear the plantations using chainsaws. However, using mechanical forestry equipment it would take months. This concurred with the author’s experience on Diego Garcia where two 10-hectare plots took several months to clear, and the third plot took days using tracked machinery. (For perspective, ecologically degraded Eagle Island is 252 hectares). This time differential has huge financial and logistic implications and has led to the requirement to determine whether forestry vehicles and equipment can be landed on an island safely. For the VMP (and particularly the EIA section), a specialist in planning landing vehicles and equipment from small craft on to beaches is to be contracted by CCT (with funding assistance from the Bertarelli Foundation) to answer this question.

A veteran grand devil’s-claws tree (*Pisonia grandis*) on Moresby in Peros Banhos – the upcoming VMP expedition will map specimens like this to ensure they are preserved.

2 What are the best forestry techniques for converting abandoned coconut plantations to habitat conducive to breeding seabirds?

There are a variety of methods available for clearing abandoned coconut plantations. Injecting herbicide into the trunk of trees has been used on tropical islands. This system is safer than using chainsaws or forestry machinery but, its effect is not immediate and therefore will not fit into the very limited timeframes of the ‘expeditionary forestry’ needed when working from a mother-craft in the remote central Indian Ocean.

On Diego Garcia between 2009-2011 clear-felling was used on two of the three trial plots and the sectioned trunks of the fallen trees were used to build corrals within which to gather the fallen nuts. The fronds of the fallen trees were cut off and placed over the full corrals to block off light to nuts to prevent growth. Whilst effective, this was extremely labour intensive and time consuming and is not an option for use in the northern atolls where time will be a very limiting factor. The third trial plot was levelled to ground zero by machinery.

Over a decade on, all three trial plots have matured successfully into habitat akin to native lowland rainforest. To assist in deciding the most effective reforestation techniques to be used under the unique conditions presented in the central Indian Ocean, a commercial forestry company with experience of managing abandoned coconut plantations are to be contracted. They will conduct research and trials on the expedition and will contribute their findings and experience to the VMP. In addition to the two foresters, specialists from the Royal Botanic Gardens Kew and experts with practical experience of tropical island ecological rehabilitation in Palmyra and the western Indian Ocean will contribute to this discussion and the VMP.

3 What areas of an islands’ vegetation need managing?

The commercial forestry company who will be contracted to execute the VMP in the years ahead will need detailed guidance on what areas of an island to work on. What areas to be worked on will be governed by several factors such as the extent of the abandoned coconut plantations, culturally sensitive sites and areas of existing habitat to be conserved. The foresters will require detailed maps in the VMP to guide them to ensure they and their machinery manage only the areas identified in the VMP. To produce these maps as part of the VMP, CCT are collaborating with academic institutes, commercial companies and subject matter experts. For example, Oxford

University is conducting research in the Chagos Archipelago that involves producing aerial images of the islands and their vegetation communities – these images are being donated to CCT and will form the basis of the maps for the foresters.

Layered over the Oxford-produced maps will be ‘protected areas’ of native vegetation identified on the ground by botanists from RBG Kew, eg mangroves (image previous page, bottom) and areas of native habitat that remain and could form seed banks for the regeneration of native forest (image, below left); culturally sensitive areas identified by a delegate from the Chagossian community (eg image p16); beach landing sites identified by the amphibious landings’ expert and, areas identified by the commercial foresters as needing special attention. Such maps are to be produced for each of the ecologically degraded islands to be rehabilitated and will form the backbone of the VMP.

4 What baseline ecological data exists for islands?

One of the key stages of the ecological rehabilitation of any degraded habitat is monitoring change after the conservation intervention. This is for several reasons a most important phase as it ensures the intervention produces the desired outcome (eg rats were eradicated or abandoned coconut plantations were converted to a different habitat). For conservation practitioners, there can be valuable lessons learnt through monitoring that can be shared. At the species level, monitoring post intervention can demonstrate changes in abundance or distribution.

In the Chagos Archipelago, the overarching aim of eradicating rats and converting abandoned coconut plantations to native habitat is to bring back breeding seabirds. Therefore, it is essential to have up-to-date numbers of the breeding seabirds on the degraded islands to monitor change against. Two species of Red-Listed marine turtle breed in the Archipelago, as does the iconic coconut crab (*Birgus latro*); pre-intervention population estimates are required for these species.

The coconut crab is of particular interest as the impact of converting abandoned coconut plantations to other habitat upon this Red-Listed Vulnerable species is being widely debated. It is also necessary to have population estimates of organisms from rat-free islands in the Archipelago. These can be used to compare population change post conservation intervention against. The VMP team is liaising with specialists in areas where information is particularly lacking, eg Decapoda, invertebrates, to fill these knowledge gaps.

5 What logistics are required to execute the VMP?

Possibly the greatest challenge to executing the VMP is the logistics involved. It is obvious that where possible, a mechanised execution of the VMP is the simplest option but this requires both specialised shipping and the ability to transfer machinery from ship to shore. Every island, even those having their vegetation managed by machinery will require specialist and non-specialist shore parties. The specialists will, for example, conduct vegetation management in (or around) culturally sensitive sites. The non-specialists will be bearing the brunt of the hard labour. This workforce will conduct the manual labour required to support the mechanised and manual foresters. At present, [Force Blue](#), an organisation of United States Special Forces military veterans devoted to coral reef conservation is filling this crucial role.

The 2023 VMP expedition will have logisticians assessing the requirements of the foresters, forestry support personnel (Force Blue) and the ‘general’ Chagos Archipelago’ expedition support. The general expedition support when executing the VMP will be immense as it entails, for example, chartering specialist shipping capable of delivering vehicles to shore, moving forestry equipment across the world, and supporting and maintaining forestry equipment and a minimum of 30 expedition personnel for several months in the remote central Indian Ocean.

At the time of writing (December 2022), the planning of the VMP production and the necessary research expedition is in a state of flux due to talks on the future governance of British Indian Ocean Territory/Chagos Archipelago between the UK and Mauritian Governments. With uncertainty of the outcome of these talks, the detailed planning of the VMP is in a hiatus period. But whatever the outcome, it is sincerely hoped the sterling work CCT have invested into the HIHR programme will not be wasted.

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How Dolphin Poo can Support Vulnerable Coral Reefs

By Dr Tom B Letessier (Zoological Society of London)

Scientists have long suspected that dolphins provide an important role in marine ecosystems. Now, by working in the Chagos Archipelago, we have estimated the extent to which spinner dolphins (*Stenella longirostris*) may be giving coral reefs a helping hand by depositing vital reef-enhancing nutrients in shallow lagoons, via their excrement.

