2019 Annual Report
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The format of this report is slightly re-ordered from previous years to enable some comparison with the eleven conservation and environmental priorities identified by the BIOT Administration. These BIOTA priorities were described in the proposed management plan drafted in 2018 and adopted as policy guidelines in 2019 (see https://biot.gov.io/environment/). The relevant priorities are listed at the start of numbered each section.

Contents

Key Recommendations

Illegal fishing

Concerns remain that illegal fishing prosecutions and punitive measures may not be followed up and any punitive measures may be insufficient to act as a deterrent. This needs to be better understood and acted upon.

The process of arrest, impoundment and clearance of illegal fishing vessels is working relatively well, but it would be helpful to improve data-accessibility and sharing from past and incoming catches with EOs and external partners to facilitate analysis and understanding of impacts.

Some excellent work has been prepared from the surveillance of Fish Attracting Devices (FADs). More work could usefully be done on trying to quantify the amount of other abandoned fishing gear, and on the ecological impacts.

Visiting vessels

The reinstatement of mooring buoys in Salomon Lagoon is strongly encourages, with the formulation of guidelines, but also encouraging or requiring their use as a means to limit damage

Recreational fishing

Excellent progress has been made on monitoring and controlling recreational fisheries by the Fisheries Protection Officers. At the same time, as stressed in most previous reports, there is an urgent need to improve the regulatory regime for recreational fisheries. In this report two broad sets of recommendations are made.

Firstly, the regulatory approaches need to be clarified. This includes the clear establishment of a regime to enable the imposition of fixed penalties for infringements. Equally important will be to clarify catch limits. These will include changing the maximum catch to clearly measurable quotas, and within these limits clearly laid out size restrictions should be imposed for the more sensitive species.

Secondly, a series of recommendations are made around the formulation of best practise guidelines. These are commonplace for recreational fishers world-wide, but do require some training and awareness raising. Efforts should be made to minimise harm to any fish that are not to be kept. Likewise, low-impact gear should encouraged, including utilising low impact hooks and lines and slings and nets for landing fish. Catch-and-release fishing should be more actively encouraged, particularly for key species such as yellow-fin tuna. Key elements of these guidelines should be made obligatory within two to five years.

Invasive species

Improvements are needed on controlling the key pathways of invasion. For incoming containers, there may be needs for more comprehensive treatment at port, but also some follow-through to additional control and management at the post-inspection unpacking locations. Other pathways highlighted for concern including air-freighting, and the risk of invasion on islands beyond Diego Garcia. There is an ongoing risk from yachts in transit, and attention is needed both to improve guidelines, and the processes of monitoring and inspection of these vessels. Visits to the key biodiversity islands, notably nature reserve islands, by expeditions and BIOT-approved personnel may also need a more thorough consideration to avoid risk from unintentional introductions.

While there is good documentation of invasive plants and invertebrates across many islands, better documentation of non-native species arrivals and interceptions could be useful, especially to help steer future management of invasion risk.

Public works: Infrastructure and development

The extreme sea level anomalies of late 2019 bought into sharp focus the vulnerability of certain sections of the coast to flooding and erosion. An earlier report, with recommendations is appended to this report. While there will undoubtedly be a need to consider additional coastal defence work, it is also important to develop a detailed understanding of the underlying processes. Alternatives to coastal revetments may be less expensive, with fewer ecological impacts and lower likelihoods of longshore exacerbation of erosion. These could include building submerged breakwaters and, where appropriate, managed retreat. More detailed coastal monitoring is needed to document coastal change, including erosion and deposition and changes to beach profiles. In addition, it may be valuable to develop a more thorough emergency response plan for future high sea level anomalies.

Addressing climate change

While the ongoing development of photovoltaics is good news, this will not be sufficient to enable BIOT to follow the UK commitments under the UN Framework Convention on Climate Change. Considerable further efforts are needed to reduce emissions: in the short term this should include a multifaceted approach to reducing energy use increasing efficiency, notably through transport and air conditioning. In the medium term (5 years) large upscaling of renewables should be underway.

Environmental research, outreach and communications

Multiple recommendations have been synthesised in a new “Making Science Matter” report from the Bertarelli Programme in Marine Science. In addition to these there is a need for some expeditions to behave more responsibly in their use of BIOTA resources, including the BIOT Patrol Vessel and the Science Store.

Outreach and communications

Developing greater opportunities for personnel to experience the natural world in BIOT should be encouraged, including options for recreational snorkelling sites and the development of trails. Further outreach opportunities should be explored including public information opportunities, and social media engagement.

1. Illegal fishing

BIOTA Priorities:

- *Combating Illegal, Unregulated and Unreported (IUU) fishing in BIOT*
- *Managing the impact of Fish Aggregating Devices and Lost and Abandoned Fishing Gear*

Transit and IUU vessels in 2019

The BIOT Patrol Vessel continues to provide a critical service in the surveillance and monitoring of vessels transiting BIOT waters and in preventing or intercepting illegal fishing activities. Data suggest that the BPV was active for fewer days in 2019 than in previous years, but during its working time it showed an increasing proportion of time spent on active patrols with fishery patrols or Outer Island Security Patrols. 2019 saw the largest number of transiting vessels ever reported (590). Alongside patrolling BPV takes time supporting research projects, Chagossian heritage visits, VIP visits and refuelling trips to the Maldives, all of which can reduce both time patrolling and the physical reach of these patrols.

Illegal fishing continues to be a problem in BIOT waters, despite continuing, vigilance and growing use of additional intelligence. Although 2019 had a low number of vessel detentions, with three IUU vessels being intercepted (see infographic) this does not signify any evidence of reduced IUU pressure.

The three intercepted vessels were all Sri Lankan long-line / driftnetting vessels, wooden and relatively small. They were all targeting pelagic species. All three were found to have a mix of tuna and shark species, with one also reportedly holding swordfish. One had clearly targeted sharks.

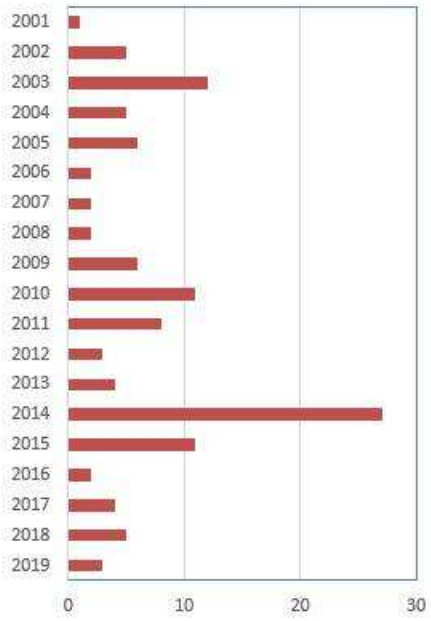
Of these vessels, one was released pending actions by the Sri Lankan Authorities. The other two were both tried in BIOT and found guilty. One was fined by the BIOT authorities, the other was released to be tried and fined in Sri Lanka. In all of these cases, no evidence has been provided that fines have been paid and in at least one case the vessel is now released. In all three cases the vessels have been reported to the IOTC for inclusion in formal listing as IUU vessels.

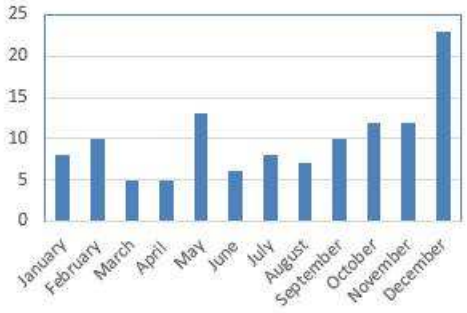
MRAG do try to follow up on “sanctions of adequate severity” (the Indian Ocean Tuna Commission terminology), and while some vessels are impounded for significant periods it is unclear whether this will be a sufficient deterrent for owners or fishers facing very poor returns from local fishing. From the 2019 arrests it would appear that at least some vessel owners are not even paying the small fines that they do incur, and that Sri Lankan authorities are allowing some vessels to return to fishing without paying a fine. No recent figures are available on the past payments of fines, but it is believed that payment decreased considerably since 2010. This apparent inadequacy of punitive measures for IUU has been commented upon in previous CSA reports.

Recommendations:

- A detailed reporting on punitive measures, including the delivery of final payments is urgently needed.
- Where fines or other measures are not being paid, diplomatic pressure is needed to ensure that vessels cannot be returned to the water, even under different ownership
- With this information an independent assessment is needed of the likely level of deterrence punitive measures could provide (if implemented) and, if necessary, such measures should be revisited to ensure that fishing in BIOT waters is no longer “worth the risk”

	Month												
Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
2001	0	0	0	0	0	0	1	0	0	0	0	0	1
2002	0	0	0	0	0	0	0	0	1	1	1	2	5
2003	0	2	1	0	0	0	3	1	2	0	3	0	12
2004	3	0	0	0	2	0	0	0	0	0	0	0	5
2005	0	0	0	1	0	1	1	2	1	0	0	0	6
2006	0	0	0	0	2	0	0	0	0	0	0	0	2
2007	1	0	0	0	0	0	0	1	0	0	0	0	2
2008	0	1	0	0	0	0	0	1	0	0	0	0	2
2009	0	0	0	0	0	0	1	0	0	0	3	2	6
2010	2	0	1	0	2	0	0	0	0	4	0	2	11
2011	0	2	0	0	0	0	0	1	0	2	2	1	8
2012	1	1	0	0	0	1	0	0	0	0	0	0	3
2013	1	1	0	1	0	1	0	0	0	0	0	0	4
2014	0	0	1	2	0	2	1	0	1	1	3	16	27
2015	0	0	1	1	5	0	0	0	0	4	0	0	11
2016	0	0	0	0	2								2
2017		3	0	0	0	0	0	0	1	0	0	0	4
2018	0	0	0	0	0	0	1	0	4	0	0	0	5
2019	0	0	1	0	0	1	0	1	0	0	0	0	3
Total	8	10	5	5	13	6	8	7	10	12	12	23	119





Details of IUU interceptions and arrest from 2001 onwards.

Handling illegal vessels

The process for handling incoming arrested vessels is now working relatively well: the Police are engaged on vessel arrival in port, as a crime scene. The EO and Customs are involved in documentation of gear and catch, and in packing up the catch for disposal. Meanwhile the legal processes for incoming arrested vessels are being updated by the BIOT legal advisor.

Further improvements could be made, as listed in the recommendations.

The challenges of patrolling with limited fuel remain as reported last year. These are being dealt with using smart patrolling approaches involving critical use of historical tracking and third-party intelligence inputs. There are still limitations, notably on more exploratory patrolling. Refuelling in the Maldives represents a critical cost-saving, but is clearly a drain on time, and this has also led to frustrations from expeditions who are required to pay for their fuel, but are still told the vessel must move slowly or stay put to prevent avoidable fuel use (which would otherwise still reduce available patrolling time due to the need to refuel after the expedition).

Recommendations

- Develop a full record of payment of past fines and/or vessel impoundments or other measures.
- Strengthen punitive measure to ensure that the benefits of IUU are not greater than the risks/costs of occasional capture.
- Improve vessel processing including:
    - Advance warning to EO at or soon after the time of arrest and prior to arrival in port
    - Better collaboration between EO and fisheries officers (Customs) in documenting catch prior to disposal
- We should encourage the full documentation of IUU catch as part of the processes of understanding the offence and its impact. It would be valuable to have legal team consider this to reduce the dichotomy between the "crime scene" and the subsequent processes of quantification of catches.
- CSA requests that past records, written and photographic, be shared with EOs for adding to a database on catches.
- Can BIOT negotiate some "at cost" fuel allowance from DG in order to avoid spending multiple days (and $$) transiting to the Maldives.

Fish Attracting Devices (FADs)

FADs continue to be collected and tracked by MRAG, who produced a useful synthesis report in July 2019 (MRAG-Ltd 2019). This summarises the geographic spread of FADs collected by or for the SFPO since 2015. At the time of this report these amounted to 136 FADs plus an additional 45 FAD transmitters (without the associated and often extensive structure that forms the "device" (typically wooden frameworks netting and buoys). They also report on abandoned, lost and discarded fishing gear (ALDFG), although it is apparent that this latter class is not comprehensively monitored, as ALDFG comes in numerous forms and sizes and some fishing materials, notably floats, ropes and netting are found regularly on every beach.

Recommendations

- The MRAG report makes further recommendations for ongoing work, both to understand and better model the regional and local patterns of drifting and beaching; and to improve our ground-truthing of rates and patterns by a repeated survey and cleaning of selected beaches.
- In addition to these recommendations it seems important to better understand the ecological impacts. Part of this work is being undertaken under the Darwin Plastics Project (see "Plastics"), however it would be valuable to understand the relative contribution to damage caused by the physical presence of all fishing gear, including understanding the proportion of strand-line impacted and potentially the extent of underwater entanglement, or at least to start mapping sites of known marine entanglement.
- FAD Transmitters have generally been removed from beaches and are stockpiled in DG. It would be helpful for EOs or MRAG to draw up a plan for their disposal, which may require dismantling and the removal of toxic components (batteries) and recycling of other parts.
- From a practical perspective, unlike transmitters, remaining gear is typically left *in situ*. This is understandable as such gear is bulky and often part buried or entangled in beach sand, rock and vegetation. Some assessment of the value (and cost) or removing such gear and indeed all large ALDFG, as part of wider beach cleaning, would be helpful.

2. Visiting vessels

BIOTA Priority:

- *Ensuring that visiting vessels do not harm BIOT's unique environment*

Some 19 yachts completed applications to visit BIOT water in 2019. Of these, we believe that one did not arrive due to adverse weather conditions.

During the CSA visit to the northern atolls it was noted that only two of the mooring buoys in the anchorage area adjacent to Boddam still remain. One of these was observed in the water and appears to have been strengthened so there are now two separate lines around the same very large coral head, one of chain the other thick rope. Another mooring buoy site was visited (adjacent to a small shipwreck) and while rope and chain are still attached to the coral head there was no surface rope or buoy. During our visit the BPV support vessel threw an anchor onto the coral rich seabed and in a matter of minutes several corals were damaged, highlighting the scale of impact that will come if more boats revert to anchoring.

Recommendation

- Strongly encourage that mooring buoys are reinstated and that guidelines are put in place requiring their use as a means to limit damage

Left: The use of anchors in the designated anchorage at Ile Boddam causes inevitable damage as shown here by the small anchor from the BPV support vessel, dropped on the reef for just a 20 minute period. Centre and right show one of the last two remaining moorings where both a thick rope and a separate chain mooring are wrapped around a large (now dead) coral head and provide a secure mooring with no further ongoing anchor damage.

3. Recreational fishing

BIOTA Priority:

- *Sustainably managing the recreational fishing allowed in the Territory*

No major changes have been reported to fishing practises in the past year, although some valuable insights have been gained on the nature and volume of fishing from the pre-positioned vessels (below). Fishing represents one of the most popular recreation activities on Diego Garcia, while also providing a not insignificant source of food for many contractors. It undoubtedly has an impact on the ecology, as reported elsewhere. This may include changes driven by the harvesting of small or immature individuals; but also impacts from the removal of large, long-lived and ecologically significant predators such as groupers at rates that may not be sustainable. In all cases such impacts are likely to remain localised and are certainly reversible.

Concerns also remain about yellowfin tuna (YFT), a popular sport-fish which is unfortunately in decline across the Indian Ocean. It will be very difficult to prevent the hooking of YFT as these are largely caught by trolling which is a non-targeted method used to catch many species. If YFT were protected, a catch-and-release programme could still allow such fish to be caught. It had been suggested that a tagging programme could even provide a popular mitigation against the likely unpopularity of such a ban. Unfortunately, a tagging trial from the MWR vessels in September, 2019 (Curnick et al. 2019) was not a great success: few fish were caught but it also became apparent that the catch and handling methods are too difficult for amateur fishers, and any attempts would lead to high mortalities, and hence low scientific validity.

Patrolling and monitoring

Through 2019 there has been a strong increase in the engagement of Fisheries Protection Officers (FPOs) from Customs personnel (all are FPOs). They have had some training from SFPO (including training on likely fishing spots and a strong focus on maintaining good public relations). Customs have developed a procedure with a designated FPO every day, undertaking searches across the island in a systematic process, taking into account fishing “hot-spots” and key times for fishing.

An agreement has also been made with MWR enabling FPOs to join the MWR patrol boat when there is space. They are also attempting to cover occasional checks on returning fishing vessels (aiming for two times per week). Included in their work, FPOs are now checking for illegal gear and confiscating gear (notably lines/lures with more than 3 hooks).

SFPO and FPOs are filling in the basic creel survey form every time they make a formal inspection. There are a lot of blank returns but these are still data. These are currently held by the SFPO.

The Police are not doing active fisheries patrolling, but reported that they will generally check up if they see fishing.

The great challenge reported by the police, and by FPOs is that the regulations, particularly around catch are too vague (see below).

Recommendations

- The regulatory regime for fisheries urgently needs to be re-written to allow a clear path for implementation and to avoid unnecessary impacts on fish stocks and to enable enforcement. Suggested amendments are provided below.

