Chagos Conservation Management Plan

for

British Indian Ocean Territory Administration
Foreign & Commonwealth Office
London

by

Dr Charles Sheppard

Department of Biological Sciences,
University of Warwick
Coventry, CV4 7AL
csheppard@bio.warwick.ac.uk,

and

Dr Mark Spalding

17 The Green, Ashley, Newmarket, CB8 9EB
mark@mdspalding.co.uk

October 2003

Top: Salomon atoll,
Bottom: the Chagos Anemonefish

Chagos Conservation Management Plan

Contents

Acknowledgements

We gratefully acknowledge the help of many people. The following offered comments on earlier drafts of this CCMP: **Dr Geoff Hilton**, Royal Society for the Protection of Birds; **William Marsden**, former Commissioner for BIOT and Chairman of the Chagos Conservation Trust; **Dr Paul Pearce-Kelly**; Royal Zoological Society of London; **Dr Mike Pienkowski**; Chairman, Overseas Territories Forum, **Dr Andrew Price**; Warwick University; **Nigel Wenban-Smith**, former Commissioner for BIOT and past-Chairman of the Chagos Conservation Trust.

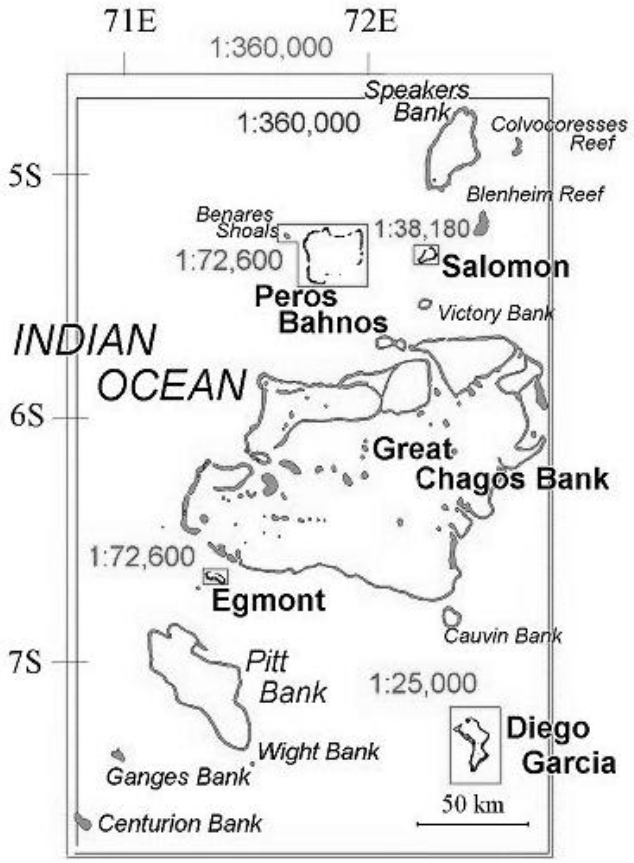
Several people generously gave information on specific aspects: **John Hooper**, **Chris Mees**, **Catherine O'Neill** and **John Pearce** of Marine Resources Assessment Group, Ltd, London provided substantial help with fisheries matters, and then provided extensive comment on a draft.

Andy Watson, Fisheries Officer in the late 1990s provided details on offshore banks. **Trish Bailey**, **Lena Maun, Nancy Woodfield** (BVI), **David Rowat** (Seychelles), **Dr. Alain Jeudy de Grissac** (Egypt) and **Kenny Buchan** (Saba and Bahamas) gave advice on moorings and related visitor management. **Linda Corpus** and **Nestor Guzman** in Diego Garcia supplied copies of the Natural Resources Management Plan and Final Governing Standards for Diego Garcia.

Grateful acknowledgement is also due to **Mr Charles Hamilton** and **Ms Ann Furey** of BIOT Administration, **Cdr Adam Peters and Cdr Neil Hinch,** British Representatives in BIOT, for providing numerous, sometimes obscure documents. **Mr Henry Steel** reviewed the legislative matters.

Most essentially, **John Topp**, former British Representative in BIOT and Conservation and Environmental Consultant to BIOT for 10 years, has been involved heavily in all aspects of the conservation of this exceptional archipelago. His advice and help in all aspects have always been invaluable, as was his review of a draft of this document.

We recognise that not all those named here will agree with all the contents, or on the necessity of particular elements. We have not steered what we saw to be an unsatisfactory course of greatest compromise but, while heeding advice, have outlined a course which we believe this large region needs in order to be conserved over the years ahead.



Charts available for the Chagos Archipelago

Diego Garcia: Admiralty Charts and Publications, chart No. 920. 1:25,000 Transverse Mercator, UK 1996.

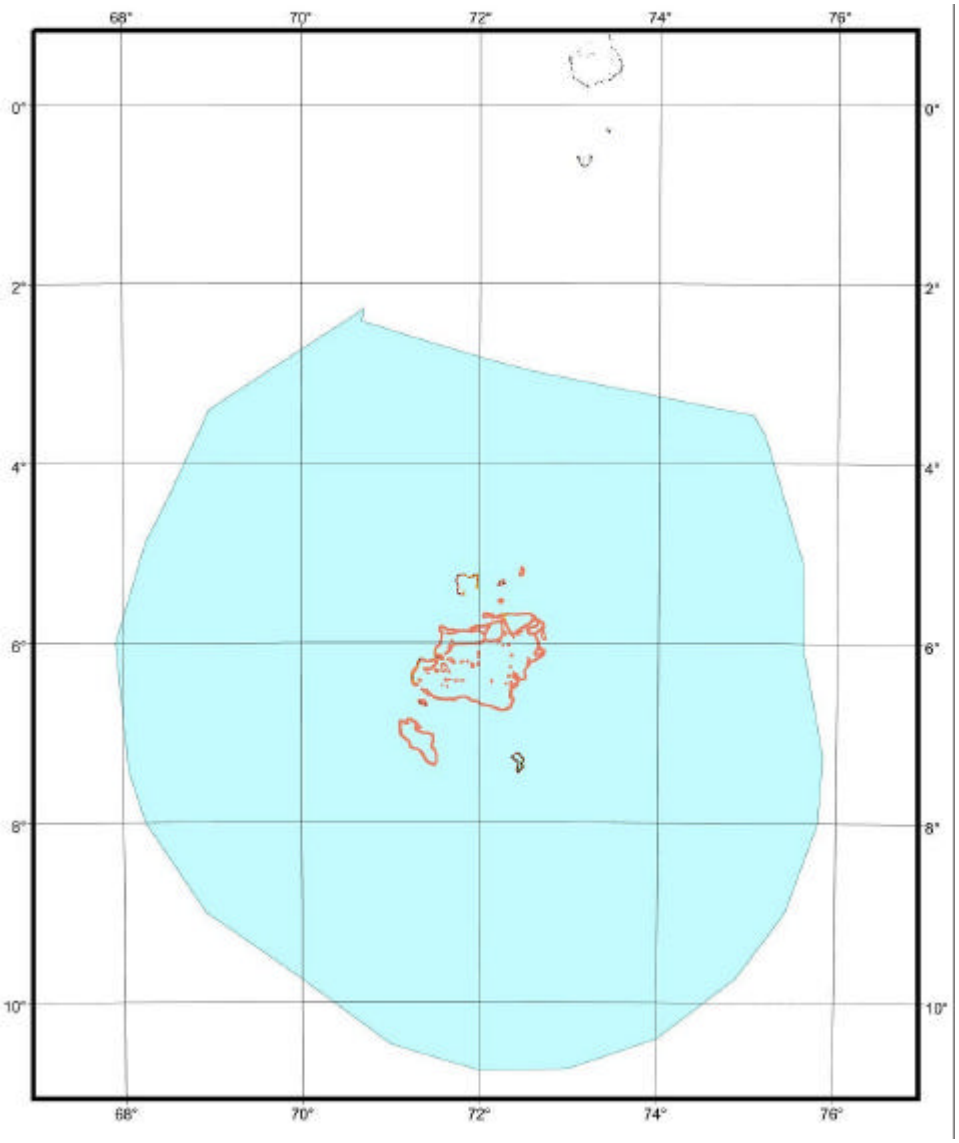
Salomon Islands , Admiralty Charts and Publications, chart No. 4. 1:38,180 Gnomonic Projection, UK 1994,

Egmont Islands, Admiralty Charts and Publications, chart No. 4. 1:72,600 Transverse Mercator , UK 1994;

Peros Banhos , Admiralty Charts and Publications, chart No. 4. 1:72,600 Mercator, UK 1994;

Great Chagos Bank , Hydrographic Office, UK, chart No 3, 1:360,000, Mercator Projection, 1976.

Great Chagos Bank , Defense Mapping Agency, USA, chart No. 61610, 1:360,000, Mercator Projection, Washington DC, 1976.



The British Indian Ocean Territory Exclusive Economic Zone. The EEZ area is approximately: 160,000 square nautical miles, or 209,000 square miles, or 544,000 square km.

This is also approximately the outer boundary of the Environment (Preservation and Protection) Zone.

1 Summary

This Chagos Conservation Management Plan (CCMP) takes a fresh look at the conservation of the biodiversity and natural resources of the British Indian Ocean Territory (BIOT). Various legal and management interventions already exist, but the government has recognised the need for a more comprehensive approach to ensure the long-term protection and sustainable use of this region. This document does not aim to replace existing management but rather seeks to complement it, and add to it in matters relating to good environmental governance of the region. The archipelago is arguably the most important island and coral reef wilderness area in the Indian Ocean, and with its vast reefs (Figure 1.1) and about 50 small islands (Figure 1.2), it is a place of unrivalled conservation interest.

To date Chagos has suffered relatively little in terms of direct human impacts. Its location makes it a place of critical value regionally, providing a connection or stepping stone between east and west. It is an unusual site in the increasingly pressured Indian Ocean, whose surrounding shores are over-exploited and degraded.

Implementation of this CCMP will go some way to implementing the UK Government's conservation objectives, including the targets for 2012 of the World Summit on Sustainable Development. It takes into account:

- The existing legal framework, existing protected areas and current management practices,
- The particular conditions of the area, namely its remoteness and difficulty of access, the small size of most islands, and the vast and widely dispersed reefs,
- The inappropriateness of many aspects of con-

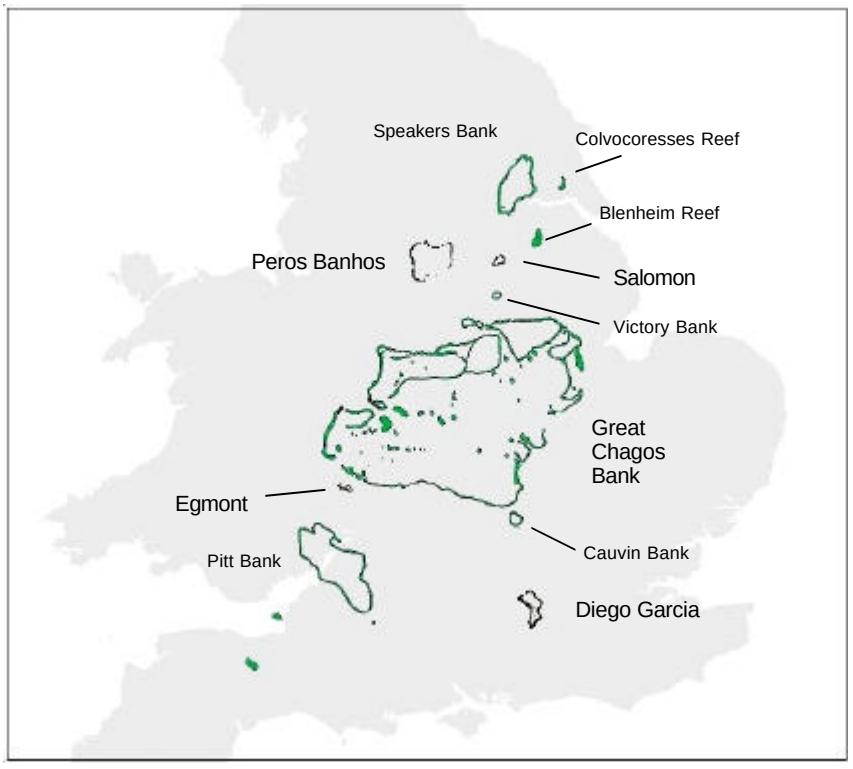


Figure 1.1 British Indian Ocean Territory and part of England and Wales, to same scale, illustrating the size of BIOT. Green shows shallow, submerged reefs. Islanded atolls, and major or referenced submerged atolls and banks are named, the latter in smaller print.

ventional management plans, given the absence of a local population which needs managing and the lack of simple facilities in most of it from which to carry it out, and

? The need for up-to-date management methods despite the above, to ensure its long term conservation.