Using a combination of visual observations and hydrophone recordings of dolphins – some stemming from patrol-observations from the Chagos Archipelago and whale watching trips from the Maldives – we notice that, like clockwork, the dolphins entered coral atoll lagoons during the morning, leaving only late in the afternoon.

Since the dolphins spent approximately half of their day resting in the lagoon, we were able to use metabolic models to estimate the amount of nitrogen taken into the lagoons during the daily commute to foraging grounds. The conservation experts estimated that one dolphin pod would produce around 288 +/- 17 kg yr⁻¹ (about the weight of three human adults) of reef-enhancing nitrogen inside shallow water lagoons, during resting sessions.

The clear and pristine ocean in tropical regions like the Chagos Archipelago are often deemed relatively oligotrophic (unproductive) compared with the seas around the UK. Coral reef ecosystems are therefore a paradox – how are they able to support an oasis of biodiversity? This biodiversity makes them critical for local livelihoods that depend on them. And, while coral reef habitats are critical for both human and marine life they are also highly threatened by the current biodiversity crisis, especially from climate change which can cause extreme stress on reefs, leading to coral bleaching and mass die off.

Simply by going to the toilet in the shallow atoll lagoons, these dolphins may be providing a vital nutrient supply for the corals – making a strong case for protecting the dolphins in order to save coral reefs. The night feeding mammals eat smaller marine life that migrate up from the 'mesopelagic'

area of the ocean, between 200 to 1,000 metres below the surface of the water, which is believed to hold staggering amounts of prey (between three and nine gigatonnes).

Other colleagues working in Chagos have already highlighted how nutrient run-off from bird colonies can enhance coral reef productivity and resilience. These nutrients are important for coral reefs which are threatened by coral bleaching and other stressors. Spinner dolphins are super-abundant in the tropical Indian Ocean and scientists are now trying to further establish the extent to which they can have a similar role. It is positive to have found a possible mechanism by which the dolphins' behaviour could be sustaining the health of surrounding reefs.

Spinner dolphins are known to be highly dependent on shelter, and are therefore likely very sensitive to human disturbance. A fully protected reserve in the Chagos, as well as legal protections offered by the Maldives, combined with local fishery practices (which use pole-and-line rather than net fishing) are some of the reasons that they thrive in these areas. Elsewhere in the Indian Ocean however, spinner dolphins are subject to high levels of bycatch in gillnet fisheries. Our study, which demonstrates the potential importance of spinner dolphins to the health and resilience of coral reefs, underscores the need for improved conservation of cetaceans and management of fisheries across the Indian Ocean.

This study is just the first piece in a bigger puzzle that we, together with colleagues from the Indian Ocean region, will explore further as part of a wider project funded by the Bertarelli Foundation, dedicated to exploring the cetacean species and their abundance using hydrophones and visual surveys in the Chagos Archipelago.

The study was published in the *Journal of Zoology*: Letessier TB, Johnston J, Delarue J, Martin B, Anderson RC. 2022. Spinner dolphin residency in tropical atoll lagoons: Diurnal presence, seasonal variability, and implications for nutrient dynamics. *Journal of Zoology* 318:10–22.

Building Biosecurity on Diego Garcia

By Jodey Peyton (UK Centre for Ecology & Hydrology)

The Chagos Archipelago is home to globally important numbers of nesting seabirds and a huge array of marine life, including hawksbill (*Eretmochelys imbricate*) and green turtles (*Chelonia mydas*). It is also home to a variety of terrestrial plant and animal species. Although there are many native species on Diego Garcia, there are also non-native species, some of which are considered invasive – ie they have negative impacts on either biodiversity and ecosystems, human health, and/or infrastructure. Invasive non-native species present on Diego Garcia include the tropical fire ant (*Solenopsis geminata*), cane toads (*Rhinella marina*), and southern sandbur (*Cenchrus echinatus*) – a mat-forming grass that can be detrimental for nesting seabirds.

In order to understand potential impacts of non-native species on Diego Garcia and the outer islands, our UK Defra Darwin Plus project is generating an updated inventory of the native and

non-native terrestrial plants and animals of Diego Garcia. This work includes two field visits (one which we undertook in June-July 2022, and one we aim to undertake in April 2023) to collect invertebrates and update the plant checklist for Diego Garcia with the Royal Botanic Gardens Kew.

The invertebrates we collect will be identified and the DNA barcoded by the Natural History Museum in London. We are working with the Zoological Society London to update their existing database, (which can be accessed at the [Chagos Information Portal](#)) with the records we collect once they are identified. New records for the island include, for example, mantids and several species of ants. Species records from the project will be made freely available via open access databases such as the [Global Biodiversity Information Facility](#).

Alongside this inventory, our work is also supporting the British Indian Ocean Territory Environmental

Photo: Cane toad © Keith Bensusan



Photo: Tropical fire ant (*Solenopsis geminata*) © Rhian Guillem

Officer in delivering biosecurity for teams working on Diego Garcia. Our project partners the GB Non-native Species Secretariat are working with the British Indian Ocean Territory Administration (BIOTA) in developing a biosecurity manual for the region, a compilation of existing biosecurity materials developed by BIOTA, the Chagos Conservation Trust, and others, as well as developing training materials for the customs and teams who manage biosecurity on the island.


These teams based on the island include the US Naval Facility Public Works Department (PWD). Lhemar Antipasado has been undertaking monthly ant surveys to monitor for the presence of new invasive ant species such as the little fire ant (*Wasmannia auropunctata*) at the port, airport, and warehouses as part of DPLUS151. The UK customs team and US Naval facilities inspect newly arrived cargo vessels and animals that are found, such as spiders, ants and wasps are reported to Pest Control for extermination, as part of the island's Early Detection, Rapid Response plan. The teams also monitor aggregates from off-island sources for signs of imported ants and plants. In addition to surveying for newly arrived non-native species, BIOTA and the PWD work to control and eradicate or control invasive plant species on Diego Garcia.

BIOTA and the PWD also raise awareness to the public about invasive species. Our project has been working with BIOTA to create biosecurity materials for the island, including mini-guides to raise awareness of some of the invasive species that could arrive on the island. You can find these on the [Chagos Information Portal](#).

During the visit in June-July 2022, we updated the [iNaturalist project site](#) for the region that was set up by Kew, while other teams on Diego Garcia are also updating the records of the island via the iNaturalist site. Finally, we are also developing new guides to the plants and animals of Diego Garcia, such as this [guide to the amphibians and reptiles of BIOT](#).

You can read more about the [project](#) and you can read our [trip blog](#) from when we visited in June-July.