- There is a need for the EOs to follow through and ensure that the FPO surveys are being properly filed and to develop a process to use the findings through a process of summation and reporting. Ownership of this reporting needs to be determined (EO or SFPO/MRAG)
- The long-awaited creel survey which was largely completed 2 years ago has still not been completed. This must be a top priority for the outgoing EO, working with the SFPOs.

Fishing from Pre-Positioned vessels

Fishing from the Pre-positioned vessels has had some attention and it was noted in past reports that at least some of these vessels were diligent in compiling fishing reports. Even so, it was apparent from discussions with key personnel from these vessels that this fishery may be larger than has been estimated in the past, with two significant components:

1 Lagoon fishing. While not all Pre-po vessels are in ideal locations for fishing, several are. In addition to fishing by crew members it was noted that these vessels are popular also among land-based personnel visiting these vessels. This is a rod-and-line fishery and fishers from DG typically number "4-5 guys off the back of the boat every 2 days".

2 Fishing in the Marine Protected Area. The pre-po vessels are required to leave the lagoon on a regular basis (~monthly) and in some cases they are providing a critical patrolling support to BIOT through the CAMDA programme. At the same time, they are fishing, including on the Sandes and Schwartz Seamounts. The key targets are pelagic species and a recent steep decline in catch of YFT and Wahoo was noted. This is an unquantified observation, and it would be misleading to apportion the declines to this single recreational fishery, but it reflects the known declines across the region. Other pelagics are still reported to be commonly caught, notable "Tunny" (kawakawa?) and rainbow runner. This fishery is not being monitored.

Recommendations

- Consider the possibility of FPOs making observations from Pre-Po vessels and joining them on trips out from DG.
- Provide an official request to the Commodore for self-reporting the fishery, and provide them with the relevant (or specifically designed) creel survey forms.
- Remind the regulations for total catch if necessary. Possibly come up with guidelines on total catch during a 3-day circuit to Seamounts. It may be necessary to close all fishing on seamounts if this fishery cannot be managed.

Fisheries management

The US Commanding Officer has initiated biannual Town Hall meetings with the Base Operations Support Contractor (BOS Contractor, the main on-site contractors), during which he has discussed issues of fishing waste (encouraged to pick up) and of fishing. In particular to discourage capture of juveniles. At the same time it was noted that BOS Contractor have been highly punitive, with cases that resulted in a magistrate's court hearing then leading to expulsions from the island.

In November, SFPO had prepared a new simple outline of current fisheries regulations to be promulgated with the map of fishing limits. This was been approved from technical perspective by the legal advisors and in many ways follows previous similar efforts. Such work is excellent and such renewed efforts are always necessary to keep regulations in the foreground of public awareness.

Meanwhile, efforts were underway with the BIOT legal team to develop a workable fixed penalty notice procedure for infringements. There is an ongoing discussion about the need for a simple on-the-spot fine versus a system with a 21 day appeal period.

Recommendations

- Overall, the fixed penalty approach needs to be solved as it is considered valuable.
- Further discussion is needed to consider mode of implementation, including fine (amount?), confiscation and a "first warning" process.
- The EO should attend Town Halls with CO and BOS Contractor, and ideally help in presenting/explaining fisheries conservation and regulatory measures
- A longer-term plan should be developed for strengthening regulations on gear and on additional protected species, which should include yellowfin tuna and coral groupers (*Plectropomus*).
- An additional problem which may require changes of practise is the bycatch of seabirds mentioned in a previous report

Suggested amendments to regulations and best-practice

Defining catch limits

While many of the fishing regulations on BIOT regarding species protection, gear, and spatial restrictions are adequate, confusion over the current regulations on catch size and storage is widely reported, making enforcement very difficult. Following a review of regulations in Australia and in Florida (the former having similar species, and both jurisdictions having similar fishing demographics and approaches), and after consultation with others, the CSA recommends the following as workable regulations on catch limits to replace current rules[1]:

- A maximum of two fish per person per day may be kept for personal consumption, or only one fish if that is yellowfin tuna. Further size limits (minimum and maximum) must be adhered to as these are developed.
- Catch limits can be shared between persons fishing together on a small fishing vessel, but this does not apply where to larger groups (more than four) fishers. Catch shares cannot be extended to non-fishing participants or crew
- Shore fishers targeting smaller species can use a weight restriction of no more than 2kg total unprocessed catch. They may not share catch limits.
- Any additional fish hooked beyond these limits must be released alive. They should be kept in the water if possible. They may be removed from the water with a net or sling only for hook-removal and recording purposes, but should be returned alive to the water within 2 minutes, and all reasonable efforts must be made to prevent stress, injury or accidental death.
- Protected species, if hooked, must be released without taking them out of the water – hooks must be removed in-water, or the line cut as close to the hook as safely possible without removing them from the water.
- High-grading (the discard of already captured and dead fish to allow for new fish to be kept) is strictly prohibited.

[1] Sources included:

- Queensland Government Recreational fishing rules and regulations, accessed February, 2020 on www.qld.gov.au/recreation/activities/boating-fishing/rec-fishing/rules;
- Department of Primary Industries and Regional Development, Government of Western Australia – Recreational Fishing, accessed February 2020 on www.fish.wa.gov.au/About-Us/Publications/Recreational-Fishing/
- Fishbase, www.fishbase.com was used to determine natural length at maturity statistics

- Accumulating catch: no more than six fish, or parts thereof, may be held in personal accommodation[2]
- Catch may be for shared consumption but may not be sold, bartered or otherwise used for profit.
- Protected species currently include:
    - All sharks
    - Billfish
    - All molluscs, sea cucumber and crustaceans

  It is expected that this list will be extended

While the above are the basic minimum regulations. In addition it will be important to amend species specific regulations, as the norm for most recreational fisheries world-wide. For these the key recommendations would be:

- Move to the mandatory use of barbless hooks in BIOT (see below)
- At risk species highlighted for addition to the protected species list:
    - Maori wrasse – *Cheilinus undulatus*
    - Giant grouper – *Epinephelus lanceolatus*
    - Coral trout – all *Plectropomus* spp.
    - Large rock-cods – *Epinephelus polyphekadion* and *E. fuscoguttatus*
- Size limits. The following are recommended size restrictions for key species. Lower size limits are broadly set at minimum size at maturity, to allow fish the opportunity to reproduce. Upper size limits recognize the prodigious reproductive capacity of larger individuals, which have the capacity to make a disproportionate contribution to recruitment across large areas of reef.
    - Coral trout – 45cm, 80cm max
    - Rockcods – 40cm, 80cm max
    - Snappers and Jobfish – 40cm min
    - Wahoo – 85cm
    - Mahi Mahi – 55cm
    - Yellowfin tuna – 90cm
    - To consider – dogtooth, bigeye, skipjack, mackerel/bonito/kawakawa, longtail tunas; giant trevally

Trophy photos from the Marina. Right: large coral trout Plectropomus*, increasingly rare world-wide: adults of this size are at their reproductive peak and play a critical role in stocking the reefs. Left: yellowfin tuna, a species in decline across the Indian Ocean. (Images cropped for privacy reasons.)*

[2] Alternatively: no more than 3 fishing days per week

Establishing best practice

The areas open to fishing around Diego Garcia are unique, and are surrounded by one of the world's largest "no-take" protected areas. It is critical that BIOT establish the highest standards in best practise for fisheries. World-wide, fishers are increasingly aware of the potential impacts of their sport, and many countries are working with fishers to develop a code of conduct or guidelines to protect their fish-stocks and to ensure continuing enjoyment of their sport. It should not be a challenge in a relatively small community to develop similar guidelines including advice on where, how and what may be fished. Ignorance, for example of species identity, cannot be an excuse when it is so easily undertaken by fishers in other countries.

A key priority in the recreational fishery is to reduce the impact from poor handling of fish at capture, which is particularly problematic for individuals that are subsequently released. At present most large fish are gaffed with large hooks to bring them aboard – this may include some sharks and billfish. Gaffs are highly injurious to fish and greatly reduce survival chances. Once aboard, fish intended for subsequent release are regularly mishandled. This may include placing them on hot deck areas; holding them up by the tail; and simply keeping out of the water for too long, all serving to further reduce their survival chances.

Recommendations for incorporation into Code of Conduct/Best Practice Guidelines

1. Fishing staff in MWR should be given comprehensive training on best practise, including fish identification and handling, the use of landing nets, landing/unhooking mats, and in-water hook removal;
2. Communications materials need to be posted in the Marina and held on all fishing boats.
3. Given that the shark and billfish may not be harmed, and given the high likelihood of harm caused by any removal from the water, it should be made clear that these cannot be taken out of the water and should never be gaffed.
4. In all other cases of catch-and-release, removal of fish from the water should be discouraged.
5. MWR should ensure that all boats are be furnished with landing nets or slings (ideally knotless to reduce damage to fish skin and scales) of different sizes and landing/unhooking mats to bring smaller catches on board in a controlled and safe manner.
6. Where catch-and-release fish are landed, perhaps for data-gathering and/or trophy photos, such removal should be as brief as possible and good handling techniques should be undertaken – holding fish with wet hands or gloves, keeping the fish horizontal, not placing them on the hot deck…
7. Where fish are not to be landed, hooks should be removed in water using long-nose pliers (or long-handled bolt cutters if it is unsafe to remove the whole hook safely for both fish and fisher), or the line cut as close to the mouth as possible.
8. Fish revival techniques should be used where fish are stressed and lethargic from the catch. In some cases, fish with barotrauma can be revived with venting tools or descending devices.
9. Gaffs should only be used for fish that are to be landed at the marina.
10. Low-impact hooks are to be strongly encouraged. Barbless and circle hooks can reduce hook associated mortality if left in the fish on release, while the former are also easier to remove. It has been shown that neither reduce catch rates. Likewise, the use of carbon or non-stainless steel (or bronze) hooks may be better than stainless steel or other alloys as they are non-toxic and break down faster.

11. Biodegradable line should be supplied in Diego Garcia. Although this is a relatively new innovation several makes are now available. These break down in a few years where nylon line will remain in the environment for 500 years.
12. All points of sale (Marina, T-Shirt Shop, Seamans and Ships Store) should be strongly encouraged to supply only these hooks and lines.
13. The sport of game fishing with catch-and-release should be more actively encouraged for key species, notably YFT and threatened reef species. There are ample opportunities for with incentives around such fisheries.

These are advisory, but BIOTA should aim, where relevant, to these elements obligatory within two to five years.

A number of excellent guides exist which detail aspects of responsible recreational fishing, notably:

Department of Fisheries Western Australia. 2013. Code of Conduct for Recreational Fishing in the Kimberley. Government of Western Australia, Perth, Australia.

DPI. 2019. Recreational fishing guide 2020. Department of Primary Industries and Regional Development, Government of Western Australia.

FWC. 2016. Fishing Lines: An Angler's Guide to Florida's Marine Resources. 9th edition. Florida Fish and Wildlife Conservation Commission, Division of Marine Fisheries Management.

4. Invasive species

BIOTA Priorities:

- *Protecting BIOT from invasive flora and fauna*
- *Eradicating invasive rats which threaten native seabird populations, and impact the delicate balance of BIOT's ecosystem*
- *Ensuring that visiting vessels do not harm BIOT's unique environment*

Invasive pathways, inspection and regulation

The most likely pathway for invasive species is probably the high-volume regular arrival of container-based supplies – food and other items. Countries of origin are unable to exclude invasives, although there may be mechanisms reduce levels of accidental infestation. On a recent arrival (October or November, 2019) 117 containers were inspected: 10 were found to have evidence of infestation, with a clear acknowledgement from Customs that they would expect at least one or two others to have insects. This suggests an infestation rate of ~10% and hence there are likely to be hundreds of known potential invasive arrivals annually from this single pathway.

Given the high frequency of infestation, this challenge of making adequate inspections is of particular concern (see previous reports). The EO (NAB) has prepared and given excellent training to Customs on this problem, covering both containers and incoming planes, with guidelines for their work. Likewise, customs are to be commended on their efforts to prevent the arrival of invasives. Officers undertake a best possible inspection: check around entrance for spider webs, droppings, insects (even dead); they work inwards, opening boxes, checking floors and ceilings, but are limited by tight packing of containers. Any with signs of infestation and are closed and sprayed. The failure to catch all invasions at arrival points is unfortunately inevitable in the current inspection pathway.

Following release by Customs, containers are passed to processing areas where there is no further requirement for inspection but where staff can still have some role in identification and reporting of risks (e.g. the finding large snake in banana import, as reported previously).

The system for air freight also carries some concerns. Fruit and veg are considered highly perishable and there is considerable pressure to expedite their clearance, creating the risk of inspections being cursory or incomplete. There appears to be insufficient warning of incoming flights being given to Customs Officers.

Other potential pathways include vessel hulls and ballast-water where again there is a need for greater clarity on policy and on legal requirements. The import of large volumes of rock and rubble for coastal engineering and other building purposes has been a high-risk pathway in the past and while there are mechanisms in place it will be critical to follow this process closely.

Visiting personnel are potential vectors, both in luggage and on any clothing and shoes that may have seed or mud still attached. Visiting yachts also present a risk, both on hulls and in the yachts themselves.

Similarly, the BPV and other research vessels and associated personnel and equipment must be considered a special case, particularly when these are being permitted to visit the Strict Nature Reserves and other sensitive islands. Almost every island in the Archipelago is visited on one to several occasions annually, and the more inaccessible nature reserve islands are typically visited by both scientists and Outer Island Security Patrols. These may include several people, often in jungle clothing and carrying materials such as machetes or research materials. In other highly sensitive

settings, stringent regulations are strictly applied to prevent the risk of contamination. This can include tight visual inspections, the wearing of disinfected clothes or new and previously un-worn clothes and even the prior freezing (for 48 hours) of all clothing prior to island visits (Hathaway and Fisher 2010).

Recommendations

- Improve our tracking of containers. Customs work with the EOs to build a simple recording framework to quantify rates of infestation from containers and other sources Subdivide by simple categories (spider, ant, other insect, mice/rats). Investigate the possibility of documenting different sources (suppliers and places of origin) for these.
- With observed rate of infestation it would be prudent to investigate whether it might be preferable to treat ALL incoming containers with insecticide
- Request further information about insecticides being used, and enquire as to the potential impacts of treatment on environment and human health.
- Undertake a review of best practise in other highly biosecure countries. For Diego Garcia it may be sufficient to mirror practises in countries such as New Zealand.
- Develop a more vigorous programme of control for any personnel or visitors visiting rat-free islands. More complete regulations should be drafted, taking expert advice. In the interim it would be appropriate to forbid visitors to wear any clothing that has not been washed prior to island visits, and for strict visual inspections to be made of all clothing, footwear and equipment to avoid accidental transport of seeds or soil from other areas in BIOT.
- Explore the possibility of improving pre-export control. Consult with key logistics units on DG and explore the possibility of placing a burden (or incentive) on suppliers, with financial levy or other cost for every infested container.
- EO to visit unpacking location for containers and consider biosecurity training and measures. Ask and assess efficacy and consider response protocols.
- Based on the above, develop post-inspection bio-security measures, including biosecure unloading areas and additional training for unpacking staff.
- Consider the response facility at airport. Need a biosecure cleaning area for removal of dirt/seeds etc. This should include secure biohazard disposal process
- Establish a longer notification period for air-freight perishables to ensure full customs inspections can be undertaken without risk to produce.
- Consider possibility of a “cold-room” for such processing.
- BIOTA should devise policy and processes for visiting yachts, including responses for contravention. Guidelines/regulations should cover – no live plants, or soil; no mud; no animals; clean hulls; rodent and insect traps should be on all incoming vessels;
- Based on the above, EO should prepare materials to be built into yacht guidance, along with advice on best-practise e.g. on storing food, cleaning hull, check-clean-dry of all equipment prior to departure). EO should further develop a presentation for Customs on due process for visiting yacht inspections.
- Formalise our regulations on ballast water

Tracking and monitoring invasion

Public works also maintain a list of noted non-native arrivals (“hitchhikers”), with a record of over 80 arrivals since 1995. This is a useful list, although it does not cover any of the numerous arrivals in

containers. The list is dominated by the presence of black and brown widow spiders on almost every IUU fishing vessel from Sri Lanka (along with other arachnid and insects species on occasion). It is also noteworthy that air freight is mentioned on multiple occasions (including 3 snakes, and also, more recently a scorpion and several unidentified millipedes.

In the above cases invasion has probably been prevented, but BIOT is already host to a growing number of non-native species, some of which are invasive (aggressively spreading and competing with native species and ecosystem processes). A plant species list prepared for, and held on, the Chagos Information Portal includes 222 non-native plants and 44 natives. Likewise, a separate list includes 504 invertebrates of which 266 are non-native and a further 14 are listed as invasive.

Non-native vertebrates

- Donkey
- Rattus rattus
- Birds – common mynah, Madagascar fody, Madagascar turtle dove, zebra dove, chicken,
- Agamid lizard
- Cane toad

On Diego Garcia, Public Works have an active control programme for rats and cats and for three plant species – two mimosas (*Mimosa invisa* and *M. pudica*) and the ironwood. They have also run controls over the spread of the coconut rhinoceros beetle *Oryctes rhinoceros* apparently through the release of a biological control agent (bacilovirus) (U.S. Naval Support Facility 2015).

Other than these there are no control programmes, and there have been no studies of their ecological impacts, although these are likely to have been considerable.

