

Chagos News

The Periodical Newsletter of the Chagos Conservation Trust and Chagos Conservation Trust US
No 45 December 2014

ISSN 2046 7222

Editorial

Things are rapidly taking off in Chagos!

We have increasing support, growing almost exponentially, from numerous organisations leading to increasing research in Chagos, and leading to the collection of even more data on this hugely important territory. There are four or five different expeditions to Chagos this coming year, each with a different research agenda - the study of pelagic fish, manta rays, reef research and of course the important continued monitoring are only some of the aims. These data are used to inform about the nature and state of the reefs and islands of Chagos. The information portal discussed in this issue will be extremely useful in bringing all this data together for maximum benefit to everyone.

Resulting from some of this research is the incontrovertible evidence that sea level is indeed rising significantly around the archipelago. These are very worrying, especially for the security of the islands and the huge numbers of birds which nest there. An article which gives more information on the sea level rise data is presented in this issue of *CN*.

We are very pleased indeed to have the support of so many of the Chagossian community. It was a pleasure to meet them at the recent very successful CCT Conference. Their enthusiasm for the conservation of Chagos was infectious and we look forward to taking our newest Chagossian scholar diving with us on the next expedition in March.



The CCT Executive Committee members are now CCT Trustees. But there is little change except for the name. We are still all volunteers and are dedicated to working to protect this important place.

It would be good to have some input to *Chagos News* from members from some of the very knowledgeable and pertinent questions raised at the conference I am sure that there are many of you out there who have interesting stories to tell.

Anne Sheppard
Editor





CCT 2014 - Chair's Report

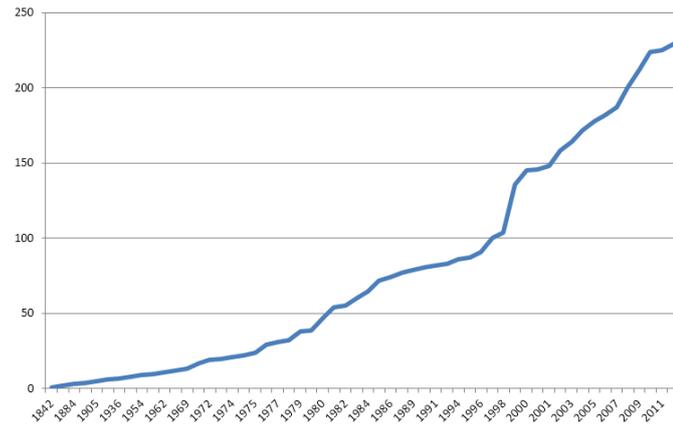
Professor Charles Sheppard
Chair, Chagos Conservation Trust

It has been a tremendously productive year. Those at the Chagos conference at ZSL on Friday 5 December heard about the successful science expeditions that produce results that continue to show just how important this archipelago is. There are worrying early signs that climate change (or other unidentified problems) might be affecting these reefs, and this is the subject of an article later in this Newsletter. Several scientists on future expeditions will focus on this.

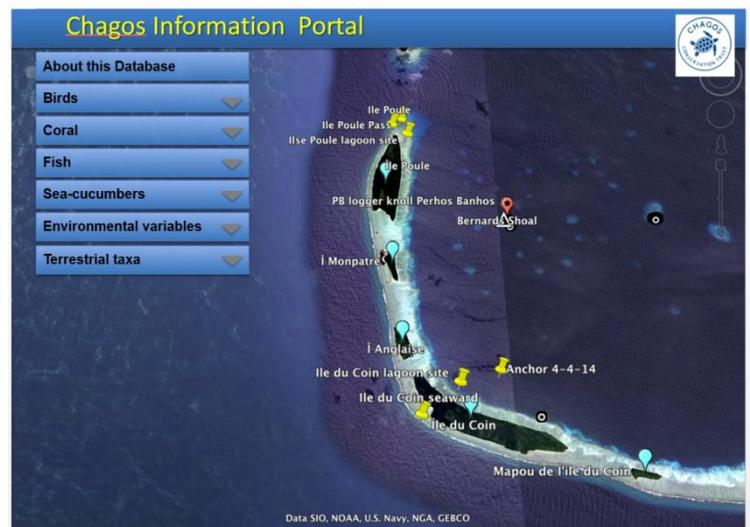
Reef work continues to look at sea temperatures, coral cover, fish abundance (which is extraordinarily high) and several other programmes. Of new work on land, in addition to the now 'usual' monitoring work, a rat eradication project was carried out on three northern islands, one to simply eradicate rats from the important *Vache Marine*, and also to eradicate them on two tiny ones in Salomon, to test assumptions about how far rats can re-colonise. The latter is the start of a feasibility trial of a more ambitious plan to eradicate such invasive and harmful species from the whole archipelago.

Overall, the science programme is now large. We are delighted with this, and much of the information we gather feeds in to decisions by the government, which recently produced its excellent and ambitious interim management plan. To help put all this into context and make information more readily available, the CCT Chagos information portal site should be up and running by around the middle of 2015. CCT has funded the database core of the project, being done by Dr Elizabeth Widman. The Bertarelli Foundation will generously put funds towards it also, so it will likely have a better interface as a result. The database itself will contain all possible information which, from the rate of publications produced by all who go there (Figure 1) is very substantial. Much of the data is geographically located, so can be displayed via a Geographical Information System that can be queried (Figure 2).

Publications resulting from Chagos Expeditions



The data will be accessible at two levels. The first will be unrestricted and will include numerous images and film clips, plus all the already-published data and scientific articles. The second level will be restricted to scientists working on their data, but as results become published and available, elements there will be moved to the public level. It will also include a huge library of often very old archival information which supports the *History* that will be published in 2015 (see later). In all cases it will include the names of all contributors who own the data, so others may 'mine' the archives for further work after seeking appropriate permissions. The total amount of information that can be obtained will be much greater than the sum of its parts.



CCT has been asked for its input into the KPMG resettlement feasibility study and our Secretary Alistair Gammell will be co-ordinating the CCT response to the draft

that was recently issued. People are free to comment individually too if they choose.

There are now more scientific expeditions, some part funded by CCT but others quite separate from it (though commonly including CCT members), and there are also changes also in scope. One big change derives from the fact that some of us have had permission to film there. This has always been permitted, for example, for taking photo-transects of a scientific nature. But now, for the first time (as far as we know) since the BBC film in the *World About Us* documentary series of 1975 when a film called *An Island Called Danger* was broadcast, documentary filming has commenced and this has been a great success. As part of a near-finished series of four programmes produced by film-maker and naturalist Stewart McPherson, aided by CCT member Jon Schleyer, the episode which covers both BIOT and Pitcairn was shown at the Chagos conference, to great applause. More filming projects have either been completed or are in late stages of planning, using state of the art camera systems too.

The Chagossian outreach programme (organised so well by ZSL) continues again for another year. Its uptake now includes hundreds of people with Chagossian heritage – it is designed for them. We remain ready to take this to Mauritius as well, but political issues mean this might not happen yet. Many Chagossians there want it, but others don't. Whilst it seems a shame that those who don't want it are denying it to those that do - we are ready when it is allowed.

Another major element in CCT's remit is history, mentioned above in connection with the Chagos Information Portal. The authoritative history entitled *Chagos: A History* by former Chairman Nigel Wenban-Smith will be completed and printed early next year, and we look forward to that too. All in all, we have had a very successful year.

Our liaison with CCT-US continues to thrive, and they too raise funds for US citizens and scientists to participate in

research expeditions. We are always very glad of their involvement.

The Big Ocean Network is taking off too, with several new large sites being declared recently (Figure 3). IUCN, always good supporters, are funding a book on the hows and whys of very large MPAs, and of course several CCT Trustees and members have been involved in this. More and more, the media and science media express alarm about the state of the World's oceans, and large and fully protected areas are an important tool (there are others, such as partially protected areas, better enforcement and sustainable fishing) which, if implemented together, will delay the demise of our oceans and, let us hope, turn the corner to give our oceans a healthy future. On matters of major collaborations, we are part of a 'Chagos Consortium' too, a grouping of universities and NGOs which is focussed at present on the huge pelagic zone of the territory, funded by the Bertarelli Foundation. Those at our recent Chagos conference will have been introduced to some of the results from what is becoming a remarkably exciting programme.

