

2018 Annual Report Chief Science Advisor, BIOT Administration



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Key Recommendations

Fishing

With some moves towards allowing boats to return for in-country prosecution, for example in Sri Lanka, it is important to actively follow prosecutions (and compliance with sentencing). From this consider whether such measures are sufficient to act as a future deterrent.

Current efforts around FAD documentation and removal are welcomed, but need to be built into a more comprehensive plan in terms of disposal, and of wider solid waste removal

For recreational fishing the creation of a closed zone along most of Eastern side of Diego Garcia needs to be expedited. Further work is needed to reduce impacts of seabirds from certain fishing methods.

The recreational fishery for yellowfin tuna needs to be converted to a catch-and-release fishery only

Enhanced and ongoing outreach is needed to ensure that fishing regulations are well understood. The establishment of a simple fixed-penalty regulation for low-level fishing infringements would improve ease of enforcement.

Vessel inspections for visiting yachts need to be strengthened to discourage infringements, including, fisheries infringements.

Waste

The solid waste holding areas need to be set back to at least 30m from the sea.

Further work remains needed around both water and soil sampling to assess for nutrient and toxic loadings.

The excellent efforts at island-wide beach clearance from 2017/18 need to be followed through with protocols for ongoing clearance, monitoring and waste disposal. Additional special measures may be needed to remove toxic or fragmenting waste around shipwrecks (currently on Diego Garcia and Sea Cow

Further work is needed to develop comprehensive and independent water quality sampling in lagoon and ocean waters. Some further work is needed to understand if runoff from stormwater in downtown areas may be having a localised impact on lagoon coasts.

Infrastructure and Development works

The BIOT Administration should seek to be more closely informed of planned development work, including coastal engineering, master planning, construction and demolition works. It should be actively engaged in advising on the latest revision of the Final Governing Standards.

Processes need to be established, building on any existing environmental review processes, to ensure full Environmental Impact Assessments (EIAs) are undertaken for all significant works on Diego Garcia. This would include EIAs for the very welcome efforts to improve energy efficiency and sustainable energy generation. There are particular concerns for the latter that they do not create any ecological disturbance through the laying of cables or pipelines in shallow water areas and are incompatible with the fragile ecology of the southern lagoon area.

Further developments around C-site have raised specific concerns for the protection of an ecologically important fern wetland.

Conservation planning and progress

The draft Conservation Management Plan, even unpublished, represents an important document that should be utilised by the BIOT Administration as a guide for decision-making and planning.

Through a small trial plot there has been some limited success at assisted regeneration and this method should be explored further as a means to achieve rapid expansion of hardwood forest cover

The appearance of humpbacked whales in BIOT waters is an exciting development, however it would be valuable to develop plans and a regulatory regime to ensure whales remain secure in BIOT waters, including avoiding disturbance from sightseers, boat traffic and marine noise. Draft a series of work elements

The appointment of a second Environment Officer is most welcomed. Staff time should be arranged to ensure near-continuous EO presence on Diego Garcia including some overlap/handover time

Environmental outreach is already strong, however there remain many opportunities to increase this, including the placing of signage, the engagement of community liaison officers; and the use of social media and existing materials such as the BIOT film.

Two sites – a fern wetland and an ancient hardwood forest – in the more populated areas of Diego Garcia have been highlighted as being of considerable conservation importance and should be given special protection. The hardwood forest also represents a location which may be highly suitable for the preparation of some public outreach with a short walk or nature trail.

Introduction

The natural environment of BIOT is unique. In a world where ecosystems are increasingly compromised by human activities BIOT represents a vast area, including an entire marine “ecoregion” which is being held up to some of the highest possible standards of environmental management. Of course, it is not without pressures. The military facility on Diego Garcia is large and dynamic, and as emergent mission and facility requirements change these can lead to new developments in terms of facilities and infrastructure. There is thus a need to continue to reassess regulations and policy to best protect natural resources. At the same time the facility has played a critical role in supporting management and research, and the island is carefully zoned and managed to ensure that wide areas remain wild and managed for the benefit of nature. Threats also remain in the marine and terrestrial spaces beyond Diego Garcia – the coral reefs are recovering from coral disease and bleaching events on 2015-16, and they will undoubtedly be damaged again and again as climate change takes its toll. A majority of the islands are impacted by invasive species such as rats, which impact the wider ecology, both of the lands and, it turns out, from adjacent waters. Solid waste, notably plastics and fishing debris affect all of the islands.

Overall, 2018 has provided a number of positive developments. Coral recovery is continuing apace. The first sightings of humpbacked whales may be the beginning of more regular returns linked to the an increasing population of the Southwest Indian Ocean population. Scientific research in the Archipelago continues with research expeditions on the islands, beaches, reefs and deeper waters. The US have commenced planning for the conversion of much of the energy demands on the naval facility to sustainable energy, an important commitment, particularly for a jurisdiction which is so vulnerable to the threats posed by a changing climate. Efforts to develop a joined-up conservation management plan also developed through 2018 and while these may not be published, the exercise of reviewing environmental management overall has led to great improvements in a holistic vision.

The defence of the remarkable natural environment of BIOT is an important responsibility for personnel working on Diego Garcia and on the BIOT Patrol Vessel, and this fact is increasingly recognised across the board by administrators, military and contractors working in BIOT. Protecting the lands and waters of BIOT also provides an important sense of purpose and team spirit, as witnessed by the enthusiastic uptake of voluntary activities such as beach-cleaning and turtle monitoring.

Protecting this environmental heritage should be a paramount concern for all parties with a keen interest in the jurisdiction of BIOT, including the Chagossian communities in Mauritius, the UK and the Seychelles, and the government of Mauritius. Ensuring that the remarkable natural environment BIOT is protected, enhanced, and, where appropriate restored, is something that is in the interests of all.

Fishing

Illegal fisheries monitoring and assessment

Patrolling with the BIOT Patrol Vessel (BPV) has continued, with patrolling times increasing substantially, in the year from October 2017 to September 2018, and now very close to their pre-established patrol-time target. By contrast, time in port has been substantially reduced (MRAG, unpublished report, 2018). Although it remains difficult to ascertain the effectiveness of patrolling, strategic efforts to target locations considered to be at particular risk during different periods are likely to be improving effectiveness year on year.

The CAMDA patrols have continued to provide another critical surveillance platform, although these have not led to any additional interceptions in 2018.

Drones trialled under the BPMS were also considered for their patrolling potential, however success was limited in this first trial (<https://www.zsl.org/blogs/chagos-expedition/project-drone-pioneering-steps-into-water-landing-drones-in-marine-ecology>).

Trends in vessel arrests have been presented by MRAG to the British/Seychelles Fisheries Commission and their infographic on this is replicated below

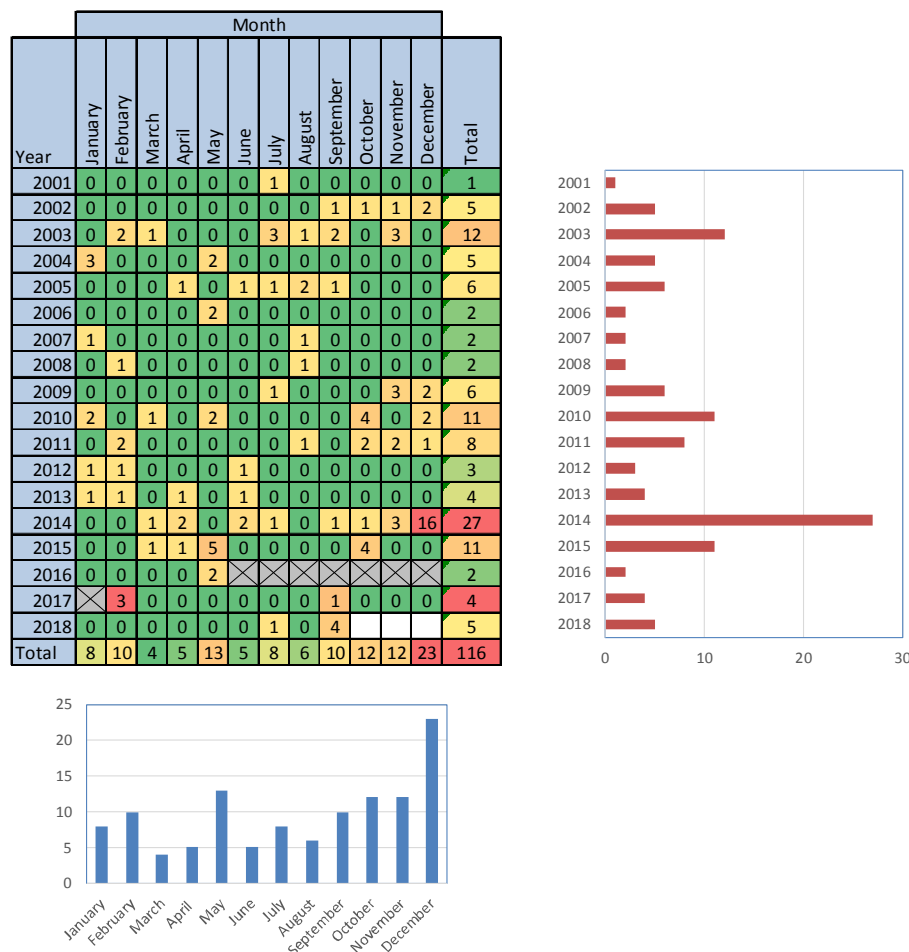


Figure from MRAG, 2018 unpublished data: Summary infographic of vessel detentions for presumed IUU in the BIOT FCMZ / MPA since 2001.

Between October 2017 and September 2018, some 370 vessels notified their transit through BIOT (as required). The most numerous reporting were some 226 inboard multi-day (IMUL) boats from Sri Lanka, with the other vessels being mostly long-liners (105) and purse seiners (34). Some forty-six vessels were sighted by the BPV. Fourteen of these were boarded and inspected, but permitted to continue as vessels presumed to be in transit. Five others were arrested (MRAG, unpublished data, 2018) including four vessels in September. One of these vessels was found fishing, the others were suspected of fishing and in addition one had illegal fishing gear (steel trace for shark fishing) and in another a further offence of obstruction of a fisheries officer. Each of these vessels was detained and taken to Diego Garcia. In all cases the vessels were then passed to the jurisdiction of the Sri Lankan authorities for trial, and hence allowed to return home to a trial in Sri Lanka.

Recommendation:

- MRAG actively follow prosecutions (and payments of penalties) in Sri Lanka (Deputy Administrator, BIOT, pers comm), but these should be reported and acted upon. If the punishment is insufficient we can expect these vessels to come back.

Handling illegal vessels

During the CSA annual visit some time was spent discussing the current procedural aspects for vessels brought in under arrest. Incoming vessels fall under police jurisdiction and are investigated in line with BIOT legislation. There are some procedural issues which are highly relevant for environmental reasons and these are briefly summarised below.

- A key initial task is to check for invasive species (a recent vessel was found to have brown widow spiders and was fumigated)
- Catch are then offloaded, sorted by species and photographed by SFPO, EO or police as such data are useful to understand impacts on BIOT marine life.
- Preservative salt is removed.
- Ice is allowed to degrade as holds left open (this is presumably then pumped into the small boat basin and could be a source of pollution/invasion).
- If catch disposal is required (under a legal order) the catch is boxed and loaded onto BPV for disposal at sea.

During and following this discussion it is clear that there are some opportunities for improvements or alterations to this process

Recommendations:

- While MRAG and ZSL have prepared a sampling protocol to obtain a more complete inventory of catches, this is not yet being implemented (get these)
- The use of existing and historic catch photos should be permitted for research (subject to any security limitations), while additional sampling of catches should be permitted for research purposes if appropriate
- To ensure that the entire catch is removed it may be necessary to offload other materials, including all fishing gear. In the last arrest this was only part-done (“to improve efficiency”) and may have been part of the reason why 36 sharks remained undiscovered under the ice for some time.
- Improve invasives inspection and control for detained vessels
- Investigate possibility of removing and destroying all fishing gear not just illegal gear (given that this process is already voluntary).