The recent report from Centre for Ecology and Hydrology (CEH) (Roy et al. 2019) provides a review of likely high-risk invaders. Although broadly useful, the list appears to fall short in some areas: there are no marine species listed, while others seem highly unlikely (pets, grass species that may even be native). The document also does not consider air freight as a possible risk, which it certainly is.

The same CEH is team also did some survey work and reported the existence of 2 potential invasive ant species: *Paratrechina longicornis* (already recorded from Boddam, Salomon Atoll) and *Solenopsis geminata*. They provided guidance for EO to continue ant monitoring, although did not leave any traps for sampling.

Recommendations

- Commence a formal list of non-native species arrivals and interceptions, combining the ongoing lists from Public Works and BIOT Customs. Where relevant to include information on total inspections, in order to better assess risk pathways
- Work (with CCT and Public Works) to standardise and continue maintenance of lists of current non-native and invasive species. Potentially turn this into ID guide.
- Develop an ongoing action plan for invasives monitoring of those species not already being sampled by PWD/Natural Resources Program Manager.

The removal of rats from Chagos, and particularly from the outer islands continues to be a key priority. While an approach to Darwin Plus for potential funding for this work was unfortunately not funded the evidence-base that rat free islands may support reef recovery from bleaching related mortality continues to grow thanks to ongoing research in BIOT (Benkwitt et al. 2019). This may be

one of the only direct interventions remaining for supporting reef resilience in the outer atolls, and it remains important that BIOTA, along with partners such as the Chagos Conservation Trust and the Bertarelli Programme in Marine Science continue to explore means to fund wide-scale rat eradication projects.

5. Public works: Infrastructure and development

BIOTA Priority:

- *Ensuring the highest possible level of environmental protocols within the Territory*

Infrastructure developments

The ongoing development of C-site by the Naval Research Laboratory is continuing to present challenges, but in some ways is providing a useful training ground for developing a more robust and clearly demarcated approach to new developments on Diego Garcia, including the development of well-understood standards for Environmental Impact Assessments (EIAs) and BritRep Site Approvals (BRSAs).

BIOTA should be sympathetic to the need for this development, but the project should likewise consider the options and be open to requests for changes that might reduce pressures on the natural environment.

Construction material for new facilities on C-site may require imported aggregate, although fine aggregate will be supplied from the borrow pits (Green waste site). Both will require separate BRSAs. As with all imported aggregate there will be a need to avoid import of invasive species, while the moving of aggregate from the borrow pits must not be allowed to increase the spread of ironwood trees and there will need to be a period of monitoring post-installation, together with removal of any young trees.

Recommendation

- Continued progress is needed to ensure that proposals for infrastructure development are developed in a consistent and comprehensive manner. Fully worked proposals encompassing entire programmes of work, with full EIAs are important prior to approvals, as incomplete or modular approaches run the risk of delaying works in the long run by generating concerns or project limitations in the middle of project cycles.

Coastal vegetation

The coastal scaevola is still being cut too low outside VIP accommodation and Headquarters building, despite previous requests that this be halted. The northern seawards margin of this scavvy is eroding, an effect that is almost exacerbated by this hard pruning and the partial dieback of scavvy. In enquiring about this it was apparent that the request to halt this heavy cutting had been heeded, but that it took a year for the request to be processed and in the interim was re-cut!

Shoreline monitoring

The dramatic impacts of extreme sea level anomalies (SLAs) reported from late 2019 were detailed in a separate report provided to BIOTA by the CSA (Spalding 2019), which is included as an Annex to the present report. These events led to dramatic seawater flooding in multiply low-lying locations; with overwash and deposition in some locations, and probably exacerbated and rapid erosion in others.

Following this report the CSA has also reviewed the 2016 report that was provided by Public Works (Moffatt and Nichol 2016a) which includes a number of separate reports as annexes detailing past patterns of erosion, the effects of coastal engineering and past and ongoing monitoring.

Coastal erosion is not new, and it is notable that even prior to the dramatic erosion of late-2019 there were estimates of >2m per year erosion outside Reindeer Station and also erosion along the unprotected coast adjacent to the golf course. By contrast, there is active deposition south-east of the wastewater outfall there, induced by the engineered structure of the outfall itself. A key problem defined by this report is that mining pits act as sinks for all longshore coastal sediments, impacting the regional sediment supply to adjacent beaches, and leaving natural coastal protection to nothing more than a diminishing beach and the adjacent coastal vegetation (Moffatt and Nichol 2016b).

While the coastal revetments have clearly played an important role in halting erosion, these reports also point to challenges, including design faults, which have led to the excessive trapping of sediments by these structures (at Eclipse Point) and to the existence of revetment terminal effects where wave-scour wraps around the end of the revetment causing very rapid erosion, already witnesses at Reindeer Station in 2016, but now greatly increased (Moffatt and Nichol 2016c).

There is a suggestion for some re-building to set-back existing revetments, although this would undoubtedly be very costly. The Eclipse Point revetments were built in a series of extensions from 2011, and it is likely that there may be a call to further extend these in response to the rapid erosion in front of Reindeer Station. The risk here is that this will simply transfer the problem as this appears to be a continual "littoral cell" and the interruption of longshore sediment supply will simply be transferred. In addition, to the south of this point there is the first of a series of shallow offshore reefs. This reef may have already been compromised by the building works on the earlier revetments (see earlier CSA reports) and it would certainly be impossible to imagine how further revetment extension could be undertaken without destroying part or all of this reef, potentially disturbing still more the natural coastal protection functions and the production of additional sediment.

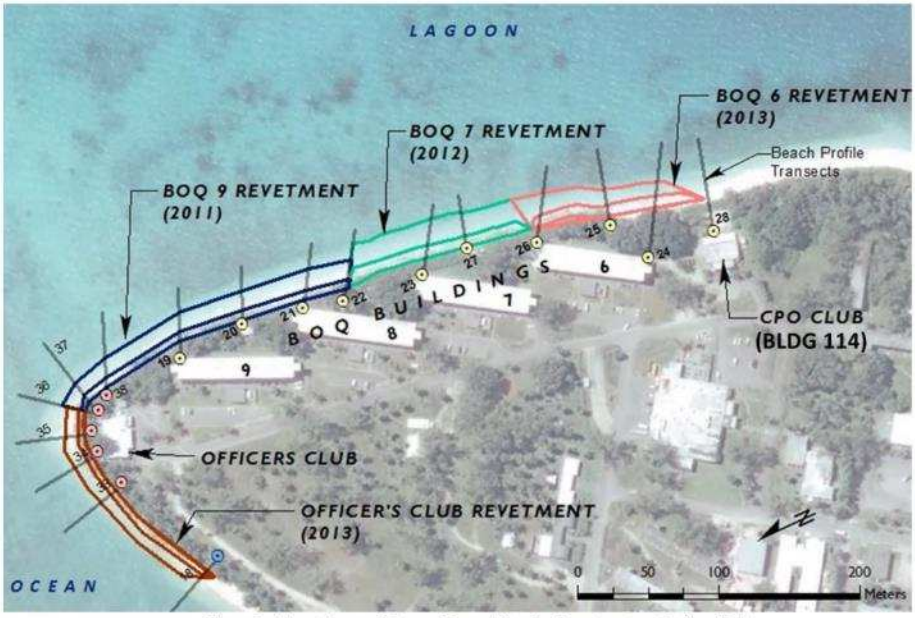


Figure 5-4. Location and Dates of Completion for Revetments at Eclipse Point

Figure showing the time-series development of coastal revetments around Eclipse Point (Moffatt and Nichol 2016c)

A programme of beach profile monitoring has been undertaken for PWD under contract since 2008 (Moffatt and Nichol 2016d). This programme was reduced from 59 sites in 10 broad locations around the western arm of Diego Garcia, down to 33 sites considered to be more likely to change in 2016. These have been very useful in showing change in shape and extent of beach sand and slope (Moffatt and Nichol 2016d). Such beach profiles can provide a much clearer vision of processes than simple horizontal extent and erosion mapping, although clearly the latter can be undertaken over more extensive areas.

Recommendations

- Additional expertise should be sought to consider the likely longer-term implications of managed retreat at this point (with the loss of the Reindeer Station. Whether there are other alternatives, including beach nourishment, or the construction of a short, submerged breakwater to reduce wave entrance between the end of the breakwater and the reef.
- Coastal monitoring needs to be increased. Island margin change should be monitored from remote-sensing, potentially using Lidar. Beach profile monitoring should be expanded beyond the work already supported by Public Works. It may be valuable to consider adding new locations in the southern and eastern sections of the island, particularly along the narrow and vulnerable sections of atoll rim where a breach of the island could lead to profound changes to the lagoon dynamics. The monitoring of inland flooding may also be valuable.
- Following the recent SLA it would be of considerable value to map locations of overtopping and the incursion points for inland flooding. Detailed elevation modelling (+/- 10cm vertical resolution?) might further help in the development of projections of future change.
- Responses to erosion and overtopping need to be further developed. An Emergency Response Plan was developed (Moffatt and Nichol 2016e), but this is relatively simplistic – it considers the measures that might be taken to avoid damage to infrastructure. This might be reviewed with a view to minimising damage to biodiversity or indeed to long-term natural coastal dynamics. It might also be valuable to trial some of these flooding prevention mechanisms on a future high sea level anomaly.
- The approach of building ever-increasing numbers of revetments needs to be reconsidered and an alternative contractor should be invited to suggest alternative options which should include efforts to combine hard engineering with the existing coral reef and natural sediment dynamics.

Energy consumption and Renewables

The Saltwater air-conditioning (SWAC) and wind turbine projects are no longer being progressed. For SWAC it appears that the cost of the deep, wide-bore horizontal direct drilling (HDD) component of the project was too costly.

In contrast, the photovoltaic (PV) Array is approved and a 4.7ha (492,300 sq ft) site is now being developed adjacent to photo-labs. This is on former reclaimed land, some already cleared to grass, while the rest appears to include ironwood and is likely to be of little biodiversity value, although the site was only viewed from the road and not actually visited. The proposal is for a 3MW plant and we were informed that typical peak capacity use on base is 9MW. The challenge will be managing the flow, but the plan includes some battery capacity.

There are also plans to consider the possibility of installing PV on buildings in DG.

Over the longer term we were informed that NAVFAC are looking at the possibility of inwater turbines for tidal energy and are also investigating use of small modular reactors (trialling in USA), although there are no plans for either of these in BIOT at the present time.

While the likely cancellation of large-scale plans for renewables beyond PV is disappointing, it would be wrong to reduce ambitions for energy saving and indeed it was suggested by the CO that it would still be reasonable for the facility to respect the UK emissions reductions targets, when rapid progress could also be made around transport, building regulations, water heating and air-conditioning.

Recommendations

- Every encouragement should be made to extend renewables as rapidly as possible through further PV development or other means.
- The lack of sustainability of energy supplies should give extra urgency and impetus to other emissions reductions efforts including
    - Restricting or banning the import of any non-electric vehicles; with the phased replacement or conversion of all existing vehicles to electric
    - Encouragements and incentives to utilise public transport or bicycles
    - Lowering the intensity of air-conditioning island-wide and in non-essential buildings
    - Lowering water heating and fridge temperatures (especially in empty buildings).
    - Exploring solar water heating options.

Working together

The Environmental Protection Council still exists and meets approximately quarterly, providing a valuable opportunity for on-island BIOT representatives to discuss environmental matters with the Public Works Department. Such meetings should be encouraged, but should also remain focused, concentrating, as needed, on particular issues rather than overly repetitive summaries of everything.

The proposed departure of the Natural Resources Program Manager in Public Works in early 2021 will present some particular challenges as his accumulated knowledge from over ~30 years in Diego Garcia is unique and of critical value. Given his unique knowledge across the spectrum of environmental matters in DG every encouragement possible should be given to finding a replacement who can spend ideally 12 months learning from him.

Exports from BIOTA

Considerable attention has been given to ensure compliance with existing regulations relating to the export of biodiversity related material, with strict regulations of CITES listed species (notably turtles and corals) applied to research expeditions, and with excellent implementation of the limits and permitting for taking sea shells.

A possible oversight to this has been closed regarding the postal system, with SCIO now implementing routine random checks of outgoing mail, in collaboration with the US.

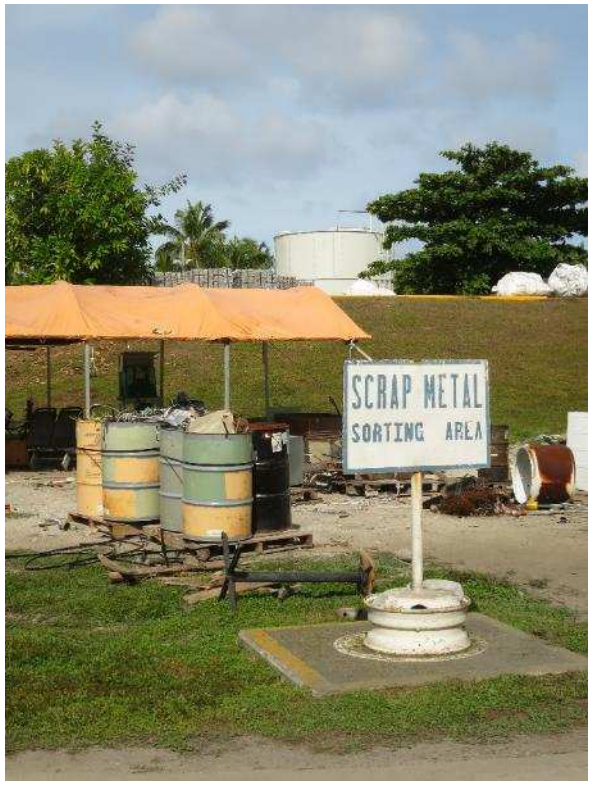
6. Public Works: waste

BIOTA Priorities:

- *Ensuring the highest possible level of environmental protocols within the Territory*
- *Developing new methods for managing waste and combating plastic pollution*

Solid waste

The areas used for the sorting and stockpiling of non-burnable solid waste have been moved. Previous CSA reports had commented on their proximity to the ocean and likely flooding, and so their translocation to a point further inland is welcomed.



Top left – solid waste storage area in 2018, virtually on the beach. Bottom Left – the same area largely cleared in November 2019, with new sorting areas moved inland (Right)

At the same time flooding was observed at the waste disposal area during the late-2019 extreme sea level anomalies and has been commented on in a separate report (Spalding 2019).

Incinerators

Concerns have been growing for a number of years about the remaining longevity of the incinerators on DG. Two new incinerators have now been ordered and will be set up in 2020. These are replacing the existing in a like-for-like manner and so will provide no opportunities, for example for additional energy generation.

Public works have also begun to invest in other waste treatment products, including:

- dehydrator which will remove water from wet compostable material to reduce incineration costs. Liquid from this process will be sent to waste treatment, dry matter to incinerator.
- medical incinerator
- plastic granulator
- tyre shredder
- metal baler, to be used alongside their current capacity for Aluminium baling

These latter three items should make the final removal of these items from the islands by waste and recycling vessels a more attractive option.

Green waste

The preparation of the green waste site, reported last year, has had all approvals and was in final stages of clearing. CSA made a brief site visit, there is nothing of concern.

Composting

There has been no further progress on plans for composting. PWD believe plan was to locate this on top of old landfill site (but lined). For this work to progress it likely needs to be championed and pushed by BIOT Administration as well as Public Works, and it further needs a very clear and secure cradle-to-grave plan, to ensure a secure production facility with no leaching and to designate locations for end-use. This latter may include identification of locations and methods for growing a pre-determined list of approved crop-plants.

Wastewater

The Public Works Department are working on various aspects on the monitoring and prevention of pollution, with two elements in preparation:

1 An illicit discharge survey, looking at any contamination of waters both lagoon and oceanside

2 A “slug” (accidental or high strength discharge) prevention plan to reduce the possibility or likelihood of illicit or harmful loadings into the wastewater treatment

In addition, the EO and CSA were informed that there is a 2017 stormwater pollution prevention plan, and a copy of this has been requested. This should cover some of the concerns raised by the CSA in 2018/9 over the likely discharges into lagoon and offshore waters from the more intensively maintained areas of Diego Garcia.

In addition to the above, water quality surveys were undertaken by CEFAS in 2019 (Painting et al. 2019). Their monitoring incorporated multiple tests “to inform the concentrations and levels of:

- Dissolved inorganic nutrients (nitrate, nitrite, ammonium, silicate, phosphate) in sea
- water
- Contaminants
- Heavy metals
- Dissolved Oxygen
- Microbiological pathogens (E. coli colony forming units)
- Whole sample toxicity”

Their sampling was guided by prior requests from BIOTA and included focused attention on areas adjacent to the waste disposal site, the two offshore wastewater outfalls and then a broad array of

sites across the lagoon, and in open ocean off lagoon. Thus far no findings from this work have been shared.

The BOS Contractors are now undertaking monitoring and attempting to repeat the locations developed by this work and the previous CEFAS study (Malcolm and Lee 2013). They have raised some concerns about undertaking sampling outside of the lagoon.