But there are some critical opponents as always! Some advocate the resumption of industrial fishing, and there is opposition from Mauritius. Much of the opposition is in one way or another concerned with the UK Government's sovereignty over the Chagos, which is not within CCT's remit. It is worth noting (again!) that CCT really is not involved in government! Rather, we promote and undertake science, history and conservation, to supply accurate information to government so they can make informed decisions on matters of conservation and its management.

Those attending the AGM in December will know that we have changed our structure. Most members will not see any difference. In part this need is due to our success, which is in part fuelled by the generous and enabling legacy of John Topp which has allowed us to expand what we do, the funds being ably managed by our Treasurer Richard Martin, with Trustee Birgitta Bostrom. Like so many such

bodies, we might risk outgrowing ourselves, and I think we need now to start thinking about managing our affairs with more professional help. All Trustees are volunteers of course, as always has been the case, and several amongst us now spend quite a lot of time on matters arising, and on planning and conducting research there. Unsung in this are quite a few students too who assist with data analyses, and of course much of the work is now done by our three excellent consultants Charley Cranmer, Jon Slayer and Victoria Picknell who assist very ably. I hope that by next year we will have achieved some sort of restructuring, which will enable us to rise to another level of success, and I hope I will be able to relate how we have done so. The aim is always to be collegiate in our approach, inclusive and active, always with the purpose of ensuring the conservation of this remarkable place. Meanwhile, I thank all of you for your continued help in so many of the aspects that we engage in, or which we fund, part-fund, or help to co-ordinate or organise.



Deadly Silence

*Victoria Picknell
CCT Media Consultant*

There is a 97% consensus among scientists. Ice caps are melting. Sea temperatures are rising. And yet we've dumped 200 billion tonnes of CO₂ into the atmosphere in the last seven years. Are we in denial about climate change and as a result, unwilling to even talk about it?

In October I attended a talk by George Marshall, co-founder of the Climate Outreach & Information Network (COIN). He said climate change is a subject that invokes public silence. COIN [surveyed](#) a group of 18-25 year olds to gauge their views. The result? Climate change is a difficult subject to talk about because it comes with a "certain stigma of being 'uncool' or it's considered preachy to do so". COIN also found that people with children are less likely to talk about climate change than those without children. A startling fact when you consider predictions about its future impact.

But it's not surprising that people feel this way when even the best communicators in the business – advertising agencies – are lost for words on the subject. "I've worked in the industry for 20 years and that's the first time I've been asked about climate change," revealed one executive from M&C Saatchi when interviewed for a project called [Break the Silence](#). "To be fair, I don't think it's talked about anywhere," added another.

Recent research by the RSA (Royal Society for the Encouragement of Arts, Manufactures and Commerce) has found that while many of us accept the moral imperative to act, we continue to live as if it's not happening. Their report, [A New Agenda for Climate Change](#), states that climate change should not be "viewed as a green issue that is peripheral to everyday concerns, but a social, economic and security issue that is relevant to everybody". It recommends creating platforms for public discussion so that climate change "becomes a topic of

conversation in the way ‘the economy’ or ‘schools’ or ‘the NHS’ is at present.”

So while the scientific and environmental communities have been discussing climate change for decades, it appears that we have somehow left the rest of society out of the conversation. We’ve used narratives that appeal to people with shared values, while ignoring the fact that they may not engage others. Many people remain silent because they believe that it’s not relevant to them and they are powerless to do anything about it. It’s our job to explain how it is relevant. And to offer practical solutions of what each one of us can do to help. Only then can we start a global conversation on climate change.

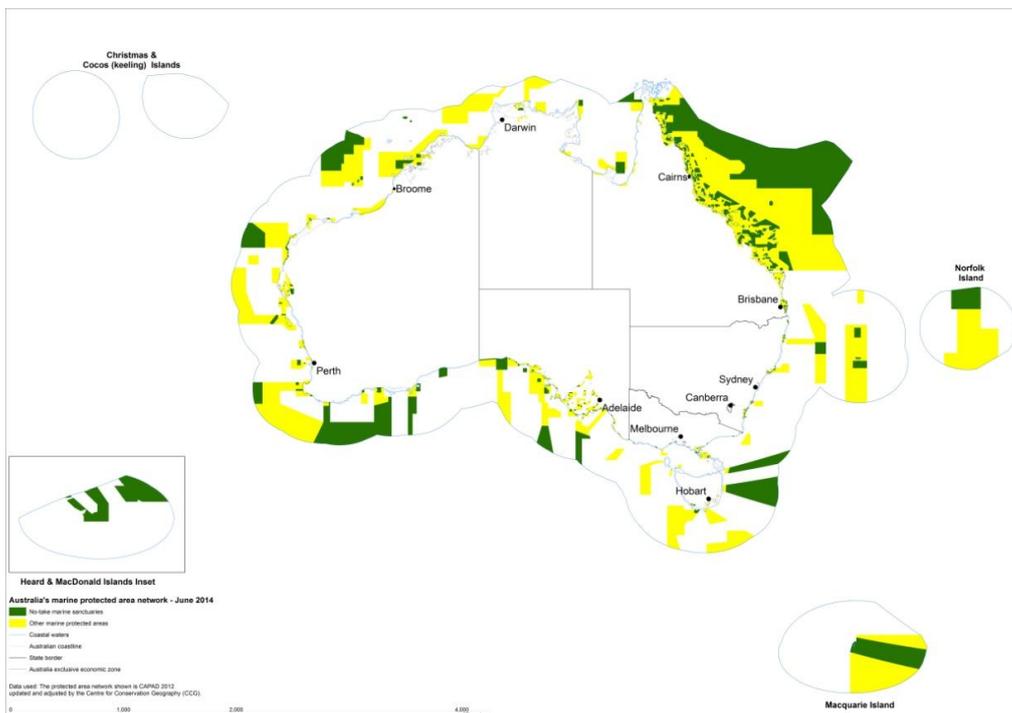


Why isn't climate change part of pub conversations?

The Chagos Marine Reserve Leads on Sampling the Big Blue

Professor Jessica Meeuwig, Dr Tom Bech Letessier, Dr Phil Bouchet, David Tickler and Dr Heather Koldewey

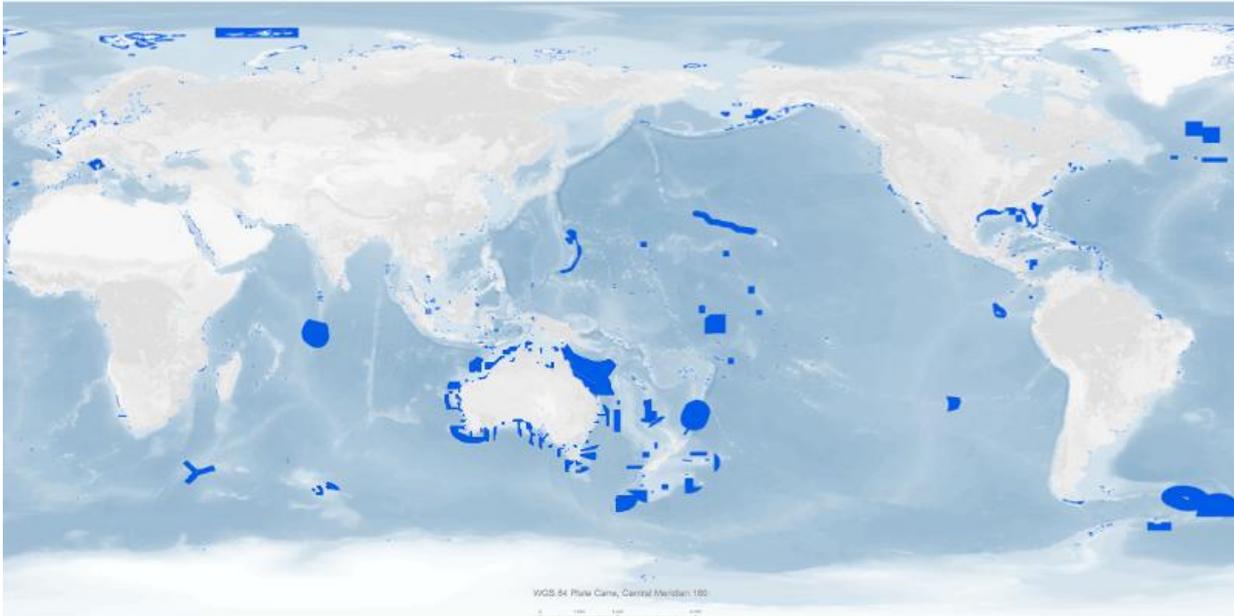
Increasingly, large marine reserves are being established as a strategy to both protect marine biodiversity and increase ocean resilience. The Chagos Marine Reserve was the first of the super-sized fully protected marine reserves and remains the largest contiguous no-take marine reserve globally. Palau has closed its EEZ to shark fishing and has committed to closing the entire area to foreign fishing. The United States has substantially expanded the Pacific National Monument and Australia announced a network of Commonwealth Marine Reserves that, although currently under review, could afford protection to over 30% of its EEZ.



