Chagos News

The Periodical Newsletter of the Chagos Conservation Trust and Chagos Conservation Trust US
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Editorial

The CCT Trustees are delighted to welcome our new Director, Helen Pitman. She has a lot of experience in areas that the trustees felt they were lacking, so look out for the new and interesting ways forward that Helen will take us.

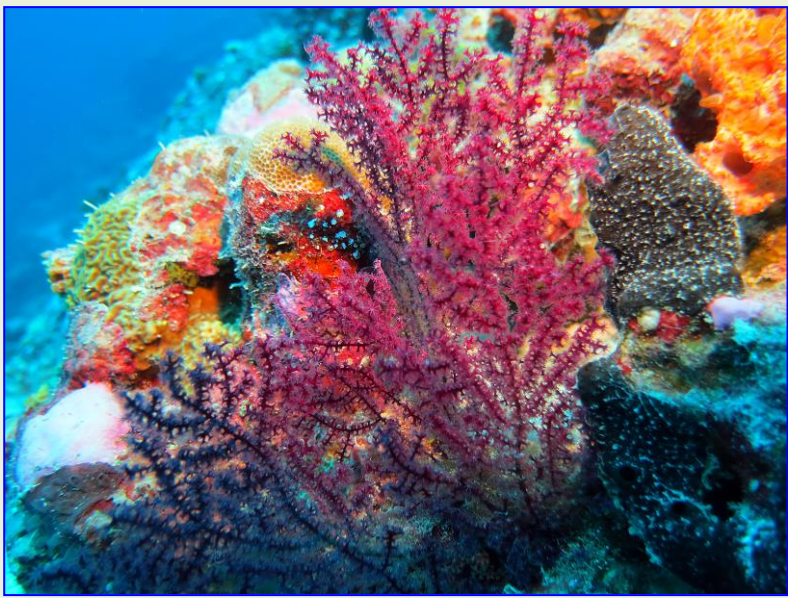
Chagos has become so widely recognised as an important unspoilt place that the research expeditions are literally queuing up to work there in the brief weather window between the trade winds that make being on the sea more difficult and certainly uncomfortable. This is becoming even more important during this current warming event which is affecting the entire Indo-Pacific region. Chagos had a bleaching event last year and far from abating, it is now predicted to intensify into next year. We are anxious to return to see the fate of the corals.

We will be saying goodbye to the wonderful old *Pacific Marlin* that has served us so well on expeditions. She is being replaced by something else, and we await details of that, but assume it will be faster and more modern. While this may have benefits, we have all come to love the *Marlin* and her fantastic officers and crew.

By the time you read this newsletter, COP21 will be upon us. Even if an agreement is reached to keep the rise in global temperature to under 2^0C, this may be too little, too late for coral reefs and for low lying reef countries and communities. We are an inventive species and the general hope is that someone will come up with a way to *remove* the CO_2 from the atmosphere that we have been dumping in the past few decades. However, crossing your fingers for a good outcome for the world is a very worrying way to run the planet!

Should we manage to get things back on track before it is too late, Chagos will become an even more important study area to help those parts of the world that that have been so badly damaged. Let us keep trying our best to keep it that way.

Anne Sheppard



From crocodiles and cockatoos to the corals of Chagos…

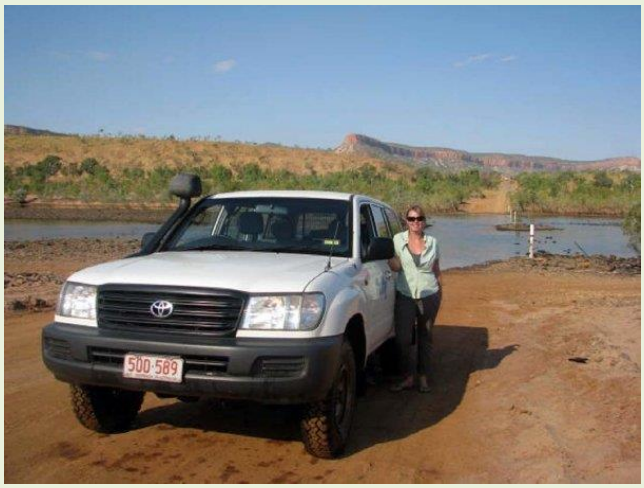
Helen Pitman
Director, Chagos Conservation Trust

I am extremely pleased to have joined the CCT team as the new director and I very much look forward to meeting many of you soon.

British born, I grew up in Hong Kong and then from my late teens lived in Australia. Both places have an affinity with the ocean, although in rather different ways.

My love for nature and wildlife grew significantly while living in Australia and I therefore studied for a B.Sc. in Conservation Biology at Murdoch University. I began my career as a field biologist working on threatened species conservation with WWF-Australia and Birds Australia. With them, I was lucky enough to visit some amazing places from the Top End to the Great Australian Bight, learnt how to climb over barbwire fences, spot a snake from 50 metres and how not to swallow flies in the outback.

Diverting from field work to communications and campaigning brought me back to the UK to work for Fauna & Flora International and later the Marine Stewardship Council, where my interest and understanding of marine conservation and fishery science grew. Next I was off to WWF International in Switzerland to manage the global marine communication programme. I worked with colleagues from around the world on a whole range of marine issues from unsustainable tuna fishing and shark finning to EU policy.



CCT's contribution to the science and conservation of coral reef ecosystems and how they function when not having to cope with local human threats is remarkable. I hope to be able to help CCT build on all this great work by supporting the board of trustees and partners to launch a new business strategy that will take CCT to 2018 and beyond. There will be new challenges and opportunities to explore and it should be a very exciting time!

In addition our science information portal, ChIP, will enter phase two and expand to include a coralpedia, a mapping function and the newest science and research focused on Chagos. With the help of the Bertarelli Foundation and the John Ellerman Foundation, ChIP will be a one-stop-shop for anyone wanting information on the Chagos and will be a valuable resource for us all.

I've come from crocodiles and cockatoos to arrive at the corals of Chagos and what a new adventure it will be!

2016 CCT-US Expedition Scholarship - Chagos Atoll Restoration Expedition

This message to announce that applications are now being considered for the 2016 Chagos Conservation Trust U.S. (CCT-US) Expedition Scholarship.

For application criteria, expectations and other specifics, please see the online announcement posted on the CCT-US website, here: http://cctus.org/?p=463.

Under the auspices of its annual Expedition Scholarship, the CCT-US seeks to fund a US-based invasive plant management specialist to participate on the Chagos Atoll Restoration Expedition (CAREX) which will be of one month duration in August, 2016.

Like all expedition participants, the successful candidate will be expected to contribute their relevant expertise to the Terrestrial Action Plan being developed for the outer islands of the British Indian Ocean Territory.

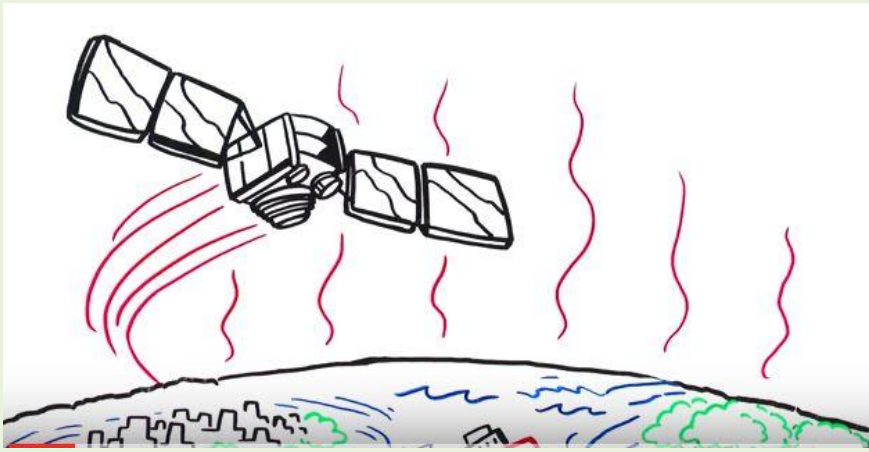
Interviews will commence upon receipt of applications and will continue until the scholarship is filled.

Sam Purkis [purkis@nova.edu – Chair of the CCT-US]

Pete Carr [petecarr1@hotmail.com – CAREX Expedition Leader

Global Sea Level Rise

NASA have produced a useful series of infographics showing why the seal level is rising due to climate change. There is a link to them here.



Taking Stock of our Overseas Territories Wildlife

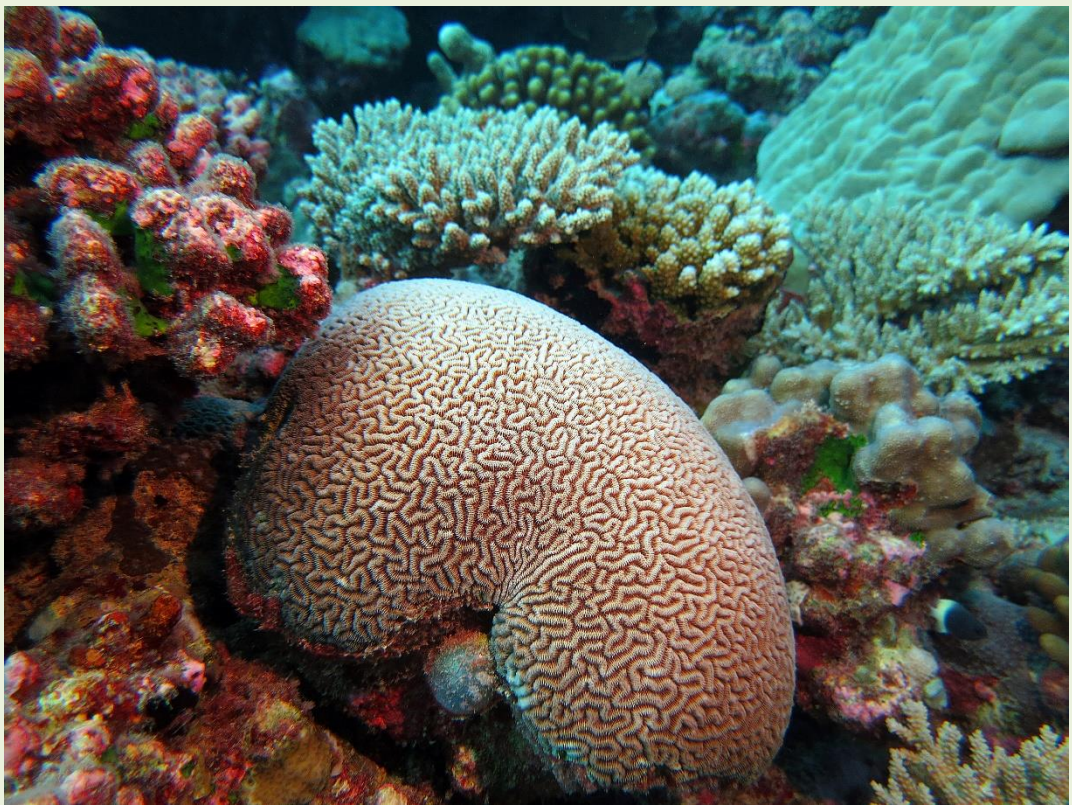
In May, the RSPB published a report titled "The UK's Wildlife Overseas: A stocktake of nature in our Overseas Territories". This was an attempt to bring together all known species records and conservation assessments from the island Territories to enable an overview of their biodiversity value, and to highlight the gaps in our knowledge to enable the targeting of future research efforts.

The results were impressive. More than 28,000 native species have been recorded from the Overseas Territories (OTs), and more than 1,500 of these are endemic, compared to 90 endemic species present in the UK "mainland". Only 9% of the species endemic to the OTs have ever had their conservation status assessed for the IUCN Red List, and of those that have, 77% are considered to be Globally Threatened. In Chagos, only one of the nine recorded endemic species has had its global status assessed: this is the brain coral *Ctenella chagius* which is considered to be Globally Endangered.

The Chagos stood out amongst the island OTs for having a high level of knowledge of its marine environment. However, we could find no species-level records of sponges, and there were very few worms recorded (either in the marine or terrestrial environments). We were also unable to find any species-level records of spiders or other arachnids.

It is apparent that the OTs hold the majority of the biodiversity for which Britain is responsible. Places like the Chagos are of international significance, and a huge amount of fantastic research has already been done to describe and document the richness of species present. However, we have really just scratched the surface with huge areas still to be explored. We estimate that there may be a further 65,000-90,000 species still undocumented in the OTs – so there are plenty of opportunities for new discoveries on future expeditions.

The UK's Wildlife Overseas: A stocktake of nature in our Overseas Territories is available for download at http://www.rspb.org.uk/ourwork/projects/details/369443-the-uks-wildlife-overseas-a-stocktake-of-nature-in-our-overseas-territories.



The endemic coral *Ctenella chagius* is considered Globally Endangered due to the very restricted locality where it is found.

Image Anne Sheppard

Finding Nemo

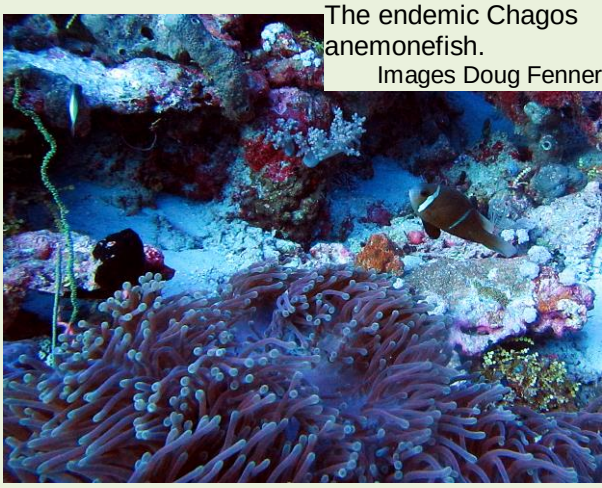
Professor Doug Fenner
NOAA consultant scientist

I got to go on the expedition to Chagos in May, 2014, to study coral species. At one point, Anne Sheppard said something about there being an endemic anemonefish in Chagos. So I looked it up in the one fish book I brought along, Lieske and Myers (2001), *Coral Reef Fishes.* It shows an orange fish with two vertical white bars. Not long after we started diving in Chagos, I spotted orange anemonefish and got excited and took a fair number of photos of them. Along the way, I also saw some brown anemonefish. I didn't know what they were, but they weren't the endemic species, so I took very few pictures of that fish.