Fish Attracting Devices

These continues to be monitored by the SFPO. Where accessible, transmitters are removed. Lost and Abandoned Fishing Gear (LAFG) is also being recorded. This recording has been underway since 2014, and although there may have been some increase in the search intensity the growth in observations is notable – from 8 in 2014 to 40 in 2017 to 60 just in the first ten months of 2018.

Typically the presence of a FAD indicates a large amount of wooden framework and non-degradable fishing netting all of which represents a risk for physical destruction of reefs during entanglement and a major obstacle to nesting turtles as these wash up on shore (MRAG, 2018, unpublished data).

Despite the efforts to gather FAD transmitters, the majority are difficult to trace, while the physical challenges of removing the associated gear usually mean that this is left in situ.

Recommendations

- It would be useful to have a plan for dealing with transmitters. Are there toxic components, e.g. batteries. Can they be recycled?
- There may be some value in prioritising activities around FAD clearance, including the risks and benefits of removing transmitters or netting and other components in comparison to other solid waste.

Recreational fishing

Recreational fishing continues to be one of the most popular outdoor leisure activities in Diego Garcia. Efforts to quantify and map this fishery remain inadequate, and the long-awaited report on the creel survey has still not been undertaken.

The only regular reporting comes from MWR who compile fishery return forms from the boat-based recreational fishery. This information is sent to MRAG monthly. "Data collected include the date, number of fishers, number of lines, location (approximate based on a grid system for the lagoon), the number of hours fished and species caught and the weight of fish (lbs.). In addition, IOTC Resolution 10/02 requires the collection of length frequency data on yellowfin tuna and MWR have been collecting these data since January 2011" (MRAG, unpublished report, 2018).

The latest report from MRAG summarises the 2017 recreational fishery, documenting some 25 tonnes of landed catches from the three vessel types operated by MWR (MRAG, unpublished report, 2018). Tuna and tuna-like species make up over half of the total catch (13.18 tonnes), including 2.73 tonnes of yellowfin tuna. The latter remains subject to excessive fishing throughout the Indian Ocean, with stocks already considered overfished (IOTC). (Catches of billfish such as blue marlin are not recorded as these must be returned alive.)

The fishing observed during this one-off visit took place oceanside close to the Plantation. This implies that travelling quite long distance (in this case some 30km, 15nm) is not a deterrent for fishers.

Red-footed boobies are following fishing vessels and taking the bait from trolling lines. This has been confirmed by others. Fishers struggle to unhook them: one returning fisher who was interviewed said they caught four, released three, but killed one. As the nesting grounds for boobies are increasing on this eastern arm of Diego Garcia it seems likely that such fishing-related mortality is also on the rise.

Separately it was mentioned to the CSA that when fishers are bringing fish alongside or aboard which they intend to release they may be causing unnecessary damage though the use of gaff hooks to lift the fish onboard.

Recommendations

- The plan to create a closed zone along most of Eastern side of Diego Garcia needs to be expedited to protect nesting birds and to establish a large core area for increasing reef resilience around the atoll.
- Further work may be needed to investigate fishing method which reduce risks of seabird bycatch, such as the possibility for deeper set lines or different baits
- Non-damaging gears such as nets for lifting fish-catch aboard need to be utilised where possible for any fish that are intended or may be returned to the water. This may also require the supply of tools and training of MWR staff.
- Given the ocean-wide status of yellowfin tuna as overfished, and the current fishing practise largely taking immature fish, there should be a ban on any further take of yellowfin tuna, with the immediate return to the water of any captured individuals.

Outreach, education and enforcement

All police and customs are designated as Fisheries Protection Officers so there are potentially 24 persons qualified to enforce fishing regulations.

Currently the main fishery enforcement for recreational fishing concerns the patrolling for infringements in no-fishing areas. Although there are catch-limits, these are not enforced and there is no clarity as to how it might be enforced. A further concern expressed to the CSA is that any infringement requires a court hearing. This could be avoided if a fixed penalty regulation could be developed for spatial, gear or excess catch offences. The primary purpose is deterrent, so this would not only be easier to enforce but would help to convince personnel of the likelihood of enforcement.

A BIOTA ordinance has increased the fine for tampering with coconut crabs to £5,000, and all new island residents are informed of their protected status. Additional communication efforts explaining the accumulation of rat poison in crab meat (who eat the baited rats) has probably further reduced demand. Since the Navy completed a recent coconut crab population study, the resident biologist has noted evidence of increased coconut crab populations near inhabited areas.

Awareness-raising and community outreach are a core element of improved behaviour and a lot more could be done. The police have Community Liaison Officers who can carry messages to the “villages”. It was also suggested that other methods could be utilised to raise awareness (see below)

Recommendations

- As recommended in previous years, establish clarity on catch-limits to enable future enforcement
- Establish a simple fixed-penalty regulation to enable swift action on low-level fishing infringements.
- Enhance awareness of environmental values and regulations via:
 - Cinema
 - Police Facebook Page
 - Large noticeboard of marine regulations at the Marina.
 - Laminated cards with regulations and ID guides on all vessels.

Visiting Yachts

Some 39 yacht permits were granted in 2018, with a further 18 applications for 2019 had already been made by early January 2019.

The islands visited by the yachts appeared to be in good shape and clear signage has been placed describing the new fire-pit regulations. It would appear that at least some yachts are keen to undertake environmental enhancement work such as beach cleaning. For the present there is no facility for them to leave collected waste on-island, nor any provision for its removal by the BPV. If requests for help like this are regularly made or if this is seen as an opportunity for positive engagement it may be valuable to revisit this option.

As has been discussed in other reports yachts stopping over in BIOT on safe passage represent a low environmental risk, however two areas of potential risk include the introduction of invasive species and impacts from fishing. Yachts do receive prior warning and are requested to abide by a number of regulations however there remains little or no activity to ensure compliance: incoming boats are boarded, but never searched and there is a risk that they could be in breach of regulations (e.g. holding unpermitted fish or invasive species. In discussion with customs officers on BIOT it was felt that it would be entirely appropriate to for customs officers to board and inspect vessels. (By contrast, police would not be permitted to search vessels without valid reason.)

Commencing a programme of regular or occasional vessel inspections would be of considerable value both to reduce risks of damage to the natural environment and to act as a deterrent, however it will be important to develop simple protocols including processes for infringement.

Recommendations

- Develop vessel inspections protocols for customs officers, including procedures for infringement. These could include a fixed penalty fee or the revocation of permits and requiring immediate departure from BIOT.
- Enquire into possibility of requiring or requesting vessels having a declaration of inspection at the port of departure.

Public Works: Waste

Waste sorting plans

The removal of solid waste from Diego Garcia, which was just commencing and documented in a previous report, has been completed and from a site visit it was clear that a large proportion had been removed by the contractor from its location adjacent to the lagoon. Statistics from Public Works suggested that this was in total only a fraction of the total and that much remains.

Additionally, the air curtain incinerator which was installed in late 2017 has enabled the removal of virtually all of the timber waste that was being stockpiled. This is still being used on a regular, as-needs, basis.

As on previous site visits, the CSA remains concerned that the location for the stockpiling of non-burnable solid was is inappropriate. At present this is located only 3m from the ocean. The ground in this area is highly compacted and appears to be very clear of leaf litter which might normally be seen. It is likely to be washed clean either through rainwater or tidal flooding. This narrow area of land is probably critical in reducing the risk of breach or leaching from the unlined waste pits that are just a few metres further inland.



Upper pictures – solid waste, stockpiled in 2017. Lower left – solid waste storage site after the clearance. Lower right – solid waste sorting area: compacted, low-lying and bare ground immediately adjacent to the lagoon.



Wood waste stockpiled in November 2017. This has almost entirely been burned in the air curtain incinerator

Recommendations:

- Move the solid waste holding areas to at least 30m from the sea and allow re-vegetation of the intervening coastal strip.
- Establish a programme of water sampling in the nearshore waters to test for both toxic and nutrient loadings.
- Similarly, undertake some soil sampling across this area to assess for nutrient and toxic loadings.
- Develop a highly detailed monitoring programme to assess inundation and erosion of the coastal strip, and a plan for remedial action, including engineering should risk be considered high.

Plastic

The completion of the new water treatment plant means that tapwater across DG is now potable. This should greatly reduce the demand for plastic bottled water on the island. In parallel, efforts led by the Environment Officer have led to considerable successes in driving the reduction of plastic waste including significant progress towards:

- The phasing out of plastic straws and single use plastic in the restaurants and shops (being replaced by paper, wood or biodegradable plastics)
- The encouragement of the use of reusable plastic storage containers
- The replacement of plastic with paper grocery bags
- The replacement of Styrofoam boxes for takeaway food with cardboard containers

In parallel there have been excellent efforts to clear beaches of plastic across DG (see below).

With the Zoological Society of London (ZSL), the BIOT Administration have obtained a grant to look into reducing the impacts of plastic on the BIOT natural environment. The project (see Darwin Initiative, below) commenced in April 2019.

Recommendation:

- While encouragement and engagement have already begun to achieve reductions in consumer use of plastics the possibility of regulatory approaches, payment or incentive-based approaches might be needed in future.
- Explore other major sources of plastic packaging and encourage the purchase of minimal packaging for food and equipment imports

Composting

Following the 2016 composting study, the US Navy has continued to assess locations, technology and costs required for the building of a composting facility without the risk of impacts through pollution or to human health. No further work has been undertaken to advance the development of a composting facility

Green waste

Green waste (mostly cleared vegetation, some untreated wood) is currently disposed at a site close to the deepwater port, however concern has been expressed about the proximity of this site to the coast, and the possibility of leaching of nutrient rich water into the lagoon. It is not clear that there is any evidence for this, and it should be noted that this waste appears to be largely benign in terms of likely toxins.

A new site for this dumping has been proposed on the lagoon side of the southeastern end of the runway. This site is part of the large reclaimed area developed in the early 1970s, close to the former settlement of Pointe Marianne. Large amounts of solid building rocky waste are already being dumped in this area, and this use is ongoing and will continue, although there are also plans to rebuild some roads and some or all of this may get used as hardcore. Overall the site is highly disturbed, with many invasive plants, including banana and taro. There are also areas of freshwater wetland with considerable dragonfly diversity.

The current plan is to use of this area, with a clear demarcation of uses with 6 acres (2.4ha) for wood waste (see image, below). There would be some value in using the opportunity of change of use in this area to perhaps contain and control the dumping areas, and to re-habilitate some wetland areas.

At the time of departure (end-November, 2018) this conversion of use was on hold due to the very high cost of clearance requested by the BOS contractor.



Above: proposed area for new green waste disposal site.



Left: Current wood waste site. Centre and right: Wetland area with mostly invasive trees behind. Part of the proposed new area is already used for dumping of inert construction debris.

Beach litter

The one-off beach clean of the eastern coastline of Diego Garcia (from Barton Point to GEODDS), lagoon and ocean-side) was completed in early 2018. In total some 60 tonnes were removed. The cleared litter from this work is currently held at the solid-waste disposal plant. There are plans to sort this and separate recyclable materials, potentially for off-island disposal. The plastics team from ZSL may also be able to undertake a more detailed sampling to gain a better understanding of categories, volumes and origins of this waste.

Volunteer beach cleans are continuing, co-ordinated by the EO. In 2018 these cleared 2.1 tonnes of plastic and 1.2 tonnes have by mid-April, 2019.

During an albeit brief visit to the eastern ocean shore in the nature reserve area it was possible to make two brief walks (~150m and ~50m) along the ocean coast to look at current levels of litter. These were very low in both locations, especially compared to previous visits. Further review would be required to ensure this was consistent along the entire shore, however assuming it is the case, then we can infer two points.

Firstly, the clearance of this shoreline in 2017/early 2018 was very thorough, even extending under the dense coastal vegetation. Secondly that the rate of return of litter appears to be slow.

This latter point is likely to show considerable spatial variation based on localised currents. A general conclusion for BIOT more widely would be that effective clearance can be achieved along ocean shorelines, and further that the benefits derived from such clearance might be relatively long-lived. Such benefits would include the removal of physical obstacles for coastal species such as (nesting turtles, ground-nesting birds, crabs and waders), but also the removal of a very large proportion of a substance which, if left *in situ* will become a major source of highly polluting and irremovable micro-plastics which threaten marine life world-wide.



Part of the waste gathered from the 2017-18 coastal clearance exercise, currently held in the solid-waste treatment area.