Australian Commonwealth Network of Marine Reserves

Indeed, the value of large marine reserves is reflected in the recent World Park Congress recommendation that calls for nations to “Urgently increase the ocean target that is effectively and equitably managed in ecologically representative and well-connected systems of MPAs or other effective conservation measures by 2030; these should include strictly protected areas that amount to at least 30% of each marine habitat and address both biodiversity and ecosystem services.”

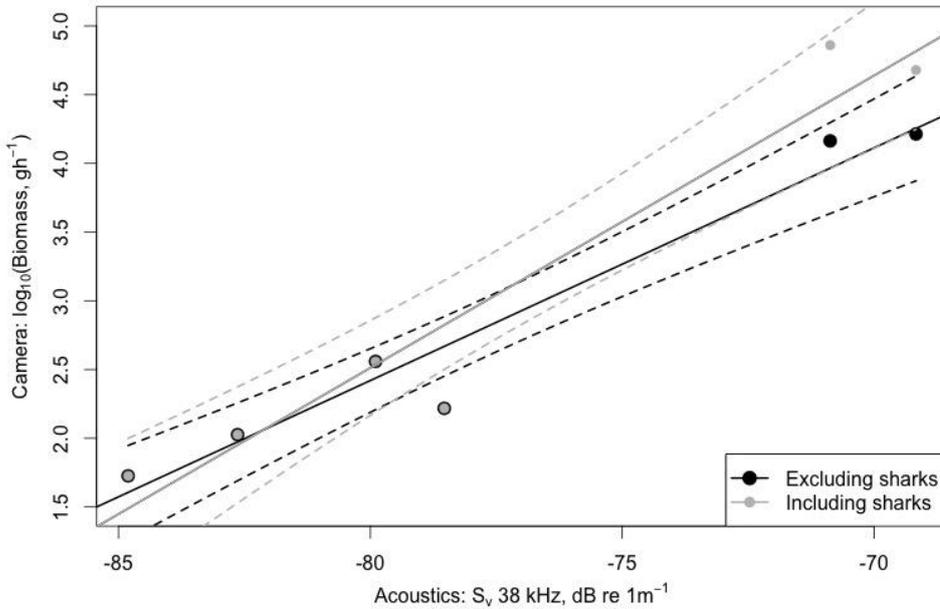
Much of these new marine reserves are pelagic “big blue” ecosystems. And while there is extensive research demonstrating the benefits of (relatively) shallow marine reserves in coastal waters, less has been done in offshore environments, largely because pelagic reserves are a relatively new phenomenon



Global map of marine reserves

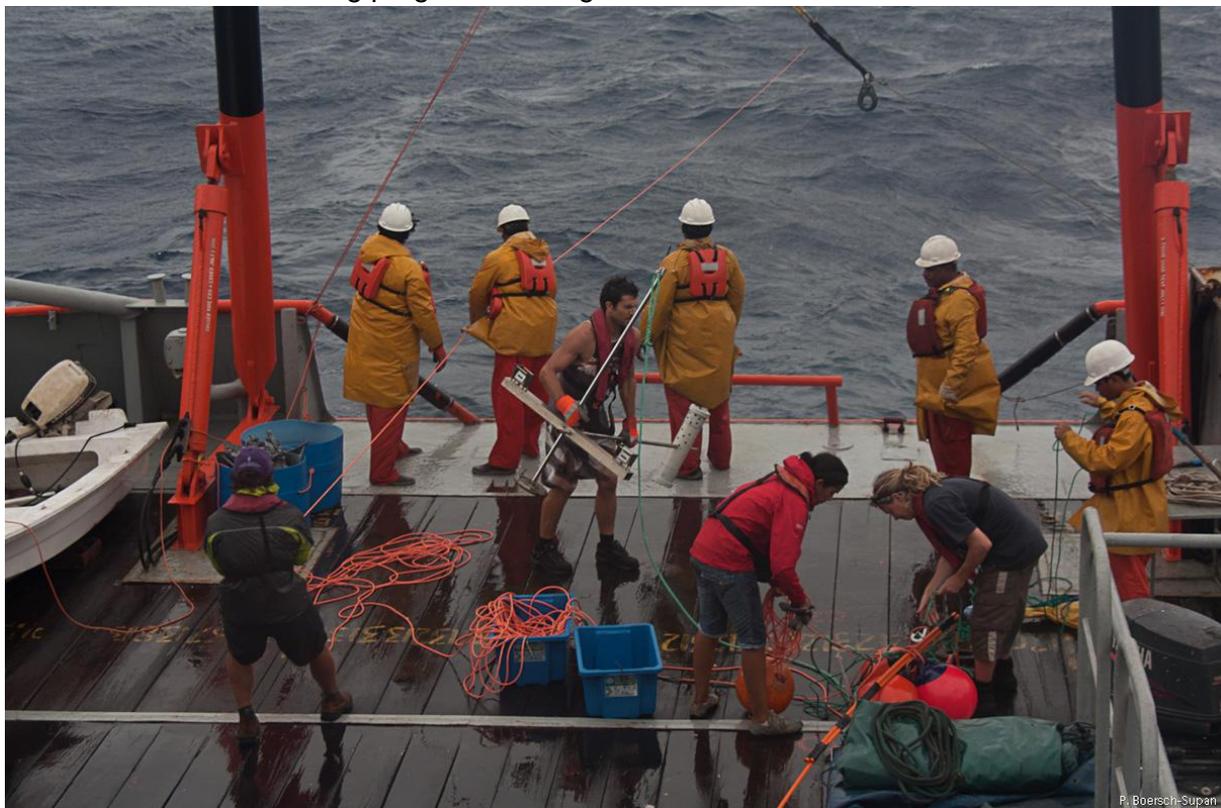
Moreover, whilst much of our knowledge about pelagic species is derived from long-term fisheries data, the advent of no-take pelagic marine reserves such as Chagos requires non-destructive sampling techniques. The challenge is thus to find a technique that allows us to answer basic questions such as: what species are in the pelagic, what is their relative abundance, and how big are they? These are fundamental questions that establish a baseline against which change through time can be measured (are diversity, abundance and size increasing?).

In November 2012, a team of scientists from the University of Western Australia and the Zoological Society of London travelled to the Chagos Marine Reserve to trial a set of mid-water stereo paired video rigs combined with active acoustic sampling supported by the University of St Andrews to demonstrate the capabilities for non-destructive sampling. The stereo video rigs were modelled on the use of such systems on reefs as these have been highly effective in documenting trends in space and time in reef fish biodiversity. Importantly, the rigs have been designed to be light-weight and highly flexible to allow their use under a range of research platforms from 5 m zodiacs to large ships. On this inaugural trip, the team collected data from 134 deployments. A total of 1,378 pelagic fishes were sampled from 21 species representing 11 families. These included a number of species at conservation risk such as the silky shark, recently listed on the Convention for Migratory Species and species of commercial importance such as yellowfin tuna. Excitingly, the team was also able to show strong relationships between the total biomass observed on the mid-water stereo video rigs and the abundance of small prey species as measured by the total backscatter strength from the echosounders.