I wrote one episode of my blog about the endemic Chagos anemonefish, and featured my best shot of the beautiful orange fish. Anne pointed out that the anterior white band on the endemic Chagos anemonefish narrows over the head, and on my orange fish it widened over the head. The orange anemonefish is the Two-Band anemonefish, which while pretty, is no big deal. Two-Band, too bad!!

Now fast forward to October, 2015. I'm looking through a book by Fautin and Allen (1992), *Field guide to Anemonefishes and their Host Anemones*. There, on pages 68-69 is the Chagos anemonefish, in glowing orange. I notice that the pictures are of preserved fish (colors can change in preservative). Glancing at the text, I notice it says "light to dark brown"!!! Aha!! I quickly look up my photos. I have only 3 photos of the brown fish, but the white band clearly narrows over the top of the head! Bingo, it's the Chagos anemonefish!! I see it says that the species of anemone that hosts it was not recorded. A quick look at my photos again and in all three photos, the host anemone is the magnificent sea anemone, *Heteractis magnifica*. I remember lots of them at one spot, with brown anemonefish in them.

Charles Sheppard just sent me a new article about the biogeography and genetics of all known anemonefish. In one of their graphs, the article indicates the host anemone of the Chagos anemonefish as the bulb-tentacle anemone, *Entacmea quadricolor*. Many anemonefish species are hosted by more than one species of anemone, so the Chagos anemonefish could be hosted by the bulb-tentacle anemone as well as the magnificent sea anemone. Indeed, my photos of the two-band anemonefish show it in three of the five anemones that are known to host it. At this point I don't know of any book that presents a picture that shows the correct colours on the Chagos anemonefish.



The endemic Chagos anemonefish.
Images Doug Fenner

Chagos research programme makes Top 20

The Chagos research programme has been ranked amongst the top 20 most impressive examples of UK research contributing to global development. CCT's chair, Professor Charles Sheppard from Warwick University, was notified in September that the Chagos Research Programme had been selected from nearly 7,000 impact case studies submitted to the Research Excellence Framework – the new system for assessing the quality of research in UK higher education institutions.

"An important thing here is the endorsement this gives to the overall Chagos research programme, in which CCT has been so important for many years" said Charles.

As we all know the Chagos archipelago is the UK's most biodiverse marine environment and has the cleanest seawaters ever tested, with a high degree of biological richness, biomass and productivity.

The case study focuses on Professor Sheppard's coordination of a research programme by over 100 researchers that have worked in Chagos. Using it as an important reference site provides a strong foundation for the restoration and management of other damaged reefs and helps communities and scientists better understand how coral reefs function and what can be achieved from repaired reef ecosystems.

The important research in Chagos shows that the effects of climate change on healthy tropical reef environments can be lessened in the absence of other threats compared to the long lasting effects on damaged reefs.

Other top 20 case studies include research on using honeybees to deter crop raiding elephants, fighting bird flu, creating disease resistant crops, helping communities rebuild after conflict, education-enhancing technologies and more.

Inclusion of the Chagos research indicates the broader importance of this no-take marine protected area. Not only is it crucial to the survival of the reef and terrestrial ecosystems but also as a way to ensure food security in a region where millions rely on the ocean for food and livelihoods.

"The UK Collaborative on Development Sciences brings together UK government departments and research funders to deliver effective development outcomes." Professor Duncan Wingham, UKCDS Chair, Chief Executive, Natural Environment Research council (NERC)

Sustainable Development Goals – what does it mean for oceans?

Helen Pitman
Director, Chagos Conservation Trust

2015 has been an interesting year in terms of setting a new global agenda for social, economic and environmental development. In September world leaders agreed to sustainable development goals (SDGs), a new universal set of goals, targets and indicators that the UN member states will use to frame their development agendas over the next 15 years.

2015 also signifies the end of the millennium development goals (MDGs) agreed on in 2001. Entered into with the hope of developing policies and overseas aid programmes to end poverty and improve the lives of poor people, it is widely agreed they were too narrow.

SDGs are the successor framework and the seventeen global goals were developed during an extensive consultation with non-government organisations, business, children, women and indigenous peoples and the science and technology community to end poverty, fight inequality and injustice and fix climate change.

Although governments have now agreed and indicators are now being decided on, certain countries have voiced concerns, including the UK. The Guardian reported that David Cameron publicly stated he wants twelve goals at the most, preferably ten.

It's not clear which goals the UK government would remove but it has been suggested the more uncomfortable ones such as those relating to the environment.

Recognising the link between social, economic and environment development is a positive step towards a sustainable world. Five global goals focus on the importance of a functioning environment and the impact it has on people.

Seven targets under the *Life below water* goal focus on:

- Reducing marine pollution
- Sustainably managing and protecting marine and coastal ecosystems
- Minimizing and addressing the impacts of ocean acidification
- Effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices
- Conserving at least 10 per cent of coastal and marine areas
- Prohibiting certain forms of fisheries subsidies
- Increasing the economic benefits to small island developing states and least developed countries from the sustainable use of marine resources

Global threats such as marine pollution, ocean acidification and overfishing all have a negative impact on the Chagos ecosystem so reducing these can only be a positive step.

Commitment to conserving 10 percent of coastal and marine areas by 2020 has long been the goal and mirrors the Convention on Biological Diversity target but at the most recent World Parks Congress recommendations were made to increase that to 30 percent and for that 30 percent to be no-take. Regardless of aspirations, decision makers are lagging behind with only 4 percent currently protected. Any increase in well-managed, no-take, protected areas would be beneficial to the marine environment and the millions of people that rely on it.

Time will tell whether this round of goals will make a difference and start reversing some of the damage done. But we can be momentarily optimistic that the importance of healthy oceans is now recognized as an integral part of sustainable development globally.

Environmental global goals

Clean water and sanitation: Ensure availability and sustainable management of water and sanitation for all.

Affordable and clean energy: Ensure access to affordable, reliable, sustainable and modern energy for all.

Climate action: Take urgent action to combat climate change and its impacts.

Life below water: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

Life on land: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Connect Chagos 2015

Kirsty Richards, Rudy Pothin &
Amdeep Sanghera

It's been a busy year for the Connect Chagos team, with another successful Chagos Environmental Training Course (CETC), several tailored sessions held in both Manchester and Crawley communities, three Connect Chagos ambassadors headed out on expeditions and one lucky individual joined us here at ZSL for a 6 week internship.

Expeditions

We were incredibly fortunate this year that three Connect Chagos ambassadors had the chance to join each of three expeditions to Chagos. The call for applications went out late last year with a handful of ambassadors grilled on their reasons for applying, what they would bring to the expedition team and how they would cope living on a boat for a month! Three lucky ladies were chosen after successfully completing the interview process.

Jenny Bertrand, 2014 CETC graduate, kicked things off in January joining Tom Letessier and his team on the pelagic expedition. Jenny was blown away by seeing Chagos for the first time, having heard many stories from her family *"the first time I saw a glimpse of the islands my heart jumped, all the history I've been hearing all these years just blew to the surface"*. Not afraid to get her hands dirty, Jenny worked long hours alongside the scientists preparing bait for the BRUVs (baited remote underwater videos), assisting where needed and challenged herself like never before!

Jenny Bertrand on the Pelagic Chagos Expedition, Jan 2015
Image ZSL

Nadine Dorothee visiting the islands during the Catlin expedition. Image ZSL

When a last minute spot opened up on the Catlin Seaview expedition in February, Nadine Dorothee, 2014 CETC graduate, jumped at the chance to join the team on the Pacific Marlin. With the "ok" from her work and goodbyes said to her family, Nadine soon found herself thousands of miles from her home, walking in the footsteps of her mother who was born on the islands.

As well as assisting with filming preparations for Seaview, Nadine was able to implement skills learnt during the CETC when monitoring sea birds and sampling corals. *"It was a once in a life time, unforgettable trip… I have learnt I can push myself to overcome challenges in my life and I feel more empowered to speak on behalf of my ancestors".*

Claudia Naraina, on the Darwin Chagos expedition. Image Anne Sheppard

Claudia Naraina, 2012 CETC graduate, was selected to join the Darwin expedition in March. As a qualified SCUBA diver, Claudia

was an invaluable member of the team and was able to call on her marine life and coral knowledge gained during the CETC to help with surveying the reefs. Claudia was also involved with seabird and coconut crab surveys with Pete Carr. Some of her trip highlights were rescuing a juvenile Green turtle entangled in a fishing net whilst on a long walk around one of the islands and surviving a very wet night camping out on South Brother Island with Pete and Jon Slayer. *"It was a brilliant night, I was just not expecting the torrential rain… I thought that it was quite an adventure to be stuck with two ex-marines on a deserted island. I was also later told that I was the first of my generation to stay overnight on one of the Chagos islands after nearly 50 years!"*

Chagos Environmental Training Course 2015

2015 Chagos Environmental Training Course Image ZSL

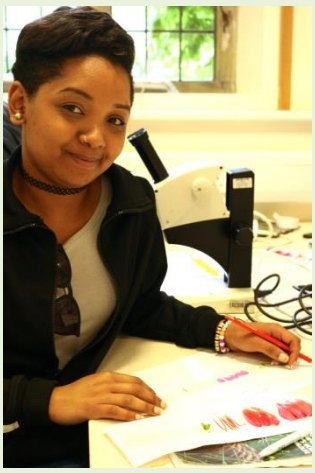
This summer 10 new trainees from both Crawley and Manchester embarked on the 4th Chagos Environmental Training Course. The sessions held were similar to the previous three years, including bird monitoring with the RSPB, habitat management with Tower Hamlets Cemetery Park and SCUBA diving with London School of Diving (LSD), although these were all new topics to the trainees!

This year saw the addition of a Chagossian cultural session where we invited elders from the community to share their stories, memories and traditions from their time living on Chagos. Trainees worked together with the elders to prepare a traditional lunch by cracking and shaving coconuts, cooking curry and baking traditional cakes. This session gave the trainees the opportunity to ask questions and spend some quality time learning about their heritage from elders who were grateful for the opportunity to share their experiences.

Connect Chagos Internship

In July, following a successful application, Jenny undertook a six week internship with the team here at ZSL. Ever since her participation on the CETC in 2014 Jenny has remained involved with the project and has proved an integral link between the ZSL team and the Chagossian community. As a key part of her internship Jenny spearheaded the planning and organisation of the cultural session of this year's Environmental Training Course. With support from the team, Jenny reached out to several elders from the community, developed an itinerary for the day and ensured it was a success! It was great to have her working alongside us in the ZSL office and we hope she gained an insight into the daily life of working at a large NGO.

Chagos Environmental Training Course



Botany, Kew Gardens Wakehurst

Habitat Management, Tower Hamlets Cemetery Park

Rocky shore, Birling Gap

Coral session, ZSL

Discover SCUBA, London School of Diving

Communications, ZSL

Cultural sessions

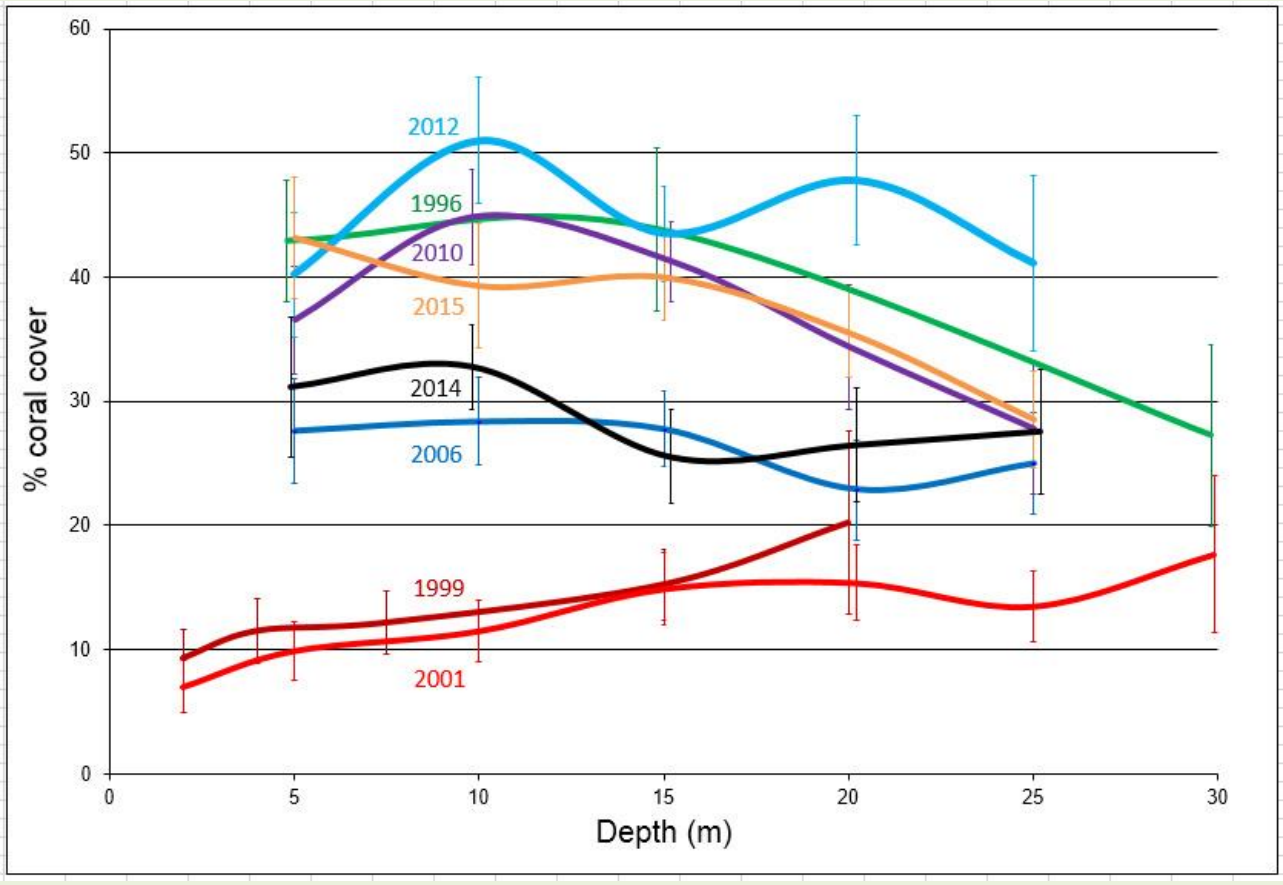
Enjoying some traditional Chagos food.