Recommendations

- CEFAS need to prepare and provide a final report with all findings
- CSA and BIOTA to request a copy of the stormwater prevention plan
- CSA and EOs to request (again) a copy of any map of the drainage channels if not provided in the above plan

Plastics

Efforts to reduce the use of plastic, especially single-use plastic (SUP) are advancing rapidly on multiple fronts, greatly helped by the work of a Darwin Plus project described below.

The EOs have been making excellent progress in collaboration with US personnel, including CO and BritRep, in establishing reductions in the use of disposable plastic, and have been developing a Working Group to further develop policy. In parallel the EOs are continuing to engage with Ships Store and the Restaurants to discourage single use plastic bags and plastic drinking straws.

There is a clear need to encourage all personnel to drink tapwater instead of purchasing bottled water. This could include a communications campaign, a levy on single-use plastic bottles, and the widespread sale of low-cost drinking water bottles in ALL places where drinking water is sold.

PWD are expecting delivery, in September, of plastic granulator to shred and pelletise plastics which should enable greater levels of plastic recycling, however this should not provide an excuse to reduce use.

Beach clean-ups

The Adopt-a-Beach scheme was commenced before Christmas, although there is still need for some further finalisation. Prior to this there were already some early adopters including the Branch Health Clinic who took on a stretch near GEODDS.

The hope is that each of the 15 Tenant Commands (Navy Suppliers, Port Ops, Air Ops…) will adopt a beach stretch of ~2km, and to encourage a 2-month return over a 2km stretch. By March 2020 some five sections (of 15) had been adopted

The EOs defined the beach-sections for adoption, and identified entry points, utilising existing entry-points in almost all cases. If or when new entry points are needed it is important that the EOs take charge of access point identification, with any additional vegetation clearance kept to a minimum, with narrow paths (sufficient for one person plus a rubbish bag), and zig-zagged to reduce risk of water flow and erosion during future sea level anomalies.

The EOs need to develop written guidelines (what to wear, how to collect, access points, gear if needed (e.g. to cut fishing line), avoiding exacerbating erosion, how far inland). It will be useful to develop recording protocols (weighing and recording categories of waste) and to link these with the efforts being developed under the Darwin Plus project (below).

The system will greatly benefit from incentives. The initial materials suggest that there will be "certificates, a reward on completion of 6 beach clean ups and an annual winner's trophy". The latter could form a focus for and generate a community spirit through an annual special day with awards, with judges and consideration given to numbers participating, total cleared, thoroughness of clean.

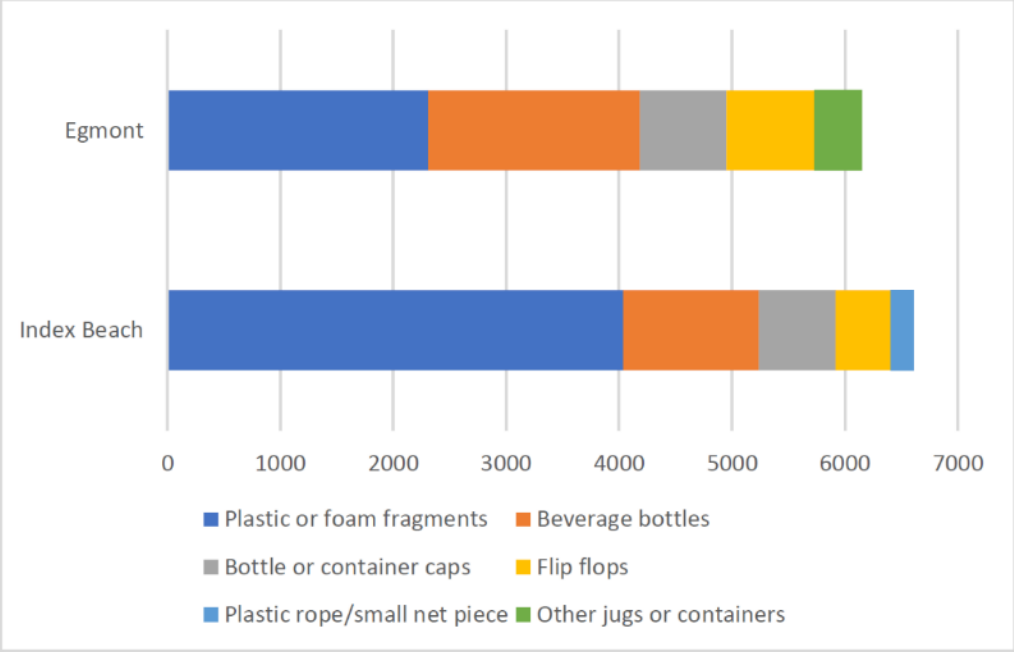
The role of base contractors (KBR) in this remains unclear. While their contract does include some beach cleaning they have not been doing this. At the same time, they are cleaning and handling the waste, which is clearly a valuable task and perhaps enabling a process that, overall, will cover more beaches more frequently.

Darwin project

Much of the work and investment around plastics is benefitting from the support of the Darwin Plus-funded project that commenced on 1 April 2019 and provides a collaboration between BIOTA, the Zoological Society of London, Swansea University and Deakin University. This project has three objectives:

1. Reduce the negative impacts of plastics on turtles in BIOT
2. Reduce the use of single-use plastic (SUP) on Diego Garcia (DG)
3. Provide alternatives options for reuse or recycling of plastic waste streams

Work will be focused on three annual trips where the partners are focussing attention on each of these components. The beach surveys undertaken during this project in June, 2019 logged approximately 7000 debris items each from an Index Beach in Diego Garcia and a part of Egmont Atoll. Of these 87% and 82% respectively were plastic and were itemised as shown below



Breakdown of the types of plastic logged from beach surveys in Egmont Atoll and Diego Garcia under the Darwin project (BIOT Administation et al. 2019).

Alongside this work the project has also analysed some of the waste gathered by the base contractors in 2017/8, with the initial findings showing a similar predominance of polystyrene foam, plastic bottles and flip-flops.

The project is providing comprehensive support in the development of the measures described above for reducing SUP us in Diego Garcia.

Shipwreck

The shipwreck on coast behind C-Site has moved and broken up considerably. There is still considerable waste coming from this vessel as it breaks up and it would be useful if the plastic foam that was held in the hull could be removed as part of the beach clean-ups on a regular basis as the larger chunks are clearly easier to remove, before they break up.

7. Addressing climate change

BIOTA priority:

- *Understanding and mitigating against the effects of global climate change where possible*

Progress towards reducing emissions from the base has unfortunately suffered a significant setback with the decision not to implement either SeaWater Air Conditioning or Wind Turbines. The solar array is currently under development and may help to reduce emissions, but will not come close to the recommendation to match the commitments by the UK government under the UNFCCC.

In the short-term, considerable progress can still be made within the existing energy array by improving energy efficiency. Currently all buildings, even empty, are chilled to below comfortable, and empty fridges are all held on medium and many individual thermostats do not work. Staff are reminded that they can call KBR if they are unable to control their air-conditioning, although it is not clear that this is working either because few actually do report this, or because changes are not being effected. Meanwhile many personnel are dressed for cold-climates with heavy clothing and boots, a requirement which may prevent them from seeking to change the cold room temperatures. There are no solar arrays on the individual buildings either for electricity or hot-water generation. Beyond the buildings there are very large numbers of highly inefficient vehicles, notably SUVs, which are used even for short-distance movements, and frequently only with single occupancy and no cargo.

In the medium term, alongside the solar arrays, further transformational changes should be developed for sustainable or renewable energy development.

While there has been growing use of bicycles for transport in Diego Garcia, very large SUVs remain the most popular mode of transport for many personnel.

Recommendations

- BIOT Administration need to require that BIOT follow the UK commitments under the UNFCCC.
- In the short term every effort should be made to make energy efficiency gains. For example:
    - Halving vehicle emissions: create policies to reduce unnecessary vehicle use and encourage public transport, walking and cycling (incentives). Establish a policy around new vehicles and reducing total vehicle stock and setting emissions targets. Improve public transport where needed.
    - Halving emissions from existing buildings and bringing in state-of-the-art efficiencies on all new buildings: bring in efficiencies through insulation, reducing air-conditioning and emissions from electrical goods.

    - Increase room temperatures installation-wide by 2°C. The current system of allowing individuals to request changes to their thermostats is not working.
    - Increasing room temperatures may require a re-think of uniform requirements, but this in turn might make walking/cycling a more attractive option as heat would become less oppressive for people in warm-weather clothing.
    - Explore other options to increase efficiencies, for example with shipping and air-freight.
- In the medium-term, (within five years) new plans for transformational energy savings through renewables should be approved and work should be commencing
- In the long-term (within ten years) new sources of renewables should be providing 90% of on-base energy needs using wind, wave, currents/tides, deep-ocean water cooling or other systems.

8. Environmental research, outreach and communications

BIOTA Priorities:

- Understanding more about BIOT's unique terrestrial environment
- Studying our key species and habitats to ensure we are providing the best protection and stewardship

Research summary

Academic research in BIOT is world-class, and 2019 was another year of considerable investment in scientific research with 11 BIOTA approved research trips and expeditions. Most of this research was wholly or partially supported through the Bertarelli Programme for Marine Science (BPMS).

The CSA and EO (HM) had the opportunity to visit one of these expeditions in the field (ZSL, Plymouth and Manta Trust) and were highly impressed by the multi-faceted, tightly managed and efficient nature of the work, within the confines of a relatively small research vessel.

Jan-Feb 2019	BPMS - Sea Birds	DG (Wood et al. 2019b) and Danger (Carr et al. 2019)
Jan 2019	BPMS - Tuna Tagging	(Curnick et al. 2019)
Mar-Apr 2019	CEFAS - Water Purity	(Painting et al. 2019)
Mar 2019	BPMS - Reef 1	(Meekan et al. 2019)
Mar 2019	BPMS - VAVA II	(Koldewey et al. 2019)
Apr 2019	BPMS - Reef 2	(Bertarelli Programme in Marine Science 2019)
Jun-Jul 2019	Darwin and BPMS - Plastics	(BIOT Administation et al. 2019)
Jul 2019	BPMS - Sea Birds/Turtles	(Wood et al. 2019a)
Sep 2019	ZSL - Tuna Tagging 2	
Nov-Dec 2019	ZSL - Plymouth & Manta Trust	
Nov-Dec 2019	ZSL - Turtles 2	

Reporting from most of these expeditions has been exemplary, with rapid production of expedition reports and several of these including useful, management relevant feedback. BIOTA is also to be commended for making expedition reports available on their web-site alongside reports from earlier years (https://biot.gov.io/science/). In addition the BPMS pulled together a comprehensive review of this work, *Making Science Matter,* with a clear focus on management relevance (linking this to earlier CSA recommendations where appropriate) (Koldewey and Jones 2019).

Alongside reporting to BIOTA, the researchers behind these expeditions are publishing a steady stream of top-level research articles, many in the most prestigious journals. Through this work, it is clear that BIOT-centred research is now having a global influence, and in so doing is likely supporting conservation and management efforts far beyond the Chagos Archipelago. A listing of recent research publications is provided in the *Making Science Matter* report (Koldewey and Jones 2019), and many of these publications are also listed on the Chagos Information Portal (https://chagosinformationportal.org/).

Drawing together the 15 key management recommendations from the BPMS a number of themes stand out:

Illegal fishing. They highlight the need to improve detection, interception and prosecution, including a enforcement strategy that draws on our knowledge of species, habitats and ecological drivers, and improving understanding of the socio-economic drivers that drive overfishing, including seasonal market forces in India and Sri Lanka. They also call for greater efforts to ensure punitive measures that act as effective deterrents.

Research. Draw attention to the continued need to study BIOT as a globally significant scientific reference site, but also to improve sharing of data between BIOTA, MRAG, the MMO/Blue Belt teams and BPMS scientists. The latter should include be a two-way flow, with research findings shared to managers in a time-appropriate manner but also the sharing of data from the managers, including data on confiscated catches. BPMS may be able to further support BIOTA and the UK Government under reporting requirements, for example under international conventions.

De-ratting. This is highlighted for its particular importance in supporting seabird abundance and coral reef resilience and they suggest the creation of a formal de-ratting working group to guide the process

BIOTA research support. There is a call for continued support from EO and SFPO to record turtle and seabird activity and routine reef health observations. In addition, they encourage additional recording of key species, including coral and sea cucumber species.

Science advisory committee. It is suggested that such a committee should be formed to review progress and align priorities.

Many of these recommendations tie closely to recommendations of the CSA made in this and earlier reports. One further recommendation under science would be to

- encourage the presentation of all the research outputs in a searchable format online. Many of these are listed on the Chagos Information Portal (CHIP), however the search function on this site is limited and they cannot be sorted or filtered, while there are no connections to full copies of the work.

Logistical support to expeditions

The Science store on Diego Garcia provides a critical role for several research expeditions to BIOT every year, reducing logistics and costly shipping costs. This is something that must be continued. At the same time there are regular concerns about how it is being used. This includes concerns about internal organisation, the storage of damaged and broken kit, and of expired prescription drugs, which need to be disposed of. A more serious issue was raised about the co-location of flammable materials alongside compressed gases, representing an unacceptable risk. The store is at capacity, or even beyond capacity. Air conditioning in the store is at best weak.

On at least one occasion in 2019 the CSA was informed of a failure of expeditions to properly undertake the final sorting and storing of equipment. There was an expectation that BIOTA and UK personnel would play a key role in helping, with one expedition apparently expecting marines to unpack and not even turning up to help. BIOTA requires that scientists dedicate 24 hours to tidying up, but this is not being enforced. While there may be a reason for this, linked to external factors not entirely under the control of the researchers (e.g. late return of a research vessel, cancellation of a later flight, making personnel decide to leave early), this cannot be allowed to occur again.

Further demands have also been made by researchers in the field, with one expedition requesting the BPV to resupply fresh fruit and vegetables and 2L of ethanol after less than 2 weeks in the field. In fact, this expedition had been offered such a re-supply as part of the scheduled BPV tour, 4 days later, but they insisted that it was urgent and arranged to meet the BPV at Sandes Seamount. Unfortunately, this was arranged with the BPV directly as permission would not have been granted by either EOs or BIOTA in London. The economic cost of this re-supply would have been extremely

high, while it also led to a decision for the BPV to remain in port rather than undertaking a short patrol prior to its next scheduled trip, at a cost of perhaps 5 days of patrolling.

Nonetheless, the use of the BIOT Patrol Vessel is a critical contribution to research efforts by the BIOT Administration. The utility of this vessel, and of the knowledge of the SFPO, Captain and crew make it a highly valuable platform for research.

There remains some tension over fuel use during these expeditions. Even though expeditions are paying for the fuel, the ship's Captain and crew are keen to avoid heavy use through excessive speed or constant movements. This is because the BPV is making efforts to avoid buying fuel at very high cost in DG, and preferring to travel to the Maldives for refuelling. So, if all the fuel for a given period is used in fast or constant manoeuvring for expeditions it will generate a need to either reduce movements during subsequent patrolling or creating a need for additional trips out of the region to refuel, both of which will reduce effective BPV time for other work. This issue perhaps needs a direct discussion in advance of future expeditions, with options to consider expeditions paying a premium to purchase additional fuel in DG.

Recommendations

- Strictly enforce the 24 hours to pack-up requirement, and ensure that on any occasion where this is not built in, that flights should be cancelled and re-booked later at the expedition's expense. Additionally, it may be appropriate to demand that at least one expedition member must leave 48 hours after all others as a means to ensure that someone is available.
- Do not permit BPV to provide any support to third-party expedition vessels other than in case of emergency or without prior permission from BIOTA in London.
- Request a re-ordering of the Science Store, including the disposal of defunct or unused kit and development of safe storage practises. Consider relocation to a new air-conditioned location if appropriate.

Outreach and communications

The natural beauty and biodiversity of Diego Garcia is remarkable presents an important resource for morale and wellbeing of personnel. Such engagement with nature can, in turn, engender support for, and engagement in, conservation activities. To this end sustainable, non-damaging activities should be actively encouraged. At present many recreational activities benefit from nature – mountain-biking, fishing, beach activities. Even so it should be possible to increase engagement and enjoyment.

Marine environments

Snorkelling is possible on DG, but the site previously encouraged for snorkelling, adjacent to the Marina, is rarely being used. Although having a healthy coral and fish population, this site suffers from having typically low visibility for extended periods which likely discourages some use. There may be some merit in finding other snorkelling sites, even those requiring boat access, to enable personnel to enjoy some of the spectacular underwater life. UK personnel are now regularly doing swim training in the semi-enclosed lagoon area south of Middle Island. This site, or another similar, could provide an alternative location for managed recreational snorkelling and would serve to generate a new level of interest and engagement in the natural marine environment (beyond fishing) and should be explored.

Recreational scuba diving would provide a further highly popular activity. A key obstacle here has been risk management around the lack of emergency treatment facilities. In reality, there are two

decompression chambers on DG, and it was pointed out to the CSA (by the CO) that it would be relatively simple to train up the key personnel (Flight Doc and nurses) to use these. If this was an option, then recreational diving could be considered as a new recreational activity, depending on Host Country approval. An additional advantage of operationalising the decompression chambers would of course be risk reduction for research scientists. CSA would recommend approval subject to appropriate safety regulations and management by MWR.

Recommendations

- Explore options for recreational snorkelling sites, including any requirements for safety and training for swimmers or MWR staff to support boat-based snorkelling
- Request further input from US authorities on the possibility of training staff and maintaining decompression chambers with a view to establishing a small, but managed, recreational diving programme.