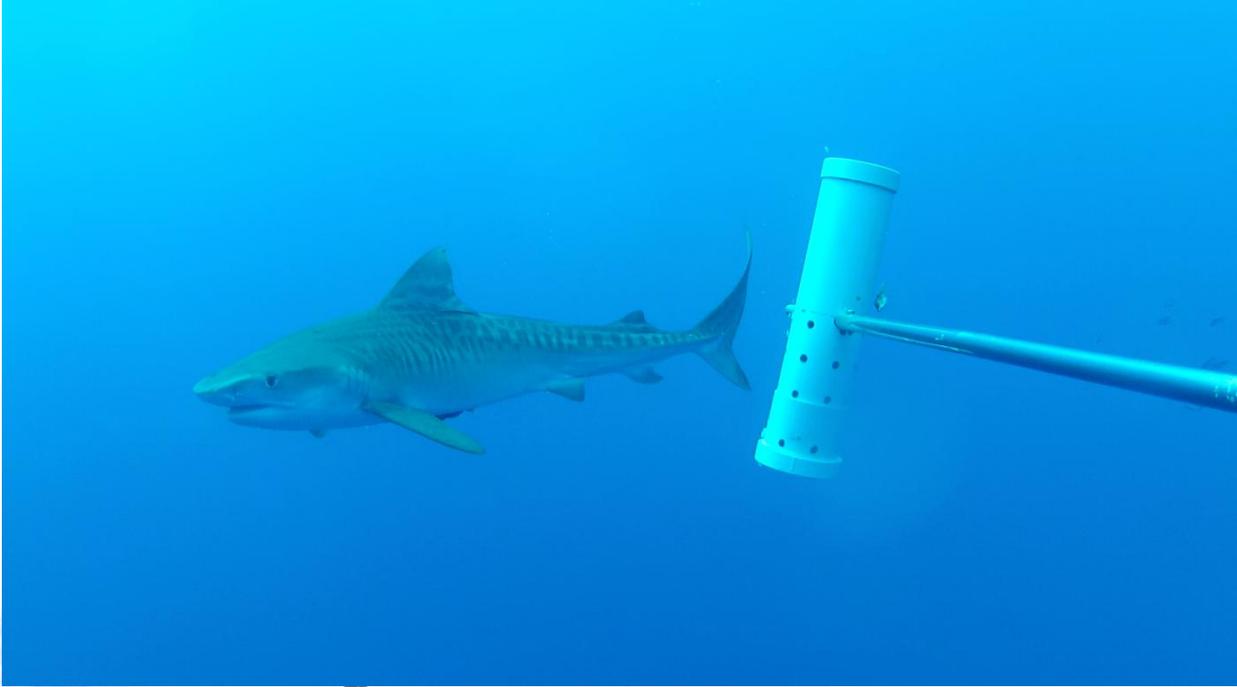
Correlation between fish and shark biomass as observed on the mid-water cameras and the echosounders.

With a successful approach to non-destructive sampling of pelagic fishes and sharks trialled in Chagos, the team has now extended its sampling to other existing or proposed protected areas. With partners such as Dr Laurent Vigliola from the French Institute for Regional Development, more than 250 rig deployments have been made in New Caledonia, Tonga and French Polynesia. The team also recently partnered with National Geographic's Pristine Seas program to complete 199 deployments in Palau's Shark Sanctuary and in Rapa Nui. In Australia's nascent Commonwealth Marine Reserve Network, sampling with the mid-water rigs extended from the far north in the Oceanic Banks and Shoals Marine Reserve to the Perth Canyon Marine Reserve in the subtropics with over 170 deployments. The latter was under the auspices of Australia's National Environmental Research Program to assist in the establishment of monitoring programs for large marine reserves.



Deployment of midwater rigs in Chagos on the back deck of the *Pacific Marlin*. ©Centre for Marine Futures, UWA

A juvenile tiger shark approaching the bait in Chagos.
© Centre for Marine Futures, UWA



Deploying a mid-water rig from a small zodiac in Rapa Nui with curious Galapagos sharks below. ©Manu San Felix

Image from video of silky sharks swirling around mid-water rig's bait canister in Palau's shark sanctuary
©Centre for Marine Futures, UWA



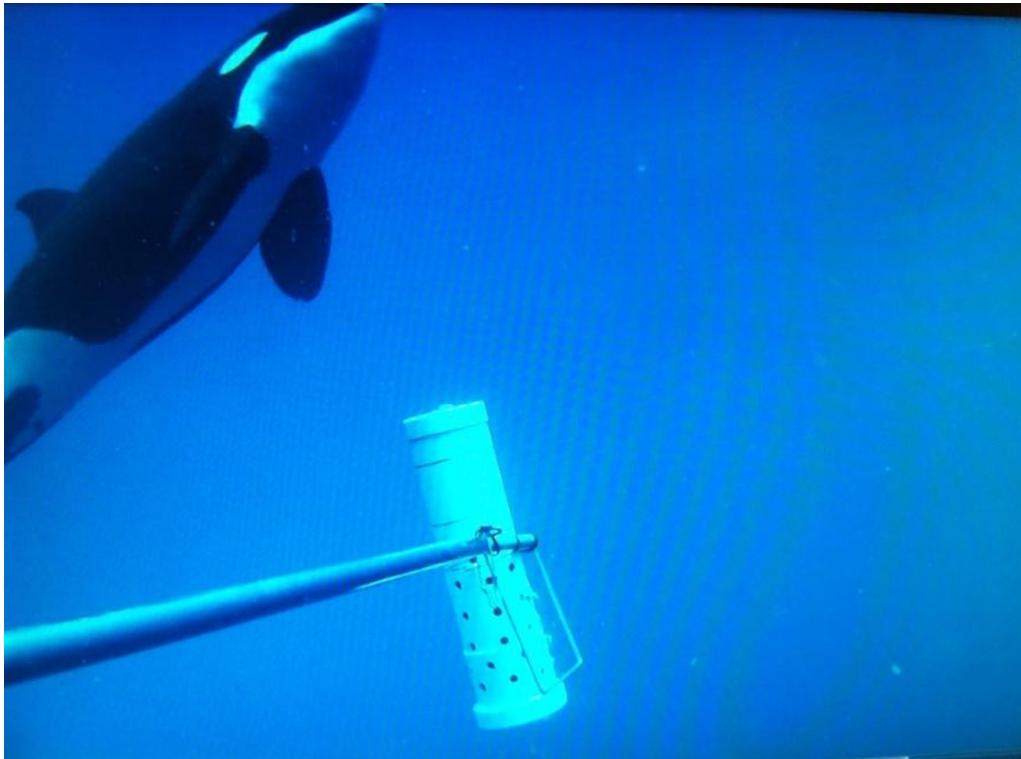


Image from video of an orca passing by a mid-water rig's bait canister in Australia's Oceanic Banks and Shoals CMR
© Centre for Marine Futures, UWA

Partnership Videos

CCT partner, the Bertarelli Foundation has released some videos showing some of the research that they are doing on sharks in Chagos. We are delighted that our collaboration with this Foundation is progressing speedily and well. This particular work is done with other CCT partners the Zoological Society of London and the University of Western Australia.

The videos have been uploaded to YouTube and can be seen at

<https://www.youtube.com/watch?v=mneARCzIDZE>



The Chagos Marine Protected Area - YouTube

The Chagos Marine Protected Area (MPA) is the world's largest no-take marine reserve. Chagos is important because of its size, location and condition. It con...

[Watch now...](#)

<https://www.youtube.com/watch?v=DeglCGaXfLk>



Tagging Sharks in Chagos - March 2014 - YouTube

In March 2014, scientists from Stanford University, the Zoological Society of London and the University of Western Australia, travelled back to Chagos to ser...

[Watch now...](#)

We are delighted that we are being joined by partners who help to expand so effectively conservation work in the MPA, and these short films demonstrate some of the huge and important extent of what is now being done in the vast blue water area of the BIOT Marine Reserve.