Eastern oceanic shore 2016 (left) and 2018 (right). While some plastic appears to have returned, after almost one year since clearance this appears to be relatively little and would not likely be a major ecological disturbance.

Recommendations:

- Attempt to develop some further degree of quantification of the solid waste to understand relative concentrations of different elements, and origins.
- Consider options to take this further with research partners
- Develop a plan for the sorting and removal of this waste
- Commence a simple monitoring programme to quantify waste arrival rates in different locations around the island.
- Encourage and support the finalisation of the Adopt-a-Beach scheme

Shipwrecks

The remains of the fishing vessel on DG are still in place and the two largest sections, although moved, are still holding their shape. Considerable amounts of fishing waste remain alongside the vessel while other materials have spread along the shore. Several batteries on the beach have clearly already leached their contents (lead acid) and are unlikely to be any more toxic than other plastic and metal components from this wreck. Hardened polyurethane foams are spreading most widely,

and these are also likely to be rapidly disintegrating into microplastic components which will become impossible to remove.

The decision to remove this wreck in 2018 was abandoned due to the high costs (while minimising damage to the coastal vegetation and dunes). There has been some removal of debris by volunteers.



Fishing vessel on NW DG shore, November 2018. The vessel has moved and changed orientation but the two largest parts of the hull remain intact. Waste matter from the vessel continues to spread along the shore, including large volumes of light, hardened polyurethane foam (right).

A new wreck was observed on Sea Cow Island (Great Chagos Bank) and was reported to BIOTA, with a series of photographs. The vessel was approximately 20m in length, of a wooden construction with a fibreglass shell. It was lying on an intertidal rocky shore, with quite high wave action even on what was a relatively calm day. Fishing gear was visible under the boat and strewn along the beach along with other materials of wood, plastic and fibreglass. This suggested South Asian, possibly Sri Lankan vessel, and a relatively recent arrival.

Recommendations:

- If funds remain unavailable to remove the wreck regular (maximum 3-monthly) clean-up visits should be made to remove loose and transportable debris, including fishing gear and hardened foam. It would also be valuable to observe impacts, including the shifting and breakup of the vessel and adjacent patterns of coastal erosion.
- The shipwreck on Sea Cow may be impossible to remove given its location. If conditions permit it would be valuable to attempt to remove any toxic components and to consider the benefits of removing fishing gear if or when the island is included in any programme of beach clearance.



Shipwreck on Sea Cow Island

Stormwater runoff and drainage

Although this item has not been explored previously by the CSA, there would be value in considering the risk of nutrient rich runoff from drainage and stormwater culverts. Large parts of the developed part of Diego Garcia, including roadsides and most of downtown, have been landscaped in order to prevent flooding and take away excess surface water. Ditches and culverts, take water, at least in some cases to the ocean. In places and at certain times, such water will be contaminated with road-surface waste and potentially any chemicals or fertilisers used on the vegetation, buildings, car parks and so on. It is impossible to make a definitive link, but the very slow apparent recovery of the coastal reef which once ran from Reindeer Station to the VIP accommodation could be linked. This reef is directly offshore from such a drainage system and there is a very high coverage of algae on this reef which may be symptomatic of nutrient pollution.



Left – part of the surface drainage system in Downtown. Right – the exit of this drainage system onto the beach close to the Reindeer Station.

Recommendations

- Get a full plan of the drainage system for the island, which we were told is likely to be held by the Facilities Management Division.
- Investigating all locations where these enter onto the beach and potentially requesting water sampling (and making simple observations during peak runoff). (An investigation was subsequently begun, in July, 2019, with report pending)

Water sampling

The need for water sampling has been discussed in previous reports. The BOS contractor in the past has done some of this and some data were provided to Cefas for comparison with independent sampling in 2013 (Malcolm and Lee 2013). This initial review and study left a number of unanswered questions and did raise some concerns about nutrient pollution.

Details of the sampling regime around pre-positioned vessels and pier-side have been provided to the CSA by Facilities Management Director. There about 20 sites around the entire lagoon which are required to be tested annually/quarterly for a variety of potential harmful materials. During the change in contractor this work has stopped and had not be re-initiated at the time of the CSA visit.

Recommendations

- Request independent review of the adequacy of the contracted sampling and request copies of results for review by independent body.
- Develop an independent sampling protocol (see earlier CSA reports) to include sampling lagoonside adjacent to the waste treatment area and the stormwater runoff points; as well as oceanside adjacent to wastewater outfalls.
- Engage with the PWD to ensure sampling is re-started and, with independent expert advice request any necessary improvements to locations and sampling protocols.

Public Works: Infrastructure and Development

As a large and strategically critical facility it is inevitable that large engineering works will be undertaken for development, maintenance and replacement of buildings and infrastructure on Diego Garcia and in the lagoon. For years or decades such works have been undertaken with a mixed level of scrutiny from the BIOT Administration. Applications are made to BIOTA for all larger projects, and there has been considerable progress in requesting that more attention be paid to environmental issues, reducing risks and impacts. The US Department of Defense has its own environmental regulations, largely laid out in the Final Governing Standards for Diego Garcia. In many cases these provide high environmental standards and have certainly helped in the avoidance of long-term or irreversible damage. At the same time BIOTA has regularly raised concerns on risks not covered by these Standards, and, gradually, additional best practises are being developed and refined, covering issues from coastal setback to water treatment anchorage practises.

Concerns remain that many projects and works are presented to the BIOT Administration with very little notice prior to preferred start-dates, sometimes with flights already booked for expert personnel to begin work. This was clearly the case for the proposed work at C-Site (see Fern Wetland, below), but was also mentioned as a broader problem by the Facilities Management Director.

There are still no robust Environmental Impact Assessment protocols for proposed works. The Environment Officer has developed a briefing on what is needed as a minimum for EIAs (See Annex 1). Having well-defined structures for EIA and permitting may actually help to ensure continuity of planning as well as ensuring the avoidance of hurried and ill-informed decisions. Meanwhile, few works are proposed which offer a range options for different approaches which may have differing impacts, as recommended in the EIA briefing. External and impartial review of proposals is also rare.

Part of the challenge on Diego Garcia is the short-term nature of many of those working in BIOT: typically spending only a year on-post perhaps makes it inevitable that staff may assume that large developments have been discussed prior to their arrival. The converse may also be true, and long-planned developments may appear new when there have been ongoing discussions, however this issue is mitigated by the presence of some long-term staff on-island, and long-term advisors to BIOTA. In some cases projects have been approved, but then left aside for a long period only to re-surface as “approved” projects. Given the improvements in environmental awareness and scrutiny it will be important in future to time-limit any project approvals.

During a meeting with the CO, the Chief Science advisor was made aware of a 2014 DG Development Plan. While it was stressed that this plan is not a blueprint and was indeed already out-of-date, if this document, and any updates could be shared with BIOTA it would be highly useful in providing a vision for new developments, coastal engineering, sustainable energy and other activities. This in turn would allow BIOTA to forewarn the owners of the plan over areas of concern.

Recommendations:

- Request that the Facilities Management Director or Public Works Officer regularly provide information or updates on coastal engineering, master planning, construction and demolition works
- Request a copy of the broader development plan for review and comment. Consider a process and means of engagement in broad-scale visioning and planning with the US.
- Request to have an active role in reviewing the latest revision of the Final Governing Standards and influencing key areas

- Continue current engagement to incorporate EIA into all formal works on Diego Garcia, and into the Final Governing Standards, building, where relevant, on any current US Navy environmental review procedures
- Develop protocols for EIA approaches to establish triggers for EIA requirement and to ensure standards such as developing options with scenarios and to formalise processes for independent expert review, possibly in collaboration with UK statutory agencies such as Natural England.
-

Sustainable energy

There are large-scale plans for reducing energy consumption and the development of sustainable energy on Diego Garcia. These include the development of wind and solar power and a system for salt-water air conditioning (see further notes below). Each of these will have impact at large-scales on DG in terms of a physical footprint. In addition, there will be a need for a grid battery storage plant. Additional personnel will be involved during construction.

There is also a plan for emissions reductions through installation improvements such as insulation and weatherproofing, with no likely additional impacts (beyond waste generation).

Overall it was estimated that these developments could bring in savings of US\$19M per year (including \$10M from SWAC, 2.6M from wind).

These are excellent developments, but as with all changes on this scale considerable scrutiny will be required to ensure they built in the right locations to avoid natural impacts and to ensure they are not at risk, for example from rising seas and coastal erosion.

Wind Turbines

The plan presented to the CSA and EO in November 2018 was for a 4 MW array, which would consist of 14 x 65m high wind turbines. These can be lowered for maintenance (or incoming storms)

The clearance between turbines was recommended at 3x height of the turbines, so approximately 200m between each. For 14 turbines this would be an area of over 50ha (~1.4 x 0.4km). They were considering one proposal to put these in an area close to GEODSS. There is a small area of bare land/scrub at this point and some areas of ironwood/coconut, but it was not clear at this point whether it would be large enough for this size of array, noting the need to ensure a 50m strip of untouched shoreline vegetation.

A further big challenge will be in running cables from this location to the main areas of need in the naval facility. At the time of meeting there was concern that a land-based cable might present certain challenges where it would have to run close to a narrow stretch adjacent to a munitions storage area. An alternative was discussed around running a submerged cable across the lagoon.

The CSA and EO subsequently raised considerable concerns about the likely risks of such developments on the delicate and unique ecology of the southern Diego Garcia lagoon, both from the construction work and from the possible risks of electromagnetic fields disturbing the movements and behaviour of key species (for a useful review, see: Taormina et al. 2018).

Sea-Water Air Conditioning

The naval facility on Diego Garcia currently expends a considerable amount of energy on air-conditioning, driven by conventional systems. Baseline studies suggest that conversion of the current AC system to a Salt-Water Air Conditioning (SWAC) network would cut energy consumption by ~50%.

SWAC systems typically operate by pumping cool, deep ocean water where it is ~43°F (=~6°C). In DG this is estimated to be at a depth of around 1000m. This is taken to a titanium heat exchanger where the cool water is used to cool freshwater in a closed circuit that is circulated to all buildings to provide cooling. Water is returned at a depth equivalent to the ambient water at 55°F (~12°C, likely to be >180m). Initial concerns is that this very deep water could be 10 NM offshore and so costly to reach. Alternative options could be to bring in slightly warmer water (from less far offshore), but would then run the system with a further cooling process (so some energy costs, much reduced). This system is only proposed for downtown/N of airport. In southern sites similar low-cost, low-emissions cooling could be provided by a Water Source Heat Pump taking cooling from groundwater.

An additional service could be to use the SWAC water for reverse osmosis desalination.

The locations under consideration in November 2018 including Cannon Point and off Seabreeze Village. The former would require Horizontal Direct Drilling to take pipeline from land under the reef and emerge below depth of wave/tide influence. Beyond this pipeline would be weighted and dropped to seabed.

At Seabreeze discussions were still underway on exact locations but there was some suggestion that it might be effective to trench a pipeline across the reef excavation pits, but possibly still undertake a horizontal drilling process to cross the reef crest. Some further discussion was held around the possibility of using the existing wastewater outflow pier as this presents an existing physical structure which could be used to traverse the reef flat. Tunnelling out through the reef crest from here would be a relatively short stretch.

The idea of this work is highly commended, but it will be important to minimise any potential environmental impacts. The very deep extraction and deep emission of water will require some scrutiny, but it seems unlikely to threaten shallow or even mesophotic reefs. It will be important to get an independent review and perhaps to consult with the oceanographers and deep marine experts from the current research teams already supported by the Bertarelli Foundation.

If they use the same water for reverse osmosis, the returning water will be hypersaline water, which will clearly have a locally pernicious impact on marine life.

The most immediate concern is for the transit of pipelines over the reef flat and reef crest – trenching could weaken reef structure, infilling with waste sand and rubble will not be secure, and could lead to blowout type scenarios, threatening both the pipeline and the adjacent reef and coastal areas with accelerated erosion.

Photovoltaics

Work on these has been approved. We still have relatively little information about proposed locations for this.