Terrestrial environments

Cycling, and particularly the mountain bike trails, give some access to natural forests. Walking trails are more limited. The southern Restoration Point nature trail is in place and signage has been put up to explain various aspects of the terrestrial and coastal ecology. Unfortunately, this site remains somewhat inaccessible. This might be somewhat improved by the addition of a bus stop on the weekend routes to East Point Plantation, although it is likely that some additional incentives might also be needed, including exclusion of this site from permitting requirements (see earlier CSA reports).

Additional sites to enable personnel to enjoy the natural environment could be found, notably at Pointe Marianne, and potentially in the Stoddart Swamp fern wetland. The proposed Pointe Marianne Trail has been investigated by EO and revisited with CSA. The proposal is a short loop with one access point to the lagoon coast, where at low tide there is a beach; and a second viewpoint across the tidal wetland. The overall route will be short, but it should be possible, in the space of about a kilometre to show a remarkable range of island history and natural history including hardwood forest, former settlements, beach and barrachois with saltmarsh. A small additional loop on the other side of the road leads to a small but representative patch of freshwater wetland.

The need to ensure protection for the cultural and natural heritage in Pointe Marianne needs to be considered, including the giant trees. New regulations now allow for fines for any damage to Chagossian heritage, and one suggestion would be to extend this to including historic trees (both in Point Marianne and potentially other sites such as the Banyan Tree Cemetry)

Recommendations:

- Establish a formal and clearly demarcated trail at Pointe Marianne, and investigate the possibility for a boardwalk trail in the Stoddart Swamp wetland. For the former:
    - Develop legal protection for giant trees and cultural heritage, including a clearly called out penalty for graffiti and a prohibition on tree-climbing. This needs to be done in advance, as it will be much harder to prevent further graffiti after the first infringement.
    - BIOTA or the on-island management will need to make a risk assessment on any potential risks from tree-climbing or entering the cultural ruins
    - Tree protection orders are needed.
- Consider roles of Plantation Managers in this work

Raising awareness

Informing people about the natural world is another critical component of encouraging engagement. The signage about the natural environment is on display in the Marina area, which is a good start. Other environmental information has some prominence at the airport arrivals area and in some of the induction programmes for new staff. Visiting scientists are regularly invited to present their work to personnel on the island and such talks can be well attended. There has also been excellent engagement of volunteers both around beach cleaning and the turtle research. The use of social media as a means to promote and support some of this work is illustrated by the success of the Chagos Turtles Facebook page (308 members, a closed group) is notable.

The MWR could have an important role here, through their role in the use of boats and sport fishing, mountain biking trails and even the regular photography competitions they organise. Despite these examples, much more could be done.

Some of the EU supported signage on display at the marina

Recommendations

- Develop a dialogue with MWR leadership to encourage greater environmental engagement.
- Display the second set of these information boards in a prominent downtown area
- More regularly screen existing environmental films both on TV and in the cinema
- Develop new content from the abundant film and image banks available (CCT, BMPS and many, many individuals)
- Investigate developing social media outreach (Twitter, Instagram, Facebook, Snapchat), possibly considering different groups, such as fishing, beaches, and perhaps more broadly an environmental group with features covering places, species (species of the week?), campaigns.

Environmental management

The engagement of a second Environment Officer in 2019 has been a highly positive change. The role of the BIOT Administration in safeguarding one of the most important coral reef archipelagos in the world is paramount, and, while many people play a part in this, the EOs are the front line with identified roles in developing and supporting policy and implementation strategies, advising on environmental aspects of all activities in BIOT; undertaking baseline research and monitoring; supporting conservation and outreach activities; and in supporting the ongoing research activities

for external researchers who visit BIOT. Such a role was clearly beyond the capacity of any single individual, and even for two it remains a challenge.

A key component of the new role should be to ensure near permanent presence of at least one EO in BIOT at all times, with close co-ordination of key shared activities, as well as utilising opportunities for individual specialisation. For the present it would appear beneficial for the two positions two continue to operate at an equal grade as this clearly ensures that both EOs will be able to maintain equivalent influence and engagement when operating as the sole EO, particularly in DG. At the same time there is a clear advantage to enabling some degree of specialisation. Thus it is clear that certain elements of strategic and advisory work, particularly those requiring on-island advisory and feedback roles, both EOs must be able to fully engage. Likewise science-supporting roles on DG must be undertaken by both EOs, particularly during visits by scientific personal. During 2019, some of this division of labour included specialisation in particular elements of marine and terrestrial work.

Further support for environmental work comes from the Fisheries Protection Officers, and the deeper engagement of Customs staff in this role is welcomed and should be continued. The Senior Fisheries Protection Officer is another critical role, although more could perhaps be done to clarify roles and responsibilities and to ensure better sharing of both activities and findings.

The Plantation Manager continues to provide useful support across a number of environmental tasks, however the scope of this role remains a little unclear. This is a BIOT funded position and has the potential to play a far greater role, particularly to terrestrially focused conservation work. The Plantation Manager reports to the BritRep and XO, however there is considerable opportunity for the EOs to engage in the tasking and to support or supervise conservation tasking.

Recommendations

- Develop a clearer outline of the roles and responsibilities of the EOs
- Develop a ongoing programme of work detailing specific tasks
- Strengthen a science and monitoring programme
- Develop a clearer understanding of the potential for the Plantation Manager to engage in conservation related activities and, working the senior BIOT management, to develop a programme of work to incorporate key conservation needs and opportunities.

9. Biodiversity Observations

BIOTA Priority:

- *Studying our key species and habitats to ensure we are providing the best protection and stewardship*

Reef monitoring

The BIOT MPA is one of the most important coral reef protected areas in the world, and its scientific value is now receiving considerable attention from academic researchers (see above). It was recommended for a number of years that BIOTA would benefit from maintaining its own simple programme of long-term biodiversity monitoring, in much the same way as most other Marine Protected Areas.

Such monitoring enables the managers to have direct knowledge in real time of coral reef condition, with ownership of the information which otherwise can be hard to obtain from researchers. It further enables the possibility to undertake rapid response monitoring to review particular impacts without the complex and slow set-up times required for expeditionary research. The possibility of engaging on-site personnel in this reef monitoring process has yet to be realised, but remains a potential additional benefit in generating awareness and support for biodiversity conservation.

Initial attempts at monitoring were undertaken in 2015, however the regularly changing BIOTA policy on scuba diving made continuity impossible. Since 2017 simple marine monitoring of a number of shallow lagoon reefs across the archipelago has been undertaken by Environment Officers with the Chief Science Advisor. While shallow lagoon reefs are only a small part of the ecosystem, and cannot be used to interpret conditions on the important outer reef slopes, this work nonetheless represents a useful beginning. At the same time the CSA has made efforts to visit outer reef sites and make basic observations of reef condition – such observations are informative at a basic level, and can provide insights at a different time of year from the research expeditions.

The basic programme of reef monitoring has followed the approach developed and widely used by ReefCheck, with some additional components. This focuses attention on summarising the substrate cover on the seabed and separately a simple fish-count[3]. While it is intended that the EO should create a full report of this work, some summary data are provided in the following notes, both of the lagoon reef monitoring and other coral reef observations.

Earlier in 2019 there were signs of a bleaching event, with a Coral Bleaching Alert from NOAA on 18 April, and early bleaching noted as “widespread, involving most genera” and “everywhere in shallow water” (pers comm, Charles Sheppard 30 Apr, 2019), but this was not mentioned in the final report from that expedition (Bertarelli Programme in Marine Science 2019), and it would appear that it did not transit to a full bleaching or at least that there was minimal mortality.

Pisonia and scale insects

An apparent outbreak or plague of hawk-moths causing major leaf-loss on *Pisonia* trees on Sea Cow island was reported in 2018 (Spalding 2018) and in the same report the risk posed by an invasion of

[3] A 100m transect is laid on a lagoon reef in about 1-2m of water. Substrate is recorded every 50cm. On a return swim fish are counted within 2.5m of the transect (5m width). Finally, a 0.25m^2 quadrat is placed every 5m along the transect and is used to count all young coral colonies in three size classes, and is photographed for a subsequent photo-quadrat analysis.

scale insects *Pulvinaria urbicola* was highlighted as similar invasions have caused considerable damage to *Pisonia* forests on similar coral islands elsewhere.

In November this year some scale insects (identification is being sought) were observed on Petite Ile Bois Mangue in Peros Banhos and on North Brother, Great Chagos Bank. There were possible occurrences on Middle Brother, and West Island DG.

Subsequent feedback from Dr Chris Malumphy (pers comm, 20 Mar, 2020) have confirmed that this is most likely to be *Pulvinaria urbicola* Cockerell (Hemiptera: Coccidae), but also that this species is possibly native and was first observed in BIOT in 1971. Despite being natural, it is has been recorded as a highly destructive forest pest on small coral islands in Australia, where some control was achieved by release of natural enemies, both a ladybird species and three parasitoid wasps. It is suggested that the former, *Cryptolaemus montrouzieri*, may already be resident in BIOT and if so might provide an option as a biological control agent if this were required.

At the present time the numbers observed were very low and worthy of observation rather than concern. It has however been suggested that "Stressed plants are often far more susceptible to insect attack and it is likely that the scale insects are only a secondary problem. The primary cause is likely to be due to abiotic conditions, such as drought, salinization due to high tides or possibly a rise in the underground saltwater level. Stressed plants have less resilience." (C. Malumphy pers. Com). Given this, and the observations of considerable plant stress associated with both drought and salinisation observed at the end of 2019 it will be important to remain vigilant for possible damaging outbreaks of this species.

Coconut crabs

It was noted that none were seen on any of the northern Atolls. Visits were generally brief and during the middle hours of the day, but previous visits would have always shown some of these. They remain abundant on Diego Garcia. This is a casual observation, but should definitely be followed up. They have not been seen on Nelson's Island for at least two years (Wood et al. 2019a), but this may be a normal feature of population dynamics.

Diego Garcia

Birds: red-tailed tropic birds are still nesting in small numbers at R-site. Overall there appear to be many more brown noddies and fairy terns in downtown.

Pointe Marianne

This small tract described in the 2018 CSA Report was re-visited and it was possible to exit onto the lagoon beach and walk to the barrachois channel entrance at falling tide. This would be a valuable addition to any trail developed by the EOs/BIOTA as it increases the diversity of habitats. Lemon sharks and flag-tailed rays in abundance and a range of terns on the beach, including a few common terns. Inside the barrachois is a small but very well-developed saltmarsh area, with quite a complex of dendritic drainage channels. Good population of waders.

Fern wetland

See notes on EIA and Infrastructure developments. The CSA made a very brief foray into the western area of this wetland (not previously visited, and somewhat inaccessible). It was possible to confirm

that this too is a fern wetland normally waterlogged although at this point in a drought cycle it was largely dry.

- With this confirmation it is recommended that this area be included in future protection,

Left: View of the Stoddart Swamp, western area. Right: Eastern swamp (yellow) and western swamp (red) with a proposed boundary line for a protected area (pale blue).

East coast restricted area

The dramatic impacts of seawater inundation during the late 2019 high sea level anomalies are described in some detail in Spalding (Spalding 2019). These included likely heightened erosion on some shores, notably around Horsburgh Bay, and widespread inundation. Significant flooding had already apparently killed all terrestrial plants in the Restoration Area south of East Point Plantation and further flooding was noted all along the coast.

In many areas, defoliation was reported, even of large and old hardwoods and while it was reported that there was a possibility that these trees might recover, photographs provided from 4 February show no sign of recovery to date.

Perhaps even more surprising is that areas of coconut forest have apparently succumbed to the flooding impacts. Coconuts are typically relatively tolerant of brackish water.

Hardwoods on the road immediately south of East Point Plantation, lagoon is immediately to the left of the image – all of this, including the road was inundated multiple times between early October and late November. Left in late November 2019, with most leaves already lost and remaining apparently dead. Right, approximately the same view on February 4, 2020.

Coconut forest south of East Point Plantation was extensively flooded in October and November. Right shows the same forest, with widespread coconut death on 4 February, 2020.

It would appear that the repeated inundation, combined with drought conditions may have created saline soils and removed the freshwater lens on which many of these trees rely for an extended period. It is still possible that some trees may recover although this will be less likely over time.

Recommendations

- Continue tracking tree loss versus recovery
- Consider options for restoration

West Island, DG

This small island is eroding on both sides and it was clear that it had been overtopped, probably in all areas during the late 2019 sea level anomalies. Almost all shores are rocky, with a small sand and shingle spit at the west end.

The vegetation is almost entirely compromised. Beach heliotrope dominates at the coast and in a single line of trees along the very narrow western end – many were showing signs of defoliation. *Pisonia* becomes more common moving eastwards but much of this was observed to be defoliated or in the process of leaf-loss. High tides and salinization may have exacerbated this, but there is also considerable herbivory of the *Pisonia* trees. No scale insects were observed although there were some ants, which often live in a symbiotic partnership with scale insects, that may have been protecting eggs. Three large weevils were also observed on the leaves and it is not known if these may be herbivores, or indeed whether they are native species.

West Island – general view (left) and details of Pisonia trees showing partial (middle) and total (right) defoliation

West Island: left: ants on Pisonia leaves. Centre: unidentified weevil. Right: juvenile egret.

Bird notes

Greater noddies are roosting on the beaches and low vegetation at W end, and some at E end, although there was no sign of nesting. Quite dense nesting of RFBs on all available coastal vegetation, so probably ~100 pairs total. One dead RFB was observed in a dense patch of vertical saplings (*Pisonia*?), which appeared to have simply got its wing wedged in a v-shaped notch and was unable to escape, but also inaccessible to predatory crabs.

Egrets are also nesting in significant numbers: at least 6 chicks and another 4 nests with 2 eggs in each. These nests are visited occasionally by PWD to cull the population which creates a nuisance for take-off and landing planes.

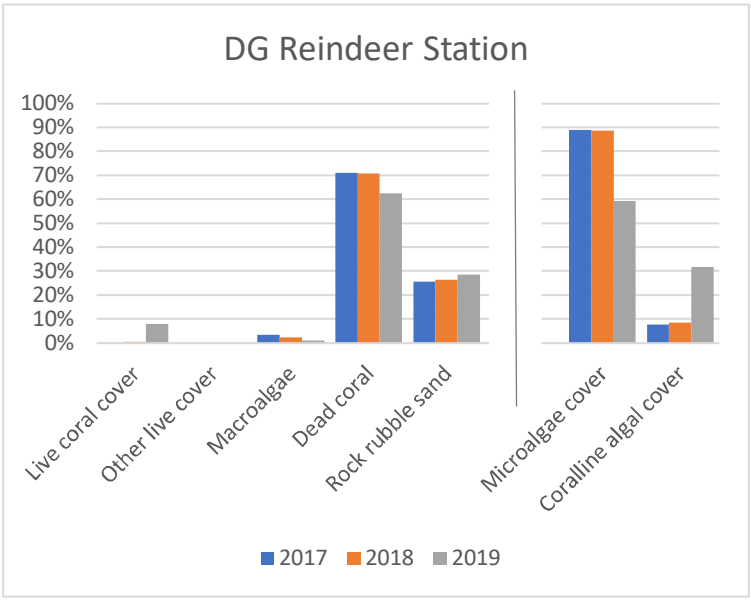
Frigates were present flying above the island but not observed to be roosting or nesting.

Lagoon reefs

The three reefs surveyed by the EO and CSA show remarkably different trajectories following the 2015-6 coral mortalities and these are clearly reflected in the coral survey data.

Reindeer Station/UPH6: The Reindeer Station reef remains dominated by dead coral, although live cover appears to have begun to return (increasing to 8% in 2019), while the microalgal turf formerly present on most other hard surfaces has beeen partially replaced by coralline algae, a more suitable substrate for coral settlement and growth. The slower recovery of this reef compared to the Marina (see next page) may have some relation to the impact of terrestrial runoff as noted in previous CSA reports and could possibly have been compounded by the disturbance to the adjacent seabed during the extension of the coastal revetments in 2013-14.