Learning a traditional Chagos dance.

Coral Cover on Chagos Reefs

Professor Charles Sheppard
University of Warwick

The graph below is an update of the general coral cover of ocean-facing reefs of the Chagos archipelago. It follows several earlier ones that have appeared in *Chagos News*, and adds results from the research visit in March-April this year (orange line). We saw in 2014 that coral cover fell that year, mostly attributed to the demise of very many coral tables. We think that was to a large extent because of senescence, followed by a storm. The reefs up to that time had a high cover of these, which were all of similar age and size having settled together a couple of years after the massive mortality of 1998. This year, cover is up again. The dead table that littered the reefs between about 5-15 m depth were visibly fewer (having been broken up) and the corals this time were rather more diverse, with many brain, leafy and encrusting forms that would have been present in previous years but much less conspicuous. Readers might notice that the error bars are rather broader in the 2015 results, caused in part by the inclusion of a few sites (fortunately not many) where coral cover was approximately zero, in one case at least from crown-of-thorns exposure. All this is encouraging, except that by the time we left in mid-April, another bleaching episode was on the way. During our visit, ocean water was very often 29.5 to 31 degrees C down to 20m depth, astonishingly high values for ocean facing sites, and the warming event is predicted by NOAA and many others to become the worst ever. We urgently need to visit and retrieve the temperature data again in March or April 2016.



Building CCT-US from the Ground Up

Commander Stephen F. Snell,
U.S. Navy (Retired)

This article provides some background information on the formation of the Chagos Conservation Trust – US (CCT-US), explains our relationship to the Chagos Conservation Trust in the UK, introduces the Board of CCT-US, and provides a brief outline of our approach to our organizational structure, our outreach efforts, and solicitation of charitable donations in the United States to support initiatives consistent with the vision and goals of CCT-US.

I. Vision for US branch of CCT

When Friends of the Chagos/Chagos Conservation Trust was formed by Commander John Topp OBE, RN, and others in 1992 in the UK, it was only a matter of time before some initiative would be taken to establish a sister organization in the USA. John and I spent coincident time on Diego Garcia in 1984 and enjoyed one another's company, most notably on Sunday evenings over a rubber of bridge and some single malt whisky. John reached out to me almost immediately when CCT was formed, and I signed up just as quickly as one of the early members of the trust. William Marsden was also instrumental in the formation of a CCT-US, and he played a key role in connecting the respective boards. William had met both Dr. Sam Purkis, who was a resident professor at Nova Southeastern University in Fort Lauderdale, Florida, and Carol Garner from Mount Vernon, Ohio. Carol, as it turned out, had significant experience in charitable and non-profit fundraising. I became the third piece of the puzzle which was to form the leadership team of CCT-US.

By the time Sam, Carol, and I had connected via teleconference, Sam was already ahead of the pack. CCT-US launched itself with a booth at the 11th International Coral Reef Conference in Fort Lauderdale, Florida in 2008.

Sam Purkis signs up one of the first members of CCT-US at the 11th ICRS in Ft. Lauderdale, Florida, 2008

II. Establish a Solid Organizational Foundation: Staff

CCT-US could not have been more fortunate to have assembled an ideal match of complementary skills that would serve us well as we attempted to establish a solid foundation for a new organization. Sam, Carol, and I have established a strong working relationship, and as we each have different strengths, it is not difficult to distribute needed tasks to the right talent. And not one of the three of us seems to be shy about taking on responsibility.

Permit me to introduce the 3 Co-Founders of CCT-US and provide some background detail:

Chair: Sam Purkis PhD. Sam is a Professor at Nova Southeastern University Oceanographic Center, Fort Lauderdale, Florida. He thus has a foundation in the sciences, credibility in academia, and also delivers strong links back to CCT through his personal acquaintances. His work stretches from field monitoring and GIS, to software development and mathematical simulation. Sam has authored more than 80 scientific publications including several books. Sam is well versed in state-of-the-art technological solutions for seabed mapping, and his expertise is relevant to a broad spectrum of marine applications.

Sam Purkis (right) with Alex Dempsey, coral reef ecologist with Living Oceans Foundation and cameraman Doug Allen (left) filming in Chagos in 2015

Vice Chair and Treasurer: Steve Snell. Steve is a retired Naval officer, and was assigned to Diego Garcia as Executive Officer of the U.S. Naval Communication Station in 1983 and 1984. After retirement from the Navy, he worked for 20 years in a Fortune 500 corporation in the computer sciences. He has strong organizational skills, and coincidentally has past experience as Treasurer of another tax-sheltered charitable organization.

On Diego Garcia in 1983, displaying the stern demeanor required of an Executive Officer

Secretary: Carol Garner. Carol has extensive and exceptional experience in fund-raising, large-scale capital campaigns and grant application writing for non-profits and charitable organizations, and conducting public and private fund-raising campaigns. She is adept at public relations and outreach; as such, she is CCT-US' own goodwill ambassador extraordinaire.

Carol (on the right) along with two CCT-US benefactors, Ann and Ted Schnormeier.

CCT-US has also had the good fortune to have added two additional contributors:

Web Site Administrator: Gwilym Rowlands PhD. Gwilym is an expert in the spatial ecology of tropical reef environments, and has been invaluable in being our resident expert in computer operations and social media. He earned his doctorate at Nova Southeastern University studying the diversity, distribution and genesis of contemporary coral reef environments in the Saudi Arabian Red Sea and is well versed in seafloor mapping, along with techniques for advanced spatial analysis. Gwilym has written and contributed several academic papers and on the subject of coral reefs in different regions of the globe, and his work spans both ecological and geological disciplines.

Gwilym Rowlands. Also capable of a stern demeanor

Outreach and Publicity Director: Chip Batcheller. Chip is also a retired Naval officer and was assigned as Commanding Officer, Naval Air Facility, Diego Garcia, 1983-4, providing us with additional on-island experience. Chip unfortunately had to leave CCT-US for family reasons but provided us great service with outreach and publicity.

With the more pleasant demeanor of a Commanding Officer on Diego Garcia, 1983

III. Establish a Solid Organizational Foundation: Legal, Tax Status, Corporate Direction

With Sam, Carol, and me in place as co-founders of CCT-US, we set out to get ourselves established officially, legally, and with the approval of the Internal Revenue Service for tax purposes. Our first effort was to compose a vision statement to bound our potential activities. Our vision statement encompassed three focal points: conservation, scientific research, and education as relates to the Chagos Archipelago. It was always our intent to create a sister organization that retained its independence and freedom of thought,

while at the same time was able to act in concert with CCT in the UK and provide value-added to tangible and meaningful preservation goals. After defining our vision, we developed By-Laws and Articles of Incorporation, which were filed in the State of Ohio as a matter of convenience for Carol since she lives in Ohio.

Following incorporation, our next major task was to file for non-profit charitable status (known as 501(c)(3) after a section of the Internal Revenue Service (IRS) Code) with the IRS. While there are many individuals and organizations willing to shepherd the application through the IRS for a fee, we were budget-limited and did all the work ourselves. Through Carol's connections we did engage in a pro bono legal review prior to submission. We achieved our 501(c)(3) approval on February 10, 2010. The significance of the approval was huge, as it meant that charitable contributions could be made by organizations or individuals who would enjoy tax deductions.

We next developed a Strategic Plan with detailed Goals & Objectives to guide our schedule of activities and ambitions. Of vital importance, the Goals & Objectives were resource-constrained by linkage to our corporate budget documents. Although our achievements at this early stage are modest, CCT-US has nonetheless accomplished many things. Of note, we were able to fund the CCT-US Expedition Scholarship program and sent one scholar, Dr. Doug Fenner, to Chagos in 2014. This program is ongoing and is the centerpiece of our investment of donated funds.

IV. Establish a Solid Organization Foundation: Outreach

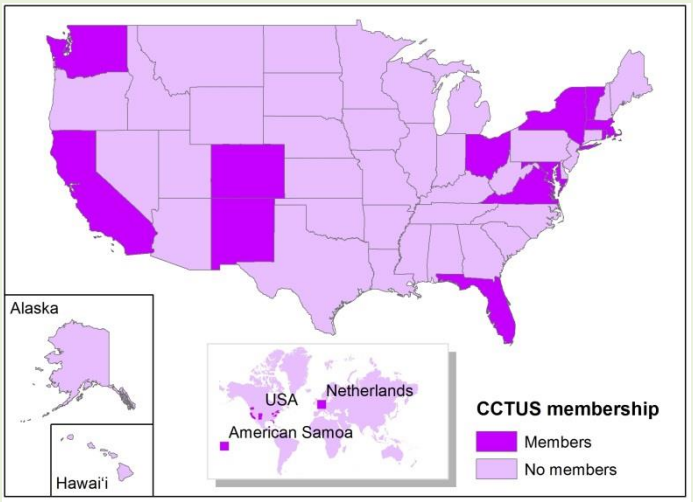
At the outset, we were faced with a real challenge to not only gain name recognition among the myriad of charitable organizations in the USA, but to do so in a professional manner to establish our credibility as a charity worthy of both participation and donations. To most in the USA, Chagos is either unknown, or is so remote as to not register on the public consciousness. Our efforts at outreach, therefore, are as much about educating the public as anything else.

In setting out to answer the questions: *Who is CCT-US?* and *What do we do?* we very quickly built a website and hosted it on the internet (see www.cctus.org); we have Gwilym to thank for all the hard work in bringing the website to reality—an effort that was performed with virtually no expenditure of resources. Carol has also championed our cause in social media by building and maintaining a FaceBook page (www.facebook.com/chagosconservationtrustus).

We are identifying candidate US-based conservation entities (e.g., the Loggerhead Marinelife Center (http://www.marinelife.org/)) for potential strategic alliances. We are additionally seeking out other interest groups within commonalities to our corporate vision. One such interest group, Big Ocean, a network of the world's large-scale marine protected areas (MPAs) hosted a meeting in 2011 in Victoria, British Columbia, Canada which was attended by our own Carol Garner representing CCT-US with full support from CCT in the UK.

From L to R: John Parks, Executive Officer of John Parks consulting LLC; Alistair Gammell, Director Pew Environmental Group Chagos Campaign; Carol Garner, and Suzanne Taei, Marine Program Director, Conservation International, Apia, Samoa

We have a great deal yet to do in expanding our outreach. For example, there is a large cadre of present and former US military personnel who have been assigned to Diego Garcia who are potential candidates for involvement in CCT-US. While our membership numbers are modest, we have members in 12 states and territories and one foreign country. The pool of former residents of Diego Garcia represents a resource that is yet to be tapped.



V. Establish a Solid Organization Foundation: Fundraising

Our approach to fundraising has had to conform to some fundamental realities. While these realities will change over time, for the time being we must be guided

- Capitalize on a tax structure in the USA which encourages charitable donations—from individuals, from corporations, from foundations, from trusts; be mindful and be respectful of constraints on donations such as limitations on the flow of funds outside the country in the wake of 9-11
- Recognize our small beginnings; keep our objectives manageable, which keeps our fundraising goals manageable
- Keep growth objectives in fundraising reasonable – so far a 33% positive return rate on tendered proposals
- Cultivate partnerships with corporate and individual donors
- Publicize to donors the returns on our investment of their donations in scientific or educational achievement
- Strive to advertise the CCT-US through public speaking and other public events to solicit donations, however large or small

VI. Summary

From humble beginnings, CCT-US is gaining good traction in its efforts to remain a viable force in environmental preservation and education for many years to come. We will continue to strive to serve as an equal partner with CCT in the UK as we pursue common objectives. We recognize the synergies that can be realized by applying the resources of two organizations against these common objectives, instead of just one. While our constituents and the legal framework in which we live and work are vastly different from those in the UK, CCT-US can and will bring new perspectives to our shared ecological challenges.

An initial trial to determine an effective rat bait application rate at Diego Garcia, British Indian Ocean Territory.

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Summary
Rat bait consumption trials were undertaken in an abandoned coconut plantation on Diego Garcia in August 2014 to inform future possible rat eradication attempts. Rat bait dyed with Rhodamine B was hand-spread on two 1 ha plots at a rate of 15kg/ha and rats trapped for three days after bait had been available for 24 hours. Sixty rats were subsequently removed from a smaller internal trapping grid and of these 98.3% had consumed the bait. It appears that the bait application rate was possibly slightly low for the very high rat densities attained in the 'coconut chaos' found on Diego Garcia and further trials will need to be undertaken to determine a suitable application rate before any rat eradication is attempted.

Introduction

Invasive rat eradications have been conducted on over 300 islands worldwide and are a successful and cost-effective method for improving biodiversity values and enabling ecosystem recovery where there is little risk of reinvasion by rats. Although the success rate of rat eradication attempts has been high on temperate islands where the technique was developed it has been somewhat less successful on tropical islands (Varnham 2010). The reasons for the poorer success rate are still unclear but are likely due to a combination of factors which could include; poison bait interference by terrestrial crabs, year-round breeding by rats due to reduced seasonal fluctuations in primary productivity, difficulties with poison bait application in habitats unique to the tropics like mangroves and availability of more favourable natural foods.
In general, one of the methods used to overcome these possible problems has been to apply poison baits at a higher rate than has traditionally been used on temperate islands, and this has resulted in some success. However there are drawbacks with increased application rates, not least being poisoning of non-target species. In order to strike a balance between achieving eradication success and reducing risk to non-target species bait application trials are conducted. Recent trials in the Pacific and Indian Ocean islands suggest that where dense populations of land crabs are present application rates of 15kg/ha are sufficient for rats to access poison bait despite bait consumption by crabs (Griffith et al. 2011, Harper et al. 2015).

On Diego Garcia (7^{o} 15' S, 72^{o} 22' E) and the other 50-plus islands of the British Indian Ocean Territory (BIOT), eradication of introduced ship rats (*Rattus rattus*) has been suggested as a method of improving the biodiversity values of this tropical archipelago. However rats exist at very high densities, especially in the abandoned coconut plantation forest, where food is plentiful year round (Vogt et al. 2014). In this case, one of the first steps for informing eradication planning for the BIOT was to determine the most effective poison bait application rate.

Methods

Two x 1 hectare plots were set out 200m apart in disused coconut plantation forest some 2km west of the small township on western Diego Garcia. The plots were divided into a 5 x 5 grid at 25m intervals. Within the plots an internal trapping grid of

15 Victor snap-traps was established at an interval of 25m x 12.5m. The internal grid was centrally located so that there was a 25m buffer from the entire perimeter of the outer grid.