Recommendations:

- While certainly welcome, all of these works need to be formally submitted for review by the BIOT Administration, and those reviews should be undertaken by experts in the different fields
- Environmental Impact Assessments are a critical component, and proposals should include sufficient details, ideally a range of options with a full risk assessment, and a full explanation and justification of choices or preferences
- BIOT Administration should not consider permitting the laying of electrical cables in the lagoon.
- Similarly, SWAC pipelines must not be allowed to create any disturbance to reef flat, reef crest, or reef slope until well below any areas of possible wave or storm disturbance (below 50m) and should be laid underground using deep horizontal drilling

Vegetation clearance

The area at the southern end of the runway that was ill-advisedly cleared in 2016 is now almost entirely re-vegetated, but a brief site visit allows for some important final observations on this impact.

1 – The growth form of the recovered *Scaevola* appears in some places to be dominated by vertical growth only – reaching to 1.5 or 2m. Under the rather thin canopy, this appears as a very “open” structure, without the structural complexity of lateral branches and leaves. This has probably occurred because recovery took the form of simultaneous re-growth of an entire community, without the usual patchiness of a more natural ecological development. A critical consequence is that such a vegetation structure will have a far lower value for wave attenuation, potentially for a number of years, compared to the more typical tangled and branching structure seen in natural coastal shrub vegetation. This represents an additional risk factor to be weighed into the risk of full clearance of *Scaevola*.

2 – Adjacent to the shore, recovery is now near-continuous, although still only 1-2m height so not yet at full stature. Some dead areas were seen in distance. The current vegetation edge is now very uneven along the shore, including some deeper embayments or blowouts, over 4m from the current vegetation fringe. It may be impossible to ascertain without highly detailed georeferenced data, but it seems probable that this uneven coastal fringe is the result of partial erosion of areas where plants took longer to recover. If this is the case then it seems likely that there has been an average coastal setback from this coastal clearance exercise, of perhaps 1-2m.



The open vegetation structure of the recovered Scaevola. This structure is likely to be far less effective than natural growth forms in wave attenuation during inundation or storm events. Right – the uneven littoral margin of Scaevola, possibly signalling patterns of differential erosion as the vegetation recovered at different rates.



Embayments or blowouts in the coastal margin vegetation: from sea side (left) and from land side (right)

The ill-advised clearance of coastal vegetation at Mile 1 (see 2017 Annual Report) has been replanted with Scaevola as recommended, however it would appear that this is at a very early stage or that surviving plants are only growing very slowly. Parts of this area would appear to have become intertidal and in some parts the regular inundation has already killed the young plants. The coastline has been slightly built up by the dumped remains of the cleared vegetation, but it may be necessary to consider further interventions to allow vegetation recovery before the need for hard engineering.



Attempts at coastal vegetation at Mile 11. Left- regular tidal inundation appears to have killed most of the Scaevola transplants. Right – healthy Scaevola, albeit still very young.

Recommendations:

- Request expert advice on the opportunities for soft engineering responses to allow vegetation recovery at Mile 11 prior to the worsening of erosion and consequent call for emergency hard engineering. This could include sand “nourishment” of the current back-beach area, provided sediment impacts can be kept away from the current beach and adjacent waters.
- Share lessons learned from this and ensure that coastal setback of 50m becomes standard and enforced

C-Site development proposal

In November, 2018 a request was made to the BritRep for some tree and vegetation clearance, for work to start within a month. This was preparatory work for a larger project at C-Site. The CSA was subsequently informed that the last-minute nature of this request to the UK authorities was a result of a similarly very short notice request coming to the US Commanding Officer in Diego Garcia. It was apparent that the requesting authorities did not expect to have to provide an Environmental Impact Assessment. Some verbal assurances had been made that there was nothing of environmental importance, that the woodland areas were largely or entirely coconut forest and that they would remove any coconut crabs prior to the work. There was a wetland, but they would avoid working in this area.

Further inspection of the proposals left the CSA and EO concerned that the proposed development was indeed very close to, and potentially overlapping the wetland area. A site visit revealed this wetland to be of considerable ecological interest (see Fern Wetland, below).

Unfortunately, permission had already been granted for some initial work, despite the lack of any independent environmental scrutiny. A short formal communication was provided by the CSA to try and manage this situation.

Apart from the direct issue of the need to protect this wetland, some significant procedural issues arise, notably around the need for Environmental Impact Assessments and for independent ecological assessments. Although the initial permit request was for a very small spatial footprint this was part of a larger proposal and should not have been treated separately. It is also noteworthy that there was a belief that the permission which was granted was a relatively broad license – it was apparent during the CSA visit that the contractors had already changed the locations planned for drilling, but were still using the “permission” granted from the proposal.

In addition to the works close to the wetland area there is also expected to be a request to build on a currently cleared area which is a low hill formed by natural sand dunes. The work would require the flattening part of this natural area of higher elevation, with possible impacts on adjacent areas of dense coastal Scaevola.

Recommendations:

- The fern wetland and a surrounding buffer of 50 metres minimum should be given legal protection.
- Environmental Impact Assessment requirements remain essential for any new development works that could have any impact on land, water or air, including any activities that may lead to damage or clearance of natural vegetation.
- Aside from the direct footprint of impact it is critical to consider access issues (creating temporary or permanent roads) and to consider adjacent areas.
- Protection of important ecological areas such as these wetlands should include a natural vegetated buffer to minimise the potential for indirect impacts from adjacent activities.
- Other mitigation measures might be considered in circumstances where a full buffer cannot be achieved.
- An independent process of reporting and inspection is required during and after activities.
- Engineering work on the higher-ground dune area should be subject to a separate Environmental Impact Assessment, and any impact on current Scaevola should be kept to a minimum and in no place to impact the coastal buffer zone, either with the work, or with consequential impacts.

Coastal engineering

We are not aware of any ongoing coastal engineering, however some work (already permitted) to protect an eroding shore is planned for May. This was described as being adjacent to road, oceanside, just after incinerator on the right: it may just be re-locating the road.

Recommendation:

- Request plans for this and any other coastal engineering plans from the Facilities Management Director.

Conservation planning and progress

Conservation Management Plan

2018 saw the preparation of a full draft Conservation Management Plan (CMP), intended to replace the outdated Interim Conservation Management Plan published in 2014, originally intended to guide management for just one or two years. Drafting of the new CMP was led by the BIOT Administration, with support from the Centre for Environment, Fisheries and Aquaculture Science and the Marine Management Organisation. Many stakeholders were invited to engage in the initial conception and in drafting. This draft CMP was passed to the US to gain their input and support and was also shared with Mauritius with a request for input.

The BIOT Administration is considering feedback received and the plan remains in draft. At the same time, in its current format, the draft CMP remains a valuable guide to secure the best possible future for biodiversity and conservation in BIOT. The plan aligns and draws together many critical issues including illegal fishing, invasive species, and the management of activities on Diego Garcia ranging from waste disposal to pollution management planning and the formalisation of Environmental Impact Assessment regulation.

Recommendations:

- Efforts should be continued to gain input if possible, both from Mauritius and the various Chagossian communities.
- Given the necessity to protect and secure biodiversity in the unique setting of BIOT for the benefit of all interested parties it is recommended here that the Draft CMP be utilised by the BIOT Administration as a guide for decision-making and planning and further to encourage uptake of relevant provisions, for example in the US Final Governing Standards.

Terrestrial restoration

Following prior discussions (see previous CSA reports) about the possibility of taking an assisted regeneration approach to restoration the CSA was informed that the Plantation Manager, working with the previous Environment Officer had undertaken a small sample plot. This was not formally recorded or reported. The total area selected was only about 40 x 90m. It consisted of a place with a mix of coconut and a few hardwoods, with hardwood saplings on the forest floor. The coconuts were removed. A return visit in early 2019 included some further clearance of *Scaevola* and vines.

The result of this small experiment is a mixed plot with an open area largely dominated by ground-level vines, but with well over half the plot now dominated by hardwood recruits including *Morinda citrifolia* and *Pipturus argenteus* already reaching to 3m or more in height. (after 18 months).

Although a small and somewhat uncontrolled experiment this would appear to support our idea that this may prove to be the most effective way to restore wide areas of hardwood forest across the archipelago. Further discussion with EO and Plantation Manager confirmed a willingness to expand this approach.



Looking in towards the assisted regeneration plot, showing the felled coconut palms and the dramatic and dense regrowth of native hardwood species.

Recommendations:

- Get detailed location of current plot and establish some basic details
- EO and PM to locate additional test plots, develop a plan, including mapping and monitoring
- Commence plot clearance and record progress.
- Consider planning for similar restoration in the outer islands. The maps currently being developed by Kew may help in the identification of suitable locations, notably places being singled out as “mixed hardwood and coconut forest”.

Cetacean protection

2018 was the first year in which multiple humpback whales have been observed in BIOT waters, including a breaching whale observed in Diego Garcia lagoon.

These sightings are not unexpected as these whales have been relatively regularly seen to the north, in the Maldives and it seems most likely that they are part of the Southwest Indian Ocean population which traditionally moves into the warmer waters around Réunion, Madagascar and the Comoros to breed and calve. These populations appear to be increasing and sightings in the Maldives are also becoming more frequent. Dr Charles Anderson (pers comm, 11-09-2018) notes:

I have been keeping records in the Maldives for many years, and despite relatively few total sightings (30+) some very clear trends have emerged. The main season is June to Oct, with a peak of sightings in August. Calves first appear in August, and increase in frequency in Sept and Oct. All in all this suggests that these must be Southern Ocean animals, and almost certainly part of the SWIO population.

As well as this seasonal pattern, sightings are becoming more frequent, suggesting population increase and range expansion (as a result of recovery from commercial whaling over several decades). I anticipate that Maldives will become a regular breeding haunt, and there is no obvious reason why Chagos should not as well.

In future it seems likely that BIOT could become a significant and very safe refuge, where the whales will be free from most human impacts, including vessel collisions, excessive disturbance and relatively low levels of marine litter.



Upper image – breaching humpback whale in Diego Garcia lagoon observed 9 September, 2018 (Photographer unknown). Lower image: Female humpback with calf just visible behind the lifted tail, Great Chagos Bank (SFPO/MRAG)

Recommendations:

- It will be important to develop a regulatory regime to ensure whales remain secure in BIOT waters, this will include avoiding disturbance from sightseers, boat traffic and marine noise. Excellent guidelines are already in place in a number of countries and it may be sufficient to draw on these.
- There is an active research base around the SW Indian Ocean humpback whale population (Dulau-Drouot et al. 2012, Dulau et al. 2017, Charrassin et al. 2018, see also the Western

Indian Ocean Journal of Marine Science, Special Issue 1, 2018:

www.ajol.info/index.php/wiojms/issue/view/17166). It will be important to utilise and collaborate with this existing expertise in future proposals for research and monitoring.

- It will be useful for BIOT (EO) to maintain a simple, central record of cetacean observations – species, estimated numbers, date, time, location (co-ordinates), and also in relation to physical features – lagoon, channels, distance reef front, over seamounts, behaviour) other basic information on sea-state, weather.
- SFPO should be encouraged to contribute to these whale observations and provide images when these can be easily obtained (it should not form a major digression from core activities as this could be too time consuming). Others (MWR vessels, OISP, visiting researchers) could make further contributions. Records should open-access and available in real time, especially to other researchers.

Environmental Staffing

All personnel and contractors living and working on Diego Garcia and on the BIOT Patrol vessel have a role in protecting the natural environment and this fact is increasingly recognised from the BritRep and CO downwards. In many of their roles, personnel are directly involved in environmental stewardship, including patrols of the outer islands, managing recreational fisheries, CAMDA patrols, waste handling, policing and customs.

In a more focused sense, the SFPO and the Plantation Manager are critical environmental roles. For these, the comments from the 2017 Annual Report remain valid and need to be fully addressed. There is a need to clarify and formalise roles and responsibilities. The important environmental roles for Police and Customs, are also increasingly recognised and are treated elsewhere in this report.