We would like to thank the funders Defra Darwin Plus for funding our project: [DPLUS 151 - Building knowledge on invasive non-native species in Diego Garcia](#), the BIOT Administration, the US Naval Facility and the project team for their great work on this project. We would also like to thank Zoological Society London, the Chagos Conservation Trust, and the Royal Botanic Gardens Kew for sharing their knowledge and expertise with this work.



Chasing the Chagos Brain Coral (*Ctenella chagius*)

By Dr Bryan Wilson (University of Oxford)

What do you get if you multiply six by nine? Forty Two. An extraordinary number. For fans of Douglas Adams' *The Hitchhiker's Guide to the Galaxy*, that number is the "Answer to the Ultimate Question of Life, the Universe and Everything". Wikipedia, our contemporary go-to source for all other answers, suggests it "is the natural number that follows 41 and precedes 43". And most poetically of all, 42 is also the number of degrees and the precise angle at which, if sunlight strikes falling raindrops, an observant (and otherwise unoccupied) viewer will witness a spectacular arcing rainbow.

For me, 42 holds a much greater and more existential meaning still. It is, to the best of my knowledge, the total count of colonies in the single largest clustering of quite possibly the world's rarest coral – the Chagos brain coral (*Ctenella chagius*). But as to how we arrive at this seminal figure, we must first journey back to the pre-pandemic days of early 2020...

In my last *Chagos News* piece (The Story of the Lost Brain Coral, No 57, December 2020), I'd detailed my find of this gathering of a once thought extinct species, whilst finning across the surface of Middle Brother Lagoon in the Chagos Archipelago. It would be one of the very last dives of the trip before many months of interminable shore-based lockdown.

Photo: Middle Brother © Shaun Smith



Photo: *Ctenella* colony © Bryan Wilson

To the credit of the [Bertarelli Programme in Marine Science](#), it wasn't too long before remote overseas field research returned. A good thing too because, as our blue planet becomes increasingly challenged by climate change, it has never been more important to document these impacts on nature if we researchers are to have any chance of convincing policy makers, governments, and the people of the world of the veracity of these threats.

So in March 2021, I became the first researcher at the university to be granted permission to journey overseas since the pandemic began. After negative PCR tests in the Maldives, a much-relieved science team joined our research vessel, the *Grampian Frontier* – now retired, but at the time, our sea-battered home for the next month – and set sail south for the Chagos Archipelago.

Arriving at the first of our destinations – Nelson Island, on the northernmost edge of the Great Chagos Bank – brought with it a feeling of unmitigated joy after a year of land-based lockdown. A single slightly disappointing dive at this site found it to be sparsely covered with corals, and certainly no *Ctenella*, but that sharp anticlimactic feeling quickly faded the next day as we journeyed on up to the resplendent Salomon Atoll.

Here I spent my days diving, sleeping and eating, plus supporting the other research team members with their studies – PhD students Nicholas Dunn and Rosalie Dowell (Imperial College), and Margaux Stayaert (Oxford) – whilst also surveying for corals (including *Ctenella*) on these 11 stunning islands. It was during one of these dives I stumbled across the most beautiful display of a diverse and functionally complex coral reef I had ever come across: a transcendent knoll lagoon-side of Île Anglaise, every surface an abundance of colourful and healthy colonies. To still discover reefs like this existing and thriving is a boon to the soul of a marine biologist.

A few days later, we headed up to the northern opening to the atoll, the appropriately named Île de Passe, where we were rewarded with exemplary diving conditions and crystal-clear visibility. The ship's doctor (Bob Crawford) and I had dropped in and followed the anchor line down to where it rested close to the drop-off, and then swum lazily east along the reef's edge, surveying the abundant corals and fish. Towards the end of the hour, we began our return to the waiting tender, and there – not five metres from where the anchor sat – were two *Ctenella*, the first to be spotted on this expedition. Whilst one was a sickly-looking remnant of a much larger colony, the other was a

full-bodied and apparently healthy specimen. We returned to that same site the next afternoon, this time anchoring much closer to the shore, in only five metres of water – and there, several metres away, lay another one! This one again in full health, and settled at the most shallow of depths I have yet seen, in only 3.8 metres of water.

After wrapping up the surveys in Salomon Atoll, we then set sail directly west for the much larger Peros Banhos – this collection of islands is home to one of my favourite dive sites in the Archipelago, Moresby Island, a wonderful (if exposed and high energy!) site, and where I came across my first ever *Ctenella* colony, on my inaugural expedition back in 2019. And here again, I found a colony almost immediately, in a beautiful heart shape. Then, descending down the reef slope to a depth of over 18 metres, I found no less than nine healthy *Ctenella* colonies. So Moresby Island continues to be one of my winning sites!

Something I am incredibly grateful for on these expeditions, is the sense of camaraderie amongst the crew and researchers, where everybody pitches in and helps out with each other's work. A special mention must go to Nicholas Dunn here, whose own work (surveying for sharks) is arguably (but only arguably) more exciting than looking for otherwise immobile corals. That didn't stop him from joyously sharing his discovery – at 14 metres, in the waters around the tiny and previously ignored Île Parasol – a behemoth of a *Ctenella*, the largest I have seen in recent times, almost a metre across and likely decades old. A fecund coral of this size would have a disproportionately larger contribution to the yearly replenishing of stocks of adult colonies, than the much smaller examples I had previously recorded – and would have also survived a number of extreme bleaching events in the region.

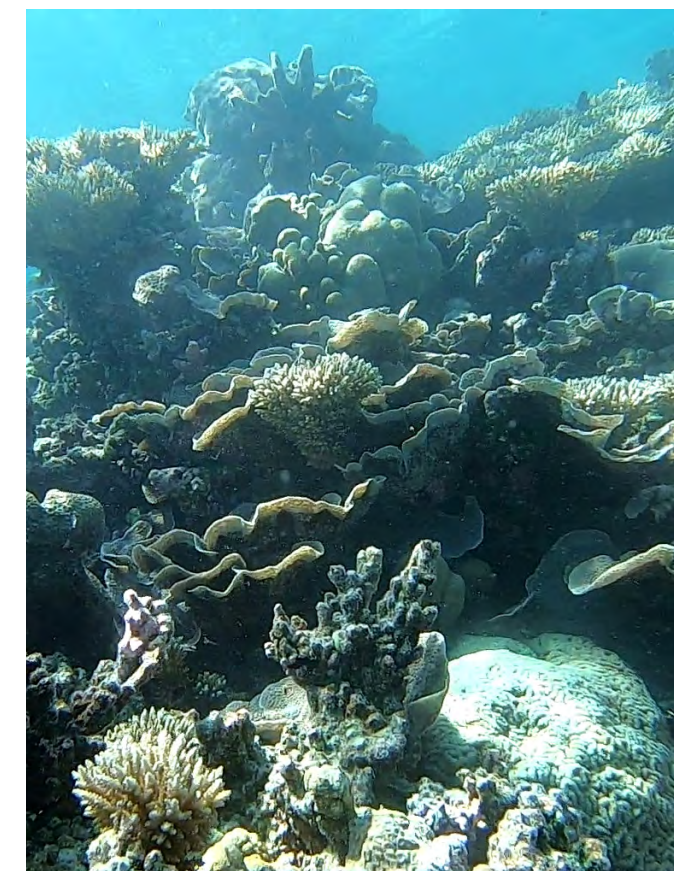
The climax of this entire expedition was my return to Middle Brother, one of the Three Brothers on the western edge of the Great Chagos Bank. The island is unique within the 50-odd islands of the Archipelago, in having an entirely contained lagoon off its shores. It is broken up by a number of small to middling knolls, coming to within a metre of the sea's surface and dropping steeply down to the sandy floor, eight to nine metres below. The walls of these are festooned with all manner of corals of so many different species, colours and forms, and the fish and ray populations abound. That being said, there is one thing in particular that beckons me back year after year to this tiny, hidden and pristine tropical paradise of biodiversity – *Ctenella chagius*.