Poison bait (Pestoff 25R pellets, Animal Control Products, NZ) was hand-spread on both 1-ha plots at a rate of 15kg/ha on 7 August 2014. The bait had been dyed with Rhodamine-B, which fluoresces under UV-light. After one night to allow rats to access the bait, the snap-traps were baited with coconut and peanut butter and set.
Trapped rats were collected morning and evening for the next three days. The rats were dissected and their gut cavities examined under UV light for evidence that the dyed bait had been consumed.
To give a simple estimate of rat population density, the number of rats caught was divided by the effective trapping area (ETA). To estimate ETA for rats, a boundary strip was added to the edge of the trapping grids (Dice, 1938). The width of the boundary strip was set by adding the average radius (15m) of the home range of ship rats from mangrove forest on Aldabra Atoll and forest on Juan de Nova and Europa (Harper et al. 2015, Ringler et al. 2015).

Results

Sixty rats were removed from traps over the three days. There was significant interference with, and removal of, trapped rats by land crabs, so this is highly likely to be a minimum number of rats trapped. Of the 60 rats, 59 (98.3%) had eaten dyed bait. The one rat that had not consumed bait was an adult female that was trapped in the first morning after the bait application, so bait had been available for a little over 36 hours. Some bait was still present on the last day of trapping.

Of the trapped rats, only two were juveniles (both female) and there was a slight sex bias towards male rats (32:28). Several adult male rats were mangy and in poor condition, whilst some rats were in good condition with substantial amounts of mesenteric fat. Of the 26 adult female rats trapped, two were pregnant.
The trapping grids within the bait grids were 25m in diameter, and adding a 15m boundary strip gave a total radius of the ETA as 40m, for an area of 0.5ha. As at least 30 rats were caught on each trapping grid this translates to 60 rats/ha.

Discussion

This trial has provided a baseline bait application rate to inform further trials should rat eradication occur on any BIOT islands in future. It appears the application rate of 15kg/ha is a little low in the face of the very high rat densities attained in the ‘coconut chaos’ of abandoned plantations on Diego Garcia and other islands in the BIOT (Vogt et al. 2014). The calculated population density of rats on the trapping grids of 60/ha, was likely to be an underestimate due to losses of trapped rats by land crabs, and as Vogt et al. (2014) had previously recorded 187 rats/ha in coconut forest on Diego Garcia. In apparently less suitable forest on other Indian Ocean islands rat population densities of up to 71 rats/ha have been recorded (Harper et al. 2015).

It is unknown how much bait was taken by land crabs and what the population density of land crabs was on the two 1-ha grids, but there were very few, if any, hermit crabs that consumed most bait in trials elsewhere. Bait was still available at the end of the trial so it appears that non-target bait interference was not a significant issue in this trial.

The reason(s) why the female rat did not consume the dyed bait is unknown, but could be due to a number of factors. The

most likely are that she either entered the poisoned area from outside the poison grid and did not encounter the bait before being trapped, or she could have ignored the bait entirely. In future trials the first possibility could be avoided by poisoning a larger area of 2-3ha, so that bait is available within all rats' home ranges likely to enter the internal trapping grid. Application rates could initially be set at 15kg/ha for a further larger-scale trial, and at the higher rate of 18-20kg/ha on the same-sized baiting grids in subsequent applications. Certainly the standard procedure for rat eradications of two bait applications at least 10 days apart should be adhered to during any rat eradication and should be tested for efficacy in the lead up to an eradication.

In relation to any possible eradication planning, pregnant and juvenile rats were trapped during this trial, which suggests breeding was taking place in the austral winter on Diego Garcia, albeit at a low level. To inform the timing of future rat eradications for when breeding activity is at a minimum, seasonal trapping and dissection of rats from a variety of habitats for a year or two on Diego Garcia would assist with future planning.

Acknowledgements

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The Distribution of Ship Rat *Rattus rattus* in the Chagos Archipelago

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Abstract: The first comprehensive survey for invasive rats in the Chagos Archipelago occurred in 1996 and reported detecting the presence of Ship Rats *Rattus rattus* on 36 of 45 islands surveyed. Incidental observations from a 1975 scientific research expedition increased this figure to 37 of 47. Presently the Chagos Archipelago has 58 named and two unnamed land masses. These have accreted in to 55 islands, islets and cays (hereafter termed islands). Extensive surveys for invasive mammalian predators post 1996 have revealed that *Rattus rattus* is actually present on 26 islands, absent from at least 20 and their status uncertain on the remaining nine. Six islands reported as rat-infested in 1996 have subsequently been proven to be rat-free and a further three islands have had rat eradication projects undertaken on them. Due to the miniscule size of the islands involved the total land mass free of rats in the Chagos Archipelago has not increased dramatically though crucially, the number of rat-free islands has. This new information on *Rattus rattus* distribution when combined with the locations of the internationally important breeding seabird colonies strategically informs the future prioritisation of islands for ecological rehabilitation.

INTRODUCTION

The catastrophic impact of introduced invasive species on fragile island ecosystems is now well recognised. One of the most widespread invasive families is Rattus, of which three commensal species have been introduced to over 80% of the world's island groups (Atkinson, 1985), where their serious deleterious effects through predation and competition on tropical islands are well documented (Harper & Bunbury, 2015).

In the tropical Chagos Archipelago, central Indian Ocean, rats were present in numbers enough to ruin crops by 1786 (Wenban-Smith & Carter, in press). They were most likely accidentally introduced during the first attempts at permanent settlement by the French and British in the late 1700s, though Portuguese mariners had been prospecting the area two centuries prior and may have been the perpetrators.

To counter the negative impact of "swarms" of rats on crops and the living quarters, at the height of the plantation era in the early 20th Century, children on the largest island of Diego Garcia were paid three cents per rat corpse collected in an attempt to control numbers (Scott, 1961). In more recent times, a scientific research expedition to the Chagos in 1975 recognised the potential for increasing biodiversity through eradicating rats on the second largest island in the archipelago, Eagle Island (06° 11´ S, 71° 19´ E) (Hirons, Bellamy & Sheppard, 1976; Bellamy,1979). This visionary plan was brought to fruition in 1996 with a dedicated eradication attempt, though unfortunately it was unsuccessful (Daltry, Hillman & Meier, 2007).

At the same time as the failed eradication attempt on Eagle Island, as part of the first scientific research expedition for two decades Barnett & Emms (1998) undertook surveys of various taxon, including mammals and located *Rattus rattus* "on most islands". During the same scientific research expedition Symens undertook the first survey specifically on the distribution of rats, recording *Rattus rattus* on 36 of the 45 islands of the archipelago surveyed; this research also demonstrated the skewed bias of breeding seabirds towards rat-free islands (Symens, 1999).

Varnham (2006) produced a database of invasive species from across the United Kingdom Overseas Territories (UKOTs) and her Chagos records were based primarily on Symens' 1996 data. Hilton & Cuthbert (2010) assessed the impact of invasive mammalian predators on avian populations throughout the UKOTs. They noted that rats were present on 95.3% of the Chagos landmass, cats were present on 62% and that only 4.7% of the entire Chagos terrestrial space was mammalian predator free. They also calculated that seabird

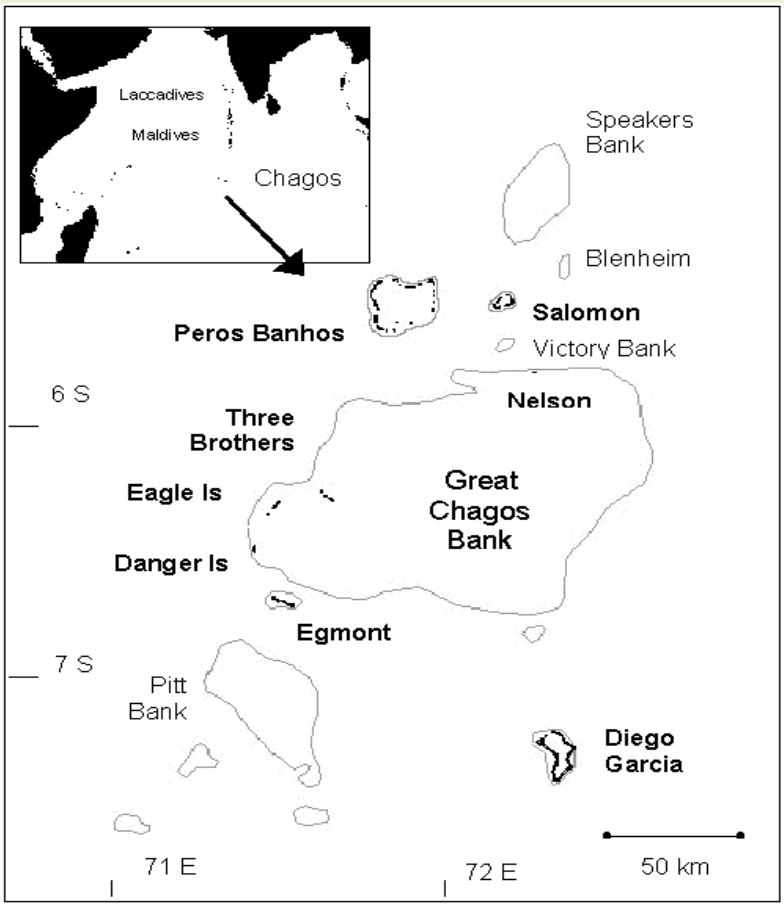
density ≈20x greater on rat-free islands, again based upon Symens' (1999) data. In 2010 in the Chagos itself a second *Rattus rattus* eradication project was being drawn up. As the success rate of rat eradication operations on tropical islands had to that date been substantially less successful than similar operations on islands with temperate seasonal climates - recently substantiated in print by Russel & Holmes (2015), the second attempt at eradicating rats was deliberately planned to be a much smaller operation than the previous endeavour. This ensured it came with consummately scaled down risks, operational and logistical burdens and costs. Eleven hectare Ile Vache Marine in Peros Banhos (05° 25 S, 71° 49E) was selected as the target island. (Two other tiny islands [>2 ha.], Jacobin and Sel in the Salomon Islands were included in the same project). The eradication phase of this project was executed in August 2014; the success or failure of these operations will not be determined until August 2016. The latest analysis of the impact of invasive mammals in the UKOTs has been by the RSPB, who prioritised Ile de la Passe in Peros Banhos as the 25th island in the entire UKOTs in need of ecological intervention - in this case rat eradication (RSPB, 2014). At low tide Ile de la Passe has a 5m wide shallow channel between it and rat-infested Moresby Island and therefore would be reinvaded following any eradication operation unless the two islands were cleared of rats concurrently. A Territory-focussed analysis using an expanded RSPB methodology would likely produce a different outcome of which islands are the highest priorities for ecological intervention in the Chagos (RSPB, pers. comm.).

The distribution of *Rattus rattus* in the Chagos was revisited in 2011 as part of a review of the Important Bird Areas of the region (Carr, 2011a) and, two years later as part of a Masters by research project analysing the factors impacting the breeding island selection of Red-footed Booby *Sula sula* throughout the archipelago (Carr, 2013). It became apparent during this research that their distribution was not as published by Symens (1999), which had been widely accepted and used for analysis. Knowledge of the distribution of invasive mammalian predators is critical to any biological management plan and this is especially so on oceanic islands where their impact, particularly on breeding seabirds, is amplified. To better inform future terrestrial environmental management plans, especially if they propose ecological intervention and island environmental rehabilitation, this paper reviews and updates the distribution of *Rattus rattus* in the Chagos Archipelago.

STUDY AREA

The Chagos Archipelago (or British Indian Ocean Territory) is positioned in the central Indian Ocean at the southern end of the Laccadive-Chagos ridge. Its Exclusive Economic Zone (EEZ) lays within 04°-08°S and 70°-74°E and covers an area of approximately 640,000km^2. Of this about 50km^2 (≈0.008%) is *terra firma*. Some 29km^2 (≈58%) of this land is the single inhabited, rat-infested island of Diego Garcia. The remainder of the archipelago holds four further islanded atolls and several other atolls and banks which are awash or completely submerged. (Sheppard *et al*, 2013). In total there are thought to be 55 land masses in the archipelago capable of supporting breeding seabirds.

There are presently three categories of sites of global importance in the Chagos Archipelago: a single IUCN Category 1 No-Take Marine Protected Area that encompasses all of the EEZ; a Ramsar site based upon the eastern arm of Diego Garcia and seas out to three miles (from Carr *et al*, 2013) and ten IUCN Important Bird Areas (IBAs) (Carr, 2006) and two proposed IBAs (McGowan, Broderick & Godley, 2008). All of the IBAs are categorised as Strict Nature Reserves with the exception of the site on Diego Garcia which is a Conservation (Restricted) Area. This affords them a degree of protection, both through BIOT Law and effective enforcement of the Law (Carr *et al*, 2013).



Map One. The Chagos Archipelago (from Sheppard *et al*, 1999).

Table 1. Criteria used for presence of rats.

CRITERIA	PRESENT
Rats trapped	✓
Rats sighted	✓
Rats detected by but not limited to:	
Obvious rat trails (see Plate 1)	✓
Rat chew marks on fallen fruits and nuts (see Plate 2)	✓
Evidence of predation on nesting birds especially terrestrial nesting terns	✓
Rat droppings	✓

Plate 1. Rat trail with path highlighted.

Plate 2. Rat gnawed coconut *Cocus nucifera*

METHOD

Through October 2008 to October 2010 one author (PC) visited every island in the Chagos Archipelago. During this period a concerted effort was made to review the distribution of invasive mammalian predators throughout the archipelago. This resulted in several islands being repeatedly visited and many camped on overnight. In addition, through 2010 to 2015, PC as a participant on seven scientific research expeditions further investigated invasive mammalian predators. Some of this data was used in a review of the Important Bird Areas of the Territory and also for a Masters by research. In 2014 (GH) visited the Chagos Archipelago twice, the second visit in August with PC. These trips were specifically focussed upon *Rattus rattus* research and eradication.

RESULTS

Table 2. Distribution of *Rattus rattus* in the Chagos Archipelago.
Legend. P = Rats present. A = Rats absent. U = Status uncertain. E = rats eradication has taken place, awaiting outcome of the operation. Comments in **bold** are for where there are differences from the results of Symens (1999) and references therein, i.e. rats are not present, or is new data.