Environment Officer

The role of the EO continues to be an essential part of the team on Diego Garcia, encompassing multiple elements broadly falling under the four classes outlined in the 2017 annual report. Brief notes follow each of these below:

- Strategic and advisory. This role is perhaps the most central and critical part of the work, the EO is tasked with advising both on Diego Garcia and to the BIOT Administration in London. Work includes advising both US and UK personnel on environmental aspects of proposed works; collaborating with the SFPO and MWR on recreational fisheries monitoring; providing advice to personnel on the existing environmental frameworks and regulations, drafting, advising BIOTA.
- Science. The intention for the EO to undertake baseline science and monitoring has been somewhat held back by the volume of other tasks and thus the synthesis and reporting of the creel survey, the expansion of the forest restoration plot monitoring, and the continuation or expansion of shallow reef monitoring have all been largely left on one side during 2018
- Conservation and outreach. The EO continues to play a critical role on Diego Garcia in encouraging environmental activities, including beach cleans and talks and presentations in town. The EO has also spearheaded an excellent campaign to reduce plastic use on Diego Garcia
- Science support. Continuing and with considerably more time commitment than 2017 due to the increased number of science visitors and expeditions.

The challenges of achieving all of these tasks remain too great for one person and this has now been recognised with the decision to support an additional Environment Officer (commencing May, 2019). Key components of the roles and the division of key elements are being determined, but it will be of great value to have permanent environmental staff present on Diego Garcia. The additional staff-time should also enable BIOTA to undertake some basic environmental monitoring.

Recommendations:

- Draft a series of work elements
- Engage CSA to develop a science and monitoring programme
- Ensure near-continuous EO presence on DG, but also some overlap/handover time, which will in most cases be most productive on DG rather than in London.

Environmental Outreach

In terms of outreach the nature trail/interpretation in the forest restoration plot is not being regularly visited or maintained. The signage for environmental issues was greatly delayed in transit, but had arrived during the CSA visit in November 2018, but had yet to be placed. The snorkel trail had largely been abandoned, and without any signage there is no formal notification of its presence.

There may be difficulties associated with these locations. The snorkel trail appears to be on a site where visibility is very low for large parts of the year. The restoration site is somewhat remote and it is not clear if the bus will reliably stop there or indeed if access will be allowed without permits.

The environmental outreach film that was developed at the same time as the signage is not being regularly shown.

The suggested site for a nature trail at Pointe Marianne might offer a far better opportunity for encouraging engagement.

The BIOTA web-site continues to be an important place for sharing environmental messaging although it would be valuable to obtain some data on traffic and use of this site. There may be value in developing a stronger social media engagement by BIOTA for its environmental work. This might be used to highlight some of the many elements of ongoing environmental work as well as to garner support on DG for events such as beach clean-ups.

Recommendations:

- The current signage is in urgent need of installation. At the same time it was recommended that copies of some of these signs be placed in public places (notably the mess and/or Island Rooms). There should be some outreach events associated with these
- Efforts need to be made to increase environmental messaging on Diego Garcia, potentially in collaboration with community liaison role of police; social media and existing materials such as the BIOT film.
- Develop social media outreach (through EOs) on Facebook, Instagram and Twitter
- The possibility of developing an interpretive path/nature trail at Pointe Marianne should be considered
- Conditions at the snorkel trail or other potential snorkel sites should be monitored in different seasons with a view to revisiting the location for this

Research and Expeditions

The following research was undertaken in 2018:

Month	Lead organisations	Aims
Jan	Zoological Society of London	Barton Point red footed booby survey.
Mar	Bangor University	Coral reef expedition, 10 scientists, 29 sites, six atolls, 400 hours underwater
Mar	ZSL, Stanford, University of Western Australia	Acoustic array servicing and data downloading, six atolls
May	Lancaster University, ZSL	Mixed objective expedition from BPV: rats on the resilience of coral reefs; reconstructing growth rates and age of key fish species; coral reef carbonate budgets and bio-erosion; the use of fixed-wing drones for surveying megafauna and detecting illegal fishing; and the identification of manta rays, their abundance and migration.
Apr	Indigo V	Citizen science water sampling for microbiome analysis
Jun	Zoological Society of London	Second seabird expedition, red footed boobies, Barton Point
Jul	Deakin University, University of Florida, Swansea University	Green turtle nesting surveys, monitoring juvenile turtles in the lagoon. Diego Garcia
Jul	ZSL, Exeter university	Nelson Island bird survey: brown and red footed boobies tagged and DG red footed booby tagging
Nov	Kew, CCI	Drone trials for vegetation mapping. Opportunistic botanical surveys.
Nov	Swansea University, University of Florida	Studies of nesting green turtles, and first time to tag nesting hawksbill turtles. Satellite tagging of immature lagoon turtles. Diago Garcia. Drone mapping of benthic habitat and to estimate turtle population numbers.

Recommendations:

- Each of these expeditions has provided a report, however these are not being rapidly placed into the public realm. BIOTA should make an effort to put reports onto the www.biot.io website within a month of receipt.
-

Forthcoming, 2019 Expeditions and research visits

The following research is proposed or underway for 2019

Month	Lead organisations	Aims
Jan	ZSL and Exeter Uni	Sea Birds Danger Island tagging Brown Boobies – DG tagging red foot tagging
Jan	ZSL and Stanford	Tuna Tagging DG in MWR vessels
March	Lancaster, Stanford, ZSL, Exeter, AIMS	Reef 1: as 2018, Mixed objective expedition from BPV
March	Cefas	Diego Garcia water quality
March	ZSL, Exeter, Stanford, Swansea	Vava II based expedition: Acoustic array servicing, Shark and big teleost fish tagging, Seabird tagging and setting up camera traps, Turtle tagging, collection of sand cores to look for micro plastics, plastics surveys, reef surveys searching for <i>Ctenella</i> and <i>Seriatpora hystrix</i> , Seagrass bed surveys, aerial vegetation surveys to help Kew habitat mapping
April	Bangor, Warwick, UCL, ZSL	Reef 2: Reef mapping, fish growth rates, temperature loggers
June	ZSL, Swansea, BIOT	Darwin plastics project
July	ZSL Deakin University, University of Florida, Swansea University	Seabird and Turtle (Burtles) Danger Island and DG
Nov	Kew	tbc
Nov	Plymouth	tbc

Darwin initiative

With ZSL, the BIOT Administration have obtained a Darwin Initiative Grant (DPLUS090) entitled “Reducing the impacts of plastic on the BIOT natural environment”. The project, due to start in April 2019, will focus on single-use plastics and plastic waste in Diego Garcia and the northern atolls. The work will include analyses of the impacts on nesting turtles; efforts to reduce plastic flows into the natural environment from personnel and activities on Diego Garcia, and on the processes for removal and recycling.

Coral bleaching and recovery

2018 was a year in which there was no significant warming and coral recovery appears to have continued following the widespread mortality since 2015/16. It was possible for the CSA to re-visit snorkel survey sites established in 2017 and data on these are under preparation. It was also possible for the CSA to undertake four dives to see the deeper areas of reef in the northern atolls. Notes of this fieldwork are summarised in the Field Notes section.

Among the key observations was that recovery was widespread almost everywhere, but at varying rates. While much of the recovery was in the form of new coral recruitment it would appear that

large areas were also linked to the re-growth of surviving coral patches which in many places appear to be re-forming over dead skeleton, with this perhaps being the dominant form of recovery in most lagoon reef settings. Relatively little has been written about this in the literature, although Roff et al discussed the “Phoenix effect” pointing to the rapid recovery of *Porites* corals in French Polynesia and talking of a “remarkable capacity for recovery even after severe partial mortality” (Roff et al. 2014), and indeed many impacted and very old *Porites* coral heads appeared to be recovering in this manner. Other authors have spoken of “re-sheeting” in which coral tissue actively re-colonises its former skeletal structures (Jordán-Dahlgren 1992, Bonito and Grober-Dunsmore 2006) and this too may be occurring. Linked to re-sheeting, in some cases may be the survival and re-emergence of coral following stress-induced tissue retraction (Brown et al. 2002), which appears to describe well the recovery of *Lobophyllia* corals described in 2017.

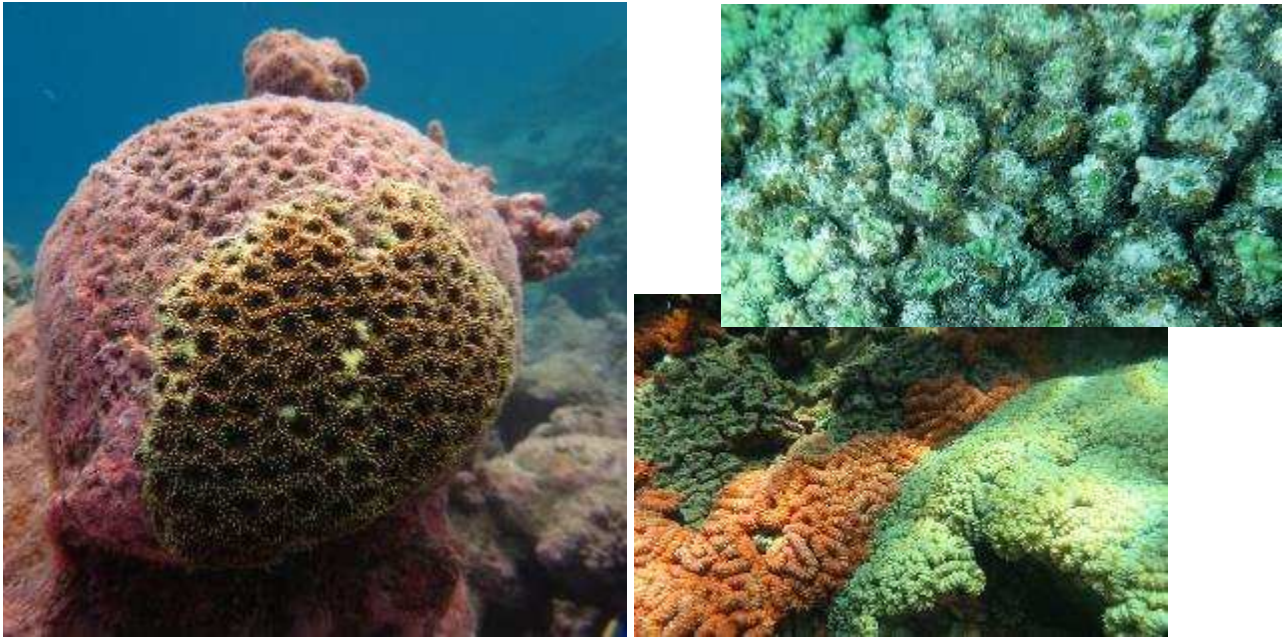
Understanding the relative importance of coral re-growth alongside new recruitment may be valuable in BIOT, particularly in trying to build a better understanding of threat and recovery pathways.



Porites colonies in Middle Island lagoon, Egmount outer reef slope, and Peros Banhos lagoon (left to right) all showing strong recovery from surviving patches, similar to the Phoenix effect (Roff et al. 2014).



Digitate/submassive corals beds, Salomon lagoon (left, 2017, right – 2018). Partial coral recovery here may have been enhanced by re-sheeting. (It should be noted that these images are not the exact same location.)



Left – possible example of re-sheeting on *Favites* coral head. Right – *Lobophyllia* corals showing possible recovery through tissue retraction: upper image showing tiny patches of coral tissue in calice mouths in November, 2017; lower image showing near-recovered corals in November, 2018 (with presumably fully dead calices in background).



The Phoenix effect? Regrowth and re-sheeting in Salamon lagoon.

Sites of high conservation interest

Fern wetland (the Stoddart Swamp)

During the CSA visit in November 2018 a visit was made to a “wetland area” that was adjacent to some proposed new research radar developments. The visit revealed an area of some 11ha of inundated ground with a predominant cover of ferns *Asplenium longissimum* ferns, with discontinuous growth of stunted trees of *Morinda citrifolia* and *Premna obtusifolia* reaching to 3 or 4m. Parts of the wetland were coconut forest, but these too were inundated to a similar depth, while they formed a more continuous canopy the trees were not at full stature and their disordered

arrangement suggested that they were probably not part of earlier plantations, and may have invaded this area. The visit was undertaken after a prolonged period of wet weather, and the wetland had a continuous cover of some 25-35cm of water. Looking at satellite imagery there may be a small additional wetland area immediately to the west of this site.

Although the CSA is unaware of any other similar wetlands in the Archipelago, Stoddart (Stoddart 1971) described a type of “freshwater marsh” with *Asplenium longissimum*, and so it is reasonable to assume this is an indigenous wetland¹. Kew scientists on Diego Garcia at the time of our visit confirmed the importance of this wetland, being natural, and with no known parallel elsewhere in the archipelago.