This document brings together activities of all sectors which impact on natural resources, over the whole archipelago, in an integrated approach. Chapters following this provide review and explanation for the plan. The CCMP is also set against the background of, firstly, the massive mortality of most reefs in the Indian Ocean in 1998 and the increasing probability that this kind of warming event will recur and, secondly, of islands which have low elevations and increasing vulnerability to climate change. This CCMP provides a set of actions that would achieve the conservation of the archipelago as a whole.

The CCMP is simple. It ***must*** be so due to access problems, but it ***can*** be simple due to the lack of complex human / interactions over most of the area. Its generally excellent condition can be attributed to this lack of human pressures. Where there are people (visitors to northern atolls as well as the special case of Diego Garcia), separate sections address important issues there. The CCMP suggested here can largely bypass many of the classic sectorial issues, and does so by use of three key actions. Specifics are important, but if these three actions are implemented, many of the details will automatically be accounted for.

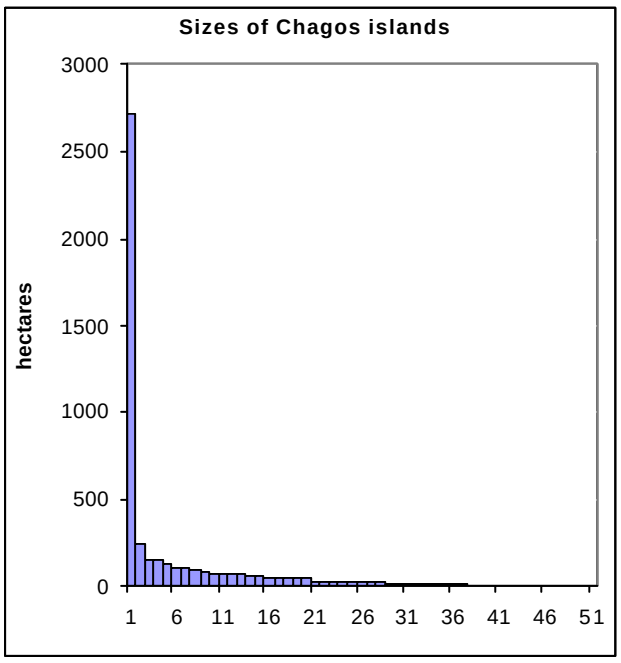


Figure 1.2 Areas of all Chagos islands (excluding seasonal bars or those dry only at low water. In order of size, those larger than 100 hectares are, from left to right:

Diego Garcia (2,720 ha), Eagle (Great Chagos Bank) 245 ha, Ile Pierre (Peros Banhos) 150 ha, Eastern Egmont ~150 ha, Ile de Coin (Peros Banhos) 128 ha, Ile Boddam (Salomon) 108 ha.

1. Extensive, fully protected areas. Much is made of the simplicity of this measure which is gaining wide success around the world. BIOT already has extensive protection on land, but its marine waters are largely unprotected. The area needed to be covered is one third. This proportion may seem large, but is based on recent scientific argument. Protection under this scheme need not mean exclusion from all access, in the case of reefs at least, but does mean exclusion of all extractive activity, construction or other interference, including anchoring on coral-rich areas. The 30% proportion has been shown to allow: recovery of damaged areas; supply of juveniles to areas which are exploited; increased and restored catches in adjacent exploited areas; and maintenance of enough protected habitat to allow a 'natural' ecosystem to persist, particularly in the face of changing climate and increasing exploitation elsewhere. In the case of special islands, it does mean general exclusion (as at present).

2. Scientific advisory group and a programme of regular monitoring and rapid managerial response. It is imperative to build up the base-

Figure 1.3 Ile Yéyé, northeast Peros Banhos, and an un-named islet.

This photo captures many issues of the northern reefs and atolls. The seaward reef flat (left side) is narrow and, following the mortality of 1998 caused by warming, currently has very reduced coral growth. Yéyé is only 60 ha yet is one of the larger islands. It used to be farmed for coconuts. The smaller islet shows signs of erosion, broaches of its rim, and 'inland' flooding. Island elevations are very low, yet sea level is rising. Island rims are generally the highest points of the islands, whose interiors tend to be near or even below water levels. In lagoons (right side) coral survival was much better, so lagoons may help restock damaged areas. The remoteness of the area is evident.

line knowledge of BIOT, but also to actively commence monitoring changes over time. It is only through such work that we will be able to determine change, which may result from fisheries impacts, anchor damage, introduced species or climate change. Key aspects include coral reef biota and condition, including fish-stocks, and assessment of coastline erosion. Coupled to monitoring, rapid managerial and legal response must follow. For example, boundaries of protected areas may need adjusting if and when rich sites are discovered - an example would be the discovery by fishermen of a spawning aggregation of grouper, which could be extinguished in very short time if not immediately protected. Another example would be discovery of reef locations where coral survival was high - such areas need protection if they are to serve as potential sites for future recovery. On islands, increasing erosion is likely to become important; here, monitoring is the only way to estimate severity and timing of problems. To attain these, a scientific advisory group is recommended. This would follow 'Guidelines 2000' and 'The Code of Practice for Scientific Advisory Committees' issued by the Office of Science and Technology.

3. A practical mechanism for information gathering. The present fisheries protection vessel already supports regular patrols to the northern atolls for BIOT administrative tasks, and has supported several scientific projects over the years. While its role remains primarily fisheries protection and sovereignty issues, continued use of this vessel for necessary information gathering will be required on occasion. No greater size or cost of vessel would be needed, and nor would there be any conflict with present use.

These three points appear throughout this document. One problem is that, despite several scientific visits, many huge areas remain unobserved, and the approach taken here reflects this limitation. Management must be flexible.

Diego Garcia.

A perfectly sound management regime already exists for Diego Garcia in terms of its 'human environment'. Nothing is added to this. What is added concerns long term conservation of the atoll, focusing on shoreline erosion, the potential problem of the excavated west-

ern reef flat, and sources and use of material for future land fill.

Resettlement and Chagossian access

Consequences of possible resettlement was subject to a separate study. Settlement would require environmental and pollution management, for each atoll, of the sort which currently exists for Diego Garcia in its NRMP. The present document addresses the archipelago as a whole, in its present condition with respect to population and visitors. This is an overall conservation plan and presents mechanisms to make it work.

Whether or not resettlement occurs, Chagossians have access to all islands except Diego Garcia. However, Chagossians are subject to conservation controls on islands in the way that applies to other visitors.

Future climate changes

Changing climate means that the past is no longer a good guide to the future; coral death, rising fishing pressure, rising sea level, coastal erosion and the rest, are already having profound effects on all Indian Ocean reefs. If these measures are implemented, Chagos stands the best possible chance of escaping the worst effects, perhaps for decades.

In conclusion:

This CCMP is deliberately simple due to logistical constraints, and it ***can*** be simple due to its unusual nature. Much of the detail normally found in CMPs of inhabited areas can be side-stepped here, and its simplicity will allow it to work well in these conditions.

Time is not on the side of the Chagos ecosystem. If these measures are to work in this rapidly changing part of the world, they should be implemented rapidly. The purpose of the scientific committee would be to suggest timely actions for issues which arise.

The archipelago is also exceptionally beautiful. Such considerations regrettably are omitted from many scientific documents, though scenic and aesthetic considerations do form key components, and even the main basis, of many protected area designations worldwide. This archipelago merits protection for this alone, in the view of many. Indeed, its government correctly alludes to this aspect in several documents such as its annual conservation reports and statements.

Figure 1.4 Seaward reef slopes of northern Chagos atolls. Both illustrate approximately the same site.
Left: A thriving reef in 1996. Right: the site in 2001, three years after the near-total mortality of corals and soft corals down to about 10-20 m depth, resulting from the warming of 1998. In the right photo, the dead corals have eroded, so that the sea bed is covered with bare rock and by mobile dead coral rubble.

2 The Management Plan

An inability to effectively police and manage most of BIOT except Diego Garcia has long been cited as the reason for the lack of active conservation management. However, several important Strict Nature Reserves have been declared, and improved management is possible with some relatively modest changes

Long term objectives

The following long term objectives should be pursued to the greatest extent compatible with current and future constraints relating to the use and occupation of the Chagos islands, including Diego Garcia, and with the resources available.

Aims are:

To maintain or restore BIOT as an intact, functioning coral reef / atoll system dominated by native species, and to maintain the resilience of the Chagos ecosystem.

To ensure that all human uses of the natural resources of BIOT are sustainable and set within the context of an ecosystem and precautionary approach.

To conserve or restore to carrying capacity the populations of globally threatened or regionally and locally significant populations of native species.

To eradicate, control at non-damaging levels and prevent further establishment of populations of non-native species which could threaten biodiversity.

Three cornerstones underpin this Management Plan. Following these three, Paragraph 4 details key aspects which should be undertaken as soon as possible.

1. To conserve within BIOT a representative and viable sample of all terrestrial and marine habitats (The 30% Protected Area scheme).

1.1 Designate a representative sample, comprising c.30% by area, of all terrestrial and marine habitats within the archipelago. Within these areas, no extractive activity of any kind should be permitted, including fishing to the extent feasible. The need for this proportion of protected area is now well documented. Figure 2.1 shows boundaries for recommended Protected Areas, with explanations.

1.2 The ability is needed to expand boundaries or add sites according to new information. This will be swift and simple given the scientific management advisory group described below.

1.3 Include in the protected area system areas with newly discovered rare or endangered species, or important, newly discovered populations.

2. Establishment of a scientific advisory group

This essentially formalises a practice which already takes place and which follows *Scientific Advice and Policy Making* guidelines from the Office of Science and Technology (www.ost.gov.uk/policy/advice/index.htm). Participants on this group should include tropical island and reef scientists, fisheries scientists and others as needed. Formalisation will allow members

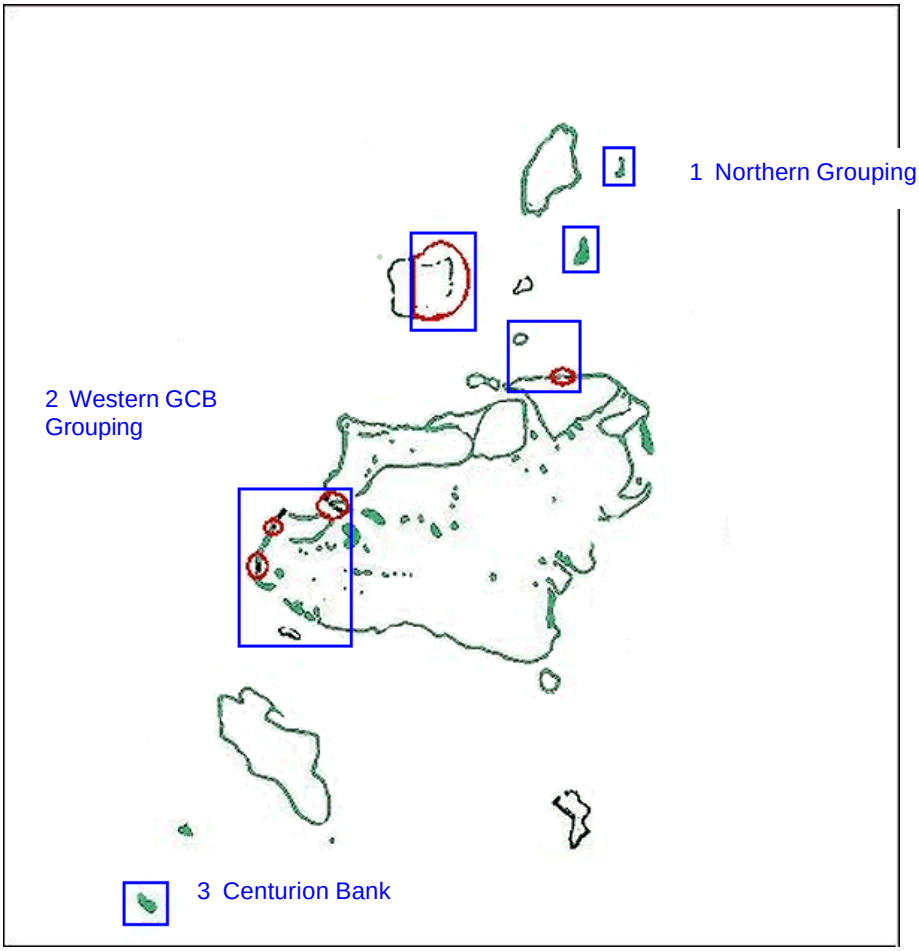


Figure 2.1. Blue boxes indicate recommended Protected Areas for Chagos Archipelago (other than Diego Garcia which is separately commented upon) based on present knowledge. Red lines enclose existing Strict Nature Reserves. This has three groupings.