Whether it be a quirk of the tiny lagoon's uniqueness (potentially constraining the dispersal of larval corals), or the phenomenon that sees lagoonal corals surviving extreme warming events (with their reefs in relatively static waters typically being warmer than surrounding high energy outer reefs and therefore pre-adapting the corals within to higher temperatures), this is a haven for the world's rarest coral. In the days I dived there, I counted 42 colonies, the greatest collection of this critically endangered species recorded on this planet within recent years.

And on our final day in the lagoon, I chanced upon the greatest hope yet that this iconic coral endures – nestled amongst the pinks and reds of encrusting coralline algae, the discovery of a single *Ctenella* yearling. With that, I left the lagoon of Middle Brother – hopefully to remain relatively undisturbed by our kind for another calendar year – and with a coolbox holding a precious but limited number of sensitively collected tissue samples, with which I continue to delve into the mysteries of the biology of corals, offered up by the recipe for its life encoded within its DNA.

In a final segue whose circularity reflects that of the seemingly endless and surprising continuum of life itself, I've just discovered that the letters 'DNA' are also the initials of Douglas Noel Adams. I think he would have appreciated that.

Photo: Île Anglaise knoll © Bryan Wilson



Documenting BIOT Species with iNaturalist

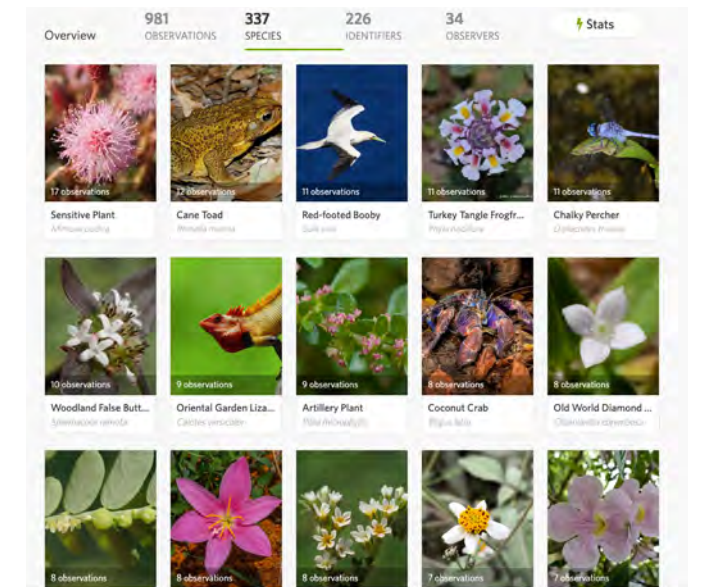
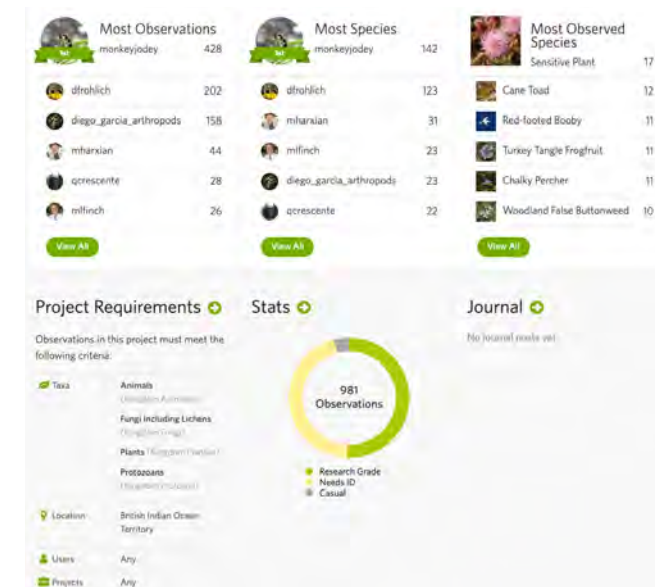
By Jodey Peyton (UK Centre for Ecology & Hydrology) and Danielle Frohlich (SWCA Consultants)

Biological recording is an essential part of conservation – you need to know what is there before you can work out how best to conserve (in the case of species you want to keep) or to manage (in the case of species that have negative impacts on rare or protected species). Making useful and accurate biological records requires a minimum of four attributes: ‘who’ (who is making the record), ‘what’ (what is the record of), ‘where’ (where was the species recorded) and ‘when’ (a date for the record). Once a record is made, it needs to be verified – that is an expert needs to confirm the original identification that was made.

Traditionally, biological recording has been undertaken with a notebook or recording card and pen or pencil, by expert recorders, but increasingly, the use of technologies and applications, such as the free application, [iNaturalist](#), are being used to make records. This has many advantages, including that it completes three of the four basic criteria for making records (who, where, when) for you and, using image recognition technologies, helps with the fourth – the what! It also makes the record accessible to all with access to the internet, for example, some people may not be able to spend time in the field making observations but can still look up and verify records that have been made.

iNaturalist enables people to look at and learn about species in places they may never visit. It also allows people who visit a new area to look and see what observations have been made in an area. The use of machine learning within iNaturalist to help with identifications means that an ID will be attempted for all records you make, before you even need to try and work out what the species might be. Tools such as iNaturalist are widening participation within biodiversity monitoring. Finally, all research grade records (records that have been verified as the same species by more than two people), are made available to the [Global Biodiversity Information Facility](#).