It seems likely that these same wetlands may be important for maintaining the water table as they are unlikely to have high levels of transpiration.



Approximate outline (yellow) of the Stoddart Swamp in Diego Garcia, at present the only known freshwater fern wetland in the British Indian Ocean Territory. The white outline is a suggested boundary for a protected area. The red outline to the west may be an additional area of wetland which should be investigated.

¹ David Ross Stoddart, OBE was a leading British Geographer and was a world expert in the coral atolls of the Indian and Pacific Oceans. He played an instrumental role in protecting the magnificent atoll of Aldabra in the Seychelles and joined a 1967 hydrographic expedition to Diego Garcia which led to the publication of the first modern suite of articles on the geography and ecology of this atoll. It is suggested here that in memory of his contributions, and to draw attention to the importance of this site, it might be named the Stoddart Swamp.



Left and centre: views of the wetlands, dominated by *Asplenium* ferns. Right: flooded coconut forest which may be slowly invading the natural wetland.

Recommendations:

- Given their apparent rarity, these 11ha of wetlands, should be protected, with the addition of a minimum buffer area extending 50m into the adjacent forest.
- A more complete documentation of the wetlands in the Archipelago would be valuable. This could be commenced with the development of a map and inventory combining remotely sensed, imagery, the vegetation maps being compiled by Kew (see <https://chagosinformationportal.org/portal/images> and search for maps), and other sources (e.g. <http://www.zianet.com/tedmorris/dg/DG-standingwater.html>)
- The coconut forest components should be monitored to ascertain if they are expanding, but given the rarity of this habitat type it might be worth targeting their clearance and removal as a restoration project. Any such work would have to be undertaken by hand without the use of heavy vehicles in the wetland area.

Pointe Marianne hardwood forest

This small area of forest lies close to the Pointe Marianne Cemetery and the southern end of the runway. On a brief visit with Kew scientists it was clear that this small area of perhaps 8ha of forest is dominated by native, and very old trees, notably takamaka *Calophyllum inophyllum* and with a rare stand of highly developed hibiscus forest. There is also excellent recruitment of native trees under the forest canopy. Large numbers of land-crabs are also found in the coastal margins of this forest.

This small area was also described by Stoddart (Stoddart 1971):

The lagoon beach at the settlement is fringed with massive trees of *Calophyllum inophyllum*, *Hibiscus tiliaceus* and *Cordia subcordata*, with *Scaevola* shrubs appearing only to the north and south. Between the houses of the settlement there are massive buttressed trees of *Hernandia* and *Calophyllum*, three tall trees of *Artocarpus altilis*, numerous *Carica papaya*, and some *Musa* sp., *Terminalia catappa*, and *Mangifera indica*. The ground cover consists of *Wedelia biflora*, *Stachytarpheta jamaicensis*, *Euphorbia cyathophora*, *Hippobroma longiflora*

and *Ageratum conyzoides*. Near the manager's house there is a clump of sterile *Pandanus*, two trees of *Leucaena leucocephala*, and such flowering plants *Sida acuta*, *Pentas lanceolata* and *Ocimum gratissimum*. *Catharanthus roseus* and *Zephyranthes rosea* are planted as decoratives round the houses. There is a long-disused cemetery south of Pointe Marianne, with tall - *Ficus* and a number of relict cultivated plants, including *Codiaeum variegatum*.

The northern margin of this forest backs onto a small barachois or tidal inlet which appeared to have some small areas of saltmarsh grasses *Paspalum* and is lined, to the north, by ironwood and coconut. Within the forest are some ruined buildings from the former settlement (possibly former leper colony buildings) of Pointe Marianne.

Recommendations:

- The considerable age and stature of many individual trees in this small area makes them worthy of protection with individual tree protection orders and it would be ideal to create a small nature reserve. This could be expanded to include the small area of barachois, giving a protected area of some 15ha. It would be valuable to ascertain whether this important forest patch continues to the north of the access road to Tent City and if so perhaps to include this (likely much smaller) patch.
- The location of this site, relatively close to populated areas, would be idea for the creation of some interpretive signs and perhaps a short walk or nature trail.



Left – very large takamaka tree (note person at base of trunk). Centre – ruined building from the former settlement of Pointe Marianne. Right – a complex tangle of hibiscus trees.



Left – land crab *Cardisoma carnifex*, abundant in areas closer to the shore. Right – the barachois, with low but dense *Paspalum* saltmarsh development on the higher sand banks.



Map showing a proposed outline for a nature reserve and recreation area at Pointe Marianne, incorporating the barachois and surrounding (non-native) forest to the north.

Field notes, 2018

Wednesday, 21 November 2018

Egmont Atoll.

Un-named sand-cay

Following up on previous visit it was possible to briefly explore a small part of the south-eastern end of this atoll, particularly the dynamic island and sand-spit situation at the western end of the island group.

An extended sand bank runs WNW-ESE from the small island of Île Carre Pate for over 900m. The first third of this is fairly thickly vegetated with scavvy and some beach heliotrope which is 2 or more years old. At its widest this was about 8m across, but with low plants, typically 1-1.5m high. A further 150-200m has sparse coconut saplings but all less than one year old and so may be seasonal, while the final 350m is bare, but dry sand. Further to these observations it was clear that the vegetated connection closes to Île Carre Pate had been breached, with largely dead Scavvy over a strip of perhaps 50m. The sand was wet and clearly overtopping at current spring tidal conditions.

- Westernmost end of dry sand - 06°40.348'S, 071° 21.390'E
- Start of quite regular coconut palms (none >1yr) - 06°40.452'S, 071° 21.529'E
- Start of scavvy (with some beach heliotrope) - 06°40.517'S, 071° 21.637'E
- Break/overwash with dead scavvy - 06°40.582'S, 071° 21.743'E



Left – sandspit looking north-west, showing the recent breached area in the foreground and the more developed vegetation behind. Right – the area of recent coconut palm which may be seasonal.

Small numbers of crested terns aggregating on sand-bank and appear to be nesting here (eggshell found). There were no recent tracks, but turtles have nested all along this spit with 25+pits in the open areas and among the vegetation.



Crested terns on the sandspit, with recent (empty) egg (right).

Île Carre Pate

This island spreads perpendicular to the sandspit described above, some 250m across the reef flat. It is showing signs of recent erosion on its lagoon shore, however the other sides projecting across the reef flat are well protected by rocky margins. There are several large *Pisonia*.

Large numbers of nesting red-footed boobies were observed, and several brown boobies seen flying from island and around island on arrival, but no clear nesting sites and perhaps unlikely as many rates were observed. Two whimbrel were seen, as well as waders (curlew sandpiper and greater sand plover identified). Small number of frigates.

Ile Tattamuca Ile Sudest

Île Carre Pate is connected to the adjacent island of Tattamuca/Sudest via a vegetated sandspit connecting. While mostly continuous, this too has been overwashed and much of the scavvy has died over a 40m stretch.

The first part of this large island is a broad headland or block of land which has been termed Ile Tattamuca although it is fully contiguous with the rest of the very large island block of Ile Sudest. It was only possible to make a brief detour along the western margin Ile Sudest. Here a very large *Pisonia* tree hosts a rich colony of red-footed boobies which were starting to nest. Some frigates were also present and one brown noddy.



Left – breached connection between Ile Carre Pate and Ile Tattamuca/Sudest. Right – partially dead *Pisonia* with dense colony of red-footed boobies.



Area walked on southeast Egmont – note that in this image, taken in 2014, the elongated sandspit to the northwest was discontinuous.

Dive at outer reef slope

Coral cover was still low at 30% on the lower reef slope at about 10m, however there was evidence of high recruitment at this depth, including a good variety of species. There was also good survival of massive *Porites* mostly smaller colonies of 20-50cm diameter. In shallower waters, from 6-8m recruitment was more patchy.

Fish populations appeared to be both abundant and diverse. At least 7 grey reef sharks and one or two white-tips. Small group of rabbitfish *Siganus argenteus* which are uncommon in BIOT>



Left – recruitment at 12m. Right – area of relatively dense *Porites* coral cover

Lagoon reef survey

Same location as previous survey. Coral cover remains high, but monospecific, with large banks of 100% live coral and net cover of all hardbottom areas at perhaps 60%. Rich fish fauna, including quite high numbers of *Caranx* and many unicornfish of several species. Three hawksbill turtles.



Thursday, 22 November 2018

Peros Banhos Atoll

Ile Fouquet

V small island 60% coconut, but with some hardwoods, mostly Takamaka, and scavvy. No nesting. Heavy erosion on all sides. Seawards side there is a band of coral rock suggested of a larger island in recent past. Limited birdlife, a few fody's and fairy terns.

To west very large sand banks between Fouquet and Mapou de l'Île du Coin. To east island has extended slightly with a few <1yr coconuts. Hawksbill nesting-pits, most obvious on extended island-end spits, with 3-4 tracks. More pits, including in central shore of island.

Netting, bamboo and flag from FAD, no transponder

Offshore lagoon reef notably for several very large century-old *Porites*, mostly alive or partially live and recovering. Coral recruitment widespread, with also re-sheeting of coral over massive structures. Soft corals. Plate corals (with no apparent disease). Big coral diversity.



Top left – oceanside shore Ile Fouquet showing eroding impacts of fallen palms and the offshore beachrock. Foreground with remains of FAD. Top right – Shallow water Porites. Bottom left – lagoon reef slope showing widespread losses largely from plate corals. Bottom right – similar location in 2015 when corals were present but bleached or dying/dead from disease.

Ile Vache Marine

Appeared to be showing good recovery of bleaching survivors, including *Porites* and branching corals. New recruitment was more variable, but with a good diversity of new corals. Some *Porites* heads with strange forms suggesting >1 mortality/recovery events. Clams also abundant. Site has superabundant fish life including very abundant parrotfish. Also predators – snapper (black and white, twinspot), sweetlips, two sharks (white-tip, black-tip).

On island, a hawksbill turtle hauled out at approximately 1130hrs and was logged and measured by SFPO. Full nesting event. Did not see any significant bird nesting activity.



Left – Porites head with almost pillar like growth forms which may be the result of multiple mortality events preventing re-sheeting of intermediate areas of dead coral. Right – nesting hawksbill turtle.

Coin du Mire

Very exposed island with just two plant species – low herb and a sedge. Swam in on western edge, somewhat rough given this was a very calm day.

Probably 8-10 nesting pairs of masked boobies – saw two nests with 2 eggs on the edges of the vegetated area. May have been a similar number of birds not yet nesting. The ground has burrows which could be crab or shearwater, but did not venture across it, hence not sure how many booby nests had eggs.



Left – Ile Coin du Mire. Right – surrounding waters with almost no coral, alive or dead.



Left – nesting masked booby. Centre and right – the two plant species – a grass and a low herb.

Grande Ile Coquillage

Arrived on lagoon side at high tide, a little north of mid-point probably 250m south of tip. Many trees on lagoon side are collapsing into the lagoon, including Takamaka and *Cordia subcordata*. Heading inland there is are many hardwoods including Takamaka, *Ochrosia oppositifolia*.

Open areas with sedge and dodder, with numerous papaya. Also some passionflower vines. Ocean side is dominated by scavvy and coconut palm.

Ocean shore protected by beach rock ridges.

Red-footed boobies are breeding in large numbers across the island, including on the lagoon-side hardwoods and ocean-side scavvy. Latter had visible RFB nests every 5m average along this shore, so probably several times that going inland. Total likely to be >1000 pairs

Greater frigates also abundant on the hardwood trees on lagoon side, including a small number with breeding throat-pouches. Small numbers of lesser noddies were nesting among inner branches of falling coastal Takamaka in northern lagoon side. A larger nesting colony of lesser noddy – ten or more trees, each with 50-100 nests and some still being built. No sign of eggs. Flock of ruddy turnstones. Fody are abundant.

FAD nets and some metal framework in pool offshore, no transponder. Litter onshore. Some likely turtle pits under scavvy. No tracks (no supratidal sand), but likely these are at N and south ends where we did not reach.



Top left – lagoon shore with large hardwood trees falling into the lagoon. Top right – inland grassy areas and a large number of papaya. Bottom left – beach rock and scavvy, ocean side. Bottom right – nesting lesser noddies.