No.	ATOLL	ISLAND	SIZE km^2	STATUS	COMMENT
1	DIEGO GARCIA	DIEGO GARCIA	29.98	P	Harper & Carr, 2014. Possibly the greatest density of rats on any island in the world.
2		WEST ISLAND	0.02	A	Symens, 1999. Post 1996 there have been a minimum of 15 visual inspections conducted between 2008 and 2015 and this island remains rat-free (Carr, unpubl.).
3		MIDDLE ISLAND	0.04	A	Symens, 1999. Post 1996 there have been a minimum of ten visual inspections conducted between 2008 and 2015 and this island remains rat-free (Carr, unpubl.).
4		EAST ISLAND	0.14	A	Symens, 1999. Post 1996 there have been a minimum of ten visual inspections conducted between 2008 and 2015 and this island remains rat-free (Carr, unpubl.).
5	**EGMONT ISLANDS**	**ILE SUDEST**	**1.95**	**P**	**These islands have not previously been surveyed for invasive mammalian predators. They have merged and are now a single entity. Seven rats trapped in ten snap traps overnight on 19 February 2009 (Carr, unpubl.).**
6		**ILE TATTAMUCCA**	**0.01**	**P**	
7		**ILE CARRE PATE**	**0.06**	**P**	
8		**ILE LUBINE**	**1.2**	**P**	**These islands have not previously been surveyed for invasive mammalian predators. They have merged and are now a single entity. Two rats trapped in ten snap traps overnight on 19 February 2009 (Carr, unpubl.).**
9		**ILE SIPAILLE**	**0.58**	**P**	
10		**ILE DES RATS**	**0.01**	**P**	
11	GREAT CHAGOS BANK	DANGER ISLAND	0.66	A	Symens, 1999. Post 1996 these have been a minimum of fifteen visual inspections conducted between 2009 and 2015 and this island remains rat-free (Carr, unpubl.).
12		SEA COW	0.2	A	Baldwin, 1975. Post 1975 there have been a minimum of twenty visual inspections conducted between 2009 and 2015, including three overnight inspections and this island remains rat-free (Carr, unpubl.).
13		EAGLE ISLAND	2.52	P	Daltry, Hillman & Meier, 2007. Post the 2006 failed rat eradication attempt there have been a minimum of 10 further visual inspections and this island remains rat-infested (Carr, unpubl.).
14		SOUTH BROTHER	0.23	A	Symens, 1999. Post 1996 these have been a minimum of fifteen visual inspections conducted between 2009 and 2015 including one overnight inspection and this island remains rat-free (Carr, unpubl.).
15		RESURGENT	0.007	A	Symens, 1999. Post 1996 these have been a minimum of five visual

					inspections conducted between 2009 and 2015 and this rocky outcrop remains rat-free (Carr, unpubl.).
16		MIDDLE BROTHER	0.07	A	Symens, 1999. Post 1996 these have been a minimum of fifteen visual inspections conducted between 2009 and 2015 including one overnight inspection and this island remains rat-free (Carr, unpubl.).
17		NORTH BROTHER	0.08	A	Symens, 1999. Post 1996 these have been a minimum of ten visual inspections conducted between 2009 and 2015 and this raised limestone island remains rat-free (Carr, unpubl.).
18		NELSON'S ISLAND	0.81	A	Symens, 1999. Post 1996 these have been a minimum of fifteen visual inspections conducted between 2008 and 2015 and this island remains rat-free (Carr, unpubl.).
19	PEROS BANHOS	ILE DE COIN	1.26	P	Symens, 1999. Visual confirmation of rat presence on 23 February 2010 when two rats were sighted (Carr, unpubl.).
20		ILE ANGLAIS	0.13	P	Symens, 1999. Signs of rat presence detected on 23 February 2010 (Carr, unpubl.).
21		ILE MONTPATRE	0.008	P	Symens, 1999. These two islands have merged and are now a single island. They have been visually inspected at least seven times between 2009 and 2015 and remain rat-infested (Carr, unpubl.).
22		ILE GABRIELLE	0.02	P	
23		ILE POULE	0.92	P	Symens, 1999. This island has been visually inspected at least seven times between 2009 and 2015 and remains rat-infested (Carr, unpubl.).
24		ILE PETIT SOEUR	0.47	P	Symens, 1999. This island has been visually inspected at least seven times between 2009 and 2015 and remains rat-infested (Carr, unpubl.).
25		ILE GRAND SOEUR	0.54	P	Symens, 1999. This island has been visually inspected at least seven times between 2009 and 2015 and remains rat-infested (Carr, unpubl.).
26		**ILE FINON**	**0.01**	**U**	**This island has not previously been surveyed for invasive mammalian predators. Visually checked 27 March 2015, no obvious signs of rat presence (Carr, unpubl.).**
27		**ILE VERTE**	**0.03**	**U**	**This island has not previously been surveyed for invasive mammalian predators. Visually checked 27 March 2015, no obvious signs of rat presence (Carr, unpubl.).**
28		**UNNAMED ISLAND**	**0.02**	**U**	**This island has not previously been surveyed for invasive mammalian predators. Visually checked 27 March 2015, no obvious signs of rat presence (Carr, unpubl.).**
29		**ILE MANON**	**0.02**	**U**	**This island has not previously been**

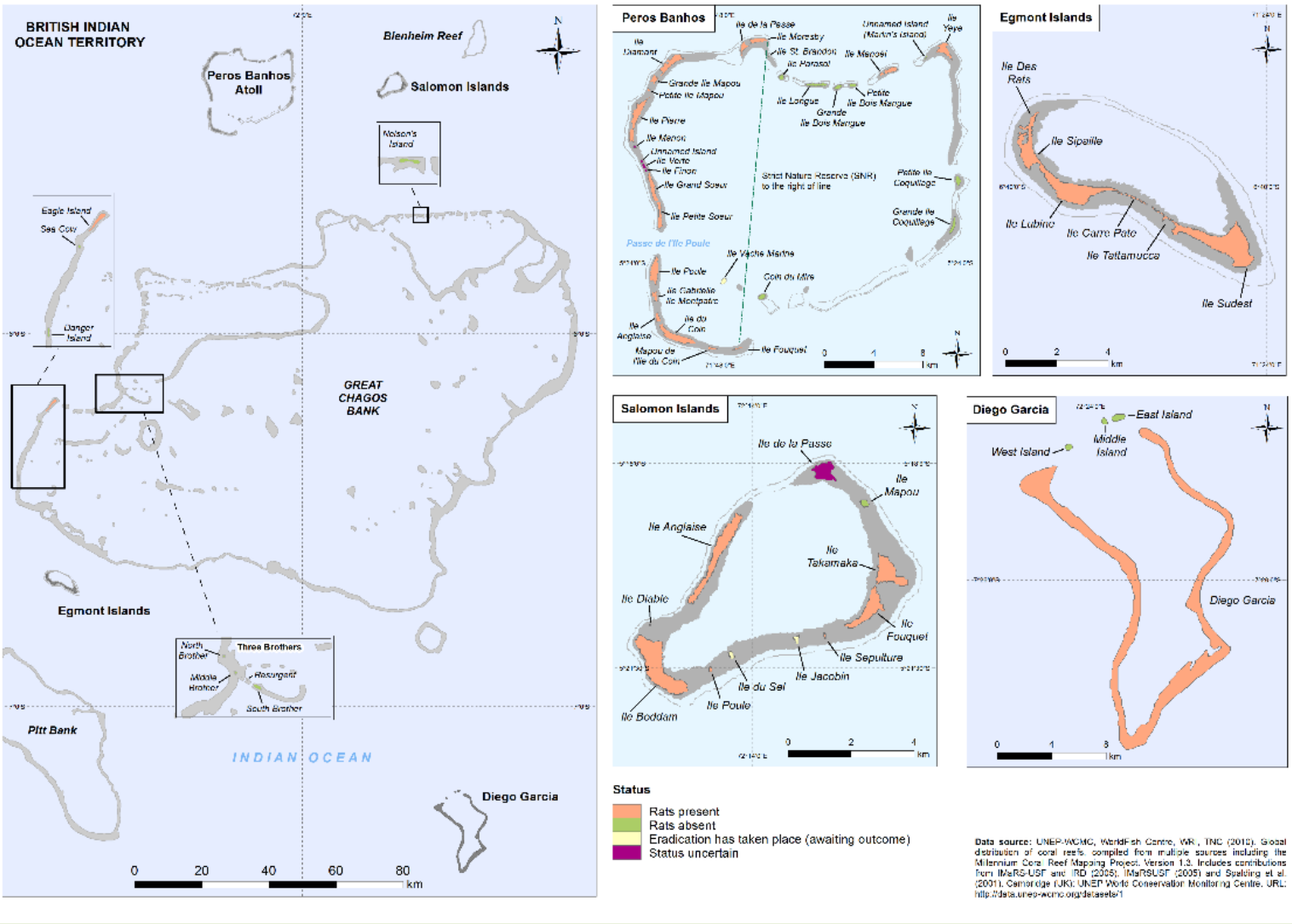
					surveyed for invasive mammalian predators. Visually checked 27 March 2015, no obvious signs of rat presence (Carr, unpubl.).
30		ILE PIERRE	1.23	P	Symens, 1999. Visual confirmation of rat presence on 25 January 2009 when two rats were sighted. Eight-eight snap-traps deployed on 13 July 2009 with zero rats trapped (Carr, unpubl.).
31		PETITE ILE MAPOU	0.01	P	Symens, 1999. This island has been visually inspected at least seven times between 2009 and 2015 and remains rat-infested (Carr, unpubl.).
32		GRANDE ILE MAPOU	0.2	P	Symens, 1999. This island has been visually inspected at least seven times between 2009 and 2015 and remains rat-infested (Carr, unpubl.).
33		ILE DIAMANT	0.9	P	Symens, 1999. Visual confirmation of rat presence with sightings of singletons on 14 July 2009 and 23 January 2010 (Carr, unpubl.).
34		ILE DE LA PASSE	0.2	P	Symens, 1999. Visual confirmation of rat presence with two rats sighted on 21 February 2010 (Carr, unpubl.).
35		ILE MORESBY	0.31	P	Symens, 1999. Visual confirmation of rat presence with three rats sighted on 21 February 2010 (Carr, unpubl.).
36		**ILE SAINT BRANDON**	**0.002**	**A**	**This emerging cay has not previously been surveyed for invasive mammalian predators. Visually checked 28 March 2015, no rats present (Carr, unpubl.).**
37		**ILE PARASOL**	**0.08**	**A**	**Symens, 1999. This island has been visually inspected a minimum of twenty times between 2009 and 2015 including deploying 50 snap-traps overnight on 30 May 2009 and 22 January 2010. Rats are not present (Carr, unpubl.).**
38		**ILE LONGUE**	**0.22**	**A**	**Symens, 1999. This island has been visually inspected a minimum of twenty times between 2009 and 2015 including deploying 50 snap-traps overnight on 22 February 2009, 16 July 2009 and 22 January 2010. Rats are not present (Carr, unpubl.).**
39		**PETITE ILE BOIS MANGUE**	**0.09**	**A**	**Symens, 1999. This island has been visually inspected a minimum of twenty times between 2009 and 2015 including deploying 100 snap-traps overnight on 06 October 2009 and 23 January 2010. Dr. Grant Harper confirmed island as rat-free on 07 August 2014 (Carr & Harper, unpubl.).**
40		**GRAND ILE BOIS MANGUE**	**0.13**	**A**	**Symens, 1999. This island has been visually inspected a minimum of twenty times between 2009 and**

					2015 including one overnight inspection and deploying 50 snap-traps overnight on 23 May 2009 and 23 January 2010. Rats are not present (Carr, unpubl.).
41		ILE MANOEL	0.3	P	Symens, 1999. Signs of rat presence detected 23 February 2009, 23 January 2010 (overnight inspection) and 21 February 2010. Twenty snap-traps were deployed overnight on 23 January 2010 with zero rats captured (Carr, unpubl.).
42		**UNNAMED ISLAND (MARLIN'S ISLAND)**	**0.001**	**A**	**This miniscule emerging cay has not previously been surveyed for invasive mammalian predators. Visually checked 29 March 2015, no rats present (Carr, unpubl.).**
43		ILE YEYE	0.61	P	Symens, 1999. Visual confirmation of rat presence with four rats sighted on 23 February 2009 (Carr, un
44		**ILE PETITE COQUILLAGE**	**0.19**	**A**	**Symens, 1999. This island has been visually inspected a minimum of twenty times between 2009 and 2015 including two overnight inspections and deploying 100 snap-traps overnight on 05 October 2009 and 20 February2010. No rats are present (Carr, unpubl.).**
45		**ILE GRAND COQUILLAGE**	**0.21**	**A**	**Symens, 1999. This island has been visually inspected a minimum of twenty times between 2009 and 2015 including one overnight inspection and deploying 100 snap-traps overnight on 22 February 2009 and 20 February 2010. No rats are present (Carr, unpubl.).**
46		COIN DE MIRE	0.01	A	Symens, 1999. This rocky outcrop has been visually inspected at least five times between 2009 and 2015 and remains rat-free (Carr, unpubl.).
47		**ILE VACHE MARINE**	**0.11**	**E**	**Symens, 1999. This island had a rat eradication operation undertaken on it in August 2014. No rats were detected throughout a two day inspection 25/26 March 2015. The island is to be inspected again in August 2016 when the outcome of the operation can be claimed.**
48		ILE FOUQUET	0.02	P	Symens, 1999. This island has been visually inspected at least five times between 2009 and 2015 and remains rat-infested (Carr, unpubl.).
49		MAPOU DE L'ILE DU COIN	0.07	P	Symens, 1999. This island has been visually inspected at least five times between 2009 and 2015 and remains rat-infested (Carr, unpubl.).
50	SALAMON ISLANDS	ILE BODDAM	1.12	P	Symens, 1999. This island has been visually inspected at least twenty times between 2008 and 2015 and remains rat-infested (Carr, unpubl.).