In 2018, the Royal Botanic Gardens Kew set up an [iNaturalist project for terrestrial biodiversity of the British Indian Ocean Territory](#): As part of a Defra Darwin Plus project (DPLUS151), led by the UK Centre for Ecology & Hydrology (UKCEH), with partners at the Gibraltar Botanic Garden, London Natural History Museum, and SWCA Environmental Consultants in Hawai’i, over 650 records of 189 species were added to iNaturalist in June/July 2022 during a three-week field trip. At the time of writing, this specific iNaturalist project has 895 records of 298 species, with additional records submitted by other researchers on the island, such as the



Zoological Society London and Northern Arizona University. The records added include records of invasive non-native species (such as sensitive plant *Mimosa pudica* and cane toad *Rhinella marina*) and also of native species including the red-footed booby (*Sula sula*). The UKCEH-led project team will be re-visiting Diego Garcia in 2023 and hope to add more records when they visit!

The beauty of iNaturalist is that it is really simple to use and you can do so by following these steps:

- Download and register with [iNaturalist](#).
- Take photos using your mobile device of the plants and animals you see using the camera icon in the app (or select images from your photo – if you have your mobile phone GPS active, the iNaturalist application will take the coordinates for the record for you). You can also make records directly from the iNaturalist webpage and add the coordinates manually.
- Upload your record.

These species will be identified by people around the world, and your records will help scientists document what is present.

To support with identifying species on the British Indian Ocean Territory, the Royal Botanic Gardens Kew and the UKCEH teams also created the following, [freely available guides](#) that can be downloaded to your mobile phone (if you have the iNaturalist application). The invertebrate species listed in the guides are primarily those recorded in the [Zoological Society London checklist](#). Additional species have been added from surveys collected through the DPLUS151 project.

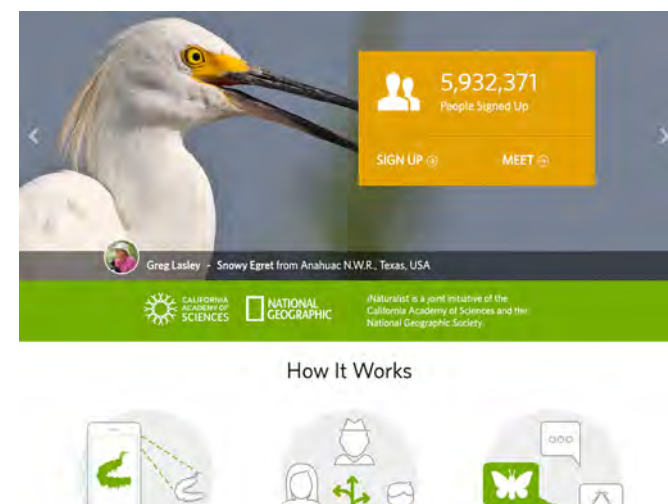
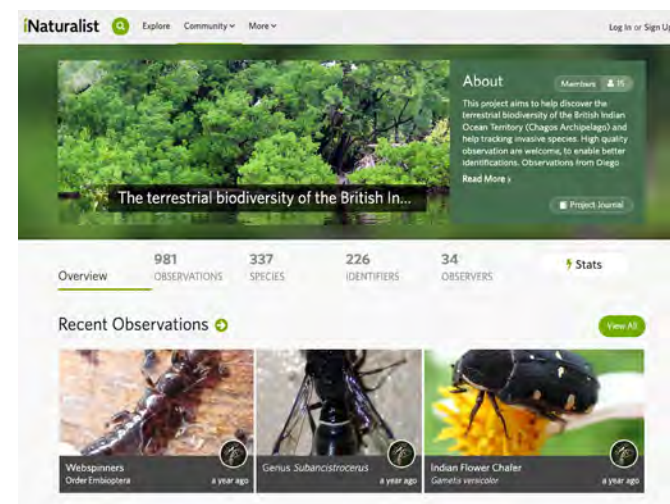
- Amphibians and reptiles
- Ants, bees and wasps
- Beetles
- Butterflies and moths
- Cockroaches and termites
- Crickets and grasshoppers
- Dragonflies and damselflies
- Flies
- Fungi
- Grasses
- Non-native plants
- Scale insects
- Sedges
- Spiders

Being able to download these guides to your mobile device, and use them offline, means that when you are in the field without mobile data, you can still access the images and information to help inform identifications.

If you would like to know more about using iNaturalist or this project, please [contact Jodey Peyton](#).

Acknowledgments

We would like to thank Defra Darwin Plus for funding [DPLUS151: Building knowledge of invasive non-native species on Diego Garcia](#) and to all the people who are contributing to the records on the iNaturalist project.



The Iron Wreck of Eagle Island

In December 2021, the Chagos Remote Ocean Voyager Expedition (C-Rove) discovered a shipwreck off the west coast of Eagle Island.

By Bridget Buxton (University of Rhode Island), Caroline Durville, Gary Philbrick, John and Casper Potter (Norwegian University of Science and Technology)

The OceanGate Foundation Chagos Remote Ocean Voyager Expedition (C-Rove) was inspired by a theory that ancient Greek and Roman navigators were utilising the southern monsoon route across the central Indian Ocean to trade between Asia and Sub-Saharan Africa. The best evidence for open-water trade routes is a shipwreck, but when your potential search area is an entire ocean, the best place to target is islands along the route. In this case, the best islands were in the British Indian Ocean Territory: the Chagos Archipelago. And when even that search area is far too big, you have to turn to... rats!

Since rats are the ultimate shipwreck survivors, the presence of rats on any remote island is sure evidence of human seafaring. Recently developed techniques of genetic analysis of modern rat populations can even reveal their geographic origin and approximate arrival date. For all these reasons, the C-Rove team sailed out in December 2021 on a mission to recover rat tail samples from all the major atolls of the archipelago except Diego Garcia. Our research vessel for six weeks was the 18-metre sailing yacht *Jocara*, owned and crewed by the Potter family of Trondheim, Norway. The expedition was a success: samples were collected from all the target islands, and *Jocara* proved to be the perfect ambassador for oceanography's environmental 'retro-revolution' of returning to seafaring's wind-powered roots.

While analysis of the Chagos rats at the Munshi-South Lab (Fordham University, New York) is already yielding interesting results to be shared in future publications, an unexpected discovery on the 2021-22 expedition warrants a preliminary note. A secondary objective of C-Rove was to test the viability of *Jocara* as a research platform for remote ocean maritime archaeological survey. This question anticipated our rat results: if the rat DNA showed that the islands were part of an ancient maritime trade route, how would we go about detecting possible ancient shipwrecks?