The Northern Grouping of four boxes cannot simply be enclosed into one, because of use and presumed continued use of the atolls. Some of its components (Blenheim, Colvocoresses, Victory, northern GCB adjacent to Nelson Island) appear lightly fished at present (see figure 3.5). Colvocoresses is exceptionally rich (A. Watson, personal communication).
The western GCB. Reefs of this section of the Great Chagos Bank is the only section of this huge atoll which has been well studied, and are known to be extremely biodiverse. This box includes extensive bird islands. It is, however, well fished at present. The box is drawn south to include Egmont atoll, which appears not to be heavily fished.
Centurion Bank. This small area is included for three reasons. It is not a heavy focus of fishing. It is diametrically opposite the Northern Grouping (ref the explanation earlier that geographically widespread sites are highly desirable), and it is apparently (in 2000) possibly the richest site of all (A. Watson, personal communication).

to bring matters to the attention of BIOT, at an early stage. This body should:

2.1 Establish by end 2004, monitoring protocols and a planned programme for priority features.

2.2 Encourage, enable and ask the BIOT Government to commission visits by scientists to undertake monitoring and survey, or to ask the BIOT Government to lend support to relevant scientific research proposals. Assist where possible applications from scientists for funding from conventional bodies for research in the area.

2.3 Include a conservation adviser and ensure annual visits by him/her to BIOT.

2.4 Disseminate the results of research and monitoring widely to decisions makers, the scientific community and wider general public.

2.5 Determine the future conservation and nature protection needs of BIOT with the BIOT Administration.

3. Support for information gathering

Any conservation management or scientific work to support it requires information gathering, and this requires some inter-island transportation. There is at present a Fisheries Protection Vessel which previously has supported a few scientific visits in addition to its primary roles. While this appears to be the most cost effective means of securing essential information and scientific data, there should not and need not be a conflict with its current essential fisheries role.

4. Details of specific needs

(Reference to later sections provides background to most items.)

1. Monitoring and research

1.1 There is a need for a regular programme of monitoring of islands (seabirds, turtles), and reefs (corals, reef fish), both within and outside designated areas. These can be viewed as 'sentinel' species.

1.2 A monitoring programme of reefs should be undertaken as directed by the scientific advisory group.

1.3 More substantial programmes (e.g. as in 1996 with 18 people) should be mounted when needed, in response to identified needs, not expected to be more frequent than every 5-8 years.

1.4 The scientific advisory group would be expected to form links with other UK research groups. E.g., the Natural Environment Research Council whose ships occasionally visit other parts of the Indian Ocean.

2. Protected areas (Background in Section 3)

2.1 The initial boundaries of protected areas shown on Figure 2.1 should be declared.

2.2 Recognising that much of the region has never been surveyed, boundary changes or additions would be recommended by the Scientific Advisory Group following results obtained from monitoring visits or by the conservation adviser on annual visits.

3. Plant conservation (Background in Section 4)

3.1 Vegetation cutting other than that authorised should be prohibited. Several species should be 'named' as is the case with fauna, specifically the high shoreline bush *Scaevola*, and all hardwood with the exception of *Casuarina*.

3.2 Exceptions required for conservation projects (e.g.

removal for access in a rat eradication project) should require specific authority of the BIOT Administration or local authority.

4 Species introductions (Background in Section 4)

The requirement to not introduce species is adequately clear in the Notice to Visitors, as are penalties for violations. The practice may fall short.

4.1 Ballast water discharge is a major source of introduced species in many parts of the world. This should be specifically prohibited in all BIOT waters.

4.2 The importance of preventing species introductions into Diego Garcia needs to be continually emphasised. Effective quarantine remains essential. This has been highlighted in several annual reports of the conservation advisor (113).

5 Eradication of introduced species to aid natural restoration of turtles, birds and vegetation (Background in Section 4)

The BIOT government is committed to continuing efforts of control and eradication of some important alien species.

5.1 Eagle Island has been selected as being a priority for rat eradication. This island is remote from other rat infested islands, minimising risk of reintroduction. Its size would mean that success would approximately double the rat-free habitat in the archipelago, with probably extremely beneficial consequences to birds, which are largely absent at present, and to turtles. Investigation and exploration of the feasibility of this has started, and should continue.

5.2 Monitoring of rats from any islands targeted for eradication should be annual (by visits by the conservation adviser) who also will monitor any bird recovery. If possible, additional 6 monthly checks should be made on an opportunistic basis.

6 Fisheries (Background in Section 5)

The intent is to ensure that commercial & recreational fisheries in BIOT are harvested sustainably, reflect international obligations & collaboration, and incorporate an ecosystem and precautionary approach.

Fisheries management provides a good example of successful management in BIOT. BIOT waters are one of the very few large areas of the Indian Ocean with demonstrable and beneficial husbandry.

Responses to changes have been implemented, and this flexibility remains essential. Notable have been the responses to the 1998 mass coral mortality when the number of fishing licences was reduced, measures concerning sharks, and measures concerning spawning aggregations were introduced.

6.1 The BIOT government should remain actively engaged in the Indian Ocean Tuna Commission, recommending precautionary measures, to ensure the sustainable management of migratory species. BIOT should argue for a ban on steel trace within the IOTC area. This would greatly reduce shark by-catch in the long-line fishery.

6.2 The observer system is effective and studies on incidental mortality carried out since 2001 should be continued. Turtle and seabird by-catch should continue to be monitored. Findings should be made widely available.

6.3 A shark plan is required under the IPOA for the Conservation and Management of Sharks, which should consider a total ban on shark fishing. Even unilaterally declared, this would have a major impact

on shark by-catch in the tuna fishery.

6.4 The drift netting prohibition should continue.

6.5 Purse seining around cetaceans should be prohibited.

6.7 The definition of "lagoon" as held in the current license agreement should be clearly stated to include atoll channels up to 500 m offshore, to avoid likely sites for spawning aggregations.

6.8 Fishing of spawning aggregations should be expressly prohibited within the license agreements. When location of aggregations become known, they should be quickly incorporated into the protected area network, giving permanent legal protection.

7 Recreational fishing in Diego Garcia (Background in Sections 5, 7)

7.1 All areas included in the Ramsar designation should exclude fishing.

7.3 The log-sheet system should be applied to all fishers. Completion of logs for the recording scheme, should be encouraged.

8. **Visitors to northern atolls (Background in Section 6)**

8.1 The present 'anchor at will' system should be changed to one of anchoring in clearly defined areas or depths.

8.2 The feasibility of moorings should be examined, with a view to adopting a mooring system as soon as possible. Moorings would result in greatly reduced damage.

8.3 Current levels of charging are very low. Once (or if) moorings are in place , BIOT Administration will look at the fee structure and the desirability of setting a maximum stay duration of 1 month.

8.4 Notice boards should contain the text found in the new handout to visitors. The latter is clear.

9 Enforcement

9.1 Enforcement is possible, in exactly the same way as is currently applied to illegal fishing vessels. The new handout explains clearly that expulsion is possible, which could be chosen as a simpler alternative to confiscation and fines by the local officers according to local judgement.

9.2 As noted by the conservation consultant four years ago: "Never has it been so important to establish a permanent BIOT Patrol vessel… It is for consideration that when the FPV is not engaged on fisheries duties, the ship could be employed on Chagos research" (114). The value of the FPV in this respect in the past has been clear.

9.3 The effectiveness of policing is related to considerable degree to the extent to which a policing party is aboard the fisheries patrol vessel. The new BIOT guidelines to visitors make clear the penalties of infringing the conservation rules, and only such a presence could impose them.

10. Diego Garcia (Background in Section 7)

10.1 A Conservation Consultant should continue annual visits which focus on Diego Garcia. These visits should, where possible, coincide with visits by other scientists. The consultant should be a key member of the scientific advisory group.

10.2 Monitoring of the natural environment is the responsibility of the UK government, but support should be sought from the US government—the main users.

10.3 Provision should be made for the inclusion of UK government appointed scientists on all monitoring activities to ensure consistency with other ongoing work, and adequate data transfer.

10.4 A 15 year material requirement study is needed, or if done, made available to BIOT Administration.

10.5 There should be a prohibition of lagoon extraction unless essential to existing channel maintenance.

10.6 A study should commence to examine 'restoration' of the western, trenched seaward reef. It has not and will not recover as some hoped, so traditional concrete strengthening and new 'electrolysis' methods should be examined. The Natural Resources Management Plan's request for 'artificial reef' work is most sensibly directed here.

10.7 Surveys are needed of progressive shoreline erosion to better than 10 cm accuracy.

10.8 Investigations should be made regarding active replacing of shoreline *Scaevola* and / or *Tournefortia* in all areas where previously it was removed, with a view to replacing the concrete debris used to repair the gaps.

10.9 All environmental reports and studies should be made available to BIOT Government.

10.10 The NRMP recommends several series of 'baseline surveys' followed by annual or near annual follow-up studies. These can all be consolidated into one series. This would best be planned and co-ordinated by the scientific advisory group in conjunction with the USA. These should be carried out.

10.11 The NRMP recommended annual monitoring. The need for this has increased, due to recent massive changes to the condition of the reefs. Changes should be measured using standard methods for both the coral reefs and the seagrass beds. These would be designed by the scientific advisory group.

Figure 2.2 Left: Middle Brother, western rim of the Great Chagos Bank. This island is part of a tiny atoll-shaped 'ring reef' with a remarkable lagoon of 10 metres deep, and with one channel cut through the reef flat. It is the only structure of its kind in Chagos, and resembles some 'faros' found in Maldivian atolls. This reef sits in a larger ring of reefs, the latter in turn being part of the western rim of the largest ring of coral of all, the Great Chagos Bank - the atoll with the largest area in the world. Aerial photo from 1970s, taken by 'Eyes of the Fleet'.

Right: Middle Brother, the shore seen from the little lagoon. All the dots on the shore are terns.

3 Protected Areas

Protected areas were recognised by the UN Economic and Social Council in 1959 as providing a means of conserving nature and natural resources, and providing benefit. Substantial work since then has confirmed that, in many cases, it provides the only or best means of doing so. Many have been designated, but in many, a lack of subsequent monitoring means their effectiveness and benefits remain unknown.

Today, estimates of what proportion should be protected to ensure preservation of many marine ecosystems, has risen to 30%. In the recent *Troubled waters: a Call to Action* (176), over 1,600 scientists called for the protection of 20% of marine areas, to be set aside for reserves. A recent review (177) cites 26 separate scientific studies on optimum reserve areas and conclude that 20-40% should be set aside for no-take. The mean figure of 30% should be the target for Chagos. It cannot be prescribed completely at present because over half of the archipelago has never been surveyed in even a rudimentary way, though this CCMP proposes a substantial start to this process through its monitoring recommendations. This proportion has, moreover, already been achieved in Diego Garcia lagoon and islands.