Left – new growth of Echinopora *coral. Right – collapsed coral*

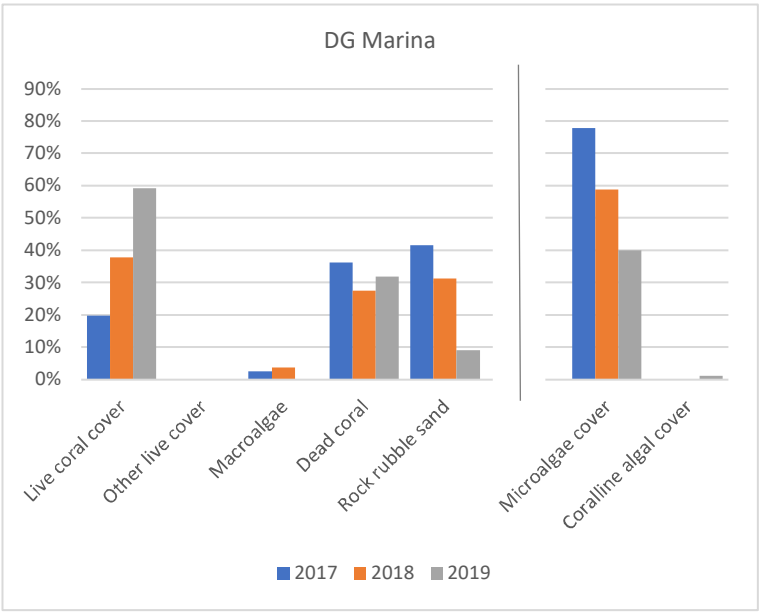


Fish count summaries	2017	2018	2019
Butterflyfish	7	4	2
Parrotfish	27	15	17
Surgeons	385	243	197
Unicorns	12	0	0
Groupers	12	7	8
Snappers & emperors	6	3	18
Damsels	503	223	33
Corallivores	3	0	1
Large herbivores	34	11	6
Small roving herbivores	378	247	206
Large piscivores/invertivores	18	10	20
Planktivores	0	0	21
Coral nestlers	0	0	21
All counted fish	1092	495	277

Juvenile corals and recruitment:

Colony size	2017	2018	2019
0-2.5cm	0	1	1
2.5-5cm	0	1	6
5-10cm	0	0	4

Marina: The fringing reef to the north of the boat ramp at the Marina continues a trajectory of increasing coral cover. While this is dominated by foliaceous *Echinopora* coral (about 40% of hard coral cover), coral diversity appears to be good, with many growth-forms present, notably branching and submassive corals.



Fish count summaries			
Butterflyfish	6	5	8
Parrotfish	0	2	1
Surgeons	26	19	32
Unicorns	0	0	0
Groupers	0	0	2
Snappers & emperors	1	1	2
Damsels	240	215	314
Corallivores	6	5	0
Large herbivores	0	1	5
Small roving herbivores	26	20	28
Large piscivores/invertivores	1	1	4
Planktivores	0	15	14
Coral nestlers	0	15	14
All counted fish	273	242	359

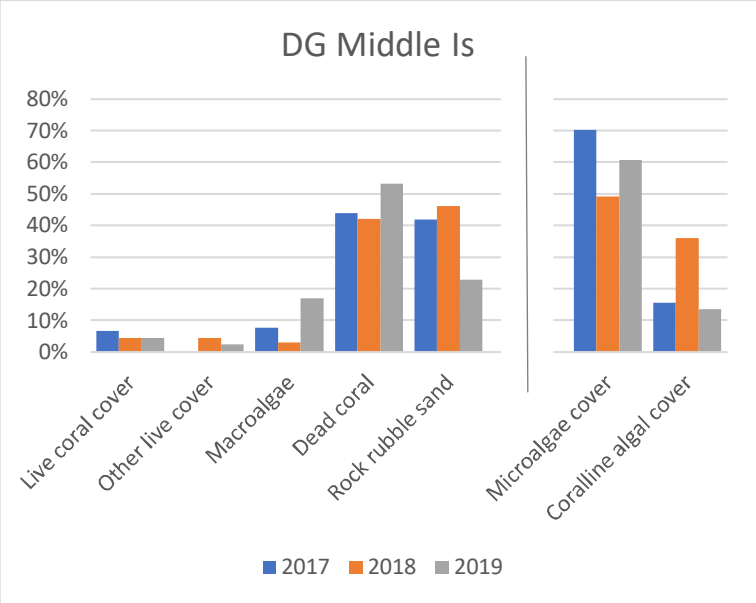
Juvenile corals and recruitment:

Colony size	2017*	2018*	2019
0-2.5cm	8	8	3
2.5-5cm	4	18	34
5-10cm	26	12	27

* Counts were made in only 10 quadrats and so have been doubled for comparison with 2019

Middle Island: The reef here remains largely dead with very slow recovery and dead corals gradually collapsing. Live coral cover is still below 5%, with low levels of recruitment and young corals present. It is not at all clear why recovery might be slower here. Grazing fish were still abundant, but there appeared to be lower levels of large predators than in previous years. This could be linked to the decline in reef structure reducing overall biomass, but we should be cognisant that this area is now being used for occasional recreational snorkelling and for swim tests by UK personnel – any fishing here (which is not permitted) would rapidly knock down numbers of predators.

Much of the substrate remains dead coral with a fine covering of algae, in places there has been significant reef framework collapse.



Fish count summaries	2017	2018	2019
Butterflyfish	12	2	4
Parrotfish	12	11	22
Surgeons	276	64	127
Unicorns	219	4	0
Groupers	2	0	1
Snappers & emperors	5	3	22
Damsels	455	0	0
Corallivores	6	2	1
Large herbivores	289	7	18
Small roving herbivores	213	71	112
Large piscivores/invertivores	4	0	3
Planktivores	305	0	0
Coral nestlers	305	0	0
All counted fish	986	85	179

Juvenile corals and recruitment:

Colony size	2017	2018*	2019
0-2.5cm	0		3
2.5-5cm	0		1
5-10cm	0		4

* Adverse current at end of survey prevented counts

Salomon Atoll

Ile Anglaise

The lagoon and fringe of *Pemphis* mangroves were first reported by the CSA in 2015 and cover about 1.6ha. First mangrove area showing considerable death of fringing mangroves at water margin, but healthier trees further from shore. These trees were already suffering mortality in 2015 when first visited by the CSA, and this appeared to be a little more extensive in 2019. Milkfish were still present in the lagoon.

For the first time the CSA was also able to ascertain that there is a second large area of *Pemphis* mangroves just a little further to the northeast covering 0.8ha. In this second area there are two smaller lagoons, but with contiguous *Pemphis* forest connecting them. In this area the trees were all in robust health, with trees in flower and fruit, with tree heights up to 5m. The central lagoon (midpoint at -5.334 S 72.218 E), has a soft mud floor, while the northern lagoon (midpoint at -5.334 S, 72.219 E) is 20-30cm deep with clear water and gravel bottom. There has been some overwash to all mangrove areas, but no clear evidence that this has been extreme and certainly no gaps in the coastal margin vegetation. The central lagoon has accumulated large amount of plastic litter.


Southern Mangrove area. The lagoon side mangroves are largely dead. A population of milkfish remains in the lagoon


Central lagoon – open with a muddy bottom, with considerable volumes of accumulated plastic litter.

The northern lagoon, shallow with a hard bottom. Right – map showing an outline of the two mangrove areas on Ile Anglaise.

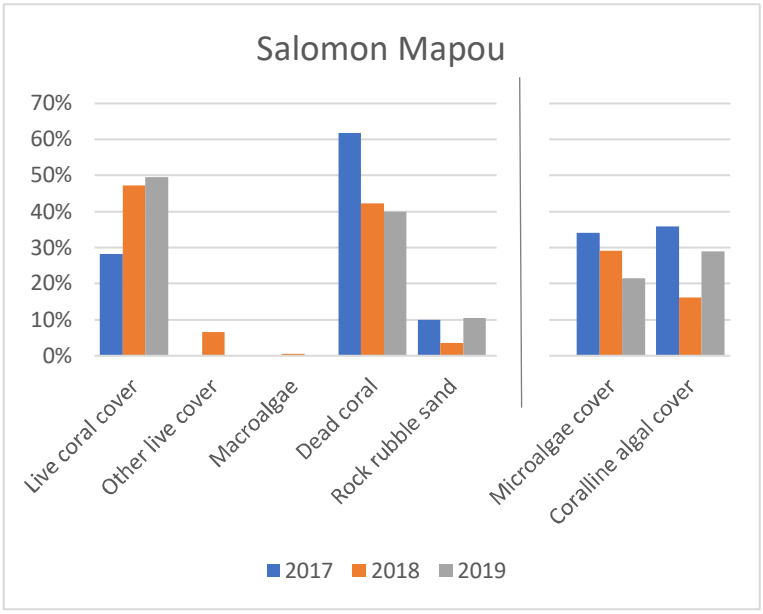
Not a great deal of insect life was observed, but some painted dragonflies were present around the southernmost of pool in the Northern Mangrove. No bird-nesting was observed around any of these mangroves.

Away from the mangroves and across to the eastern shore the coconut forest is somewhat inundated with brackish to saltwater, apparently with marine algae growing in this area.

Coral Reefs

Ile Mapou

This reef continues to be in good health. Coral cover has increased only slightly since 2018, but at almost 50% it might already be considered to be in a near-natural state (although it is noted that dead coral still makes up 40% of the substrate. Coral diversity also appears to be high with branching corals making up about one third, but various species of encrusting, massive and submassive all making up about one-fifth of the life-forms. Fish diversity and abundance is also high, with notable numbers butterflyfish (including corallivorous species) and parrotfish, as well as large predators.



Fish count summaries	2017	2018	2019
Butterflyfish	25	19	43
Parrotfish	51	68	47
Surgeons	139	82	196
Unicorns	3	0	6
Groupers	5	1	8
Snappers & emperors	8	8	63
Damsels	1000	640	210
Corallivores	21	15	22
Large herbivores	49	36	35
Small roving herbivores	141	114	185
Large piscivores/invertivores	14	5	57
Planktivores	1000	640	210
Coral nestlers	1000	640	210
All counted fish	1238	823	582

Recruitment data not available

Lagoon reefs near Boddam

A brief snorkel over the anchorage area adjacent to Ile Boddam showed the same high coral cover as previously noted in 2018 – probably >60% in most places, but a little lower further east. Of considerable note were two very large *Porites* coral heads, both reaching to the surface, the larger some 5m diameter, another ~4m. These corals are still in good health, and are likely to be centuries old.

Only two moorings remain in this area. One, inspected, is a double mooring with both a thick (4") rope and a separate chain around the same large coral head. There were no obvious signs of rope thinning. A third mooring was observed (adjacent to the wreck), but this no longer reaches to surface.

Left: The use of anchors in the designated anchorage at Ile Boddam causes inevitable damage as shown here by the small anchor from the BPV support vessel, dropped on the reef for just a 20 minute period. Centre and right show one of the last two remaining moorings where both a thick rope and a separate chain mooring are wrapped around a large (now dead) coral head and provide a secure mooring with no further ongoing anchor damage.

Lagoon corals near Ile Boddam. Left is a centuries old Porites *head. Right high diversity and high live coral cover*

Offshore reefs W of Ile Anglaise

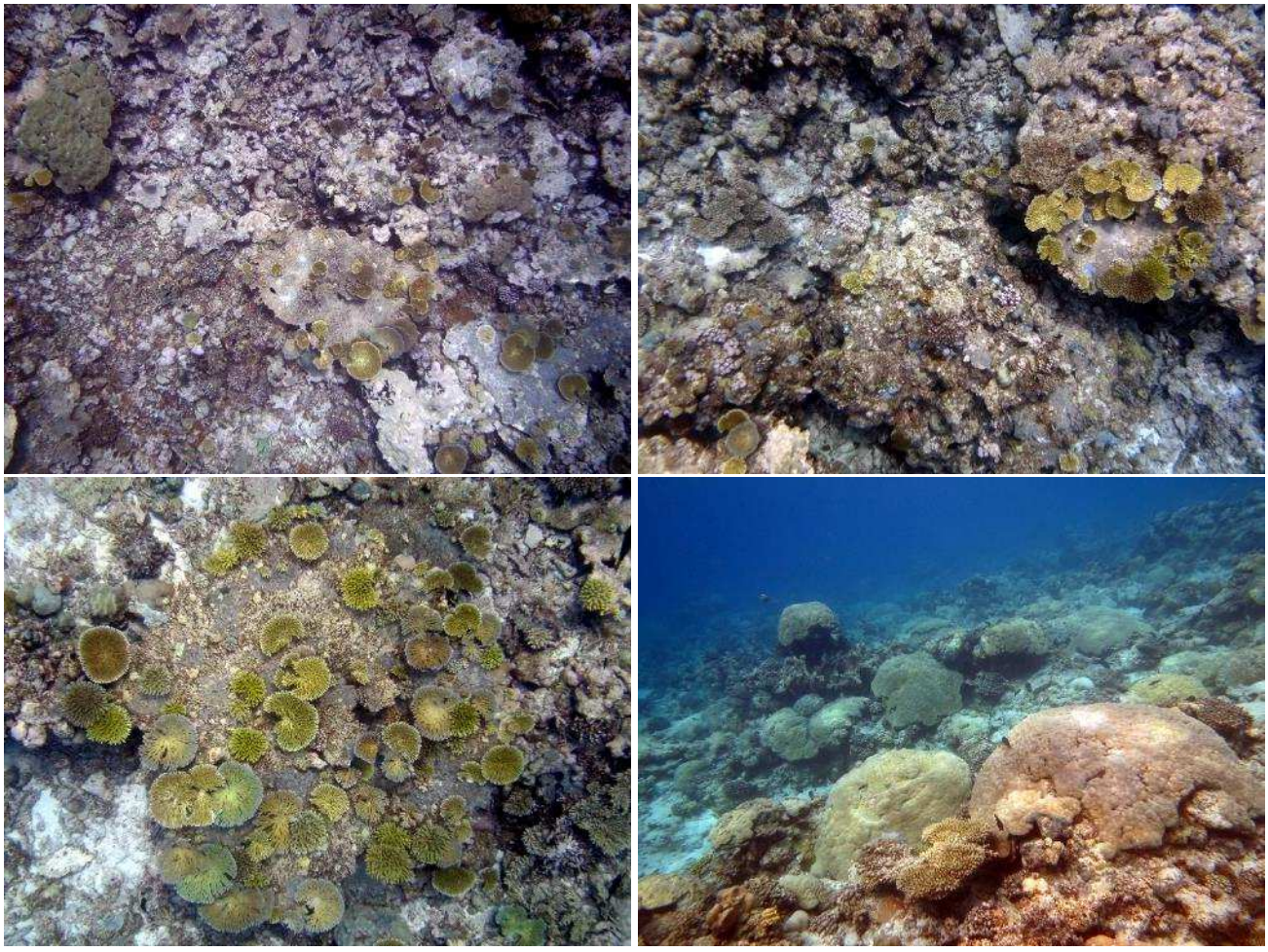
5° 19.770 S 72° 13.152 E

This site lay off the west coast of Ile Anglaise, further north than previous year's dives and snorkels. Generally good recovery but lower in deeper water.

Live coral cover appeared to be low in deeper water, perhaps 5-8% at around 10m and deeper.

From 5-10m there is some recovery with many 2-3 year old table corals growing in a patchy distribution, and favouring growth on dead table corals, a few branching colonies and surviving massive corals, notably above 8m, giving variable coral cover, averaging 15%.

In shallower water from 3-5mcoral cover dropped to some 10-12% with massive and some branching corals predominating.



Top left – reef below 10m. top right reef at about 8m. Bottom left – patch of healthy table Acropora *recruitment at about 7m. Bottom right – shallow reef scene at about 4-5m.*

Peros Banhos

Petite Ile Coquillage

This nature reserve island was briefly visited. It was apparent that high tides had overtopped the shore in a few places but it did not appear to have caused any flooding, and it was probably only during the very highest (October tides) given the location of a booby chick at very low elevation that must have hatched after any overwash.

Inland all trees were showing considerable defoliation, including a large number of helicopter trees *Gyrocarpus americanus* (a rare but native species, not found in Diego Garcia). These are deciduous trees, so it may be hoped that their near complete defoliation is natural and that they may recover. Even invasive papaya were losing leaves. A few trees of twin apple trees *Ochrosia oppositifolia* were still in full leaf although showing signs of stress (yellowing), and a few *Pisonia trees* were also present, heavily grazed on leaf margins. The inland area is largely open and covered in grasses and extensive dodder. Grass was clearly stressed/brown, but unlikely to be dead or dying.

On the ocean shore there appears to have been some deposition of sand lifting the upper beach profile and covering any low vegetation around the base of beach heliotropes *Tornefortia.*

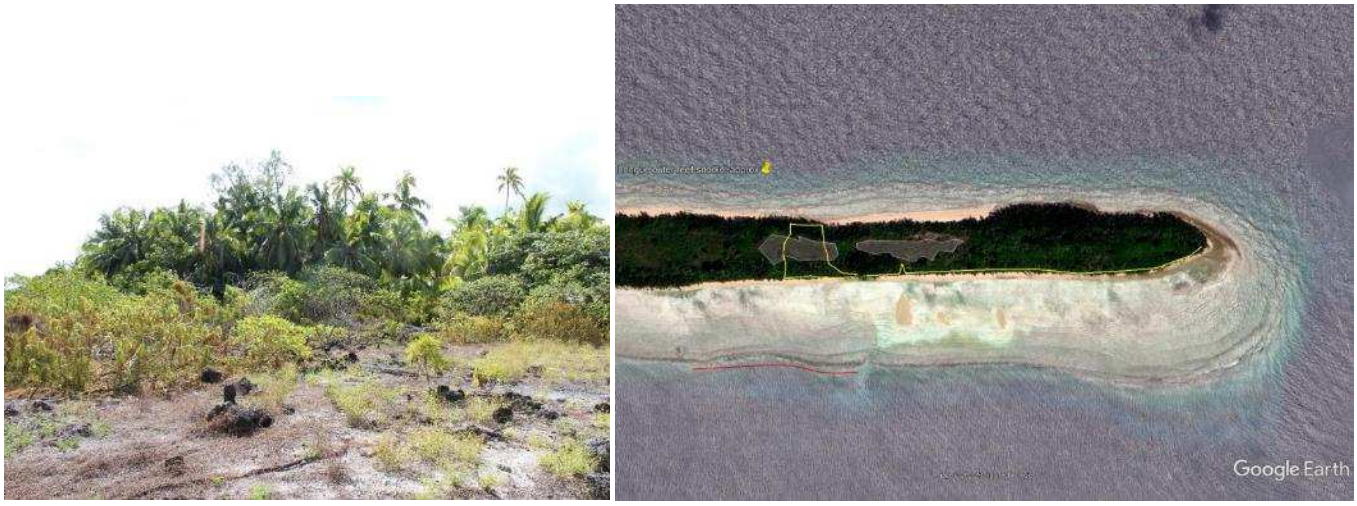
Left – helicopter trees showing complete defoliation. Right – twin apple trees, showing leaf yellowing

Bird observations: RFBs preparing to nest in quite large numbers, some courtship, nest-building. One small chick on nest. No nesting noddies or terns although sooty tern nesting was apparently ies (nesting observed by last SFPO visit 4+ weeks ago.