The best approach seemed to be a magnetic survey to detect the tell-tale signature of iron anchors or other debris that might indicate a long-lost shipwreck. Magnetometers are often large, require careful setup, considerable power, and a stable metal-free environment. They are normally towed behind large engine-powered vessels with advanced navigation for following survey patterns. We decided to experiment with our Marine Magnetics Explorer magnetometer tied to the underside of a plastic kayak towed by *Jocara's* dinghy, where the equipment was run from a GPS-enabled laptop and a car battery. A benefit of this system was its ability to be towed safely over shallow coral reefs without causing damage.

The first test of this novel deployment method off the west coast of Eagle Island was meant to be just a proof-of-concept exercise, but within 10 minutes the magnetometer discovered a shipwreck!

Our methods were vindicated by this discovery, but we still must give credit where it's due: we knew there was something to be found near Eagle Island thanks to the colourful memoirs of Mauritius-based Catholic Friar, Roger Dussercle (1902-1975), who was a regular visitor to the islands in the 1920s and 1930s. Dussercle was the original source for three of the four Eagle Island entries on a shipwreck list compiled by Nigel Wenban-Smith for his 2016 book: *Chagos: A History* (co-authored by Marina D. Carter), and kindly shared with our team¹.

From this list, we knew the western side of Eagle Island would be a good place to look for wreckage – or at least anchors, as the fate of the *SV Saint-Louis* (the only Eagle Island wreck on the list associated with a specific location) confirmed that despite the obvious risks, it was sometimes used as an anchorage.

The wreckage our magnetometer found appeared to be from a large turn-of-the century iron-hulled vessel with a debris field of 50-60 square metres.