It is now recognised that no-take zones are critical for fisheries management (this has been endorsed by the British Mauritian Fisheries Commission, Section 5), as well as for general reef conservation. Examples of benefits from such protection include the increased availability of these species to fisheries operating outside the protected areas. Such benefits may become more urgently required as vessels increasingly use the

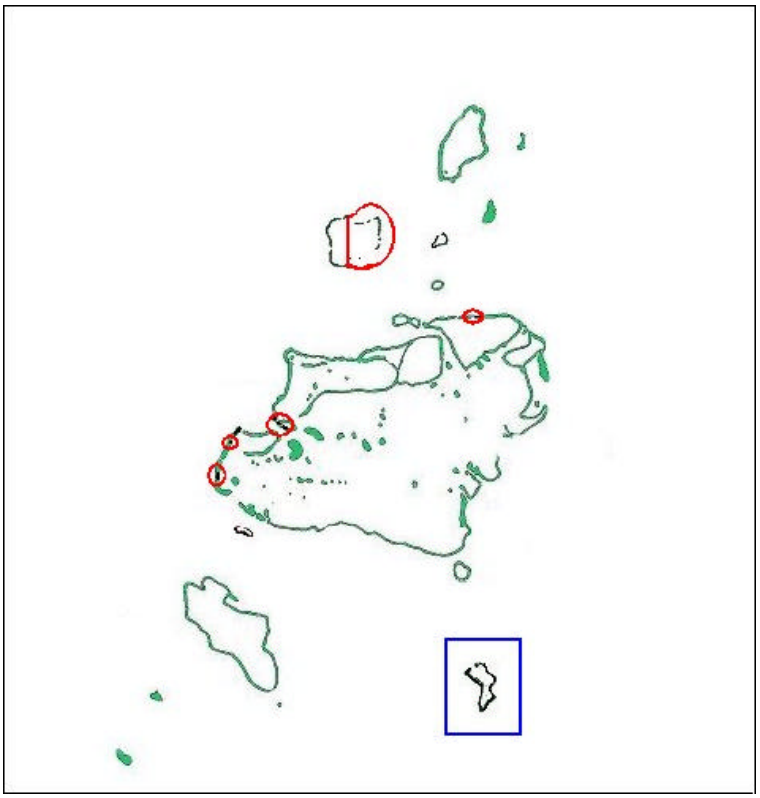


Figure 3.1 Existing protected areas. In Chagos. Red boundaries are all Strict Nature Reserves. For Diego Garcia (blue box) see Figures 3.2 and 3.3 for detail. From North to South:

Peros Banhos Atoll Strict Nature Reserve
(All islands to the east of a line drawn between the easternmost point of land on Moresby Island and the easternmost point of land on Fouquet Island).
Nelson Island Strict Nature Reserve
The Three Brothers and Resurgent Islands Strict Nature Reserve
Cow Island Strict Nature Reserve
Danger Island Strict Nature Reserve

These categories are probably equivalent to the IUCN **category Ia** "Strict Nature Reserve: protected area managed mainly for science… Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring".

Indian Ocean, as other oceans become depleted. The existence of effective protected areas also allows for the accurate monitoring of recovery of areas. Finally, marine protected areas also provide an important security measure against potential future climate change. During periods of high mortality of corals and other species, there is considerable geographic variation in the extent of the impacts; if areas of higher survival are discovered by monitoring and are then protected (e.g. from anchoring), they will serve an important role in future recovery.

Existing protected areas

Figures 3.1 - 3.3 show existing protected areas, created under various instruments. Areas in other atolls are called 'Strict Nature Reserves' into which entry is prohibited and activities are clearly proscribed by BIOT (129, 130, 148). Note however that any commercial fishing within parts of some could substantially downgrade their effectiveness. Captions to Figures 3.1 - 3.3 also show the IUCN (international) equivalent in terms of protection afforded.

Environment Zone

In addition , an Environment (Preservation and Protection) Zone was declared in 2003 (shown in page v). This has as its outer boundary the 200 mile limit of the Fisheries EEZ and has an inner limit which borders the outer limit of the Territorial Seas.

Size and representation of existing system

The total areas currently under some protection are

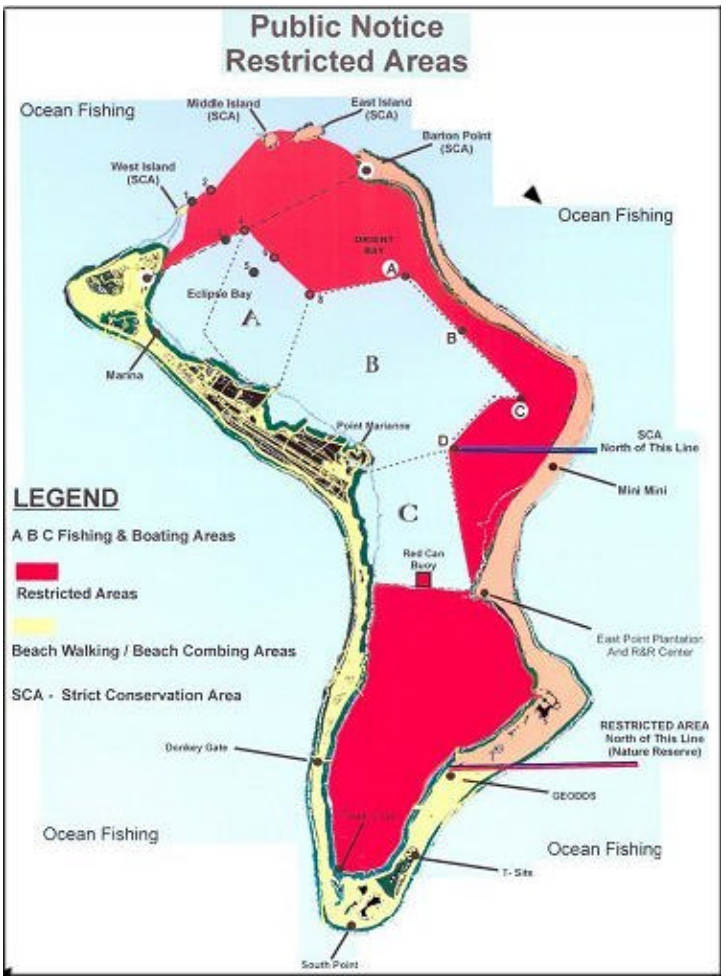


Figure 3.2 Protected areas in Diego Garcia. Diego Garcia Restricted Area includes:

Nature Reserve Area

Lagoon area: from Rambler Bay to Main Passage

These are probably equivalent to IUCN Category V.

Special Conservation Areas: Barton Point, East Island, Middle Island, West Island

These are probably equivalent to IUCN Category 1a.

Diego Garcia Ramsar Site (see next figure)

IUCN **category Ia** "Strict Nature Reserve: protected area managed mainly for science… Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring". **Category V** is "Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation") and probably equates to the Nature Reserve Area. Marine areas within the lagoon are probably equivalent to IUCN category V.

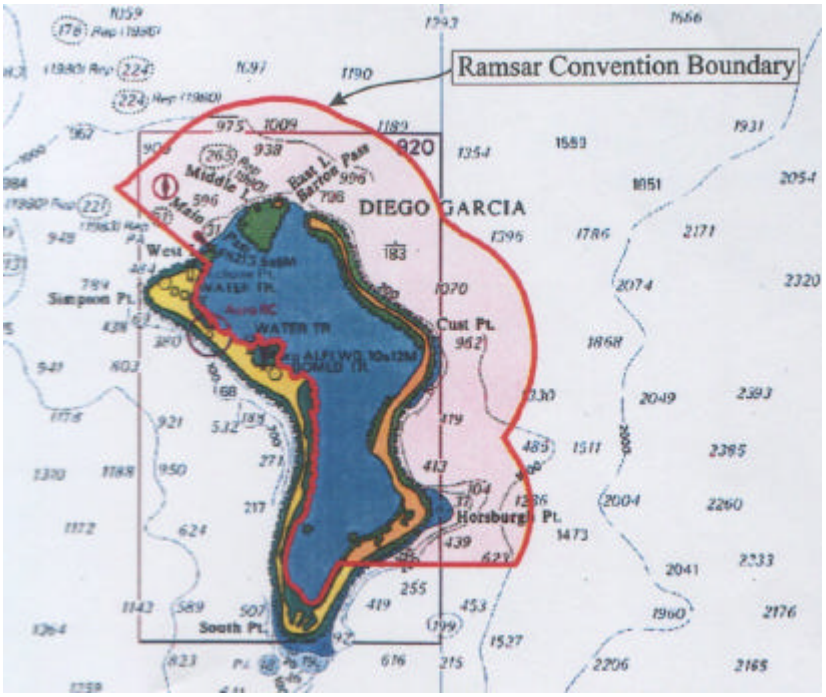


Figure 3.3 Diego Garcia Ramsar site. (Map supplied by Joint Nature Conservation Committee.)

c.19 sq km of land, and c.377 sq km of shallow reef. These represent about 35% of the total land area, and 3 % of reefs to 60 m depth (21).

For the islands this is suitable, especially since the rat-free islands are included with their seabird populations and, in some cases, native hardwood stands.

For the reefs, much too little is protected: fishing of some kinds is allowed in several of these zones, and additionally, too little is known about huge swathes (eastern Great Chagos Bank) to know how representative the present small protected zones actually are. Currently, marine protection is confined to lagoon areas in Diego Garcia and to the Strict Nature Reserve areas of the northern atolls. Although these would appear extensive, commercial fishing within some renders protection of the marine component of these sites effectively meaningless. No protection is provided to reef or shallow benthic areas away from these reserves. Thus while about 3% of the shallow waters of the Chagos Archipelago appear to fall within protected areas, the area of real protection is less.

Most of the outer protected areas (Strict Nature Reserves) are defined by their islands, with access prohibited within 200 metres of the islands, as stated in the handout given to yachts. This distance would not exclude walking on several of the reef flats surrounding these islands (e.g. Middle Brother).

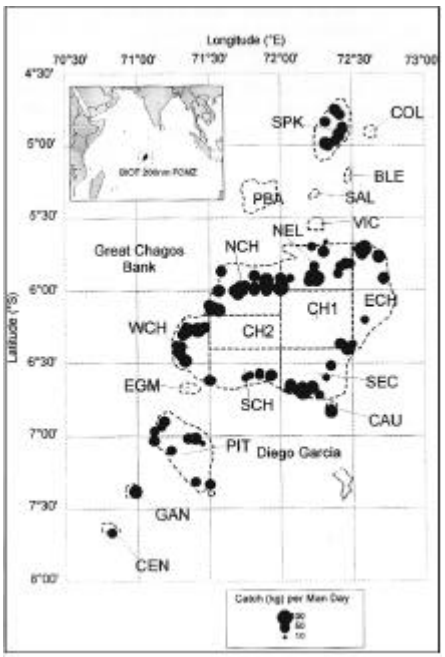
At present, commercial vessels may fish in lagoon channels, though not in the lagoon. Channels are a part of lagoons in ecological terms, and generally are some of their richest parts, and are used by several commercially important species as spawning grounds. At present fishing in these areas appears to be slight with the exception of a recent targeting of a spawning area.

Several atolls have to date been excluded because they have no permanent islands or are more deeply submerged, yet these atolls have similar marine biological characteristics to islanded atolls.

The 30% Protected Areas system

Of great importance in any protected areas system is the need to include a representative selection of all habitats. Much of Chagos remains unknown, so boundaries are proposed based on existing information. It thus has a more modest scope in terms of area than is desirable. The intent is mainly conservation, but is also designed to accommodate fisheries, which have continued here for decades, with as little disruption as possible. It is believed that reef fishery capture is currently below sustainable yields (38), and it is also possible to determine areas which are relatively little fished (38, 40) but which past surveys have shown to contain rich reefs. Rich but little fished sites are prime candidates for protection.

Figure 3.5 shows existing commercial fishing locations (38). It also shows several locations, known to support rich reefs, where fishing is apparently not high: Blenheim, Colvocoresses and Victory Banks in the North, much of the northern Great Chagos Bank near Nelson (though further south into the lagoon is heavily targeted), and Egmont atoll.



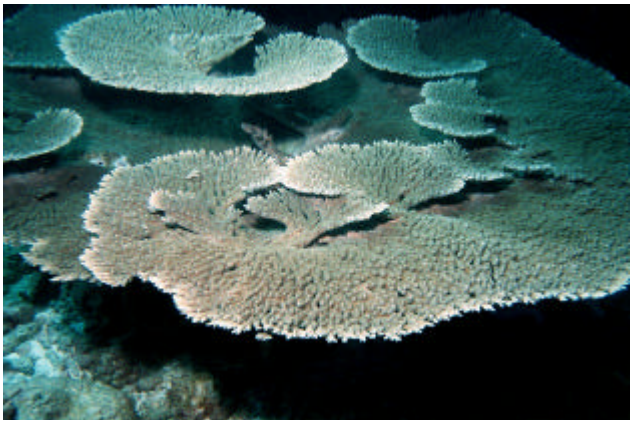


Figure 3.4 Table corals and staghorn corals were almost entirely killed in 1998. A few large survivors of these kinds were discovered in 2001 in Peros Banhos near the jetty of Ile de Coin. This is a site where anchoring currently takes place. Rapid management would be needed to protect this site from anchor damage.