Friday, 23 November 2018

Ile Longue

Went ashore at close to low tide through channel (strong out-flowing current). Walked only up E coast, on S shore and nipping inland at a couple of points.

Massive colony of nesting sooty terns. Juveniles were mostly at full plumage, although a few were still fluffy. Saw two testing their wings for flying. At least 500 juvenile birds visible from our vantage point, so likely >>1000 in the eastern bare area indicated. There were also 50+ juveniles on the beach at our starting point

RFBs nesting all along the coast. Many are still in nest preparation stages, although there are some near-fledged brown juveniles as on all islands, and also saw 2 large chicks in down plumage.

Saw one brown booby emerging from slightly open area and then found nest with single egg. A couple of other similar openings did not appear to have brown boobies. A small number of lesser noddies were nesting where we went in.

The island margins are dominated by scavvy and coconut. Inland there appeared to be just a few patches of hardwoods, but largely dominated by scavvy and other low bushes, with open grass/low herbs confined to the central areas where the sooty terns were nesting.

SFPO also visited and circumnavigated entire island – confirmed that sooty terns are nesting also in more westerly grassed area, which was traversed and if anything looks even larger, so hypothesised total nesting area marked on map. If all nesting total nesting birds >2000+ pairs. SFPO also observed lesser noddy nesting area (see map) and a few brown boobies leaving island from undergrowth, but did not find nests.



Left – nesting sooty terns. Right – red-footed boobies on a new nest

Snorkel survey

The lagoon reef here is clearly subject to high energy wave action though much of the Southeast Monsoon. On the reef flat towards the island there are some extensive patches of live coral. The reef crest is strongly built from crustose coralline algae, with spur and groove down to 2-3m. The survey was at base of this on a zone dominated by bare rock and dead coral with some patches of *Halimeda*. Surviving coral and recruitment appeared to be very low, probably less than 5% of total cover. From 3-6m depth a 20-30m wide stretch of reef slope remains densely colonised by a field of

Halimeda, with some coral heads poking up through. There is a short drop-off at 7-8m which levels out at a sandy seabed at about 10m.

Fish life was still plentiful, below the spur and groove (mostly off-transect), with large numbers of parrotfish.



Left – shallow spur and groove. Right – zone dominated by *Halimeda macroalgae*.



Grande Ile Bois Mangué

Fairly complete traverse, see map. Large numbers (50+) frigates roosting and soaring above coconut palms in W of island – mostly greater but some lesser frigates. RFBs nesting in abundance.

Inland walk through grassy area. A well suggests early effort by Chagossians to use the island.

No sooty terns despite wide areas of suitable open ground. Two small groups of brown noddies perched in open areas, possible indicating preparation to breed.

RFBs, as elsewhere, largely in preparation for breeding. One newborn under mother and one egg seen in a nest.

Lesser noddies were seen nesting in small numbers – 20 or nests so at western tip, and a few more at the northern shore

Small group of ruddy turnstone, whimbrel and striated heron.



Left - beyond a hardwood dominated fringe much of the centre of the island is open and dominated by herbs and grasses. Right – a group of brown noddies, possible pre-breeding.



Moresby

Crossed into the mangroves from the northern shore (very calm and high tide). Beach ridge here only about 7m wide, vegetated with low trees and bushes, probably *Sueda*, no flowers. Entered the mangroves approximately mid-way along the lagoon and walked perhaps 150-200m eastwards. The mangroves were in flower. Lagoon water felt superheated and highly saline. The lagoon floor is a very soft oozing mud up to 40cm thick on a base of coral rock or sand.

These mangroves are a major stronghold for nesting red footed boobies. Estimate there must be 500-1000 pairs in these mangroves, perhaps more. There were more juveniles than in other places, ranging from large downy individuals to near-mature. One dead adult was seen floating in water, no obvious cause of death.

Some of the mangroves are dead, including patches of multiple trees at the far ends of this closed lagoon. This is perhaps not new. Were unable to get close to assess risk.



Mangroves on Moresby. Left dead, standing trees. Right – long view of the mangrove lagoon

Parasol

Dive on the ocean-side slope. Beautiful dive. Coral recovery, predators.

Live coral cover was high, around 40% at 12m at the top of the dropoff, a little lower on the reef slope at 7-8m. Recruitment was dense, including younger corals as well as many that were in the 2+ year class.

This location has a very high density of predators, including pelagic species.

A large purse seine net first observed on this site (but already well entangled) is still present



Above – images of deeper reef slope at Parasol with extensive areas of surviving branching coral and also high coral cover of new corals



Shallower reef slope, at 7-8m, still showing good coral recovery



Left – remnants of an abandoned purse seine net still visible on the upper drop-off and lower reef slope. Right – probably the same net photographed in 2005.

Saturday, 24 November 2018

Salomon Atoll

Ile Boddam

Thirty minute dive on the lagoon reef from one of the mooring buoys 200m from Boddam.

These reefs still have some 50% live coral cover with apparently high diversity as noted on previous visits. Most of the remainder (some 30-40% of total cover) is still standing dead coral, with collapsed rubble at 10% and just a very small percentage of sand. The coral cover is dominated by surviving colonies rather than recruitment, but this appears to include a blanket overgrowth of former skeleton structures by surviving patches.

No extensive anchor-damage, but small patches of collapsed coral which could be anchor related.

The mooring buoy rope we tied to was highly worn and unlikely to hold a large boat in any storm. This presents a risk.



Reef scenes in lagoon adjacent to Boddam, including (far right) patch of collapsed coral, possible anchor damage.



Left – highly worn mooring rope. Right – mooring rope underwater

On Boddam Island it was good to note that the area popularly used by the visiting yachts has been cleared, with new signage. There were some materials left in the building adjacent to the beach, including dismantled FAD transponders and a sail.

Ile Mapou reef

Two hour snorkel survey on this lagoon reef (see also 2017). This reef was showing remarkable recovery to approximately 40% live coral cover and 60% long-standing dead coral. Cover dominated by branching and digitate *Acropora* but also *Porites*. Much of this recovery is likely to be re-sheeting or the re-colonising of the former dead skeletons from surviving fragments.

Rich fish life including parrotfish and butterflies, as well as *Oxymonacanthus longirostris* a corallivore which is rarely seen following major coral die-offs. Several anemones with both anemonefish and dominos in residence.



Lagoon reef at Ile Mapou showing the high coral cover. Much of the coral cover consists of large colonies of *Acropora* and *Porites* which either survived or have recovered after a rapid re-sheeting of the dead skeletons.

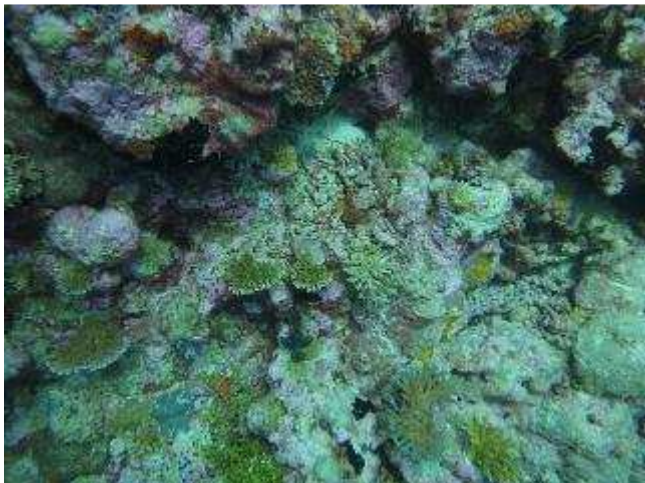


Left – expansive area of dead *Acropora* in 2017. Right – a similar view (not the same area) in 2018 showing considerable recovery which may in large part be due to re-sheeting of the dead structures.

Ile Anglaise outer reef

The reef slope was clearly severely impacted by bleaching and disease related mortality, with dead standing coral and tipped or overturned plate corals. Coral recovery was visible everywhere. At 15m live coral cover was around 40%, at the top of the reef wall, while on the reef slope at around 7m it was around 20%, with two clear year-classes of recruits and most surfaces with encrusting or branching recruits.

Fish diversity was high, including a rarely observed white-cheeked surgeonfish *Acanthurus nigricans*. Large numbers of grazing parrotfish. Grey reef shark. Hawksbill.



Left – substrate at top of reef wall ~15m. Right – reef slope at 7m showing both the extensive debris of dead coral and the new growth of both one and two-year old recruits.

Ile de la Passe

Circumnavigated the island, mostly along the coast with brief forays inland. Heavy coconut forest dominated almost all the places we saw.

There were relatively few birds – a small lesser noddy nesting site in western hardwood area. Very few red-footed boobies, although there were a few roosting on NW tip and a scattering of nests on other shores, perhaps 2 juveniles in total.

A small number of brown noddies appeared to be loitering on shores and low branches, which may have been preparing to nest.

Turtle pits abundant in forest margins on eastern sandy shores.

Lagoon reefs off the southern shore of this island showed very high coral cover.



Sunday 25 November

Great Chagos Bank

South Brother

This island has quite extensive areas of scrub and grassland. Some papaya. Not a large area of hardwood. Extensive coconut and some large stands of Taro in SE central woodland/palm forest.

Red-footed boobies nesting in scavvy all around. Small numbers of greater frigatebird, including in breeding state. 50-100 brown noddies gathered on scavvy on southwestern shore. Some lesser noddies nesting in coconut, but overall numbers likely very low <100?.

Sooty terns were nesting in bare patches throughout extensive sedge grasslands esp to east and NE. Most chicks near fully fledged and maybe 3-500 on the N shore. Estimate 1000 chicks total. 2 Brown boobies. Lots of chickens

Shearwaters in an area of mostly coconut forest in SE. Appeared to be nesting on forest floor not in holes. Saw two adults with eggs, and perhaps another 3, but sought to leave the area as quickly as possible to minimise disturbance.

FAD on NW shore.



Left – open grassland. Right – taro forming a dense understory under coconut palms,

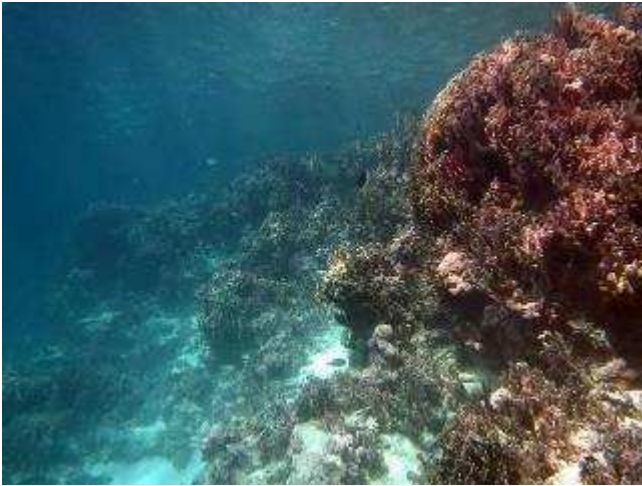


Clockwise from upper left – brown boobies, shearwater, adult and fledgling sooty terns, fairy tern, greater frigate, striated heron

Middle Brother

Established a new reef survey site in the lagoon on a large lagoon reef/bommie. This site was dominated by *Heliopora* blue coral, with a shallow reef top and a steep reef slope dropping to about 8m and a sandy lagoon bed. Large numbers of fish including parrotfish, bigeye emperors and corallivorous butterflyfish.

From a brief check the lagoon edge (back reef) to the west of this site was largely dead coral rock and rubble.



Lagoon reef dominated by Heliopora. Right – Middle Brother beach with fledging sooty terns on the beach.

Very brief (15 minute) walk along lagoon-side beach. Lots of fledged sooty terns and adults (500?). None left in presumed breeding area (open sedge with some young scavvy), but quite a few dead near-adult chicks (SFPO had more thorough look and counted 60 dead). Cause of death unclear, they had been largely eaten (crabs?) but there were no signs of plastic so unlikely that this caused death. No obvious ticks, but these would not stay on dead birds. A number of fledged chicks on the beach looked a little weak.

Some 40+ great crested terns on the beach.



Aerial photo of Middle Brother lagoon showing location of snorkel survey.