Photo: Setting up the magnetic survey

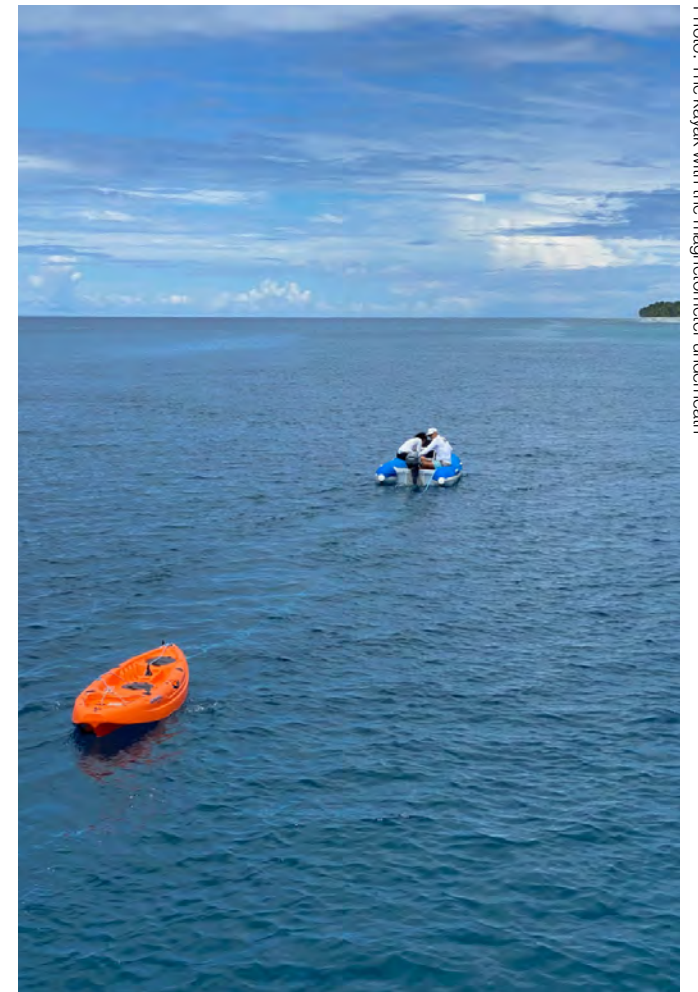


Photo: The kayak with the magnetometer underneath

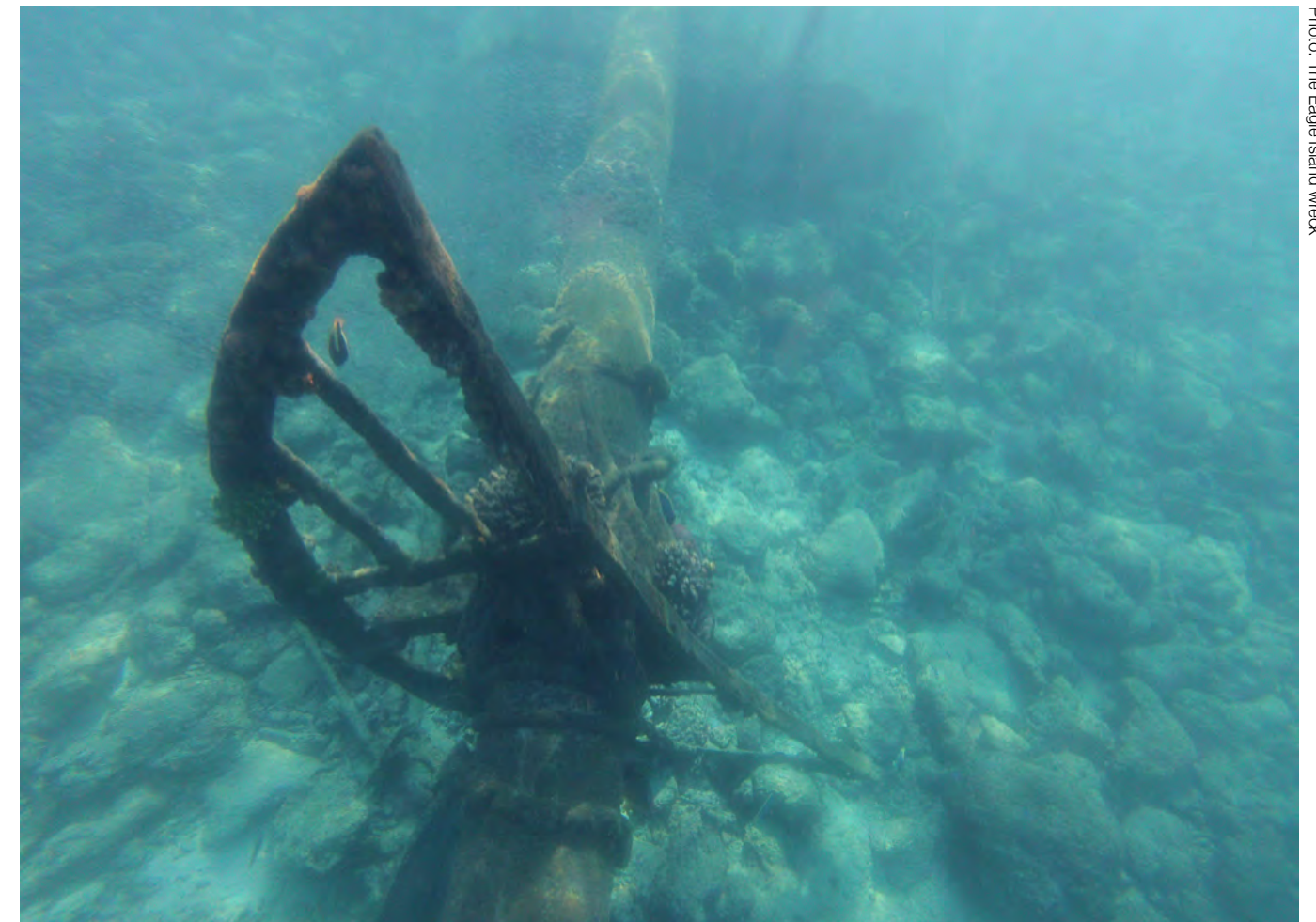


Photo: The Eagle Island wreck

Known shipwrecks around the Chagos Archipelago		
Date of shipwreck	Ship	Source
May 1880	<i>Africa</i> (schooner)	Mauritius Almanac 1916.
June 1935	<i>Diégo</i>	Barque described in Dussercle's <i>Île d'Aigle</i> .
June 1935	<i>Sauveur</i>	30ft, ex-Six Îles (Egmont), swept away in a storm. Same source.
June 1935	<i>Saint-Louis</i>	Small half-decked. Same source, left at anchor West of Eagle Island.

The main wreckage lay in less than 10 metres of water, and on calm days it would have been visible from the surface, so it made sense that the site was well known and belonged to one of the four named vessels in Wenban-Smith's list. The question was, which one? The size of the main anchors alone ruled out the 30ft yacht *Sauveur* sunk in 1935. The wreckage appeared too modern to be the 19th-century schooner *Africa*. The *Saint-Louis* seemed a reasonable candidate, since it was described as a half-decked vessel likely to be one of the larger local ships that conveyed produce and supplies between the atolls. The *Saint-Louis* was abandoned at anchor off the western side of Eagle Island after being damaged while ferrying supplies to the survivors of the fourth shipwreck on the list, the 380-ton, three-masted barque *Diégo*, also lost in 1935.

Of the four vessels, the only one given more than a sentence or two in the published literature was the *Diégo*, which regularly made the run from Mauritius laden with people and animals. Roger Dussercle's self-published account of the sinking² provided a trove of information – he was even aboard when *Diégo* foundered! From Dussercle we learned that life on board *Diégo* featured bed-bug infested wooden bunks, toe-gnawing rats, cockroaches, pigs, seasick passengers and cargo, with chicken coops and up-turned sea turtles tied to the storm-washed decks. Dussercle was a regular on the vessel, conducting several missions to save the islanders from the mortal sins of fornication, the local African 'seca' style of dirty dancing, witchcraft, and Protestantism.

But the biggest surprise from Dussercle's text was that the *Diégo* was not the venerable wooden merchantman we had imagined from the stories, but

an unusually long-lived 19th century iron barque kept in excellent sailing condition by her owners (no doubt with many 20th-century upgrades). On *Diégo*'s final voyage, there were 17 crew including the captain, Dussercle, and 15 other passengers, all of whom were saved by the courageous actions of local resident Arthur Tallat who ferried them to shore in his canoe in horrific sea conditions.

The scenario described in Dussercle's account of *Diégo*'s sinking, being driven onto a lee shore while trying to anchor just off the reef, fits the location of our Eagle Island debris field perfectly. With the lack of protected anchorages, extremely steep bathymetry and ubiquitous fringing reefs, this kind of disaster has doubtless been repeated many times in the history of the Chagos Archipelago. Older wrecks, from the 16th century or even pre-medieval times, will be a lot harder to find than the *Diégo*. However, with the rats as our guide, and a proven low-cost and environmentally-friendly survey method, we can hope that this shipwreck discovery is the first of many more to come in the Chagos Archipelago.

With thanks to the BIOT administration and MV Grampian Frontier, CCT, Zoological Society of London, URI, NTNU, C-Rove ecologist Dr Pete Carr, team physician Marc Burdick, OceanGate Foundation supporters Gary Philbrick and Dan Pierce, and the Society of Women Geographers.

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¹Wenban-Smith, Nigel, and Marina D. Carter. *Chagos: A History: Exploration, Exploitation, Expulsion*. Chagos-Conservation Trust, 2016.

²Dussercle, Roger. *Naufrage de la barque Diégo: à L'île D'Aigle aux Chagos 20 Juin 1935*. PortLouis, Île Maurice: Editions du Hecquet.

Sea Turtle Ecology in the Chagos Archipelago

By Holly Stokes (University of Swansea)

As a PhD student (based at Swansea University, Wales) who commenced my research about sea turtle nesting ecology in the Chagos Archipelago in 2020, I was fortunate to visit Diego Garcia for two long expeditions in 2021 and 2022. There, I was able to study nesting and foraging activities and collect data from observations of hawksbill (*Eretmochelys imbricata*) and green turtles (*Chelonia mydas*). The work from each expedition, initially supported by my supervisor Dr Nicole Esteban, contributed to ongoing conservation research within a wider team based in Australia (Professor Graeme Hays, Deakin University) and the Seychelles (Dr Jeanne Mortimer).

Population estimates are essential to make informed conservation and management decisions for endangered species protection. Due to the remoteness of the Chagos Archipelago, population estimates (6,300 hawksbill and 20,500 green turtle clutches are laid on the 55 or so islands each year) have so far been based on rapid island visits and foot patrol surveys at specific times of the year¹.

From satellite tracked nesting females, we also know the Chagos Archipelago to be an important nesting site for up to 50% of hawksbill and 20% of green turtles foraging across the western Indian Ocean². My PhD studies aim to improve estimates



Photo: Nesting turtle © Holly Stokes



Photo: Measuring a turtle © Ellen Wood

of sea turtle populations and assess nesting and hatchling success related to environmental conditions. We intended to extend our knowledge via two long-term expeditions to improve the accuracy of current population estimates of nesting turtles, by combining new techniques alongside traditional survey methods, for example, using drone surveys and remote camera traps.

One of the main objectives during the first expedition was to combine drone surveys, satellite tracking information, and a mark-recapture approach to estimate the immature sea turtle population in Turtle Cove (at the southern point of the lagoon in Diego Garcia). We found that Turtle Cove has the largest immature hawksbill turtle population compared to other reported sites around the world (results to be published soon³). During this expedition, I stayed on the island for eight months – the longest ever scientific expedition of this kind – to collect data on the nesting ecology of green turtles, including clutch counts, nest conditions, and nest excavations, to assess the length of incubation period (around 70 days!) and nest and hatchling success. The expedition timing extended across the hawksbill turtle and green turtle nesting season.