Other vital considerations for determining the boundaries shown in Section 2 are:

- Protected sites must be geographically widespread, incorporating representative areas of all habitats as they become known, and will include isolated banks. Future monitoring would add to or modify boundaries .
- The size of areas should bear in mind requirements of management. Fewer, larger and contiguous areas are preferable to many small ones, though some fragmentation may be needed where existing use can be accommodated without detriment.
- Particularly vulnerable communities, or locations, should be singled out. Notably, this would include areas where spawning aggregations of commercially important fish were observed, or where corals were found to have survived mortality from warming. Rapid response to extend or designate new boundaries should be permitted to capture such essential core areas as they are discovered.

Figure 3.5 Chagos Archipelago, indicating statistical fishing sectors and average dory catch rate information per mother-vessel relative to the anchoring position of the mother-vessel, recorded in log-books during 1997. (Figure and caption from reference 38 by Mees et al).

The protected area boundaries shown in Figure 2.1 reflects these factors. These areas should have complete biological protection. Passage need not be affected. As at present, there should be no access to the included islands which are Strict Nature Reserves. With regard to Diego Garcia, current protection provided to marine areas is largely restricted to lagoon waters. The restricted area coverage on this island should be extended to cover 30% of the reef flats and outer reef slopes. To accommodate present use, most suitable for this would be the seaward side of the eastern side of that atoll. With regard to terrestrial protection in Diego Garcia, there may be a need to give the Restricted Area a stronger legal instrument than the current Public Notices.

Management and enforcement

The declaration of protected areas must be accompanied by the means to manage and to enforce legislation. This is addressed in other Sections (especially 6 and 9).

International protected areas

The above is independent of any international designations. Declaration of protected areas under international legislation confers prestige and recognition of the international importance of a site. In 1999 the UK government extended its commitments under the Ramsar Convention to include BIOT. So far, a large site has been declared in Diego Garcia. Two main areas marked in Figure 3.6 (the northern grouping of reefs and banks, and the western Great Chagos Bank area), would be preferred follow-up areas (based on current knowledge of their biodiversity).

4 Species: protection and eradication

Chagos is host to as many as 60 species which are included in the IUCN Red List. Some 19 of these are defined as threatened, while many others are insufficiently known for a clear threat category to be assigned. Most species protection is achieved by proper protection of habitat, as outlined in Section 3 though special cases may require specific regulations. The Convention on International Trade in Endangered Species (CITES) governs trade of several species, local regulations prohibit access to most bird breeding sites, and other local ordinance prohibits collection of or interference with several other species groups. This section notes those which need special attention, whether or not they already are listed in CITES conservation appendices or BIOT regulations. The question of introduced invasive species is included here. Fish and fish spawning assemblages are covered in Section 5.

Of particular note is the fact that this region is especially rich, partly because of very limited exploitation to date by humans. It is a key 'stepping stone' for marine species in the Indian Ocean, and one of few and a diminishing number of areas which can continue to serve as nurseries, or sources, for other increasingly pressurised parts of the Indian Ocean. Its importance comes partly from the fact that it still does have rich and biodiverse habitats of kinds which are decreasingly common in the Ocean as a whole.

Existing measures

Current provisions to protect wildlife in Chagos forbid the killing or harming of any animal, with the exception of fish and marine products specified under fisheries legislation, pests or vermin. It is illegal to destroy or damage any nest or eggs belonging to turtles and birds. It is not permitted to be in possession of any coral, alive or dead, or of any seashell which is alive or which was taken alive. Prohibitions regarding the Coconut crab receive special mention. Trade restrictions prevent the export of almost all animal materials with the exception of seashells not taken alive. International regulations under CITES are strictly enforced. Turtles,

Figure 4.1 The tiny hardwood forest of *Pisonia* in the Three Brothers is a rare remnant of this vegetation in the Indian Ocean.

giant clams and most hard corals are listed under CITES appendices also. These are all sufficient.

There is little specific legislation preventing damage to plant-life. Prohibitions on forestry and on lighting unauthorised fires provide some protection to plants. Clearer wording is needed with respect to plants. Most hardwoods are extremely limited and their extraction is likely to be non-sustainable.

Introduced species

One of the biggest problems facing life on remote islands is that of introduced species. About 45 plant species are thought to be native to these islands (112, 113), amongst a list which now stands close to 280. Over 100 plants have arrived in the last 40 years. Many pose a threat to native species, and to the island ecology.

Introduced animals can be an even greater problem. Rats are present on 36 islands, including all the largest. Rats regularly feed on birds eggs and chicks and can severely reduce the populations of breeding seabirds. However, around the world successful rat eradication has now become commonplace, and there is no reason to suppose that it would not succeed if tried on Chagos islands.

Figure 4.2 Coconut crab *Birgus latro*. Endangered in much of the world, Chagos islands are home to significant populations. They are under threat from illegal poaching by visitors.

Rat eradication. For this reason rat eradication is proposed for Eagle Island. The island is large enough to be significant, is the only island on the Great Chagos Bank which has rats, and there is evidence that eradication here could significantly improve habitat for birds, turtles and, eventually, some native vegetation. Examination of the feasibility of this has commenced.

Marine introductions are a global problem. Although there is currently no evidence for marine introductions, this relates simply to the lack of knowledge here. Ma-

Figure 4.3 Many of the smaller islands have enormous densities of seabirds. This is Nelson Island, Great Chagos Bank, where about 22,000 nests were counted in its 80 hectares in 1996 (111). The archipelago has possibly the most important seabird diversity in Indian Ocean islands. Part of Nelson is well elevated compared with most islands (about 3-4 m above sea level in parts), but is very narrow (only about 200 m wide at one point). With the other islands of the Great Chagos Bank, mostly smaller than this, this atoll is the most important for birds in the archipelago.

Figure 4.4 Birds, birds eggs and fledglings, especially of ground-nesting birds, are vulnerable to rats. Eagle Island is the preferred island to eradicate rats because of its size (it is the second largest island in the group), its position (it is in the Great Chagos Bank many of whose islands have prohibited access already) and is least likely to become re-infested (due to its location and distance from other infested islands).

rine introductions regularly occur in other areas; on any one day an estimated 3000 different species are transported alive around the world in ballast waters of ocean-going vessels. In some cases, their release has had devastating social and economic impacts and far-reaching consequences for marine ecosystems.

Ballast water discharge is a potential problem within the BIOT EEZ. This may be covered under existing provisions of the Environment Protection (Overseas Territories) (147) which aims "to replace the Dumping at Sea Act 1974 (c. 20) with fresh provision for controlling the deposit of substances and articles in the sea…".

Pollution is a threat to many groups of species in many coral reef areas, especially enclosed lagoons. Emptying of effluents from vessels in lagoon areas, including sewage and paint scrapings, may come under this provision, though clarity to vessels would possibly help. Sewage in particular should not be discharged into lagoon areas of enclosed lagoon of Diego Garcia due to its exceptionally enclosed nature.

By-catch reduction. Efforts to reduce by-catch, especially of threatened species must be strongly encouraged, and targeting of spawning aggregations should be prohibited; these and other measures are addressed under Fisheries (Section 5).

5 Fisheries

The Chagos Archipelago supports offshore tuna fisheries and a commercial near-shore fishery on the northern reefs. These are covered here. A recreational fishery off Diego Garcia is covered in Section 7. Each operates under different management regimes.

Tuna

These oceanic fishes range widely. Details of the main species are available on request. Many are migratory, and large schools may contain several species. Globally, most tuna stocks are intensively fished, fully-fished or already over-fished. Indian Ocean stocks are being increasingly targeted: catches are "half those of the Atlantic or the Eastern Pacific Oceans, but they have increased rapidly and now account for more than a quarter of world tuna landings. The value of the annual catch of 1.2 million tonnes in the Indian Ocean is also very high (estimated to be between US$2 billion and US$3 billion), as there is a large proportion of valuable fish caught by longlines" (28). Different fishing methods target different species and size classes. Purse-seining, which targets schools containing immature or young fish, has much greater impact on recruitment to the adult population. Long-lining targets larger individuals. Levels of by-catch also vary considerably.

Since the BIOT Fisheries Conservation Management Zone was declared in 1991, monitoring and licensing of the tuna fishery has been managed by MRAG Ltd for BIOT. Since 1993, scientific observers have been placed on some vessels to provide independent information on fishing methods, by-catch, verification of catch statistics, and to undertake sampling. These observations are added to the ship-book records and supplied to the government.

BIOT is the only State in the Indian Ocean region to routinely deploy observers on commercial longline and

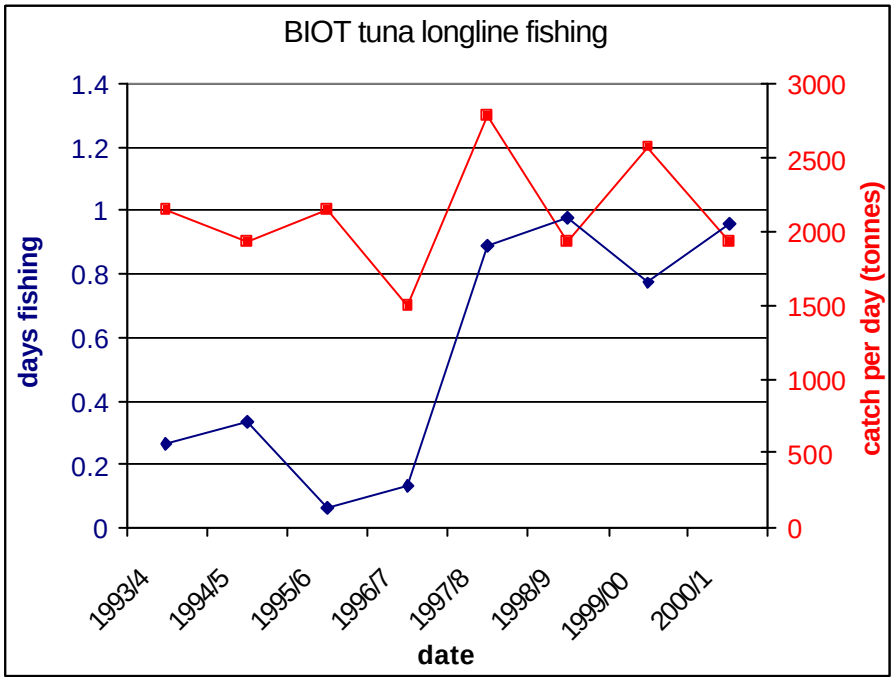


Fig 5.1: Fishing effort and catch per day for the longline fishery. Diamonds (bottom line) are days fishing. Squares (top line) are catch per day.

purse seine vessels targeting tuna. Their information on this fishery and its by-catch is thus of regional importance (J. Pearce, pers. comm., 28/8/02).

Longline fishery

Dominated by vessels operating out of Taiwan RoC (though some under flags of convenience), since 1997/8 about 20% of licences are now taken by Japanese vessels. Longlines may extend over 120 km in length, with 3000 hooks. Lines are set at different depths depending on target species (to below 300m for bigeye tuna). Setting and recovery takes a day, and fish are frozen on board. This fishery targets larger, higher value individuals of yellowfin and bigeye tuna, but there is a broad by-catch.

Over the past eight seasons, this fishery yielded broadly equal quantities of yellowfin and bigeye tuna (Figure 5.1). In 2000/01, 9% (by weight) was made up of billfish (marlin and swordfish), which have a high commercial value and are kept. Sharks make up a further 7%. These may be kept, but the 2000/01 observers noted that only mako sharks (0.23% of the total catch by weight) were kept, the remainder being 'finned', and the bodies discarded.

The 2001/02 observer programme lasted only 4 days on one vessel. Tuna made up 55% of the catch by weight, with billfish a further 15% and sharks 9%. Lancetfish made up a further 15% by weight (Figure 5.3). This common by-catch had not been counted previously. Lancetfishes are soft tissued, unpalatable, and usually are jerked off the lines before being landed, in which case they are not recorded (unless by an observer). This group has probably suffered a high and usually unreported mortality. Other by-catch is low but varied.