Ile Longue

Walked across open grass to W of central coconut palms to oceanside. Grass was looking sparse and a little dessicated. Scavvy, even inland, was wilting and defoliating. Partial defoliation was observed on some *Pisonia* and *Tornefortia* trees. One *Guettarda* also almost completely defoliated.

Oceanside showing some erosion of coconut fringe, but also some sand banking up to W. No particular coastal vegetation death. On the lagoon side most loss is defoliation of shrubs.



Left – inland on open area showing sparse grass and wilting/defoliating Scaevola. *Right – route taken (in yellow)*

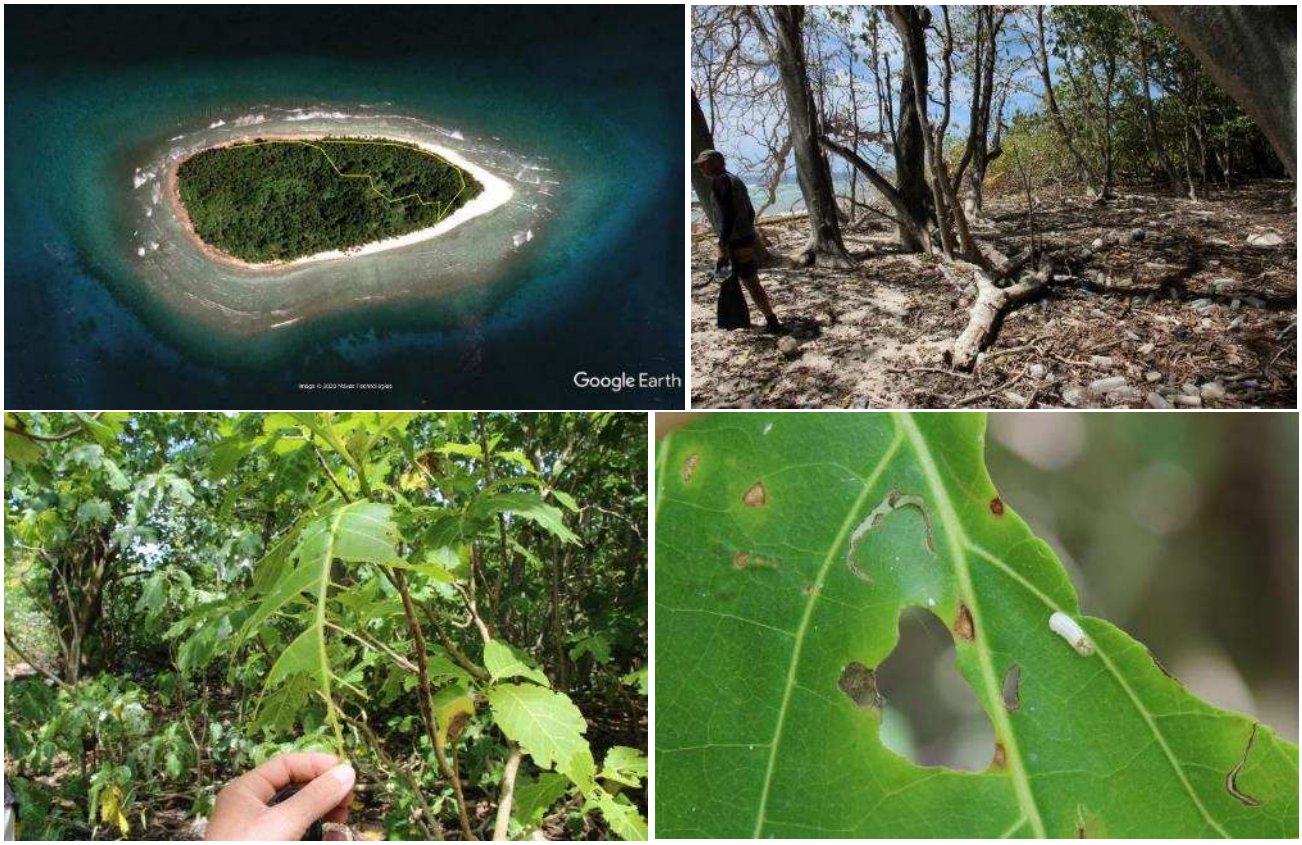
Bird observations: No nesting sooty terns or even flocks overhead. RFBs again preparing to nest. SFPO reported seeing a brown booby and a subadult.

Petite Ile Bois Mangue

The north (ocean) shore has quite a bit of sand deposition at the west end, large loose coral rocks in centre and more erosional coconut shore with bare coral rock lower down. On the lagoon coast (E end only observed at one point) there had certainly been some overwash and many defoliated *Pisonia* saplings.

The *Pisonia* forest is not in good shape with lots of leaf loss. This may have been drought-related, but some leaves have been heavily eaten.

A scale insect *Pulvinaria urbicola* was observed on one leaf. No obvious signs of hawkmoth.



Top Left – area walked on Grande Ile Bois Mangue. Top Right Pisonia *forest on NE shore, defoliation has greatly reduced the canopy shade. Bottom left – intensive herbivory of* Pisonia*. Bottom Right – scale insect Pulvinaria urbicola* on Pisonia leaf.

Bird observations. Large numbers of nesting RFBs, most at early stage and nest-building. A small group of lesser noddies just starting to nest in E *Pisonia* forest.

Ile de Coin

Walked for about 45 minutes in the former coconut plantation along the N shore from about 1km west of the graveyard to the graveyard. This is another eroding shore with many trees falling into water. Some signs of overwash were seen near the graveyard, but none had reached graveyard.

The invasive herb *Bryophyllum pinnatum* was observed in one area.

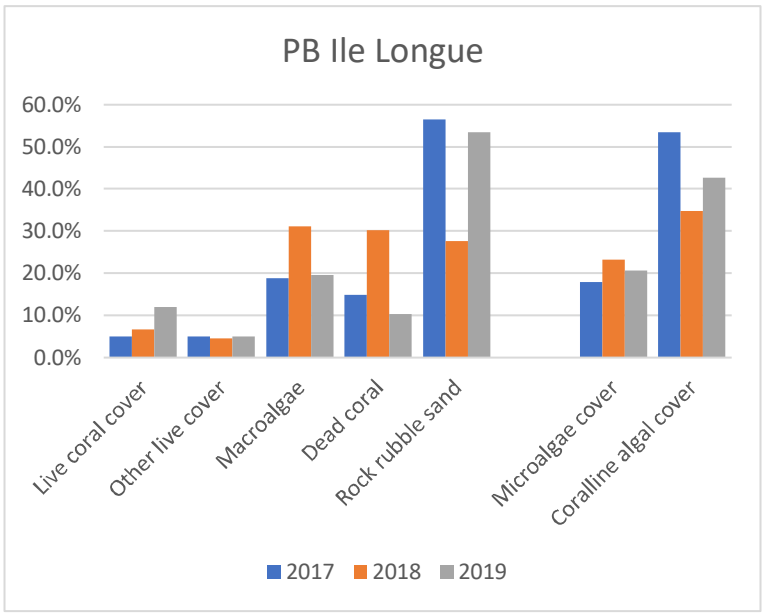
Coral Reefs

Ile Longue

Reef here making slow recovery, but the slope is still dominated by dead coral substrate, with dense *Halimeda* beds on a gentle slope from ~4-6m depth. Large numbers of parrotfish and grazing Acanthurids..

Close to channel quite a few snapper and *Plectropomus* grouper. Grey reef shark and eagle ray.

Left – deeper reef slope with high cover of Halimeda*. Right – shallower slope still dominated by dead coral.*

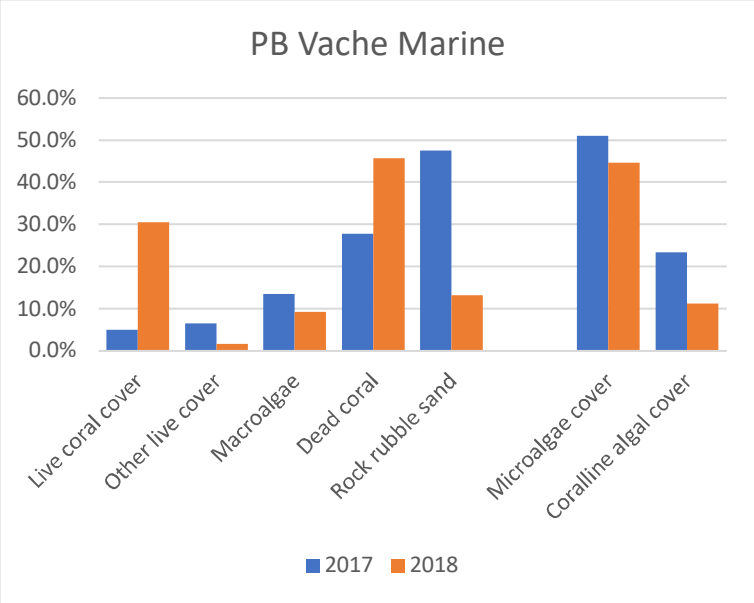


Fish count summaries	2017	2018	2019
Butterflyfish	4	0	7
Parrotfish	11	17	62
Surgeons	81	27	111
Unicorns	1	0	3
Groupers	1	0	3
Snappers & emperors	1	2	0
Damsels	32	75	60
Corallivores	0	0	0
Large herbivores	3	2	21
Small roving herbivores	89	40	150
Large piscivores/invertivores	2	2	3
Planktivores	1	0	0
Coral nestlers	0	0	0
All counted fish	134	123	253

Ile Vache Marine

Efforts to run a monitoring survey largely failed due to clouds of sediment reducing visibility to 1m in places. The cause of these were not clear, but were observed to thicken during the period of the dive, and may have been linked to some unusual combination of current and/or tidal patterns.

Data from previous years is shown below and suggested that live coral cover on this reef was recovering well.



Group summaries	2017	2018
Butterflyfish	8	10
Parrotfish	29	19
Surgeons	190	174
Unicorns	1	0
Groupers	1	0
Snappers & emperors	0	1
Damsels	0	0
Corallivores	6	4
Large herbivores	29	8
Small roving herbivores	182	179
Large piscivores/invertivores	1	3
Planktivores	5	0
Coral nestlers	0	0
All counted fish	236	213

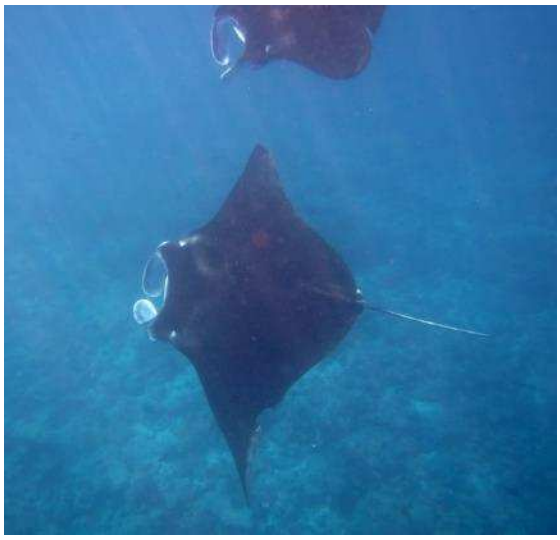
Petite Ile Coquillage: a brief lagoon-swim suggested that the reef here is showing some level of recruitment and coral growth, with some larger massive coral heads that are recovering from partial top-side mortality. Much lower coral cover than reefs of equivalent depth in Salomon.

Grande Ile Bois Mangue: a brief swim was made on the ocean side from the spur and groove out to 12m. The spur and groove looked mostly erosional, but with some coralline algae growth in places. Below 3m there was active coral recovery underway, increasing from about 15% at about 5m to over 20% in about 7-10m. In all areas a mix of species, but with massive *Porites* making up to 50% of live coral cover. At 10+m a dense school *Macolor niger* was observed.

Three large mantas were observed feeding on oceanside of **Petite Ile Bois Mangue**.

Ile de Coin. Close to the island there is a surprisingly healthy back reef with strong recovery of massive and digitate corals (no photos). Further offshore at about 6m some coral outcrops from a continuous hard-cover base, with larger *Porites* heads. Good numbers of predators


Oceanside Ile Bois Mangue: Left – spur and groove with relatively low coralline algal cover. Right – reef slope below 7m with relatively high coral cover.



Left – manta rays on oceanside of Petite Ile Bois Mangue. Centre and right – lagoon reefs at about 5m depth north of central Ile de Coin.

Dolphins – group of 20 spinner and one bottlenose on lagoon passage south from Coquillage.

The Brothers

North Brother

Access beach - 06°08.1778 S 71°30.1256 E

This island was last visited by CSA in May 2015. The southeast beach used as an access by the CSA on prior visits was not present, but was dominated by bare rock, however a relatively broad intertidal beach was present on the northwest shore. (Access remains difficult with cross-cutting waves and surge up the beach.)

Erosion was highly evident on most shores, including apparent retreat of the cliff-face on the western shores, with some trees. Several beach heliotropes had collapsed onto a fall of rock and sand – these were still growing, but may suffer during future high tides. From SW to SE there are open areas which have had some overtopping with sand deposition. There were also wide areas spreading inland that were previously vegetated, but that are almost entirely bare. Plastic litter in these areas has spread quite far inland (06°08.1619 S 71°30.2429 E) either though wind or sea-driven transport. All being used as nesting areas by brown boobies.

A lot of the palm trees look unhealthy and some have died, even far inland, like a crown dieback.

SE coast with palm trees is lower than elsewhere and there has been considerable overtopping. Erosion in parts, with fallen palms lining the coast but also a high rim of recently deposited sand

The main brown booby nesting area, formerly with a low herb cover has also had some overtopping, but mostly on outer margin (signs of flow in sandy sediments). There was almost no remaining vegetation which may have been linked to overtopping or drought.

Broad comparison of coasts. Images on Left from 2015, on Right from 2019. Top: NW shore with considerable new erosion in 2019. Centre: SE coast where considerable sand has been removed, but also some loss of palms. Bottom: E coast where main brown booby nesting colony has possibly had some new sand deposition but the herbaceous cover was largely gone.

Walked into edge of *Pisonia* forest. *Pisonia* again is being eaten by a pest, not clear if this could be hawkmoth. Also found a small group of scale insects being tended by ants.

Bird observations: There were more shearwater holes than I have ever noticed, right up to the island margin in all areas making it impossible to leave the shore (the only foray I made into this area was by carefully only walking on stones, roots or along low tree branches to avoid disturbing shearwater holes). Only observed one bird (photo) in a natural stone hole in the cliff. Brown boobies are nesting everywhere, and appear to be at all phases as we saw many large chicks, but also a few newborn and some eggs in the largest nesting area. Most areas with nests are open, but some birds are

nesting under the outer edges of *Pisonia* and more open herby areas under palms. Estimate 1500-2500 pairs.

Very view few RFBs, perhaps 30-40 nests? Small numbers of roosting frigate birds (80-120), but no signs of nesting or courtship.



Left – scale insects and ant on Pisonia*. Centre – shearwater in "burrow" on cliff face. Right – brown boobies with larger chicks, all processes from early nest-building, eggs, to young and old chicks were observed.*

Middle Brother

Erosion on most shores, including the long ongoing loss of beach and palms on the SE facing embayment. Signs of overwash were particularly notable on S point, with sand flows 8-10m inland and dead scaevola on the point. Along the SW coast were a few small *Pisonia*, one collapsing into sea but still growing. There were some sign of herbivory on *Pisonia* but no scale insects were found

Grassy areas in from central W coast and embayment all had long, browning grass, with no nesting birds. Erosion is again apparent along this coast, with a small stand of palms in the NW now isolated from the rest of the island by waveswept sand, and with some remnants of palm roots showing on what is now beach. Overwash has occurred in places all along the W coastal, with sand deposition up to 8m inland, and some defoliated/dead scavvy.

The open vegetation/grass and shrub area on the N coast was crowded with sooty terns starting to nest. There has been some overwash here and some building upwards of the island rim. Terns were nesting, so highly vulnerable. The NE shore back towards landing beach is rapidly eroding with fallen palms.

Large amounts of fishing and boat ropes on W coast. Large metal bouys/cylinders on NE coast near landing beach. Plastic litter now spread far inland with surge.