In June 2022, the second and final expedition of my PhD commenced with a focus on green turtle nesting ecology for a second season. The objectives of this expedition were to collect more data to determine nesting and hatching success to increase our understanding of sea turtle movements in and out of the archipelago, and to assess the population of nesting turtles. At the same time, the aim was to incorporate camera traps alongside traditional foot patrols and investigate the risk of resulting sea level rise from climate change on nest and hatchling success.

Our first two objectives led us to sunset to sunrise night patrols in the highest nesting density area (a 2.7km beach on the south-eastern coast of Diego Garcia), accompanied by volunteers on the island. We looked for nesting turtles so that we could count eggs as they were deposited, recorded nest locations and surrounding environment (i.e. location and type of vegetation, area of beach and level of shading) and set up surveillance cameras to monitor nests (ie presence of predators, emergence timing of hatchlings). Once the turtle finished depositing her eggs and disguising the nest, we attached a satellite tag to



Photo: Green turtle hatchlings leaving the nest © Holly Stokes

her carapace using the same successful method tested in previous years to track migration to foraging grounds.

Once nighttime surveys were complete, we moved to daytime surveys to set up and service camera traps, record sand temperature at nest depth (with repeats) and conduct foot patrols to count and measure tracks and nests. Towards the end of the incubation period, the nests were checked daily for signs of hatchlings. After hatchling tracks were observed, the nests were excavated to assess the hatching success through counts of hatched eggs, determining development stages of underdeveloped eggs, count of missing eggs and hatchling measurements. We counted 19 clutches (of up to 176 eggs), and monitored the nests through to excavation. The nests showed varying levels of success depending on location (eg open nest or near vegetation), and predation from crabs and rats was observed.

Now the expeditions and data collection are complete, the next steps are to analyse, write and submit each chapter for publication before my PhD completion date in September of this year. Our results so far show a level of concern for eggs and

hatchlings due to predation from crabs and invasive rats, which elevates the importance of planned rat eradication on the islands – part of the Chagos Conservation Trust's rewilding project, *Healthy islands, Healthy Reefs*. On the other hand, our data points towards a promising outlook for protected populations of foraging and nesting hawksbill and green turtles in the Chagos Archipelago. We look forward to bringing you a full round up of our results in next year's *Chagos News*.

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- ¹ Mortimer, J., Esteban, N., Guzman, A., & Hays, G. (2020). Estimates of marine turtle nesting populations in the south-west Indian Ocean indicate the importance of the Chagos Archipelago. *Oryx*, 54(3), 332-343. doi:10.1017/S0030605319001108
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- ³ Stokes, H. J., Mortimer, J. A., Laloë, J-O., Hays, G. C., Esteban, N. (2023) Synergistic use of UAV surveys, satellite tracking data, and mark-recapture to estimate abundance of elusive species. *Ecology*. doi:10.1002/ecs2.4444

The Man Behind Many of CCT's Chagos Images

By Jon Slayer



Photo: Red-footed booby © Jon Slayer

During the grey days of the UK winter, I find a warming escape is to think back to my first adventures in the Chagos Archipelago. Some of the earliest memories I remember involve hot sand and the cooling waters of the beaches bordering the western Indian Ocean. As the son of a marine biology professor working at Durban Sea World (now uShaka Marine World), the golden mile of the beach front there, and the exotic creatures in Sea World's tanks, were a formative environment. As the years rolled by, playing in the waves and ogling the marine life through the glass progressed to assisting with scuba diving research trips during school holidays, and caring for stranded marine mammals at the weekend. So it was no wonder my happy place in adulthood would be the ocean.

My education decisions led me away from marine pursuits and to the UK Commandos, and then an opportunity to be the Royal Marine Detachment training officer on Diego Garcia came up, which I embraced with enthusiasm. It was there I met Charles Sheppard – a forefather of the Chagos Conservation Trust – who arranged a substantial research expedition to the archipelago, with my father as the Indian Ocean soft coral specialist. I

was delighted to host the expedition, rewarded by being able to join half of the field diving trips around Diego Garcia and the outer islands.

A few other things aligned. My father was a skilled amateur photographer, and had taught me. So with a new digital camera and underwater housing under my arm, I documented as much reef exploration as I could. And that was when my love for underwater filming, photography, and relationship with the Trust was developed – a new career was forged for my exit from the armed forces.

As I departed the Commandos, Google Maps had entered the mainstream and Google Earth was in development. This opened up opportunities for me, as I explored the world, diving wherever I could, and filming what I saw. Not just for me, but also for the UK government, who wanted to capture the beauty and diversity of the coral reefs of the British Indian Ocean Territory (BIOT) as they contemplated creating one of the largest Marine Protected Areas (MPA) in the world there.

When the MPA announcement was made, it was my footage that accompanied it, which I had captured on a whistlestop trip in 2010. As my filming skills



Photo: Sauron shrimp on Pocillopora coral © Richard Stevenson

improved, I showcased the results at a few film festivals, where I met the Google team who were integrating the oceans into Google Earth and Street View. Noting some of the extremely remote oceanic places I was visiting, they asked if I could capture content for them. Photography and filming was joined by the capture of 360 virtual reality footage.

When the equipment for Street View capture evolved from a 30kg 27 camera backpack to a 300g two-lens handheld camera, I immediately wanted to take it underwater. My next trip was to the BIOT, and I focused all my effort into figuring out how to make a housing for a handheld 360 camera. After numerous hiccups, we eventually got it working and managed to capture the first user generated, underwater content for Street View. Google asked for several more of those underwater housings, and a new creative vocation had emerged.

The association with the Chagos Archipelago has continued through this media evolution for me, and I ended up participating in numerous trips to the territory, always steadily adding to the archive of photos and videos on my shelves. A good library of these from the islands and the reefs have been selected for the Chagos Conservation

Trust to be available for their use in any promotion or publication. That explains my name alongside a lot of the pictures and media that you see on the Trust's website and publications. Those photos often serve as a reminder to hop onto Street View and revisit some of the captures around the islands – a reminder that there is always tropical warmth and sunshine somewhere in the world!

[See the Chagos Archipelago via Google Earth](#)

[Go underwater around the Chagos Archipelago](#)



Photo: © Jon Slayer

The Chagos Archipelago is a rare haven of beautiful reefs, diverse wildlife and clean waters, located in the midst of the Indian Ocean. The Chagos Conservation Trust is the only UK-based charity dedicated to protecting and conserving it.

For more information, visit chagos-trust.org

If you would like to contribute to the next issue of *Chagos News*, please email chagosnews@chagos-trust.org