Purse seine fishery

This is dominated by Spanish and French vessels, with others from Seychelles and Mauritius, some under flags of convenience. Many follow the yellowfin tuna migration patterns, which means that, from December to mid-February, a large proportion of the western Indian Ocean purse seine fleet may enter BIOT waters.

Purse seiners locate dense schools of tuna, sometimes using fish attracting devices (FADs). The latter

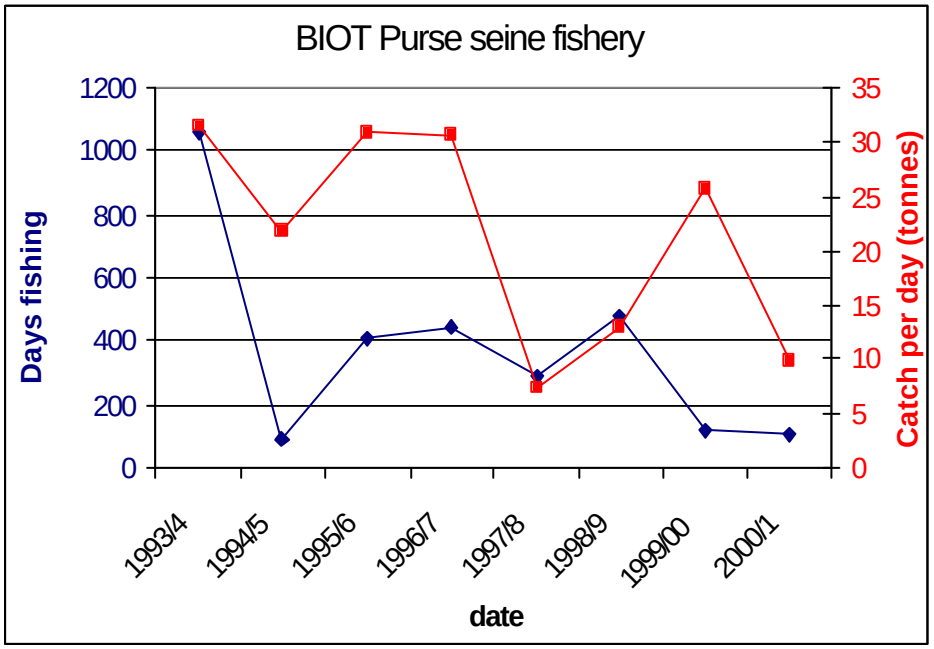


Figure 5.2 Summary of the fishing effort and catch per day for the purse seine fishery. Diamonds (bottom line) are days fishing. Squares (top line) are catch per day.

may be natural objects floating in the water, or rafts, with GPS locating units and fish detection sonar, deployed by the vessel. Nets of over 1.5 km long and 250m deep are set around the school, and the bottom is then drawn in.

Access to this fishery, its licences and fees, are negotiated annually between MRAG Ltd and the fishing companies (two Spanish, and one French) which control the fleet.

BIOT waters are one of few places in the Indian Ocean where free-swimming schools of large yellow-fin tuna can be regularly caught by purse seines. For this reason, FADs are not widely deployed, and vessels are prepared to invest more time in trying to locate these schools (J. Pearce, pers. comm., 28/8/02).

Catch composition has varied significantly over eight years. In 1997/8 the valuable yellowfin were scarce, while the following year they formed 55-75% of the catch. In 2000/01 the catch was mainly (60-75%) skipjack. By-catch is generally <1% from the free schools according to the observer programme in 2000/01.

Sets have sometimes been cast around whales, which may only be reported if observers are present, though there is a code for this on logsheets. The risk of whales damaging valuable nets, however, means that fishers generally avoid capturing the whale. Dolphins associate with tuna, but there are few records of purse seiners targeting such schools here.

Commercial nearshore fisheries

Demersal fisheries have long existed on all Chagos' banks except Diego Garcia. These focus mainly on reef slopes of 30-70 m depth and catch mainly emperors, groupers and snappers. Year 2000 figures show that Lethrinids form 48% of the catch, Serranids 35%, Lutjanids 16% and others 1%.

Coral reef fisheries are complex, and are still poorly understood. Their productivity ranges from about 0.4 to 44 tonnes per km^2 per year. These estimates are mostly based on shallow water studies in more nutrient rich areas, with multi-species targets. In BIOT's waters, which are nutrient poor, the fishery is in deeper waters and more focussed on few species, hence productivity might lie towards the lower end of this range.

Target species are all predators, so form a small part of the total biomass. Many aggregate for spawning, commonly at dawn or dusk, or at night, and individuals may travel some distance to join such aggregations. In other parts of the world, uncontrolled fishing of spawning aggregations has led to some dramatic declines or local extinction of the fish.

Several of these target species begin their sexually mature life as a female, but become male after a number of years. From a fisheries perspective, heavy fishing of larger individuals can significantly impact sex ratios and reduce the reproductive potential of a population. These targeted species live to 17 or 25 years or longer. There is now evidence, at least among groupers, of dominance by particular age-classes with different reproductive ability. This has important fisheries implications: if a stock is heavily dependent on recruitment which is only occasionally successful, dramatic stock-declines could result.

Existing fishery

The current fishery in the northern atolls is a licensed, Mauritian, mother-ship dory operation. Mother-ships are capable of blast-freezing up to 10 tonnes of fish per day, deploying up to 20 dories, each with three fishermen, whose hand-lines each have 3-5 baited hooks. In 1998 one vessel used four dories equipped with 2-3 electric reels which targeted snapper and sharks. To date, licences have only been granted to

Table 5.1: Summary of fishing effort

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Licences used	3	5	4	4	3	4	6	2	2	2
Days in zone	120	183	105	159	117	159	163	61	65	104
Fishing effort (man-days)	5,602	7,893	3,910	6,710	4,569	5,798	5,607	1,532	2,174	4,314
Total catch (tonnes)	299	305	200	305	217	320	295	82	127	309
Catch rate (kg/ man day)	53.4	38.6	51.2	45.5	47.5	55.2	52.6	53.5	58.4	71.6

Mauritian applicants, and only in 1997 were all six licences taken up.

This fishery is allowed in The Strict Nature Reserves (Section 1), along their seaward reefs and reef channels, though not in lagoons of Peros Banhos, Salomon, and Egmont (but lagoons of Blenheim and Great Chagos Bank may be fished). However, one-off restrictions can be placed on individual licenses.

Figure 5.3 The lancetfish *Alepisaurus ferox*. These are caught in large numbers, but usually are not landed, so generally do not count in the by-catch figures. (Photo Andy Watson.)

From a stock conservation perspective, the number of licences or total fishing effort are less important than the total catch (Table 5.1). As methods or equipment, change, catch per unit effort can increase considerably, and effects can be masked (such as when targeting spawning aggregations). The current management regime based on effort controls is appropriate, and there should be an automatic review of the level of effort if recorded catches reach certain levels.

An observer programme has been run for several years. Typically observers have covered up to 50% of vessel fishing days, though in 1999 and 2000 observers were present on 96% and 65% of days respectively. Observers provide good independent verification, and additionally measure numerous statistics, as well as by-catch details which are not otherwise recorded.

The total catch appears well within sustainable limits, with two concerns:

Sharks are widely hunted world-wide, where numbers have collapsed. Even in Chagos an unlicensed fishery was reported in 1996 when it was estimated that numbers of sharks had fallen by 85% (1). In 1998,

over 5,400 sharks were caught (as by-catch) by one licensed vessel, and their fins sold for $6-12 / kg. This was halted next year by banning steel trace on fishing lines, an example of rapid and relevant management intervention. Sharks are a very vulnerable group, yet essential in the ecosystem. There is evidence that numbers in Chagos have increased slightly since 1996, attributable at least in part to the presence of the effective Fisheries Protection Vessel (100).

Spawning aggregations have been fished. In 2000, massive catches of grouper were linked to a spawning aggregation in Peros Banhos, between Ye-Ye and Manoel islands. Catches have been repeated there in 2001 and 2002, with markedly fewer caught in 2002 (C. Mees pers comm., 28/8/02). The danger in targeting these is that they may contain a large proportion of the breeding stock from an area of tens of square kilometres. In some parts of the world entire regional stocks have been fished out in two or three years, and the lower numbers caught in 2002 may have been the result of this. In BIOT, the most recent BSFC SSCM stated:

"The UK delegation indicated that due to the relatively low level of fishing effort significant changes to the management strategy in BIOT were not required. However, the recommendation to the Commission for protection of spawning aggregations was discussed and closed area management was considered by the delegations to be the most appropriate management action (via extension of the Strict Nature Reserve around Peros Banhos to encompass fisheries). " The simple closed area system proposed in this CCMP should adequately encompass this. Enforcement, as always, is a key issue, whatever closed area management system is applied.

Note on turtle and bird by-catch

Leatherback turtles are widely reported as victims to longline fishing in other areas. There is a record of one individual being caught in 2001/02, and they are generally thought to be rarely caught here, although their capture would only be recorded by observers. It is impossible to ascertain whether this is due to their general rarity in these waters, or of the fact that longlines do not represent a significant threat.

Longline fishing is also reported to impact seabirds, but this impact is largely or entirely thought to relate to larger species such as albatross, where these fisheries are operating in the Southern Ocean.

In general it would appear that by-catch is much lower with the purse seines fishery than with the longlines, although there are slightly higher levels of by-catch associated with FADs. From the observer programme in 2000/01, tuna made up over 99% of the catches from the free schools (the majority of sets), and some 90% of the FAD catches. The remainder of the catch from the FADs is mostly comprised of kawakawa, bullet tuna, and rainbow runner, with sharks making less than 1%. Data from the observer records in 2001/02 season show even lower rates of by-catch (less than 0.5%).

In 2001/02, two sets watched by the observers were carried out around whales (the species was not recorded, and it not clear if these were individuals or small groups). A similar observation was reported in 1998/9. As these are only reported when observers are present, and it is possible that the presence of observers may actually discourage this activity, it should be assumed that such setting has occurred on other occasions. The very high risk that a whale could damage the nets (often worth up US$0.5 million) means that it is in the fishers interest to place the set after the whales have made off, or to ensure the whale can easily escape before the nets are fully closed.

Note on UN Agreement

The United Nations Agreement for the Implementation of the Provisions of UNCLOS (United Nations Convention on the Law of the Sea) relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks entered into force as from 11 December 2001, and the Overseas Territories, including BIOT were specifically included in this agreement. This particular agreement aims at the "long-term conservation and sustainable use" of these marine living resources. The agreement is centred upon three conservation principles: the precautionary approach, protection of biodiversity in the marine environment, and sustainable use of fisheries resources. Participating states are called to

- Protect biodiversity in the marine environment.
- Take into account the interest of artisanal and subsistence fishers.
- Adopt measures to ensure the long term sustainability of the fish stocks and promote their optimum utilization.
- Ensure that the measures taken are based on the best scientific evidence available.
- Take account of environmental and economic factors, such as the special requirements of developing States.
- Apply the precautionary approach.
- Adopt an ecosystems approach, whereby dependent or associated species are taken into account.
- Take measures to prevent or eliminate over-fishing and excess fishing capacity.
- Give a high priority to the collection and sharing of data, and
- Implement and enforce conservation and management measures through effective monitoring, surveillance, and exchange of information.

6 Visitors

The number of yachts spending several months in Chagos, especially Salomon lagoon, has risen to several score each year. This has led to two problems. First is the discrepancy between the illegality of this with the fact that it is permitted to the point of charging modest fees. Regulation and conservation here has had a rather low priority in the past. Secondly, these yachts and occupants can cause damage.

The lagoon

In no other part of the world where there is concern about conservation or management are yachts permitted to drop anchors on coral reefs. The extensive damage known to occur from this is well known (Figure 6.2). This matters in proportion to both the quality of the reefs and numbers of anchors. As far back as 1996, the BIOT conservation advisor recommended that the number of yachts in Salomon be restricted to 10 or less, for stays of 1 month or less, requiring permission in advance. This could have been achieved without further legislation (114). In 1997, the issue was raised again, with the comment that the situation "makes our claim that 'the islands will be treated with no less strict regard for natural heritage conditions, than places actually nominated as World Heritage Sites' rather hollow… and… a position hard to defend." (114). Since then, yacht numbers have increased further. Each yacht anchoring probably damages over 100 square metres of seabed.