Connect Chagos

Rudi Pothin
ZSL Connect Chagos

In June 2014, the ZSL Connect Chagos team hosted members of the Manchester and Crawley Chagossian communities in a colourful barn at Tulley's farm, Crawley. There were many conservation focused activities on offer and modules from our environment training course were represented through workshops that delivered a take home message. For example, the botany module was represented by a "Grow your own workshop" while the coral module was symbolised by "Paint-a-Reef" activity, encouraging those of all ages to get creative! The community could also take part in many challenges such as a Scavenger Hunt where they could explore local wildlife. Above all, the day was a chance to inspire people into taking part in the environment training course.

hunt and tree climbing in both communities. These sessions provided inspiring activities directly linked with messages from the environment training course. The minibeast hunt and the tree climbing both introduced the concept of habitat management and botany while the diving was a good opportunity to talk about marine skills required for conservation field work.



Tailored sessions:

This year the Connect Chagos team launched a new outreach strategy called "Tailored Sessions". Their aim is to provide continuous and inclusive engagement and learning within the community and to create opportunities for those unable to commit to the full training course. They also serve as the first step for building interest within the youngest community members.



Tailored sessions have been delivered in both Manchester and Crawley with an average of 15 young people attending each event. Sessions included were a try dive, coral reef ecology, bird identification, a minibeast



Mauritius scoping trip:

In March the Connect Chagos team travelled to Mauritius to consult with the Chagossian community on possible opportunities, receptiveness as well as appropriate modes of delivering an environmental training course. Our experience with Chagossian communities in the UK have revealed the need to initially implement strong outreach activities and then facilitate an effective and appropriately tailored training programme. Thus, the scoping visit constitutes the first stage of developing a Mauritian outreach programme.

Eleven individual interviews were held with Mauritian Chagossians and ten meetings were held with environmental partners and influential stakeholders such as the head of learning at the Durrell Wildlife Conservation Trust, the director of the Mauritius Wildlife Foundation and the founder of the Mauritius Marine Conservation Society. During the interviews and meetings a solid understanding of their interest and willingness to engage in a potential training course was established. The trip also provided us with a better understanding of the current levels of knowledge and understanding about the Connect Chagos project in Mauritius.

Reunion Weekend:

Following the completion of another successful training course a reunion weekend was held in October for trainees who have completed the course in the last three years. A group from Manchester and Crawley enjoyed a weekend at the RSPB Reserve, Strumpshaw Fen, in Norfolk. Ian Robinson introduced us to the reserve, helped us to carry out a bird survey and refreshed our knowledge of habitat management.



All images © ZSL

Understanding Through Integration: The Chagos Resource Portal

*Charley Cranmer
CCT Director of Development*

CCT has embarked on an exciting new project that will have wide-ranging benefits for Chagos for decades to come. Despite the numerous significant discoveries made in Chagos, there has never been a central place to store and display all of the data that has been captured over decades. Currently data is scattered in academic papers, government reports, unpublished sources, and the libraries of individual researchers. This makes effectively sharing, cross-referencing and analysing this crucial information challenging and time consuming for scientists impeding new breakthroughs, and also prevents the public from easily accessing what is known about this important site. The Chagos Resource Portal (CRP) will change this.

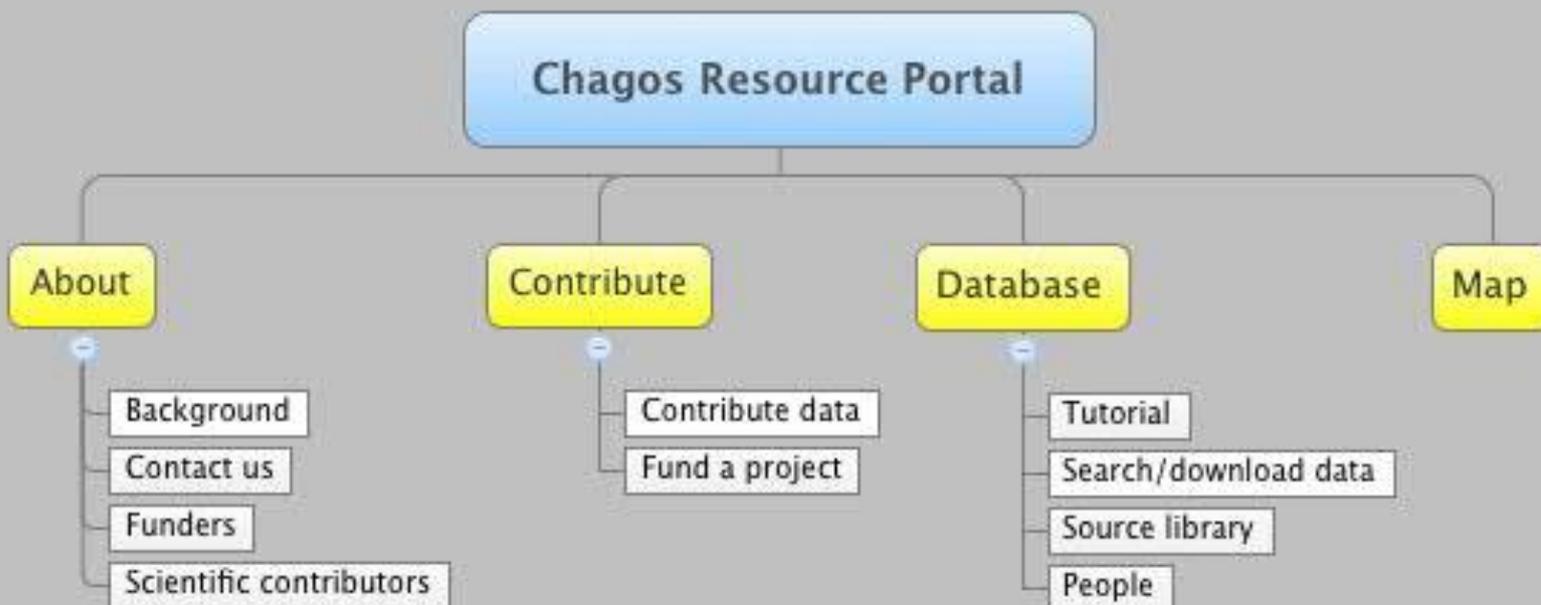
The Chagos Resource Portal (CRP) will be:

1. An online relational database storing a near complete record of previous and current research in Chagos (200 scientific articles and numerous scientific, historical and other data sets to date).

2. A user friendly and interactive online data portal available to all, with spatial projections of data, photos, video clips, data tables, figures and references to papers or the papers themselves, for all projects.
3. A series of progressive projects aimed at creating resources for scientists and historians, and outreach and educational tools for the public, to generate increased knowledge and support for protecting Chagos.

CCT has provided the initial £20,000 to establish the basic infrastructure and to populate the CRP with reef-based data and is currently seeking further funds to realize the full potential of this project (i.e. terrestrial, historical and environmental data, satellite imagery etc.).

The CRP will: enable scientists to better understand trends and to identify the most pressing research and conservation needs; facilitate decision-making by governments about environmental management in Chagos and beyond; be a resource for historians and be an accessible educational tool for the public, conveying the ecological importance of Chagos and fostering environmental stewardship. All of this will combine to further secure Chagos' future as a vitally important Marine Protected Area, a rare oasis in our over-exploited oceans.



Filming Expedition for the Stewart McPherson British Overseas Territories Series – Britain’s Treasure Islands

*Jon Slayer
CCT Media Consultant*

A few years ago Stewart McPherson approached me to ask if I could help him to film in the British Indian Ocean Territory for his upcoming television series about the natural history of the United Kingdom’s Overseas Territories. This was a great opportunity to highlight just how special the marine environment within the BIOT MPA is, so we worked together to get a film crew out there. After several years planning we finally embarked on the yacht *S/Y Jerrican*, in the Maldives and set sail for the Chagos Archipelago in late August of 2014.



The Chagos Archipelago had been by far the most difficult of the territories for Stewart to access and film. A combination of remoteness, difficulty of gaining permission, and complete lack of logistical infrastructure made this shoot particularly challenging to set up. However all of the effort was worth it. On arrival at Peros Banhos Atoll, the first of our stops, we were greeted by a Humpback Whale breaching in the distance. The animals fluting song was the underwater soundtrack to the first couple of dives we did in the territory. What a welcome!