Left and centre – SE facing embayment in 2014 and 2019. Right – coconut palms isolated from the island by recent erosion

Left – Heliotrope moth Utetheisa pulchelloides*, a native predator of* Pisonia*. Right – sooty tern on nest just above the intertidal sand.*

Birds observations: Estimate 1-2000 nesting pairs of sooty terns. 500 RFB nests.

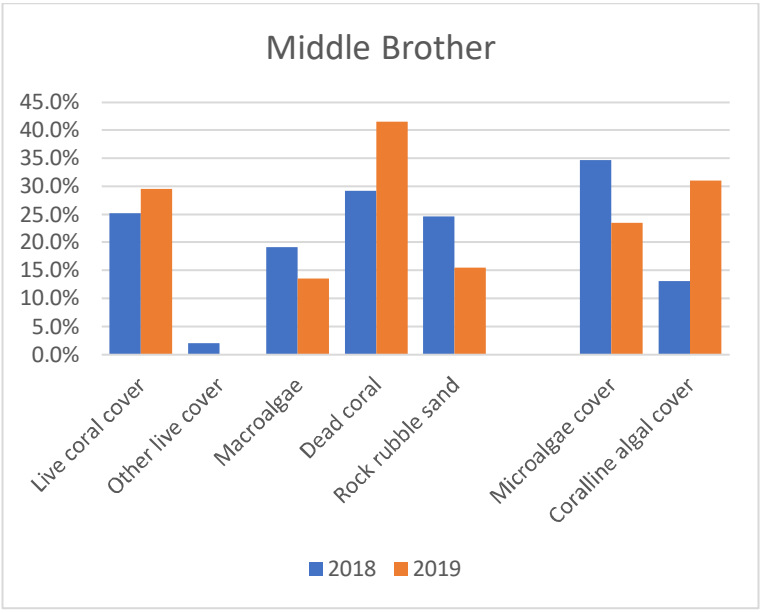
Brown boobies abundant in sky and roosting. 2-400 frigates. Bridled terns on beach.

Coral reefs

Middle Brother Survey site

This site remains in relatively good health, with a possible minor increase in live coral cover, but otherwise little change in either the benthos or indeed the fish or young coral communities. Macroalgal cover with *Halimeda* remains relatively abundant, while a single string of seagrass was observed growing on the reef.

Left - Seagrass Thalassodendron ciliatum*, a single plant was observed. Right – Environment Officer conducting young coral survey.*



Fish count summaries	2017	2018	2019
Butterflyfish	0	13	14
Parrotfish	0	59	33
Surgeons	0	119	160
Unicorns	0	6	2
Groupers	0	0	2
Snappers & emperors	0	47	64
Damsels	0	200	202
Corallivores	0	3	2
Large herbivores	0	20	36
Small roving herbivores	0	140	83
Large piscivores/invertivores	0	8	6
Planktivores	0	104	131
Coral nestlers	0	100	130
All counted fish	0	453	479

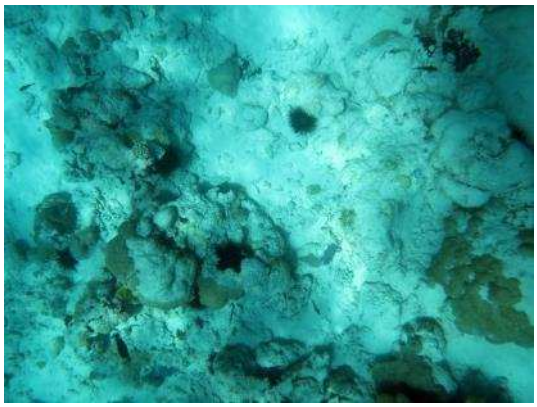
Juvenile corals and recruitment:

	2018	2019
0-2.5cm	34	23
2.5-5cm	70	105
5-10cm	58	50

Outer reef on drop-off N of Middle Brother

Shallower water (from 5m) has wide areas of low relief, but some complexity around occasional *Porites* outcrops. Most substrate bare rock and long-dead coral with algal or CCA cover, but very heavy grazing from a high density of *Diadema* urchins. Clearly some recruitment, e.g. on dead plates, but not abundant. Live coral cover probably 5%

At top of wall at around 10m the substrate becomes more complex with higher rugosity, and slighter higher live coral cover, but still only 5-10%.



Left images of shallow substrate (5-7m) showing low coral cover, grazing urchins (Top) and limited young coral recruitment (bottom). Right – reef slope steepening into drop-off at about 10m showing increased complexity and slightly higher coral cover.

Reef slope W of North Brother

At 5m the slope is gentle and essentially a scoured flat surface with quite a few simple vase sponges but almost no rugosity, few dead corals and LCC <2%.

Below 6m occasional there are occasional outcrops dominated by dead coral, but with a few live massive corals. LCC 3%. A few branching corals also occur below 7m. With a very low gradient it was not possible to swim to any drop-off.

As with previous site there are very large numbers of *Diadema* urchins.

Left – substrate at 5m depth. The circular objects are small sponges. Right – at 7m small amounts of relief are provided by small coral outcrops.

Egmont

Visited the West Island where the lagoonside coast is still actively accreting with coconut and occasional scaevola, with no sign of SLA impacts.

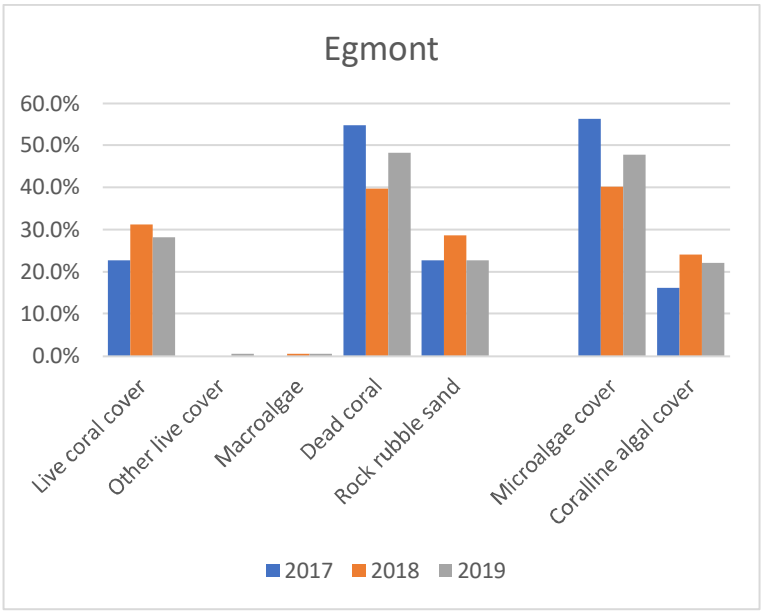
Walked through at narrowest point to lake which was full and with deep very soft mud, where natural bacterial processes are generating hydrogen sulphide. Water was lightly brackish. Quite a few milkfish. Large milkfish present. Across the norther lake margin/barrier there are some areas of low coral deposits where the scavvy had defoliated but was starting to return, it is possible that these could be linked to high tide events.

On the seaward side there is still a deep inlet where a second barrier has started to form and may in time close off a smaller lake. On the seaward- (west-)facing coast side there had been some erosion and loss of coconut palms, and there had been some overwash of beach litter into the coconut forest, along with and some dead scavvy, however most of the lagoon margin appeared to be dominated by accretion.

Coral Reefs

Survey site showed little change from 2018, with similar relatively high live coral cover (~30%) and abundant fish life. Young corals were a little more abundant in the survey in 2019.

Left – location of reef survey (red line), walk across island and outer reef snorkel sites. Right – reef monitoring site.



Fish count summaries	2017	2018	2019
Butterflyfish	13	7	10
Parrotfish	29	28	17
Surgeons	188	121	81
Unicorns	8	6	2
Groupers	2	0	1
Snappers & emperors	56	27	14
Damsels	185	300	190
Corallivores	11	6	8
Large herbivores	30	16	15
Small roving herbivores	178	123	72
Large piscivores/invertivores	49	25	13
Planktivores	255	300	190
Coral nestlers	185	300	190
All counted fish	552	495	317

Juvenile corals and recruitment:

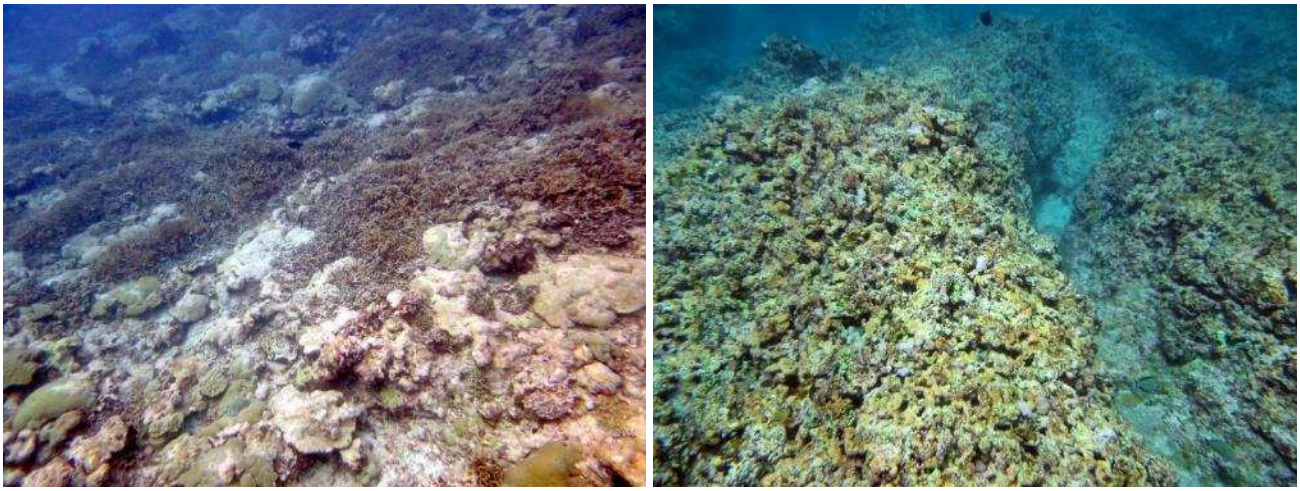
	2018	2019
0-2.5cm	7	8
2.5-5cm	0	5
5-10cm	3	13

Offshore reefs on western margin

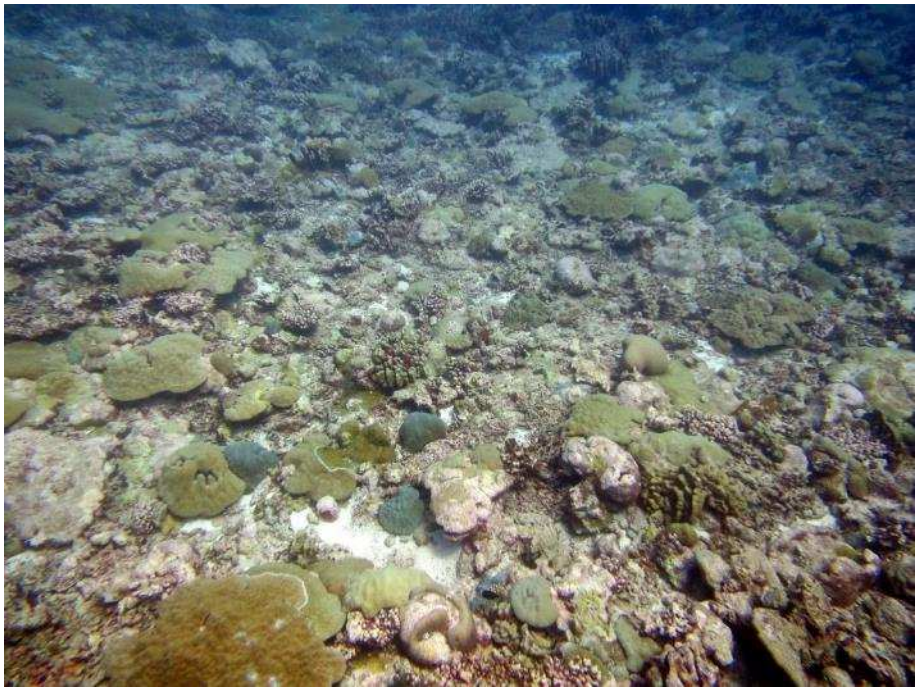
Site 1 just off SW corner of "Ile Lubine" – large amounts of branching coral in wide patches on the middle and lower reef slope, with good amounts of massive coral with total live coral cover 20-35%. High energy coast with deep spur and groove down to 5m, and a strong cover dominated by coralline algae.

Site 2 just off southernmost point of "Ile Sipaille" – healthy coral cover on the lower reef slope, 30-40%, dominated by massive coral. Three hawksbill turtles observed.

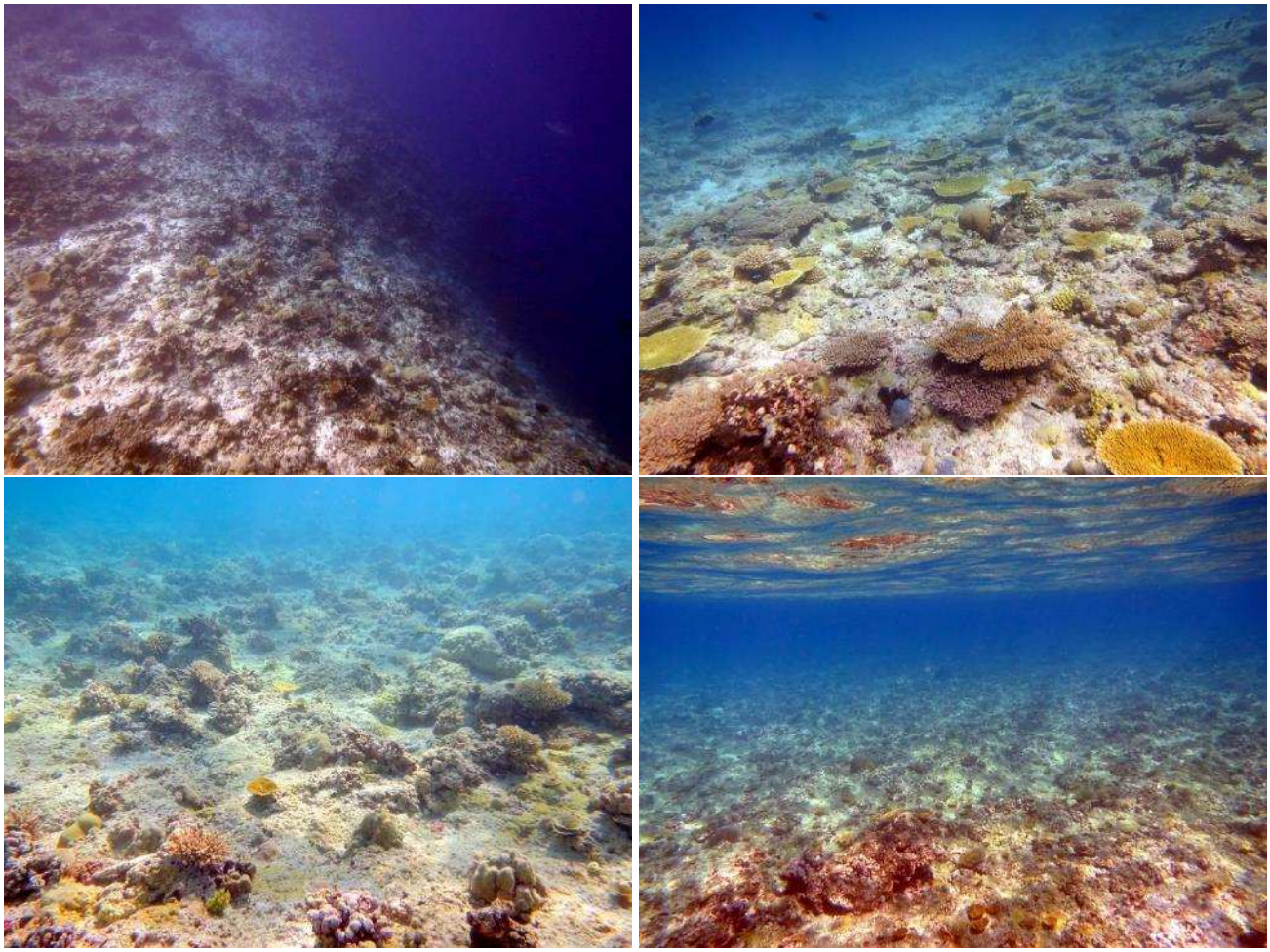
Site 3 northern shore. Lots of recovering plate coral on the lower reef slope with live coral cover at 25% at about 8-9m, but becoming lower in shallower areas.



Site 1. Left – on the middle and lower reef slope (5-10m) with quite large areas of living and dead branching coral. Right – healthy cover of coralline algae on the spur and groove formations



Site 2: Reef slope at ~8m showing the dominant cover by massive Porites *coral.*



Site 3: Top Left drop-off. Top Right – Lower reef slope at 7-8m showing with rapidly recovering plate corals. Bottom Left – upper reef slope at 4-5m with lower coral cover. Bottom Right – 2-3m, very low rugosity reef surface with low coral cover.

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Annex 1: Inundation and Erosion report: Diego Garcia, November, 2019

To be circulated with 2019 Annual Report in a separate document