There is a clear difference between anchoring and mooring, and BIOT legislation refers to 'mooring' repeatedly, where it actually means 'anchoring'. No mooring occurs, and yachts drop their own anchors in various parts of the two northern lagoons, according to

Figure 6.1 Salomon lagoon in the 1980s showing nine anchored yachts. Many more than this now anchor here. By swinging around its anchor, each yacht's chain can destroy over 100 square metres of coral.

Salomon lagoon is unusual in that almost its entire bed is a rich coral garden, and there are few natural sand patches.

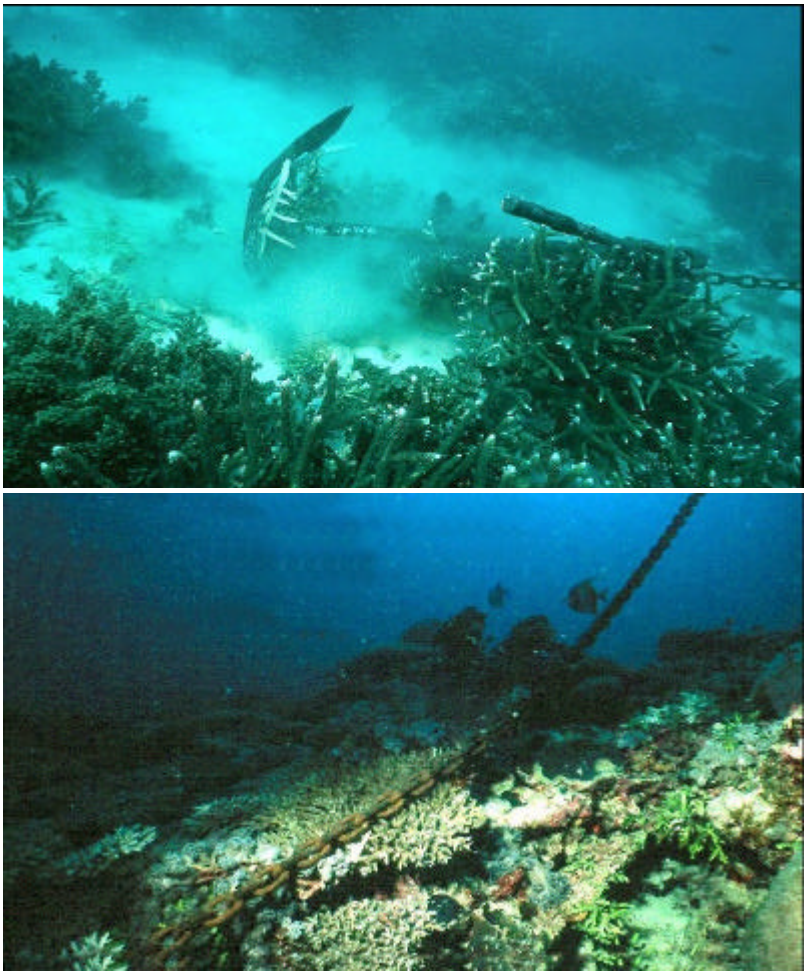


Fig 6.2 Top: Damage to branching corals typical of anchoring in lagoon habitats. Sheltered lagoons support vast stands of fragile branching corals. Following 1998, the lagoons contain almost the only surviving, mature branching corals of these types.

Bottom: Anchor chains, not the anchors themselves, cause the most damage, in circles around the anchor with a radius of many metres.

convenience and shelter. Anchor damage is severe near Ile Boddam in Salomon atoll. Mostly, damage comes from mobile anchor-chain leaders, though one huge 400 yr. old coral around which is tied several ropes, for example, has died since 1999, from abrasion.

Two methods can constrain yacht numbers and damage to the lagoon. The first allows anchoring only within an area which is buoyed and defined by compass fixes from land. This would be satisfactory if the area had been a sandy bottom, but in Salomon this preferred area is, or was and remains potentially, a coral-rich sea bed. To date the southern part of the lagoon has been described as a 'sacrificial area', but this area is clearly expanding to accommodate the greater numbers. Second, the preferred method in most valued areas, is use of moorings. With this method, usually no anchoring is allowed anywhere.

BIOT Administration will consider supporting legislation regarding moorings. Meanwhile, unless or until moorings are installed, it is recommended that an anchoring area be declared, fixed by bearings to islands, outside of which no anchoring is allowed. This area would be fixed, and would be located roughly where yachts are visible in Figure 6.1. Regarding the size and capacity of the anchorage, the number recommended repeatedly by the conservation consultant (ten yachts) could be provisionally and reasonably set, as should his suggested residence time (up to one month). Once moorings are in place, BIOT Administration will look at the fee structure and the setting of a maximum duration of stay.

In Peros Banhos lagoon, unlike Salomon, there are many sand patches below 15 m depth, above which in any case shelving is generally too steep to anchor. Thus anchoring here (Figure 6.2, lower photo) generally has taken place on the shallower slopes, which are more coral rich. Here, more flexibility could be allowed regarding location, providing depth was greater than 15 m, otherwise a similarly defined 'sacrificial area' should be defined.

Islands

While most visitors may respect the wildlife, enough do not. Coconut crab collection and spearfishing are known to occur, for example. Very recently, leaflets for visitors have been updated. These make abundantly clear all important issues about staying on islands, removal of vegetation or wildlife, growing crops, and other basic conservation activities. Complete exclusion from particularly sensitive areas remains a key point of this conservation policy, and will help ensure that, for example, rats are not introduced to more islands, and that bird disturbance is minimal.

Enforcement

No further laws or regulations seem to be needed to apply the above. The present 'Guidance to Visitors' is perfectly clear: "Breaking the law could lead to your expulsion, to your being fined or imprisoned and to your vessel being seized", "Failure to pay mooring fees on demand by a VVCO is an offence for which you may be prosecuted and/or expelled from the Territory", and: landing on some islands is already "strictly prohibited... Any person doing so is liable to prosecution and/or expulsion from the Territory." Furthermore, "property left unattended on the islands, is liable to confiscation without compensation." Regarding species, capture or interference with many is prohibited (Section 2) and in several cases is a "criminal offence". While it is accepted that far from all violators will be caught, the knowledge that some could be, and subjected to the above, would be a strong deterrent. It has proved to be so in many other sparsely inhabited and poorly guarded marine protected areas.

Notices

Notices on key points on islands should be revised. They are not 'yacht-friendly' and could be improved to convey better several key environmental messages. They state only 'do not' messages and should briefly explain 'why'. A 'carrot and stick' approach would work better. Text from the new guide to visitors is perfectly clear for this purpose and could be used. The purpose of restrictions should be clear, as this helps improve compliance.

7 Diego Garcia

Half the land area of Chagos is contained in the main island of Diego Garcia (Figure 1.2 in Summary). In the case of this atoll, it is important to note that there is no expectation that occupants are even slightly sustainable in an environmental way. For example, in the 1980s 40,000 lbs of fresh produce was flown in weekly, and more was imported by sea each month. Diego Garcia is sustained entirely from another hemisphere, which emphasises its 'special case' compared to other atolls of Chagos. To many, its 'environment' has meant primarily the 'human environment', or living conditions.

The *Natural Resources Management Plan Diego Garcia* (118) is the main document for environmental management in that atoll. Together with procedural and technical data in the *Final Governing Standards Diego Garcia* (170) it has ensured that Diego Garcia now has one of the best managed communities living on coral atolls in the world. This did not come automatically: in 1993 the conservation consultant to BIOT found a paper which said "Being located overseas, the US EPA (Environmental Protection Agency) regulations do not apply on Diego Garcia" (114). It was emphasised that EPA standards did apply, even if EPA was not the regulator. The Final Governing Standards now apply those standards.

The standards largely deal with the 'built environment': the immediate, human environment of emissions, pollution, drinking water quality and the like, and rarely cover the 'greater environment'. Of the latter, it was said in 1996: "During all this time there has been no known significant contribution from the USA who of course have caused significant ecosystem disturbance in developing Diego Garcia. The UK has even undertaken some NRMP items which should have been funded by the USA. … The USA is not pulling its weight" (114). The military base itself touches many sensitivities in the region, so that : "Conservation is about the only field of endeavor in which we can earn credit for being in the Indian Ocean where other countries do not want us." (114). This has not noticeably changed in the last six years.

The NRMP went some way in suggesting how to put this right. It includes examples of where environmental best practice conflicts with operations, and

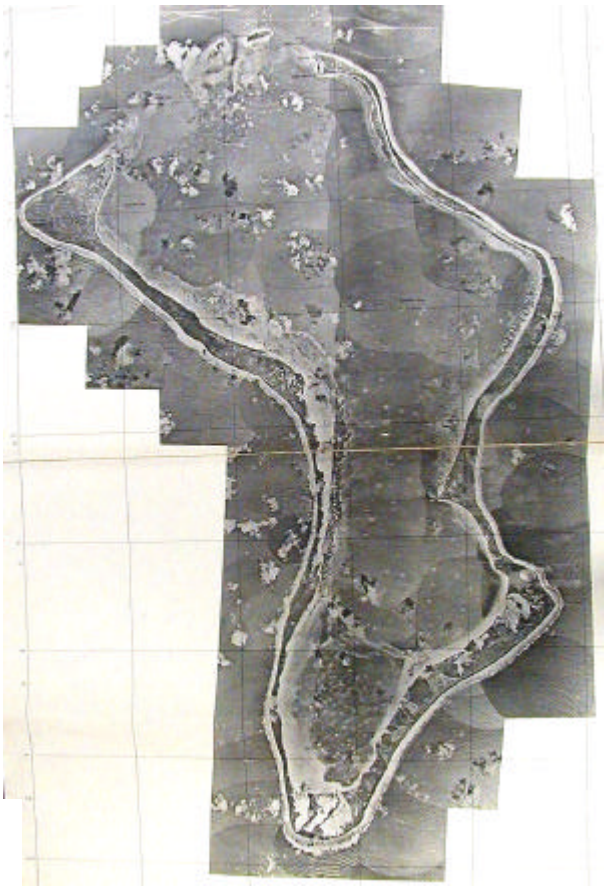


Figure 7.1 Probably the first aerial photomosaic of Diego Garcia (1965). This will be important in monitoring change. Photo kindly supplied by Kirby Crawford.

considers several future needs. It lists US regulations which locally supplement those of BIOT / UK. It does, however, have sections which need updating or which now seem wrong, and a revision is underway.

Its generalised objectives were to:

- Provide a multiple use management program for fish, wildlife and plants,
- Identify wetlands and sensitive or protected species and reduce conflicts between these and the operational requirements of the base,
- Improve land management practices, in which are included water and soil pollution and alien species introductions, and
- Enhance recreational elements.

Issues relating directly to personnel are well covered, but broader issues (e.g. the first item listed above) are less so. It lacks adequate guidance on some aspects, as its authors recognised by listing several "…principal opportunities for improvement of natural resources management and use…".

Its details are not repeated here. Instead this section focuses on development or change which are less well covered. The intent is to look forward. The NRMP is dated 1997 (*Final Governing Standards* is December 2001). The following focuses on significant issues needing to be addressed, on changes needed partly as a result of greater knowledge, on issues resulting from continued use, and on wider environmental aspects. It does not mean to diminish the NRMP's areas of considerable achievement.

Marine issues

Marine issues in Diego Garcia mostly have not been adequately addressed despite being highlighted in the NRMP:

- Use of excavated reef flat material seaward of the runway *vs.* need for landfill (this was viewed as an unresolved and ongoing conflict of requirements),
- Shoreline erosion issues,
- Monitoring of coral and sand dredging from the lagoon ,
- Recreational fish catch and its monitoring programme has been started, but requires continual attention,
- The need to carry out marine surveys of lagoon and seaward reefs and compile species inventories,
- Establishment of permanent moorings,
- Protection of turtles, especially nesting areas.

Terrestrial issues

Terrestrial issues generally are easier to manage and have a more obvious, visible and direct bearing on the population, so are much better addressed, some in ongoing programmes. The NRMP highlighted:

- Fresh water and water lens conservation ,
- Alien weed and animal control,
- Species protection,
- Wetland habitat protection and maintenance,
- Awareness and education enhancement,
- Inter-agency co-ordination,
- Waste disposal issues,
- Greater use of native trees,
- Implement environmental awareness programmes including brochures, nature trails etc.,
- Bird habitat near runways *vs.* bird strike on aircraft (now resolved by controlling egrets, the main species involved),
- Historical preservation and scenic locations.