Our route then took us through a selection of the key sites in the outer islands of the Chagos to ensure we captured the essence of the natural history of the British Indian Ocean Territory for the series. We dived oceanside reefs, spectacular with the crystal clear waters displaying the beautiful corals and plentiful fish receding slowly into the blue of distance whilst the plunging drop offs disappeared into the inky blackness of depth. En route to these dives we motored amongst cavorting pods of spinner dolphin, the swift swimmers racing our dive boat and playing in the bow wave of our yacht. On the lagoonal dives we floated amongst spires of coral of myriad form. These delicate constructions reaching upward from the seabed are protected from the battering ocean swells affecting the outside of the atolls and as a result grow into a fantastic array of forms that could be lifted from the pages of a Dr Seuss book.

The reefs here are truly amongst the very best in the world.

On the islands we recorded the impact of coconut monoculture and rats, both an ongoing legacy of man’s visits and habitation on the small strips of land here. Whilst appearing idyllic to the eye of a person, the islands are no longer such for seabirds, who rely on the sturdy branches of hardwood trees for nesting habitat and the absence of harassment by rats for roosting and nesting. The difference in bird numbers between naturally vegetated, rat free islands, such as Ile Petit Bois Mangue, and coconut palm covered, rat infested, islands was very apparent in front of the lens of our film crews. Fortunately there are 11 such locations amongst the islands of the Chagos. Internationally recognized Important Bird Areas where it was deafening to our visiting crew with tens of thousands of birds wheeling overhead, roosting amongst the shrubbery or padding along the sandy ground, all calling cacophonously - birds everywhere. This difference has been noted by those managing the MPA and we visited a pilot site where a rat eradication and vegetation restoration program is being trialled to

establish the feasibility of removing introduced rats and vegetation and allowing the seabirds to return to all of the islands out there.

We also captured the magnificent coconut crab populations. These, the largest of the terrestrial arthropods, are real characters. They played up for the camera, climbing palms, splitting coconuts and trundling indelicately through the undergrowth, battering the vegetation in front of them aside. The archipelago is a haven for these animals that elsewhere are easy pickings for the dinner pot of human settlements that inevitably inhabit the islands of their tropical distribution.



After a couple of weeks spending every minute exploring the riches of the environment within Chagos we reluctantly set sail back to the Maldives and then returned home. The production company eagerly took delivery of our footage and started to put together the very first broadcast documentary filmed within the MPA. I have viewed the draft edit of the resulting program and have to say that we have made the most of this tremendous opportunity and have done

justice to the spectacular wildlife and scenery above and below the surface of the ocean in Chagos.



Stewart McPherson should be credited for his vision and drive in pursuing this project, Steve Nicholls, the series producer, for bringing the full potential out of the footage that was captured, Simon Vacher for his deft terrestrial camerawork, Rich Stevenson for his diving and underwater filming skills, Rohan Holt for his stills photography and diving skills. I'm proud to see my underwater footage amongst the finished product too! Jeremy and Anita Bagshaw must be thanked for hosting our film crew on their beautiful yacht. And of course, thanks to the BIOT Administration for permitting this wonderful filming project a visit to the territory.

The series is being produced by Warehouse 51 Productions – www.w51p.com – and as soon as we have details on broadcast channel and dates we will pass them on so you can all enjoy our experience of the natural history of Chagos!



Catlin Seaview Survey to the Chagos Archipelago

*Jon Slayer
CCT Media Consultant*

In February 2015 we will be joined in the British Indian Ocean Territory by the Catlin Seaview Survey Team.

For those that do not know about this innovative project, the Catlin Seaview Survey is an underwater version of Google Streetview. Instead of a car with multiple cameras driving along streets taking images that can then be stitched together and viewed on Google maps, this version has multiple cameras mounted on an underwater scooter which is then piloted along a coral reef. The resulting images can then be navigated in much the same way as streetview on Google maps. So towards the middle of next year when all of the images are processed you will be able to take a dive along the reefs of the BIOT MPA from the comfort of your armchair at home.

It should be noted that the cameras are not just taking images for streetview, but the images are also of a high enough quality that research data can be extracted from analysis of them. This work is undertaken by the University of Queensland but the data is also open source, so it can be accessed by other researchers if it is of benefit to any work they may wish to do to contribute to the scientific knowledge of the territory.

Alongside the Catlin Seaview Survey team that will be working along the shallow reefs down to around 10 meters there will be a deep diving team from the University of Queensland. This team will be exploring the reefs down to a depth of 39 meters, surveying and sampling the life there for their research. But this is not the only exploring they will do though as they are also bringing along a Remotely Operated Vehicle (ROV) which can be piloted to a depth of up to 150 meters. This is one of the first occasions that anybody will ever have viewed life at this depth within the MPA as recent expeditions have been limited to only 25 meters whilst scuba

diving. New discoveries no doubt await us as we will be the first people to view these deeper habitats!

On the expedition we are not neglecting the 55 small islands of the MPA. Google have developed a backpack version of the Streetview camera that can be carried around on foot. This will be used to map around 20 of the islands so that you can view these on Google Maps alongside the Seaviews taken by the Catlin team. These terrestrial streetviews will be of great utility in planning upcoming island habitat restoration work, a further project that CCT is supporting.

In a nutshell that is the plan for the February 2015 expedition to the BIOT MPA... we look forward to sharing the results with you.

You can find out more about the Catlin Seaview Survey at <http://catlinseaviewsurvey.com/> and more about the Google Trekker at <https://www.google.co.uk/maps/about/partners/streetview/trekker/>



Chagos islands, reefs and climate change

*Professor Charles Sheppard
University of Warwick*

Reef health in the Chagos islands is showing signs of stress, and this is being looked at here from several angles; water temperature, sea level rise, coral cover and disease and island erosion, all work that we continue to conduct on science visits to the Chagos islands and reefs. Several elements are interlinked. This is a round-up of results to date.

Sea temperature rise

We have deployed several temperature loggers all around the archipelago since early 2006. These are placed at 5, 15 and 25 m depths, on ocean facing and lagoon reefs. They record sea water temperature at intervals of two hours, and each lasts about 2-3 years. Presently, we have about fifteen, all recording continuously. On most expeditions we locate them, collect them, download the data and, depending on their battery state, either put them back for another year or replace them (Figure 1).



Figure 1. A temperature logger being replaced, inside a plastic pipe to prevent it being chewed by parrotfish. © Anne Sheppard

We lose some, but we find most! Funding issues mean that some series we have had to discontinue. Some of the series have gaps where we have been able to restart after a couple of years. We sometimes expand to a new site if other

lines of research suggest it would be a useful addition, and we have abandoned at least one when weather on two or three successive years meant we could not collect them anyway. We have four series that go back to the beginning in 2006, which are some of the most valuable, though all are yielding useful results.

We found quite soon that the ocean facing reefs exhibit unexpected and important features, namely that every year, usually near the time that water should be warmest (which is Feb-March) there are sustained plunges in water temperature – something we don't understand but which might be due to region-wide internal waves (Figure 2).

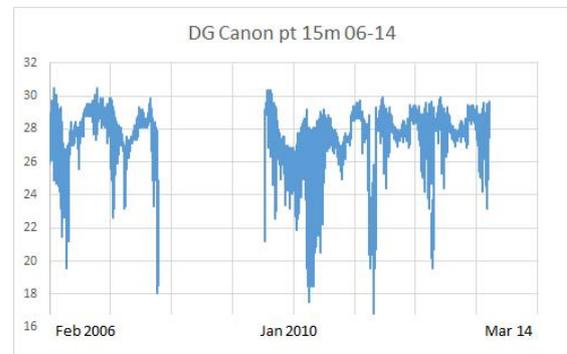


Figure 2: The plunges in temperature at Cannon Point. Water temperature can fall from about 30°C to 18°C.

Basically, the deep ocean thermocline rises closer to the surface, and this cooling may have a lot to do with the better survival or recovery of corals, from climate change induced warming that we see here.