Sea Cow Island

Circumnavigated the island, which has quite a high cover of hardwood, notably *Pisonia*. Red-footed boobies were abundant and nesting. There is also a notable population of chickens.

There is a major problem of defoliation of *Pisonia grandis* across the island. Most trees have lost 80-90% of their leaves to an infestation of the dark striated hawkmoth *Hippotion velox*. This appears to be native (one record from Middle Brother in 1996 (Barnett and Emms 1998)). Similar plague proportions of these moths have been recorded in Australian Coral Sea islets, causing 72% defoliation in 2006-7. Further details in Annex 2.

Minor additional observations: large chicken population were all around the *Pisonia forest* on Sea Cow Island and may be feeding on caterpillars as low leaves of saplings were more intact. Likewise there appeared to be more leaves adjacent to RFB nests suggesting perhaps that the adults or chicks could be feeding on these.

A shipwreck was observed on the southern shore, appeared to be relatively recent, and mostly likely of South Asian origin.

Separately a FAD was also picked up



Environmental Impact Assessment Process

Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related environmental, economic and human-health impacts, both beneficial and adverse.

UNEP defines the process of EIA as ‘a tool used to identify the environmental, social and economic impacts of a project prior to decision-making’. A crucial component of the EIA process is to predict environmental impacts at an early stage in the project planning and design. Once such impacts have been identified and the magnitude of the impact is understood, mitigating factors can be researched, i.e. to identify possible ways to reduce adverse impacts, to enable the project to go ahead in both an environmentally and economically feasible way. Such mitigation is always project and site specific and should seek to use the most appropriate methodology of installation/works for the local environment. By using EIA both environmental and economic benefits can be achieved, such as reduced cost and time of project implementation and design, avoided treatment/clean-up costs and impacts of laws and regulations.

Although legislation and practice vary around the world, the fundamental components of an EIA involve the following stages:

Screening - determines which projects or developments require a full or partial impact assessment study. This is particularly important in BIOT, there are many small ad-hoc pieces of work that will not warrant a full EIA, if at all.

Scoping - determines the relevant potential impacts to be assessed and included in the EIA report. This is a collaborative process between the applicant and the relevant authority. It identifies which potential impacts are relevant to the project (based on legislative requirements, international conventions, expert knowledge and sometimes public involvement).

Environmental Impact Assessment – This clearly assesses, predicts and evaluates the impacts of the project on the environment, in particular, protected habitats and species. Areas to be included are:

- A clear description of the project and the need for such works to be undertaken, including timings (i.e. seasons) and anticipated length of project
- Provide links to previous or ongoing similar works/projects
- Detailed information on the location of work including graphics to illustrate the overall footprint of works, access routes to area of work and locations of protected habitats and species
- A clear assessment of how the works will impact the environment, both negative and positive. This section should also include alternative solutions to the work that either avoid, mitigate or compensate for any adverse impacts on the environment and or species
- Joint site inspection of the area of works should be undertaken by the Contractor, PWD Environmental team and BIOTA’s Environment Officer to enable a clear understanding of

potential impact and identify solutions or suitable mitigation prior to site approval and or application submission

- A discussion around the sustainability of the project and any foreseen upkeep and remediation works should also be presented
- A section on waste management is required. Description of amounts of construction materials and how post construction the site will be 'made good' and restored. Careful consideration of disposal of waste products will need to be presented
- Post construction monitoring may be necessary to monitor whether the predicted impacts and proposed mitigation measures occur as defined in the plan to ensure that unpredicted impacts or failed mitigation measures are identified and addressed in a timely fashion, this also ensures future projects will not have the same impacts

Review of the EIA - This process must allow consultation time and advice/collaboration with the relevant experts particularly for large plans and projects. BIOTA will work with Public Works Department Environmental team on large plans and projects which are in the interest of day to day running of Diego Garcia.

Decision making - The EIA and its review/advice from BIOTA and PWD will be presented to both BIOTA, Brit Rep and the US Commanding Officer for approval. For large infrastructure projects that require a full EIA, such as these, will be signed off by the UK Secretary of State. When the project is signed off it is crucial that all appropriate methodology and mitigation is clearly presented, including any activities that must not be undertaken, to the contractors undertaking the works, copies of such advice should be provided to PWD and BIOTA for audit purposes. Any terms of work that are not met or are broken will result in works stopping immediately whilst the Brit Rep and US CO reach a decision in consultation with BIOTA.

Native tree declines from hawkmoth outbreaks

Prepared by Mark Spalding, PhD. Chief Science Advisor to the BIOT Administration.

30 November, 2018

On 24 November, 2018 a major defoliation event was observed of the important, but relatively rare, native hardwood, *Pisonia grandis*, across Sea Cow Island on the Great Chagos Bank. Most trees have lost 70-90% of their leaves to insects. These losses are linked to the dark striated hawkmoth *Hippotion velox*, a probable native species (there is one record from Middle Brother in 1996 (Barnett and Emms, 1998) but BIOT sites within the overall range of the species (Pittaway and Kitching n.d.). Similar plague proportions of these moths have been recorded in Australian Coral Sea islets, purported causing 72% defoliation in 2006-7. In these cases, the impact of these infestations have been exacerbated by subsequent infestation of an invasive soft scale insect *Pulvinaria urbicola* native to the Caribbean and the combined impact has led to the total loss of *Pisonia* forest on some islands. This same invasive scale insect has caused defoliation and damage across the Indian and Pacific Oceans. It was not searched for during this visit, but it is clearly something that we need to look for in BIOT.

The hawkmoth also feeds on *Cordia subcordata* and indeed defoliated trees of this species were observed in Shark Cove (see photo).

Pisonia is a species of considerable significance for nesting birds and supports important populations on several of the rat-free islands across the archipelago.

Unfortunately, defoliation was only investigated at the last island visited. Partial defoliation of individual trees or small groups of trees had been seen on other islands, this had been put down either to other stresses, including salinization of roots on coastal plants, and (probably erroneously) on the removal of leaves by nesting birds. Thus, at the present time we cannot be certain that the outbreak is confined to Sea Cow.

Minor additional observations on the current outbreak: a notable chicken population was present, and several were heard and seen in the *Pisonia* forest on Sea Cow Island and may be feeding on caterpillars as low leaves of saplings were more intact, though still affected. Likewise, there appeared to be more leaves adjacent to red-footed booby nests suggesting perhaps that the adults or chicks could be feeding on caterpillars within reach.

The scale insect *P. urbicola* has caused considerable declines in *Pisonia* in other countries, and has spread across much of the Indian Ocean, including the Seychelles to the West (Gaigher et al. 2013), Christmas Island to the East (Neumann et al. 2014), and India to the north. The impact of these insects is particularly damaging when they co-occur with an invasive ant species which provide a mutualistic partnership and deter natural predation. The BIOT Administration should pay particular attention to the risks posed by these species, noting that past efforts at biological controls have had some success including toxic ant-baiting and the introduction of biological control agents.

Suggested actions:

Hawkmoth outbreaks

- Look for evidence of this moth on other islands where *Pisonia* or *Cordia* are present (e.g. East Island, Diego Garcia, Petite Bois Mangué, Peros Banhos). Important to note all locations where trees are identified, with comments on presence or absence any observations of trees where the trees are still in good shape.
- Develop a plan for low-level continued monitoring to assess further dieback or recovery
- Discuss with biocontrol experts on other small islands to understand if intervention may be relevant or important.

Scale insects

- Although not yet observed it will be important during the above work to look closely for scale insects *P. urbicola*.
- Consult with invasive teams to understand invasion pathways for the scale insect.
- Impose any recommended actions to reduce risks of invasion and prepare an action plan for the event of any invasion.



Figure 1: The dark striated hawkmoth *Hippotion velox* observed on Sea Cow Island. The larger caterpillars (bottom right) are approximately 7-8cm in length.

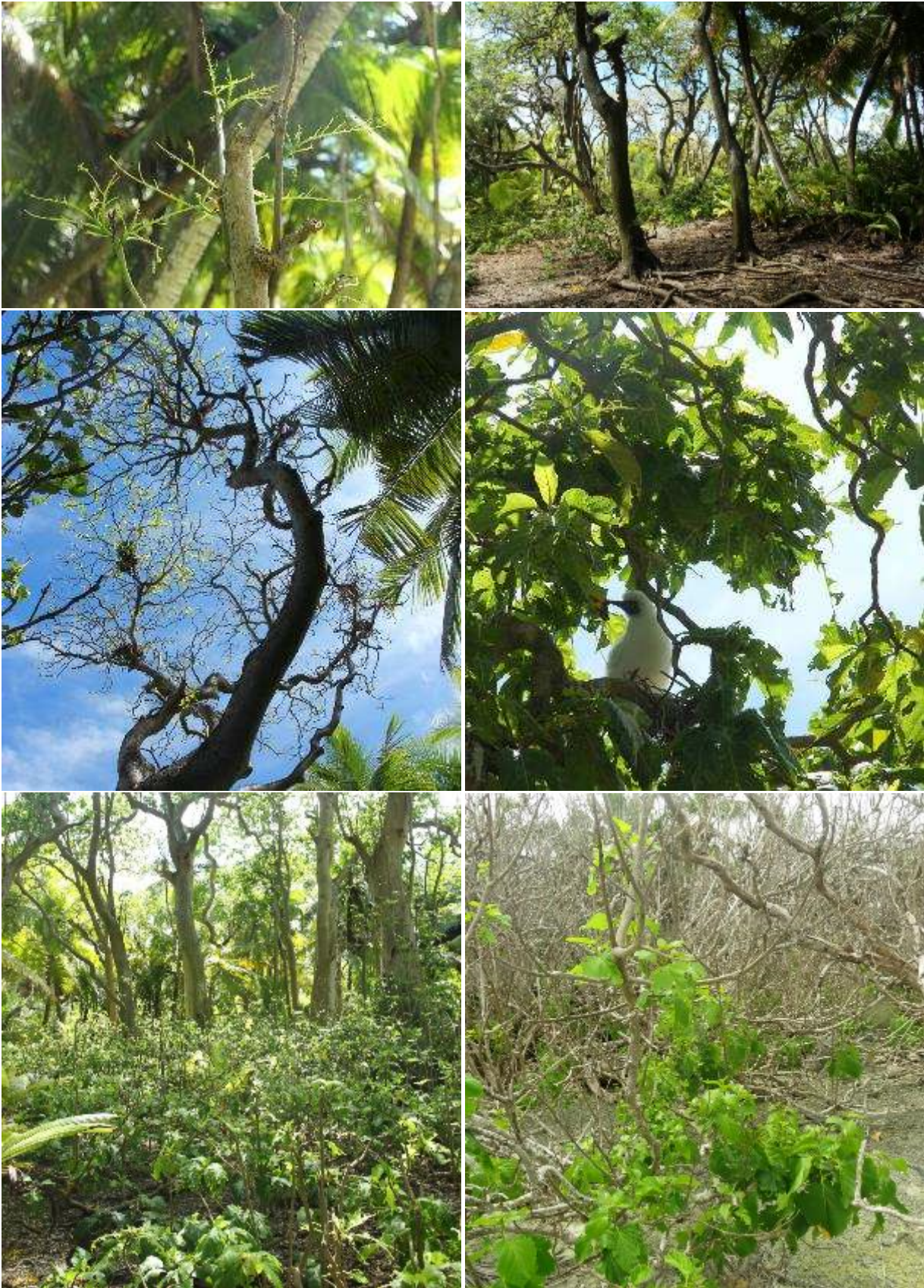


Figure 2: Upper row and mid-left – defoliated *Pisonia* on Sea Cow. Mid-right, richer foliage near booby nest. Bottom left – some foliage on saplings possible due to predation by chickens. Bottom right – defoliated *Cordia subcordata* near Shark Cove, Diego Garcia.



Figure 3: Images of the scale insect from (Neumann et al. 2014). Original caption: *Figure 2. Pulvinaria urbicola. (A) Pu. urbicola on Pisonia umbellifera. Arrows indicate females with and without developing ovisac. (B) Pu. urbicola on Pi. grandis twigs and leaves. (C) Pu. urbicola, many with ovisacs, on a Pi. grandis leaf. (D) Yellow crazy ants tending Pu. urbicola on Pi.umbellifera.*

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