51		**ILE DIABLE**	**0.002**	**U**	**Symens, 1999. This tiny islet lying some 100m off rat-infested Boddam should by rights have rats too. Five inspections between 2009 and 2015 failed to reveal any sign of their presence. This could be due to the very strong tidal currents that flow past the island four times a day.**
52		ILE ANGLAISE	0.73	P	Symens, 1999. This island has been visually inspected at least ten times between 2009 and 2015 and remains rat-infested (Carr, unpubl.).
53		**ILE DE LA PASSE**	**0.29**	**U**	**Symens, 1999. This island has been repeatedly surveyed for rats between 2008 and 2015. This includes one overnight inspection and deployment of fifty snap-traps overnight on 15 July and 04 October 2009 and 17 February 2010. No signs of chewing have ever been witnessed on fallen fruit. Against this case for a rat-free declaration is that this island is in a small, generally rat-infested atoll and this island holds obvious signs of previous inhabitation, even if it was purely temporary. It should have rats (Carr, unpubl.).**
54		**ILE MAPOU**	**0.04**	**A**	**Symens, 1999. The island that has the most rat inspections of all in the Chagos Archipelago. In addition to over fifteen daytime inspections there have been two overnight inspections and deployment of up to 50 snap-traps overnight on seven occasions. No rats have ever been detected. Rat-free status was confirmed by Dr. Grant Harper in August 2014.**
55		ILE TAKAMAKA	0.49	P	Symens, 1999. This island has been visually inspected at least ten times between 2009 and 2015 and remains rat-infested (Carr, unpubl.).
56		ILE FOUQUET	0.45	P	Symens, 1999. This island has been visually inspected at least ten times between 2009 and 2015 and remains rat-infested (Carr, unpubl.).
57		ILE SEPULTURE	0.02	P	Symens, 1999. This islet has been visually inspected at least five times between 2009 and 2015 and remains rat-infested (Carr, unpubl.).
58		**ILE JACOBIN**	**0.02**	**E**	**Symens, 1999. This islet had a rat eradication operation undertaken on it in August 2014. The island is to be inspected again in August 2016 when the outcome of the operation can be claimed.**
59		**ILE DU SEL**	**0.02**	**E**	**Symens, 1999. This islet had a rat eradication operation undertaken on it in August 2014. The island is**

					to be inspected again in August 2016 when the outcome of the operation can be claimed.
60		ILE POULE	0.002	P	Symens, 1999. This islet has been visually inspected at least five times between 2009 and 2015 and remains rat-infested (Carr, unpub.).

Map 2. Rat distribution in the Chagos Archipelago in 2016.



All 55 islands of the Chagos Archipelago were inspected for invasive mammalian predators between October 2008 and April 2015 (see Tables 1 & 2). Non-native, invasive *Rattus rattus* remains the only rodent detected in the archipelago. Taking into consideration the conjoining of islands, rats are now confirmed as present on 26 islands, absent on 20, eradicated awaiting confirmation of the outcome on three and of uncertain status on six. Seven additional islands have been surveyed since the first comprehensive survey in 1996 (Symens, 1999). Six islands assessed as holding rats in 1996 have subsequently proven to be rat-free.

In terms of the 50.07km^2 of landmass available for breeding seabirds, there are rats present (P) on 46.23km^2 (92.33%); absent (A) from 3.32km^2 (6.6%); eradicated awaiting final confirmation of results (E) from 0.15km^2 (0.3%) and islands of uncertain rat status (U) on 0.37km^2.(0.7%). If the rats absent, awaiting confirmation of eradication operations and uncertain status landmasses are combined the figure for potential rat-free land is 3.75km^2 or 7.5% of the total landmass. If the area of the inhabited anomaly of the island of Diego Garcia is removed the figure for P drops to 16.34km^2 and the remainder percentages are amended to A = 20.3%, E = 0.9% and U = 2.26% (total of 23.5% of landmass).
In terms of the numbers of islands available for breeding seabirds, 47.3% are rat-infested, 36.4% are rat-free, rising to a total of 52.7% if the U and E categories prove to be rat-free.

DISCUSSION

In a global and historic perspective, the Chagos Archipelago is not the worst impacted area by invasive mammalian predators. Unlike for example Hawaii or New Zealand, there have been no known extinctions of irreplaceable endemics. The Chagos Archipelago does not have any terrestrial endemic mammals, birds, reptiles or amphibians and has to date on land only recorded one endemic species and two endemic subspecies of Lepidoptera (Carr *et al*, 2013).

Of non-native, invasive mammals, it holds three, *Rattus rattus* and Feral Cats *Felis catus* that impact throughout and donkeys. Donkeys *Equus asinus* are found on Diego Garcia and one beast is present on Ile de Coin, Peros Banhos (Carr, 2011b). The population on Diego Garcia appears to be stable at *c.* 40-60 beasts (Vogt, 2015) and are not deemed to impact breeding seabirds (Carr, unpubl.). This population is negatively impacting the island's vegetation, especially in areas that reforestation is being attempted (Carr, 2011c; Vogt, 2015).

The distribution of *Felis catus* is debatable. There is a tiny population of >30 adults still present on Diego Garcia despite attempts to eradicate them over the past two decades (Vogt, Guzman & Necessario, 2014). Throughout the remainder of the archipelago, Barnett & Emms (1998) recorded *Felis catus* on the former largest settlements on the atolls of Peros Banhos (Ile de Coin) and the Salomon Islands (Ile Boddam). These findings are perfectly logical in that when these atolls had the human populations removed in the early 1970s (Edis, 2004), there would have been cats on them and there is every likelihood they would have been left on the islands. In the same vein, *Felis catus* should be present on Eagle Island and Ile Sudest in the Egmont Islands. However, despite intense rat eradication activities on Eagle Island in 2006, no other invasive mammals were recorded except rats (Daltry, Hillman & Meier, 2006).

Similarly, despite repeated surveys of all four of the former plantation headquarters in the northern atolls, Ile de Coin, Peros Banhos; Ile Boddam, Salomons; Ile Sudest, Egmonts and Eagle Island (Carr, unpubl.), and literally hundreds of incidental visits to Ile de Coin and Ile Boddam by British Forces personnel and visiting yachts, there has never been a single further report of *Felis catus* from any of these islands.

Hilton & Cuthbert (2010) assessed *Rattus rattus* to be present on 95.3% and *Felis catus* on 62%. The rat figures are based upon Symens (1999) surveys in 1996, who assessed 45 islands for birds and mammals in under 42 days. The revised figures are

92.33% and 73.7% respectively using data from Barnett & Emms (1998) and assumptions of *Felis catus* presence on all of the islands that held substantial human populations. The extent of the landmass under consideration, some 50km^2, means these differences in percentages as far as conservation is concerned are near inconsequential. The important figure to consider is the **number** of islands that are rat-free. Symens (1999) recorded 36 islands of 47 as being rat-infested. The revised figure is 26 islands out of 55 are rat-infested, with 20 islands being definitely rat-free. This figure could increase by nine following further surveys of islands of uncertain status post-eradication efforts or lack of visits to confirm status to date.

The second consideration of importance is the location of rat-infested islands. Map 2 shows rat-infested Eagle Island, the second largest landmass in the Territory, as being nestled on the western rim of the Great Chagos Bank in the vicinity of five rat-free IBAs. The ecological significance of this was first noted by the visionary Hirons, Bellamy and Sheppard (1976) in 1975. Map 2 further shows rat-infested Iles Manoel and Yeye in north-eastern Peros Banhos as laying between a cluster of six IBAs. It also shows that eastern Peros Banhos has Strict Nature Reserve (SNR) status, effectively preventing interference of the islands by anyone other than those permitted by the BIOT authorities to visit. The boundary of the SNR at present runs from the eastern point of Moresby to the western tip of Fouquet. Representations have been made to the BIOT authorities to shift this boundary to the eastern tip of Passe to the eastern tip of Fouquet. If this boundary change were to happen there would be two deep water, wide channels either end of a chain of islands and the discreet packages of rat-infested islands of Passe and Moresby and, Manoel and Yeye – Vache Marine already having had its' rats eradicated (awaiting final confirmation). This provides ideal conditions for localised rat eradication programmes. Without helicopter support Manoel and Yeye would likely be undertaken as individual operations. *Contra* to the recommendation in RSPB (2014) who state Passe in Peros Banhos as the highest priority for ecological intervention in the Territory, any eradication operation on Passe would have to be undertaken at the same time as neighbouring Moresby due to there being a very narrow channel separating them that is easily fordable by rats.

It has been recommended by Harper (2014) that the Chagos Archipelago offers the opportunity to have its' rats eradicated in a single, all-encompassing ship and helicopter operation. If attempted this would be a ground-breaking endeavour in tropical island eradication operations and a leading-light for others to follow. Technically this goal is achievable. If the political will or financial backing is lacking then the island by island approach can be continued. This update on rat distribution throughout the archipelago must be used to inform the prioritisation of which islands are to receive ecological intervention in the form of rat eradications.

Acknowledgements. PC wishes to thank all those who assisted in invasive mammal surveys between 2008 and 2015, especially those members of British Forces BIOT and the Captain and crew of the BIOT Patrol Vessel Pacific Marlin; Julia Morley of University College of London is sincerely thanked for her assistance with Map 2.

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Sheppard, C.R.C. & 19 others. 2013. British Indian Ocean Territory (the Chagos Archipelago): Setting, Connections and the Marine Protected Area. In: Sheppard, C.R.C (Ed.). Coral Reefs of the United Kingdom Overseas Territories. Coral Reefs of the World 4, DOI 10.1007/978-94-007-5965-7_17. ©Springer Science+Business Media Dorcrecht.

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Vogt, S. Guzman, N. & Neccesario, E. 2014. Feral cat control on Diego Garcia: current population estimate, evaluation and recommendations. Appendix J1 to Diego Garcia Integrated Natural Resources Management Plan. PWD NAVFACFE, Diego Garcia.

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A round-up of papers about the Chagos or of relevance to it in the last year

Professor Charles Sheppard
Chair, Chagos Conservation Trust

Several papers have appeared in 2015 concerning the Chagos or which utilise visits to Chagos atolls, or which use materials and data from it in a wider study. I list those here that came to my attention during the year. I shall put them in two groups: those on Chagos specifically, and those which include Chagos in a wider Indian Ocean context. With the very welcome increase in number of scientific visits to this remarkable place I suspect these will greatly increase in number in the near future. I have also added a list of general interest and relevance to us, these being on atolls generally, fishing on them, climate change effects to be expected, and similar. My apologies if I have missed any out (which is likely - please let me know what I have omitted so they can be listed in the next issue). Also my apologies in several cases for giving their references as a DOI when papers are in press and not yet assigned to page numbers by the journal – my thanks of course to colleagues who sent me these early versions. Within the groups items are not in any particular order, and the short note following each reference is my brief summary of the paper in a couple of lines.

Papers on Chagos specifically

Roche RC., Pratchett MS., Carr P., Turner JR., Wagner D., Head C., Sheppard CRC. In press. Localized outbreaks of Acanthaster planci at an isolated and unpopulated reef atoll in the Chagos Archipelago. Marine Biology DOI 10.1007/s00227-015-2708-7.
Description of the crown of thorns outbreak on the Great Chagos bank with some discussion on possible causes, and the prognosis.

Appleby T. 2015 The Chagos Marine Protected Arbitration—A Battle of Four Losers? Journal of Environmental Law, 2015, 0, 1–12. doi: 10.1093/jel/eqv027
A summary of recent arbitration by a lawyer specialising in conservation.

Perry CT, Murphy GN, Graham NAJ, Wilson SK, Januchowski-Hartley FA, East HK. In Press. Remote coral reefs can sustain high growth potential and may match future sea-level trends. Scientific Reports.
A paper on the high calcification rates of healthy corals on numerous Chagos reefs.

Gravestock P, Sheppard CRC. 2015. Valuing the ecosystem services of the Chagos: a review of challenges and estimates. Marine Ecology Progress Series 530: 255–270,
An economic valuation of the Chagos, providing estimates and analysis to show their very high value to the region in economic terms.

Sheppard CRC. 2015. The reef conservation conundrum, in one coral archipelago. Reef Encounter. 41: 11-16.
Commentary on the role of the BIOT marine reserve, the need for it, opposition to it, and more. Available at http://coralreefs.org/wp-content/uploads/2015/03/Reef-Encounter-March-2015-FINAL2-HIGH-RES.pdf

Sheppard CRC. 2015. Central Indian Ocean – Effects of Climate Change. Ocean Digest. Quarterly Newsletter of the Ocean Society of India. Vol 2: 2-6.
Invited summary of sea surface temperatures and sea levels from the Chagos Archipelago. Available at http://www.oceansociety.in/newsletter/oceandigest_2015v2i1.pdf

Carr, P. 2015. Birds of the British Indian Ocean Territory, Chagos Archipelago, central Indian Ocean. Indian BIRDS 10 (3&4).

The most current checklist of the birds of the British Indian Ocean Territory. It provides details of new and interesting records to the Territory and places them in an Indian sub-continent context. The total number of species recorded in BIOT now stands at 124 and includes 18 species of breeding seabird.

Carr, P. 2015. Cattle Egret Bubulcus ibis in the British Indian Ocean Territory: where did Pinky come from? BirdingASIA 23: 54–55.
This paper looks at the taxonomic status of the introduced Cattle Egret in the Chagos Archipelago.

Bartow, B. 2015. Atolls of the Chagos Archipelago, British Indian Ocean Territory: a video data analysis of reef slope coral community structure. MSc Thesis, Bangor University. 92pp.
This analyses transect videos filmed by Turner and colleagues, from the same places over several years, and interprets the high coral cover. Interesting aspects such as Acropora table senescence are also identified and their contribution to cover change is discussed.

Turner JR, Sheppard CRC, Koldewey H. 2015. 19-027. Strengthening the world's largest Marine Protected Area: Chagos Archipelago. Darwin Initiative Final Report. 70pp. and 7 annexes.

Turner JR Sheppard, CRC, Koldewey H. 2015. Chagos Science Expedition Report March 16th to April 14th, 2015. Expedition Report. 55pp.

Article on Scientific Expedition to Chagos 2015
http://www.darwininitiative.org.uk/assets/uploads/2014/05/November-2015-Darwin-Newsletter-UKOTs.pdf
Report to DEFRA on the 2015 Darwin funded research expedition in the Darwin Newsletter.

Head CEI, Bonsall M, Koldewey H, Pratchett MS, Speight M, Rogers AD. 2015. High prevalence of obligate coral-dwelling decapods on dead corals in the Chagos Archipelago, central Indian Ocean. Coral Reefs. 34:3. DOI 10.1007/s00338-015-1307-x.
This is one of a series of papers on small reef organisms that live within the interstices of reefs and contribute greatly to coral reef biodiversity, in the present case small crustaceans. Many have seemingly obligate associations with live coral and are therefore considered to be very vulnerable to coral mortality. We find that these obligate coral-dwelling decapods do not simply persist on dead corals, but may be moving to dead coral hosts at certain stages in their life cycle. Their vulnerability to widespread habitat degradation on coral reefs remains unknown.