While these massive plunges in water temperature of over 10°C mask any longer term small trend, they are mostly not apparent in lagoons (which is what we would anticipate from internal waves). In lagoons, there is much smaller annual variation, and an overall rise is apparent in all cases, even over the relatively short period since early 2006. Data from Peros Banhos lagoon at 15 m depth is shown in Figure 3. The trend is rising, showing a mean increase since 2006 of as much as 0.3°C. (Note the y-axis of this graph is not the same as in the previous figure for an ocean facing reef.)

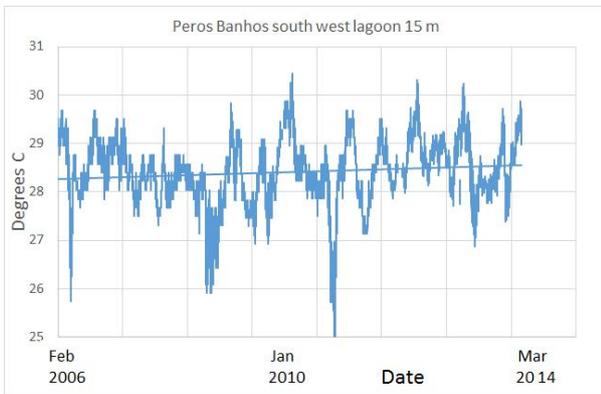


Figure 3. Temperature at 15 m depth on the temperature logger knoll in SW Peros Banhos.

We do not know what the lethal temperatures are for these lagoonal corals, nor how much acclimation to warmer water might exist here. We do know that on the seaward side, the 1998 warming pulse that killed 90% of corals was about 29.5°C. We can see that now the warmest pulses approach 31°C. In Diego Garcia where I have looked every year for over a decade, we have seen several episodes of coral bleaching (caused by warm water) since coral started to recover after 1998, though this has apparently not been sufficient to cause further widespread coral death.

But, in 2013, deeper water corals in Salomon lagoon were almost all killed, and from around mid-February of that year our data shows that there was a period of over two months where temperature at 5 m depth was mostly well over 29.5°C. Indeed it was over 30.5°C, approaching 31 degrees for a time, in early March. We saw the effect this had on the corals (Figure 4). We had lost the deeper water temperature logger unfortunately, though another has now been secured.



Figure 4. Dead leafy corals in deeper water in Salomon atolls. Photo taken at the end of Feb 2013. ©Anne Sheppard

Temperature results are not simple to explain. There are around 300 species of corals, all with different shapes, depth preferences and different capacity to resist or adapt to warming. Corals should not be taken as being just one group: like trees, where pine trees, teak and hundreds more each have different tolerances to environmental factors. But the temperature trend is upwards, in these lagoons at least. The ocean sides might, as noted, receive respite from the unusual and prolonged plunges in temperature as the thermocline rises towards the surface of the ocean.

Sea level rise

The world now knows there is sea level rise. There are two important components to sea level rise: overall oceanic levels that now can be measured by satellite (and are termed “eustatic”), added to which are local land movements. The sum of both will be detected by tide gauges, one of which (part of a global network) is located in Diego Garcia.

Published on the internet are two series of results from this gauge, firstly a ‘fast delivery’ series, and secondly, usually after a time lag, a ‘research grade’ series which has been checked and which will have adjustments if considered necessary. Because of the high quality of the Chagos tide gauge (it is not just a tube stuck in the sand), the fast and research series are in fact identical, meaning no adjustments or corrections were considered necessary. One advantage of this is that we can almost certainly use the published ‘fast’ data right up to near the present day, which gives us a run of an additional couple of years.

Figures 5a and b show the data for two runs of sea level that exist in Diego Garcia. Sea level is rising, no doubt about that, and is rising significantly. Anyone can plot this on Excel. The raw data is daily (you can get hourly data too in fact) but for various reasons, including averaging out tidal differences, accounting for ‘auto-correlation’ and other technical details, I have chosen to average out for

calendar months. In one month there are two neap-spring cycles and about 60 tides altogether, so plotting by average calendar month provides a pretty reasonable and widely used averaging out.

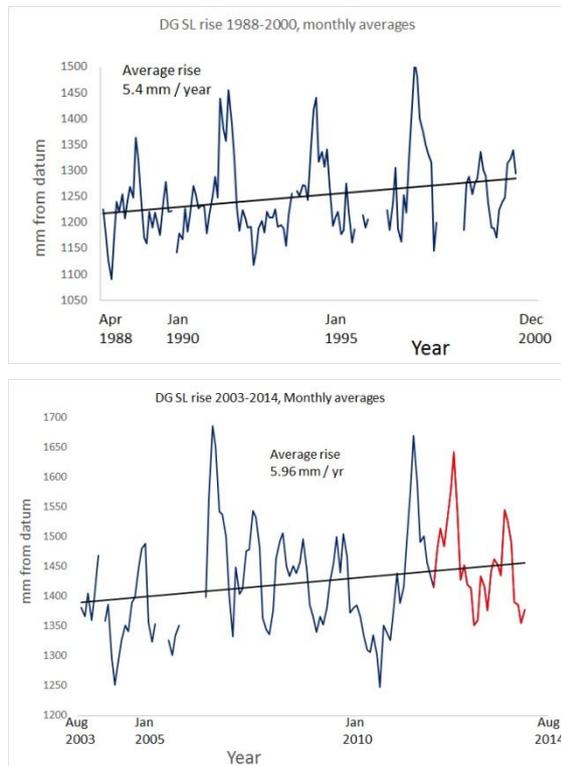


Figure 5 a, b. Sea level in Diego Garcia lagoon. The data is research grade, except for the red, recent segment in the last two years, which is 'fast' grade. (In fact the red line continues back to 2003 but all points lie exactly underneath the blue line.)

From 1988, sea level in Diego Garcia rose on average 5.4 mm per year, while in the supplied data from 2003 to 2012 it rose about 5.8 mm per year. If we add in the data for the last two years (the red segment of line), and assume it will not need adjustments as has been the case for this series for the previous decade. then it shows a rise of almost 6 mm per year.

All the simple straight line fits are highly significant statistically. It is similar to what is happening all around the tropical world. It is, of course, highly significant to islanders throughout the tropical world, as well as extremely and increasingly expensive! This is Diego Garcia where, like other atolls of Chagos, its effects are increasingly visible.

Coral cover

Coral cover is one widely used indication of good reef health. It is a simple guide to reef health, in some cases overly simple, because it ignores coral diversity, calcareous algal growth, and other key factors, but it has many uses and is widely used. I have shown on several occasions the increments of averaged coral cover with time on seaward Chagos reefs, and Figure 6 adds the 2014 results to this.

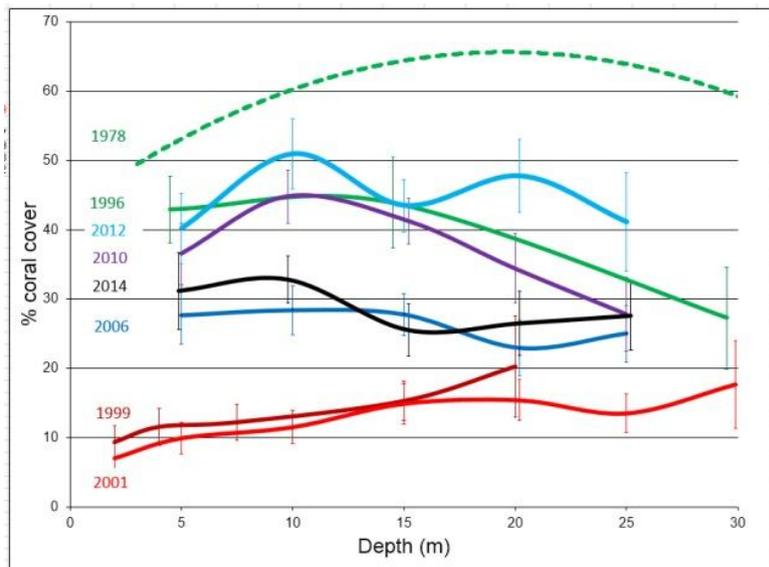


Figure 6. Averaged coral cover on ocean facing reef slopes. The 2014 line is the black line.