Papers which include Chagos and the western Indian Ocean

Januchowski-Hartley FA., Graham NAJ., Cinner JE., Russ GR. 2015. Local fishing influences coral reef fish behaviour inside protected areas of the Indo-Pacific. Biological Conservation 182: 8–12.
The wariness of two families of coral reef fishes changes markedly between fished areas and marine reserves. These results imply that as fishing pressure increases, progressively greater fish wariness may reduce the magnitude of some ecosystem functions within small marine reserves.

Bosire J, Celliers L, Groeneveld J, Paula J, Schleyer MH. 2015. Regional State of the Coast Report: Western Indian Ocean. Published by the United Nations Environment Programme/Nairobi Convention Secretariat. UNEP-Nairobi Convention and WIOMSA, Nairobi, Kenya, 546 pp.
A substantial review of the coasts of the Western Indian Ocean. Can be found at

http://www.wiomsa.org/the-wio-regional-state-of-the-coast-report-launched/

Bourjea J, Mortimer JA, Garnier J Okemwa G, Godley BJ, Hughes G, Dalleau M, Jean C, Ciccione S, Muths D. 2015. Population structure enhances perspectives on regional management of the western Indian Ocean green turtle. Conservation Genetics. DOI 10.1007/s10592-015-0723-3.
Use of genetic markers to study the population structure of green turtles within the Indian Ocean, deducing two main genetic stocks and identifying migration patterns.

Veron J, Stafford-Smith M, DeVantier L, Turak E. 2015. Overview of distribution patterns of zooxanthellate Scleractinia. Frontiers in Marine Science. 2015 volume 1. doi: 10.3389/fmars.2014.00081
A major study of coral distribution and diversity worldwide.

Graham NAJ, Jennings S, MacNeil MA, Mouillot D, Wilson SK. 2015. Predicting climate-driven regime shifts versus rebound potential in coral reefs. Nature doi:10.1038/nature14140.
A documentation and prediction of long-term reef responses to a major coral reef mortality episode, showing that some reefs recovered while others underwent regime shifts to fleshy macro algae. The authors identify threshold values for several factors that can predict reef response to coral mortality.

Vargas SM, Jensen MP, Ho SYW, Mobaraki A, Broderick D, Mortimer JA, Whiting SD, Miller J, Prince RIT, Bell IP, Hoenner X, Limpus CJ, Santos FR, FitzSimmons NN. 2015. Phylogeography, Genetic Diversity, and Management Units of Hawksbill Turtles in the Indo-Pacific. Journal of Heredity, 2015, 1–15 doi:10.1093
There is a "striking lack of observed differences between the isolated Chagos and Seychelles rookeries". This may reflect either ongoing gene flow, or a relatively recent colonization event on Chagos with insufficient time for genetic divergence. The Chagos Archipelago's nesting beaches are relatively recent, so that turtles may have colonized Chagos beaches only 100–150 generations ago, based on age-to-maturity estimates of around 30 years for hawksbill turtles in the Indo-Pacific.

Obura DO. 2015. An Indian Ocean centre of origin revisited: Palaeogene and Neogene influences defining a biogeographic realm. Journal of Biogeography doi:10.1111/jbi.12656.
A focus on the biogeography and origins of corals in the western Indian Ocean, showing evidence for origins in the Eocene, hotspots and centres of origin.

Spalding MD, Brown BE. 2015. Warm-water coral reefs and climate change. 2015. Science 350: 769-771.
Summary of some of the major changes affecting coral reefs today, the increasingly frequent bleaching events that are causing loss of both corals and reef structural complexity, and containing warnings that the future of coral reefs is increasingly bleak without substantial interventions.

Letessier, TB, Bouchet, P, Meeuwig JJ (In press) Sampling mobile oceanic fishes and sharks: implications for fisheries and conservation planning. Biological Reviews.
Study of tuna, billfish and oceanic sharks that have suffered intense exploitation over the past 65 years that has left many populations depleted. This details ways in which fishery-independent methods are increasingly improving management, for example in use of telemetry. Much of the ocean still lacks effective monitoring strategies and survey regimes.

MacNeil MA, Graham NAJ, Cinner JE, Wilson SK, Williams ID, Maina J, Newman S, Friedlander AM, Jupite S, Polunin NVC, McClanahan TR 2015. Recovery potential

of the world's coral reef fishes. Nature 520: 341-344.
This study examines recovery potential of more than 800 coral reefs along an exploitation gradient. On average, resident reef fish biomass in the absence of fishing averages 1000 kg per hectare while the vast majority of fished reefs are missing more than half the expected biomass, with severe consequences for key ecosystem functions. Given protection from fishing, reef fish biomass could recover in 35 years on average or up to 60 years when heavily depleted. Crucial ecosystem functions can be maintained through a range of fisheries restrictions. Where protected areas are inappropriate, fisheries gear restrictions can be applied more readily but are less successful at maintaining high fish biomass.

T. R. McClanahan TR, Graham NAJ, MacNeil NA, Cinner JE. 2015. Biomass-based targets and the management of multispecies coral reef fisheries. Conservation Biology, 29: 409–417.
Fisheries management failure on coral reefs is well documented with dire implications for 100 million people. Current fishing gear and area restrictions are not achieving conservation targets and result in losses of ecological functions in reefs. Fish biomass alone can provide broad ecosystem-based fisheries management targets.

Papers of general importance to Chagos

Haas AF, Guibert M, Foerschner A, Co T, Calhoun S, George E, Hatay M, Dinsdale E, Sandin SA, Smith JE, Vermeij M, Felts B, Dustan P, Salamon P Rohwer F. 2015. Can we measure beauty? Computational evaluation of coral reef aesthetics. PeerJ 3:e1390; DOI 10.7717/peerj.1390.
A standardised computational approach that is usually used for evaluating the aesthetic appearance of art is applied to coral reefs. Using categories such as colour intensity and diversity, texture and discernible objects, indices are produced using machine learning algorithms and tested on over 2000 random photographic images from nine coral relocations exposed to various levels of degradation. It is proposed that this can be used as an inexpensive monitoring tool for coronary ecosystems.

Maynard JA, McKagan S, Raymundo L, Johnson S, Ahmadia GN, Johnston LY, Houk P, Williams GJ, Kendall M, Heron ISF, van Hooidonk R. Mcleod E, Tracey D, Planes S. 2015. Assessing relative resilience potential of coral reefs to inform management. Biological Conservation 192: 109–119.
This uses the Northern Mariana Islands to assess spatial variation in ecological resilience potential. The assessments are based on resilience processes and are combined with information on stress and larval connectivity.

McLean R, Kench P. 2015. Destruction or persistence of coral atoll islands in the face of 20th and 21st century sea-level rise? WIREs Clim Change 2015. doi: 10.1002/wcc.350.
These authors show little evidence of heightened erosion or reduction in island size over the past few decades and show that instead, coasts have adjusted their position and morphology in response to human impacts and variations in ocean processes. For the future, they identify a series of new challenges relating to risk reduction and adaptation policy for atoll island governments, communities and international agencies suggesting there should be a shift away from present ideas of migration, to focus on in-country solutions.

Quataert E, Storlazz C, van Rooijen A, Cheriton O, van Dongeren A 2015. The influence of coral reefs and climate change on wave-driven flooding of tropical coastlines. Geophysical Research Letters. 10.1002/2015GL064861.

A numerical model calibrated with field data was used to examine effects of potential coastal hazards caused by wave driven flooding and how they may be altered by projected climate change. Coasts fronted by relatively narrow reefs with steep reef slopes, and deeper smoother reef flats are expected to experience the highest wave run-up. Rising sea levels and climate change will have a significant impact on the ability of coral reefs to mitigate coastal hazards in the future.

Lamb JB, Williamson DH, Russ GR, Willis BL. In Press. Protected areas mitigate diseases of reef-building corals by reducing damage from fishing. Ecological Society of America.
Reef sites located within reserves had fourfold reductions in coral disease prevalence compared to non-reserve sites. The study links disease with intensity of use in a marine reserve, and suggests that disease mitigation through reductions in for example physical injury, is another mechanism by which protected areas may improve ecosystem resilience in a changing climate.

McCauley DJ, Pinsky ML, Palumbi S, Estes JA, Joyce FH, Warner RR 2015. Marine defaunation: Animal loss in the global ocean. Science 47: ISSUE 6219. 9 pages.
Animal loss in the oceans is much more recent than on land. Although few species are known to have become extinct we have profoundly affected marine wildlife, altering the functioning and provisioning of services in the ocean. It is suggested that current trends of marine defaunation will rapidly intensify. Protected areas are a powerful tool to mitigate this, especially when designed with future climate in mind, but additional management strategies will be required to avert a marine defaunation disaster of the magnitude observed on land.

Hay CC, Morrow E, Kopp RE, Mitrovica JX. 2015. Probabilistic reanalysis of twentieth-century sea-level rise. Nature doi:10.1038/nature14093.
This paper revisits estimates of 20th century global mean sea level rise and indicates a global average rise of just over 3 mm per year between 1993 and 2010. The increase in this relative to the 1901 to 1990 trend is larger than previously thought which may affect projections of future sea level rise.

Sheppard CRC. 2015. Marine Management? Making an oxymoron more meaningful. The Marine Biologist, October 2015. Pp 16-18.
Article on marine protected areas, their mistakes and needs. Available from http://www.mba.ac.uk/marinebiologist/issue-5-the-asia-edition/

Weiss KR. 2015. Before we drown we may die of thirst. 2015. Nature 526: 624-627.
How and why coral islands will lose their ability to support humans (and plants) long before they drown, due to salination of water tables and erosion. It focusses on Kiribati and can be read at http://www.nature.com/news/before-we-drown-we-may-die-of-thirst-1.18652?WT.ec_id=NATURE-20151029&spMailingID=49884916&spUserID=MjA1NTA3MjA0OQS2&spJobID=783976831&spReportId=NzgzOTc2ODMxS0

McClanahan T. 2015. Biogeography versus resource management: how do they compare when prioritizing the management of coral reef fish in the south-western Indian Ocean? Journal of Biogeography doi:10.1111/jbi.12604
This paper estimates the contributions of fishing pressure, local habitat factors and regional geography to local diversity. The number of species in five existing fisheries management categories indicated that differences were chiefly influenced by biomass rather than by habitat.

Chagos Conservation Trust submission to the

BRITISH INDIAN OCEAN TERRITORY (BIOT) POLICY REVIEW OF RESETTLEMENT
CONSULTATION WITH INTERESTED PARTIES

This response addresses environmental and conservation aspects of possible resettlement scenarios outlined in BIOT's recent call for views.

Introduction

The 2014 World Parks Congress reaffirmed that if marine reserves are to have a meaningful effect in reducing the decline of the ocean's vital life-support systems, at least 30% of the oceans need strict protection.[i] The Chagos Archipelago is now recognised world-wide as a flagship, significant, large site for such conservation,[ii] whose value is further enhanced by being part of a global and developing network of sites with similar objectives. [iii] Chagos is entirely constructed from coral reefs, and reefs in general are responsible for a disproportionately high proportion of the world's biodiversity and productivity. Their protection is becoming increasingly needed and significant, but at present only a small and insufficient fraction of them are protected. The highly protected reefs of the Chagos Marine Reserve are important globally,[iv] as is recognised by the fact that the Chagos conservation initiative was recently selected by the UK Collaborative on Development Sciences (a grouping of a dozen UK government departments and research funders), as being one of the most important elements for international development emanating from the UK.[v] Considerations of any changes to, or increase in the use of the Archipelago therefore are more crucial than for most places. Further, any changes including effects of future resettlement are more publically discussed and scrutinised for BIOT than they are in many areas of the world where development takes place. Maintaining its relatively excellent environmental condition is regarded as being of extreme importance. This can be achieved with many aspects of development, but the procedures are commonly costly.

The following brief comments fall into three categories: potential damage caused from construction, the question of properly sustainable livelihoods, and climate change complications.

The points made by CCT are not raised as obstacles to planning or resettlement. However, the studies proposed will be necessary if environmental damage to the Chagos ecosystems is to be avoided in the event of construction and settlement. The caution is important: when such issues are inadequately taken in to account, environmentally damaging consequences almost inevitably have ensued throughout the world's reef systems. This rebounds either as extra costs to a project or else deterioration of environment and living conditions of people, and usually both together. Where issues are insufficiently accounted for initially, damaging consequences are unforeseen so the money is commonly simply not then made available for their mitigation. This would be a situation that would not be conscionable for the Chagos.

1. Potential damage from constructions – the need for EIA

Many of the possibilities that have been proposed for development would responsibly call for a substantial series of Environmental Impact Assessments (EIA). Elsewhere in the world, where such assessments were not done prior to detailed planning, problems often have ensued of species and habitat decline, even complete ecosystem failures, with unexpected magnitude and cost. Even when appropriate studies have been performed, the same consequences can ensue if recommendations are then ignored, treated as being optional rather than essential, or because of the resulting inadequate or poorly advised government directives. Many environmental studies are token, cheap projects done alongside developments rather than before them, perhaps to see what damage is being caused or, worse, to achieve the common token 'tick in the box' of an EIA requirement. Given the now recognised flagship status of the Chagos, and the fact that in the Indian Ocean there are no other large sites left like it, none of the latter events would be acceptable. Therefore, substantial investment is needed for worthwhile, EIA-driven discovery and mitigations, and for consequent government directives on plan requirements where necessary to avoid damage. A Strategic Environmental Impact

Assessment (SEA) should be considered at this stage, to provide a framework for specific projects, each of which should be assessed for their effect. [vi]

Example requirements for thorough and directing EIAs. These are indicative only:

- Lagoon constructions such as jetties and harbours. Effects of sediment on lagoon corals and fish are needed, with ways to limit sedimentation effects and consequences.
- Lagoon safe access (blasting of reefs to clear safe passage). Investigation of ways to eliminate consequential sediment and nutrient effects.
- Island constructions, including buildings, and facilities such as water, power and fuel. Studies of sediment run-off from dredging, run-off from island construction works, mitigation requirements to avoid destructive nutrient and sedimentation effects. Ways to mitigate and prevent these. Various settlement documents refer to breakwaters being likely, so EIAs on sediment and nutrient release issues would be needed for these as well. Footprints of developments on habitat. Effects of sediment and chemical disturbance and noise on species.
- Ongoing inhabitation after construction: Regular and periodic EIAs will be needed for issues such as water supply purity and contamination, sewage disposal, and solid waste removal (as happens in Diego Garcia).
- Salination of water tables from erosion and sea level rise. Salination and erosion risk, including from coral mortality, are certain to increase, with ensuing dangers to water tables. Recently, all lenses were found to be contaminated with coliforms.[vii]

It is recommended that at an early stage a comprehensive list is developed of studies that need to be made, their point being firstly to determine what any effects might be, and secondly to design studies to determine ways of avoiding them before construction starts. Most studies will incur substantial cost and require numbers of different specialists. But it is commonly seen that costs are very often greater if such studies are not done. Flaws in designs that permit environmental damage have disadvantageous human welfare consequences and, if attempts are made to remedy the situation later, the cost of doing so can be much higher or even prohibitive.

2. Food sustainability, self-sufficiency and non-damaging livelihoods

There have been assertions that newly settled communities might be self-sustaining in terms of food and fishing, that they require no or minimal subsidy, and would have minimal impact on the environment. Past settlements in plantation days have been pointed to in support of this. However, there is no evidence to support the contention, and much to oppose it. Because the sustainability issue might well be the defining one in terms of success and costs, and because the possibly damaging effects of food cultivation and extraction cannot easily be tested in Chagos itself prior to resettlement, the following amplifies why both environmental and economic assessments should examine these aspects particularly thoroughly. Maximum quantities and intensities of activities that would be non-damaging need to be determined prior to undertaking developments and extraction, because any damage done as a result of over-extraction or use cannot easily be remedied in practical terms or in reasonable time scales afterwards.

1. Locally grown food.

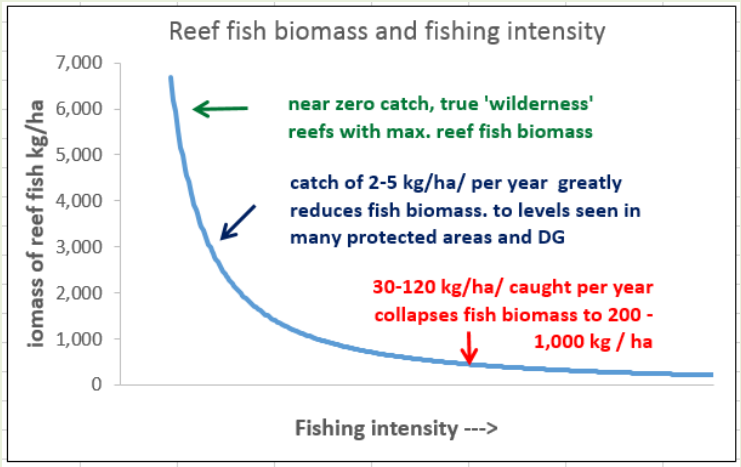
There has never been self-sufficiency of food in BIOT, and in settlement days, there was no concept or intention of it when it came to bulk foods. Carbohydrate, especially rice, was imported by the plantation managers. Vegetables and fruit were grown locally, and protein was raised mainly from pigs, poultry, turtles, etc. which severely damaged the ecology of inhabited islands. Fishing was also done (addressed later). Remarks that food supply for villagers on the islands used to be sustainable and not damaging to the environment are simply incorrect.[viii] It is also often falsely asserted that because Diego Garcia supports a large population, then so could other atolls; Diego Garcia is entirely supported, expensively, by produce shipped and flown in from farm-lands in distant continents. Any settlement is likely to rely to some extent on imported food, which because of the extended distribution lines, is likely to be expensive unless subsidised.

Locally grown foods other than coconuts are always likely to be poor or supplementary on Chagos islands. Topsoil is meagre and limited,[ix] and areas that can be used are few and small in area. Water is abundant from the high rainfall so the resulting water lenses are sufficient, but any fertiliser and pesticide use will percolate the thin soil and contaminate them unless guidelines are followed about their use.

Renewed coconut production has been proposed. Fertilizers and pesticides should be used with great caution because of run-off effects in the lagoon as well as effects on the fresh water lenses. Environmental assessments are crucial for all such agriculture, especially if livestock are to be involved, due to the potential for nutrient and faecal contamination of the water lens.

2. Local fishing.

The reef fish biomass of Chagos reefs is unparalleled because of the no-fishing regulations and policy[x], and this is an important part of the value of this marine reserve. A study in the Marshall Islands[xi] "reinforces how sensitive many remote coral reef ecosystems are to human presence … human presence, as low as 40 individuals, reduced fish size, calcifying substrates, and coral diversity in a predictable manner." Note: this compared whole atolls, not small reefs, i.e. 40 people fishing for livelihoods on an atoll. Also: "Most functionally important groups of fishes were more vulnerable to fishing than climate change." [xii] In support of this, it is seen that recreational-only fishing in Diego Garcia is sufficient to reduce fish biomass[xiii] (because it is the large, fecund adults that are selectively caught first.) Some usually important groups are much more susceptible than others. [xiv]



Fishing pressure need only be light therefore to eliminate one of the key benefits of the marine reserve. The sketch illustrates the point:

Overfished reef fisheries can take 60-80 years to fully recover. CCT has previously suggested that under a greater fishing intensity, there would be a bonanza for 2-4 years, then there would be increasing degradation to levels seen on most other reefs in the Indian Ocean, a commonly observed phenomenon. [xv] CCT maintains that the best role for Chagos reefs for the benefit of the region's people is to ensure that it retains high fish biomass for the long term rather than permit the degradation that would likely ensue if it is regarded as a food larder, or especially if reef fish are viewed as a resource for export. Regular assessments of reef fishing will therefore be essential elements of EIA and subsequent management, though prior to that must be a judgement by government of what the purpose of Chagos reefs is to be: to remain as it is now as a benchmark for ocean science and a beacon for reef health in the Ocean, or to become a food larder. Its present ecological value is reflected by estimates of its economic value. [xvi]

Estimates are needed also on the likely changes to reefs that will result from the removal of large fish first e.g. grouper, snapper, sharks and the removal of parrotfish and consequent macro-algal growth. Many lagoon areas constitute nursery areas for fish, and fishing in these areas will deplete outside reefs, and consequently fish will not return to nursery areas. Major changes to regimes in lagoons due to overexploitation, as well as sedimentation and nitrification will degrade both fish communities and the coral reefs on which they live. Such aspects have commonly led to unforeseen degradation elsewhere in the world, so their investigation is needed here before any exploitation is needed.

The intent above is not to deny all possibility of reef fishing, but to point out that low-impact fishing has rarely been achieved before and many assumptions from history have been misleading.[xvii] Intentions to fish 'sustainably' are as common as are depleted reef fish stocks; it is only easy to 'sustain' fish stocks at a depleted state, and usually this is what happens. The International Society for Reef Studies [xviii] recently stated that up to half of the World's reefs are now dead or nearly so, and a contributory cause has been reef over-fishing. Government may decide that a reduction in reef fish is acceptable, in which case consequent costs would need to be subject of another, different economic assessment.

3. Tourism

A much mooted and potentially less-damaging livelihood is limited tourism. (Note that the term 'eco-tourism' is commonly used, but it should be remembered that the 'eco' basically refers to economic, as well as ecological: if it is not economic it doesn't exist for long, and the requirement to make it economic frequently compromises the ecological goal.) CCT supported the 'Aldabra solution' a decade ago, in the context of up to a dozen residents supported and

supplied from outside, with tourists remaining ship-based (i.e. not requiring residential facilities and avoiding construction problems noted above). Potential gain might be made from this. The issue of where tourists can go will always be difficult and each instance will also require EIA, because most tourists will want to view the dense bird rookeries, coconut crabs etc. which unless strongly controlled will degrade them.

Issues around travel by any vessel, tourist or local, to the presently rat-free islands which support birds need to be carefully addressed. CCT recommends continuing to restrict access to the Strict Nature Reserve islands because of their fragility and susceptibility to disturbance and degradation. Funding for a management plan for each island is currently being sought (regardless of any potential resettlement). [xix] These plans are costed at a total of £0.3 million to prepare and their implementation clearly would need much more. These island plans would need to be updated regularly.

The above list of uses and 'sustainable' activities is far from complete, and is merely indicative of what is required if the present very high quality of most of the Chagos environment is to be safeguarded. If this quality is to be not lost through accidentally ignoring key features, the environmental studies should also be directive, capable of directing construction.

3. Climate change and sea level rise in BIOT

Several scientifically undeniable aspects of climate change such as sea level rise, temperature rise to levels that kill reef building corals, coral mortality from other reasons, very low island elevations and island erosion are all issues for Chagos [xx] (though, like all climate change issues, there are some vigorous, ill-informed deniers). Numerous recent statements by NASA and NOAA show sea level and water temperature rise to be continuing and accelerating; other work reviews the consequences these and other factors have on small islands. [xxi] Research shows that mortality events that reduce corals' ability to construct the protective reefs and islands appear to be occurring more frequently, [xxii] and their consequential effects on island erosion on 'mature' parts of Chagos islands are now substantial. [xxiii]

Nevertheless, these climatic impediments can be 'resisted' at least for a time under present climate change scenarios. However, the costs of doing so appear to have been largely ignored in the recent KPMG feasibility report, though issues of clime change were referred to and were recognised to the extent of considering costs of evacuation later. Comments that islands were previously inhabited for 200 years are of course true but largely irrelevant; accelerated sea level rise and sea warming essentially commenced only recently.

Regarding sea level rise, the accurate Diego Garcia gauge has now recorded up to 6 mm rise per year for many years, which is significant both statistically and to any islanders. [xxiv] It is likely that this will continue over the coming decades and it is widely recognised that this will put populations on low-lying islands in increasing jeopardy. The Chagos islands will not be an exception. Added to this, coral mortality episodes are increasing (something that also started relatively recently), and each mortality event supresses coral and reef growth. Reef growth and erosion are finely balanced on healthy reefs and with low growth episodes following periodic bleaching, greater erosion will become increasingly likely.[xxv]

Erosion of the islands is becoming increasingly serious. A study in Diego Garcia showed erosion in several areas of up to 15% and accumulation in other areas of nearly the same; although net change was therefore minimal, the erosion was mainly of old land whose mature soil supported mature trees while the accretion was mainly by muds infilling some southern creeks and embayments.[xxvi] Northern atolls have only very limited old photography for similar comparison, but several sites visited regularly show similar marked erosion. All land suitable for building is very low lying; though there are several areas over 2-3 m elevation, these are mostly unconsolidated dunes.

Thus the need for sea level defences should feature strongly in resettlement provision. The Diego Garcia experience should assist these measures. However, costs in Diego Garcia (where rock is imported from Mauritius) for shoreline hardening now exceed $10 million per year for relatively short stretches of coast, and are rising: the USA invested $30 million during 2014/15 for this.[xxvii] These costs should not be ignored during initial planning, and nor should the almost inevitable knock-on effects be ignored when engineered

shorelines create conditions that cause erosion further along the shore, a common event following such measures.

These factors should all provide sufficient warning that climate change will likely add to costs of any sustainable resettlement, and will be ongoing at an increasing level. The reason these issues are raised here is to stress that adequate consideration of them is needed, along with consequent design of construction, or else environmental damage will almost certainly occur in this leading protected area. From the purely human perspective, many settlement scenarios are entirely 'feasible' for many years (given enough money) but they require costs that in many parts of the world have been ignored until too late.

Final remarks

It is strongly recommended that well-documented scientific findings are used for decision making. It is suggested that the body of over 100 scientists who actively research in Chagos should be a source of reliable scientific information when this is needed, and to this end, CCT supports a database containing nearly all studies and scientists to aid in this.[xxviii] Much incorrect conjecture has been advocated for several aspects surrounding Chagos resettlement, which is understandable because it favours desired views and ignores those which are unpalatable.

Quality EIAs

It is emphasised that there is a need throughout for 'quality' EIAs. EIAs can be obtained cheaply, quickly and with little effort, almost on demand, from many companies (which may be called 'Environmental Carpetbaggers [xxix]) but given that for many aspects in Chagos there would be no 'second chance', what is needed is work by groups not attached to any pressure group or groups with interest in conducting subsequent construction. A strategic overview can be provided by SEA and may prove valuable for multiple developments over time

Falsity of savings with scale

Savings with scale are often assumed. Regarding settlements on northern atolls, a commonly held fallacy is that there would be saving in costs per person as settled numbers increase. However, a detailed study by UNDP [xxx] of costs of construction, including water supply and both solid and liquid waste disposal in the Maldives showed that costs per person increased with numbers; there were no cost savings per person with increasing scale of development. This issue should be examined very carefully for any Chagos development. The KPMG study reported that there was a consensus from questionnaire respondents that none of the islands, apart from Diego Garcia, could sustain a resettlement based on a modern lifestyle, which may be correct. They noted that it would be preferable to limit future development to Diego Garcia, since it already has the infrastructure to support a modern lifestyle. Some KPMG estimates and assumptions might hold true for e.g. a new suburb of Mombasa, but should certainly be investigated in detail for these remote, presently uninhabited islands. The costs of transport of goods, services and people also need to be fully considered – a point mentioned in this strictly environmental commentary because obtaining food locally (farming pigs, chickens, fish) are often used as a common short-cut and cost saving on atolls.

Lateral thinking, monitoring and adapting

It should be emphasised that EIAs cannot predict the consequences of all impacts, and cannot ensure that mitigation measures proposed actually work. Ongoing monitoring is needed for this. EIAs are not the same thing as Development Plans and SEA but should precede and direct them. Therefore monitoring and adaptive management is essential, otherwise if damage is done then a post-development assessment can sadly only indicate the cost of repair or compensation.[xxxi]

All these issues are of course amenable to estimation and many are amenable to mitigation if addressed adequately from the outset. Around the world, most damaging consequences of construction arise from ignorance of consequences, sometimes wilful when costs are at stake.

To repeat the point made earlier: the above issues are not raised as obstacles to planning or resettlement, but as components of any environmental assessment of it to avoid degrading the environment. The comments are intended to raise awareness of aspects that are very commonly ignored until it is too late. It is strongly advised that they are taken into account prior to and as part of any planning, because it is when they are not taken into account that environmentally damaging consequences inevitably ensue. Chagos is a flagship and a guide for marine environmental quality, so they are exceptionally important issues here.

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