There has been a marked reduction over the previous year. But before we leap to conclusions about warming being the cause (it likely really was the cause to some degree, and almost certainly was in our recorded mortality in Salomon lagoon described above), there is another factor which, let us hope, would be a more benign cause. That is, following the widespread recruitment of millions of table corals onto the bare space created after the massive coral mortality of 1998, these tables have all reached a large size more or less at the same time. The tables grow by 10-20 cm each year, age, topple, and die. It may well be that a natural old age of so many tables all at the same time (augmented we think by disease too), is partly or even mainly the cause in this case. Before the 1998 wipe-out, such corals were all of widely different ages, big and small, but in the last decade millions

grew up together, all having started growth around 2000 - 2002. Their simultaneous senescence might be (let us hope it is) the cause of the present drop in coral cover. Figure 7 shows a small cluster of tables, all still standing, some dead, partly dead or still living.



Figure 7. Some table corals, one on the left being dead over most of its surface and the others mostly living. © Anne Sheppard

For a time, these dead tables might produce more sand as they become eroded and ground down, but this source of island building material is unlikely to last long. This, as in many things, is an under-researched area of Chagos reefs that now we need to address.

Island erosion

These are low lying islands built by coral, so what will happen? We cannot be sure, but erosion is occurring in several places. Earlier in 2014 some of us (led by distinguished US reef geologists) published in *Science* a short rebuttal of some ill-considered and over simplified results saying that the growth of coral islands can keep up with the rise in sea level. We showed that the average vertical reef growth around the world over thousands of years was only around 3.5 mm per year. We also made the point that this growth rate assumes good, healthy coral growth, but, as shown above, warming is now seriously effecting coral growth by causing sporadic episodes of

mortality. This average of 3.5 mm is derived from results ranging from 0.6 to 7.9 mm per year. We do not know (because we have never measured) where Chagos reefs lie in this range, but, given warming which is damaging coral growth, and the measured sea level rise approaching 6 mm per year today, it is unsurprising that we see several substantial areas of shoreline flooding (Figure 8), which has led to attrition in many places too.



Figure 8. One area in Diego Garcia where the sea now regularly floods over 100 m inland on many high spring tides. © Charles Sheppard

One more point is important here also, which is the profiles of most Chagos islands. I have reported on this before: most of these islands have raised rims and depressions in the middle, meaning that sea level rise may show no significant erosion of coastline for a while, until the rim breaches. This is very important as this morphology means that rates of inundation of the islands will be non-linear with respect to sea level rise. I have witnessed this kind of breaching in Diego Garcia in some places several times already, as well as in several northern atolls. The only cross sections of Diego Garcia I know of were made by the late, distinguished reef geographer David Stoddart in 1967 (Figure 9). This largest of Chagos land masses is not typical as it has a very enclosed lagoon with little or no raised rim on much of the lagoon side; much of the land is rather close to present high tides already. And that is why, shoreline defence is becoming expensive

there, currently exceeding \$10 million per year, so far, for just a couple of short stretches fronting critical facilities. Also stockpiling of rocks is being done for future shoreline armouring, using rocks imported from Asia or Mauritius that are much harder than the soft Chagos limestone.

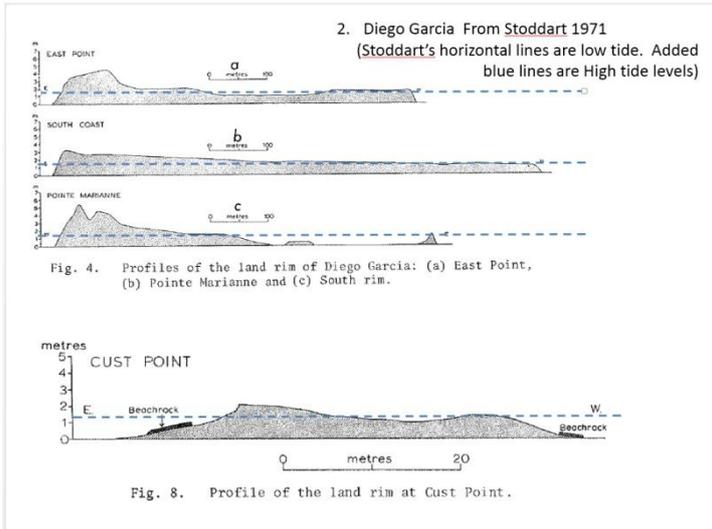


Figure 9. Cross sectional profiles of Diego Garcia (From Stoddart 1971). The dashed blue lines mark high tide levels. Profiles of other Chagos islands are in earlier issues of Chagos News, and elsewhere, and are not repeated here.

Other factors

Other factors affecting reefs include an increase in acidity of the water as atmospheric CO₂ continues to rise, much of which dissolves in sea water. We have never measured this in BIOT due to lack of facilities, but it is known from major and recent studies (such as at Hawaii and the Great Barrier Reef) that this may even be as important as warming. In brief, increasing acidification reduces coral and algal calcification, the factor which is critical to growth of corals (and reefs). CO₂ rise is a major driver of reduction of calcification rates. Chagos atolls are protected by massive calcareous ridges and spur systems (Figure 10), natural features that are major wave breaks protecting the shorelines. Problems here cause problems to the shorelines. This is another factor that we have not yet researched for this archipelago – yet it could turn out to be the most critical one.



Figure 10. These massive spurs lining the ocean-facing reefs in Diego Garcia occur equally around other atolls. They are calcareous limestone structures made by red algae, which makes them look pink. They act as breakwaters to the shoreline.

© Charles Sheppard

Diseases are another factor that may be increasing in Chagos. Diseases are low, but certainly very noticeable there now, partly because of the dead colonies they leave behind. This is one aspect on which we are carrying out more research.

The overall picture

Despite the above, Chagos reefs are probably the most healthy overall that we can see anywhere. They are certainly the largest expanse of reefs still in excellent condition in the Indian Ocean, possibly the world. They are correspondingly important therefore. But problems do exist, and it seems that, despite the lack of direct or localised impacts from populations, climate factors are possibly starting to catch up with them. Ignoring this would be foolish, and would only limit our ability to react, ameliorate, prolong, mitigate and - who knows - do some good along the way? Regarding climate change, we might even as a society wake up to the problem to try and do more to solve that too.

It is certainly the case that reefs of Chagos are, by several measures, the 'best' or

amongst the best in the world, which is why they are so important. I have jokingly talked and written about “Sharks on the Lawn” and “Stingrays in the Carpark” using photos of flooded parts of islands that I have taken during various inundations. But drowning of coral islands is increasingly serious throughout the world now. Our data series of temperatures, sea levels, coral cover and more might be of relatively short duration compared with what we would like, but some of these are longer than those from most places, and anyway we simply don't have longer term records. Good management means we have to reach informed conclusions with what we have.

There is a school of ‘management’ which we must resist strongly. I call it the MAWBID school (Might As Well Because It's Doomed), which is something we see in many areas of conservation (fisheries is a good example relevant to Chagos) where there is conflict between those who wish to exploit a resource and those who seek the greater good. Chagos must avoid such fatalistic syndromes.

Caution, science and application of sense now can buy 20-30 years more life for these reefs. Few places have reefs as resilient or as ‘good’ as those in Chagos. Many world records have been found

here: the abundance of coconut crabs, the

biomass of reef fishes, the total lack of marine introduced species, the least polluted seas so far known in the world, and others. Chagos can be used as a global reference site in a world which sees an increase in human demands on declining natural resources. Chagos can be used by those countless people too who are trying to restore their own damaged reefs and who otherwise have a poorer idea of what to aim for. It is well worth treating Chagos with great care to ensure it remains in this state, for there is almost nowhere else left in the Indian Ocean like it. ‘Management’ of reefs or islands is a misleading though popular hubris: we cannot manage a reef and we cannot even manage some small parts or species of a reef. What we can manage is human activity and our impact upon them. If we do that effectively then we know that a reef and its components can rebound with greater resilience.

The Precautionary Principle is enshrined more and more in areas of environmental management where there is still uncertainty, and for good reason. Flagging up the real and potential problems of Chagos now is simply sensible and forewarning. With good governance we should be able to sustain Chagos reefs in the condition that we all would like to see maintained, forever (Figure 11).



Fig 11. Reef scene on a Chagos atoll.

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