Priorities and past work

Unusually and constructively, the NRMP noted responsibility for implementing various plans, and prioritised tasks. Diego Garcia is classed, apparently, as a small facility in US military terms and was entered for the small installation environmental award, whose docu-

Figure 7.2 Sections of the seaward reef flat along the western side of the runway.
Left: The rectangles are excavations of reef rock to about 1 m deep, made for the purpose of obtaining landfill. The reef crest is located where the waves are breaking. The much smaller perpendicular striations to seaward of the white water are the natural spur and groove system. Photo taken in 1966 by Prof. A. Eisenhauer.
Right: Closer view of the northernmost extent, shortly after excavation. These perpendicular trenches extend right into the beach.

mentation (168) also provides useful information. UK / BIOT and US environmental regulations were noted, and it observed that sometimes priorities were partly selected for reasons of legal compliance. But some sections are rather 'light'. Those on Fish and Wildlife, for example, contain little more than a summary of regulations, with many photos and lists of species, to no apparent end. Tabular information on e.g. artificial reefs, recreational fisheries intentions and others are mentioned but not amplified. Missing also is a useful review, even a bibliography, of presumably numerous environmental impact assessments and studies done over the past 25 years prior to major works. Some subsequently found on lagoon water and sediment patterns (31, 42, 43, 120) have value beyond their original and immediate purpose. Many others may exist ,or may now be lost.

Dredging, landfill and reefs

Construction material is in short supply, as in many atolls. Lagoon sand and rock are commonly excavated for this purpose. In Diego Garcia, unusually, trenches were dug over four miles of seaward reef flat adjacent to the runway, obtaining material "for pouring over 150,000 cubic yards of concrete…" (118) (Figure 7.2). It was hoped that the reef would grow back: "The excavated basins… were designed so that, in theory, they would recapture sediments and erosion would be minimised. It is also possible that such dredged basins may recover biologically and would become more diverse than they had been previously."

This never could have been the case, which should have been known. Such excavations are of relict material, not actively growing coral. It is now confirmed that reef flats in Chagos are 2,800 – 4,300 years old (24). And the mobile sediments that the designers hoped to trap act as liquid sandpaper, which kills rather than encourages new coral growth.

There was no new reef growth seen in a very brief look in the late 1990s, and few corals had settled in the trenches. Trenches had accumulated a film of sand.

This may turn out to be especially unfortunate. Sea level is rising and storms may increase (Section 8), and seaward reef flats are a primary defence to shoreline erosion. It was suggested in 1996 (82) that a study be made of this excavation, its recovery or increased erosion; the NRMP said: "This suggestion is in concert with the dredging policy which is strongly

endorsed – that no new dredging be authorised without having careful investigations conducted by coastal engineers and marine ecologists" . There has been no proper examination of erosion or growth here.

The NRMP then recommended that, if it was confirmed that excavation of the primary sea defence was ill-advised, "excavation in on-land areas and importation may be necessary" instead. "On-land areas" certainly should be ruled out. Given the low-lying nature of the atoll, it may not be sensible to take material from anywhere on the atoll or its lagoon. Diego Garcia does have exceptionally high (for Chagos) dune systems in certain small locations. But some of these dunes line the shore along the trenched reef flat. This may be very fortunate - the dunes may be all the more required because of this.

Consideration should be given to strengthening the trenched seaward reef. Two processes should be assessed. First is filling the trenches with concrete blocks secured to prevent movement. This is an obvious measure to investigate, but should include blocks which stand proud of existing surfaces to further break wave energy (something which will eventually be needed). But concrete is colonised poorly compared with limestone. Thus a second method gaining momentum, or at least publicity, is the 'electric reef' whereby electrodes (large sheets of wire mesh serve well) are fixed on the reef and applied with about 5 volts. Little scientific information exists for this as yet, though its proponents claim vastly increased deposition of 'natural' limestone given very modest electrolysis. Increased growth of live coral on the precipitated limestone is also reported .

The lagoon. Extraction from Diego Garcia lagoon is also inadvisable, for different reasons. Parts of the lagoon include the only known reefs in this atoll where coral cover remains significant. Diego Garcia was especially badly hit by the 1998 warming (100); coral mortality on seaward reefs was extreme to 40 m deep, and was similar in the eastern lagoon's Strict Nature Reserve. But in 2001, lagoon reefs in the Northwest still supported 50% live coral. These and any other patches require the greatest protection.

Shoreline erosion in the northwest

It has been repeatedly noted (114) that shoreline erosion is evident and will deteriorate with continued coastal development and vegetation clearing. It was

Figure 7.3. Use of concrete for shore protection in northwest Diego Garcia, needed in place of removed vegetation. Taken from (172).

Note the narrow width of the reef flat to seaward of the concrete.

Note also that this island has rims which have higher elevations than much of the interior (see Section 8).

stressed in 1995 and subsequently, that a 5 m width of the shoreline bush *Scaevola* needs to be maintained to prevent erosion. As a consequence of its loss, erosion control in the inhabited area has so far involved the unsightly replacement of the shrub by "over 500 tons of construction and demolition debris, and planting *Scaevola* …" (168). With rising frequency of storms and sea level, and if coral recovery continues to be impaired (Section 8), much more shoreline protection than this may become needed over the next few years. It is understood that a survey using light aircraft was conducted in 2002, though details are unavailable.

Active replanting of *Scaevola* and / or *Tournefortia* should take place where previously it was replaced by the concrete debris. A method of adequately measuring shoreline erosion is needed, either Differential GPS in selected locations on both the inhabited (west) and uninhabited (east) arms of the atoll, or continuation of aerial mapping techniques commenced in 2002. Either way, a 10 cm accuracy or better will be needed for best forewarning of problems.

Survey of lagoon and seaward reefs

The NRMP notes in its 10 year plan under Reef Dredging: 'Conduct baseline survey' in year 3, followed by 'Annual monitoring' in years 4-8. This does not appear to have been done. The NRMP also discusses designing and installing artificial reefs, in year 3, with maintenance of them in two further years. It is not known what these artificial reefs would be for, or where they would be.

These 'Baseline surveys' (meaning better knowledge of the locations of all marine habitats and of biological inventories) have now become essential. A brief study of corals in the lagoon 23 years ago (74) showed it to be healthy then, and little different from conditions in the northern atolls. Since that date, the small boat harbour and other lagoon construction may have changed conditions, and the 1998 warming also severely damaged coral in Diego Garcia (100). Several parts of the lagoon were also dredged to obtain landfill.

Diego Garcia is the least known of the islanded atolls as regards reef life. All large studies from the 1970s excluded it, though its terrestrial aspects are amongst the best known (109). There have been investigations on current flows (31, 42, 43, 120), and brief observations more recently (88, 100). Reefs in the eastern lagoon's Strict Nature Reserve were almost totally killed, but 50% or more are alive in the North-western lagoon, and anecdotal reports further suggest good coral in some deeper areas where ships anchor.

Determination of what coral exists, and where, is necessary for making any conservation progress at all. It is especially needed if any further extraction of materials or dredging takes place.

The NRMP recommends another survey: its estimated budget for 10 years includes sums to "Conduct baseline survey" in year 2, "If required, establish additional monitoring stations on reef" in year 3, followed by "Continue monitoring / maintain stations" from years 4-10. There were good reasons for these recommendations, which are even more valid today, but if any of this was done, it is not known what the results were. It also notes that in year 1 (1997) there would be the activity "Conduct baseline survey (UK action)". This may refer to the 1996 programme, though the latter excluded Diego Garcia. The NRMP also suggests an annual census from years 2-10. These activities should be consolidated into one series of work, in the near future. This should be allied to similar work proposed for the northern atolls.

Recreational fishing

The NRMP notes allocation of $13,000 for conducting a catch monitoring programme and then a licensing and permit programme in the first two financial years, but then shows nothing for the following 8 years. In its 'Milestones' tables, however, it refers to annual catch monitoring, and to a licensing programme including 'training as necessary for staff and customers' for a full 10 years.

The fisheries ordinance 1998 (148) allows sport fishing in Diego Garcia, and limited fishing for non-profit purposes across BIOT (except in protected areas). This fishery comprises:

- a shore-based fishery, primarily in reef flat and lagoon areas. This includes sharks, jacks, snapper, grouper, mullet, rudderfish, parrotfish, damselfish, bonefish and mojarras;
- a demersal near-shore fishery on outer reef slopes. Catches are mainly top predators: groupers, snappers and emperors;
- a demersal and semi-pelagic fishery operating mostly from fishing barges and vessels at anchor, mostly in the lagoon. Top predators are again the primary target; and
- a pelagic fishery from sport-fishing boats, targeting oceanic species, notably tuna and marlin.

Top predators are targeted, so sustainable limits will be broadly similar to those of the northern atoll reef fishery (Section 5, though little is known about the smaller yacht-based fishery there, Section 6). Since 1998, MRAG Ltd has been responsible for monitoring this fishery and has established a system of log-sheets to be filled by individual fishers. Log-sheet returns are now good from some of the boat-based fisheries, but remain poor for shore-based fishers. The only other information available comes from a creel survey undertaken in 1999 by a BIOT observer.

Information on catches is thus most accurate for the pelagic fishery and the demersal/semi-pelagic fishery from one boat-type (Mako). Using this data, combined with either extrapolation or direction assumption of no-change from the 1999 creel survey, overall fish-yields have been estimated (Table 7.1).

MRAG Ltd have also calculated yields per unit area for the reefs (Table 7.1). They considered these figures were "well within the sustainable limits for both reef and lagoon habitats". While they are certainly not high, they indicate the highest levels of fishing pressure in the Archipelago. While within sustainable limits set by some authors for some waters, they are higher

Table 7.1: Combined catch by ecosystem for the recreational fisheries in Diego Garcia, in tonnes.

	1988	1999	yield/km^2 1999	2000	yield/km^2 2000
Lagoon	36.35	63	0.47	42	0.31
Reef flats		12	2.02	12	2.02
Drop-off		18	1.24	18	1.24
Reef flats plus drop-off	21.59				
Pelagic	45.8	46		48	
TOTAL	**103.74**	**139**		**120**	

than sustainable limits set in others. Also, because Chagos lies in nutrient poor waters and many of these fisheries are restricted to a subset of predatory species, it seems likely that sustainable limits here will be lower than for reefs in continental waters.

Total catches in some of these fisheries could be reduced through encouraging the practise of tagging in game fishing. This is already in place for sharks and billfish, and the scheme has reduced landings of these successfully. Following initial resistance this is now accepted. In 2000 sharks represented 13% of the landed catch from pelagic fisheries, but this had reduced to 3% in 2001; landed billfish catches reduced from 2.4% to 0.2% over the same period, suggesting the scheme is having a positive effect. Annual or monthly maximum targets for particular species could be established, with tagging alone permitted after set totals are reached. It may be possible to further encourage tagging through the introduction of reduced licence fees.

At present, the only control on fishing on the outer reefs is in the Strict Conservation Area where it is at the discretion of the Commissioner's Representative. There is no land-based fishing in the Strict Conservation Area. Permanent no-take zones covering 30% of the reef flat and drop-off (Sections 3, 9) would greatly protect stocks; fishing is currently not widely undertaken over large areas already so such measures could be easily implemented.

8 Climate change: timing and consequences

Climate change will have serious consequences to small tropical islands and reefs (166). The most recent data and climate models suggest that four main issues will become important (92, 107): temperature rise leading to reef mortality, sea level rise, greater extremes of storm activity, and changes in rainfall.

Temperature change

The most important effect of temperature rise, as understood at present, lies in the fact that corals in Chagos, on which the entire reef system is based, are killed when it rises above about 29.8 ^{o}C for a few weeks. This occurred in Chagos in 1998, when sea surface temperatures (SST) of almost 30 ^{o}C caused heavy mortality to corals to at least 30 m depth in the south, including Diego Garcia, and to 15 m depth in northern atolls (88, 100). It was not temperature alone which caused that mortality (increased light and UV penetration are important) but temperature is the most easily measured variable. The rising trend between 1871 and 2100 is shown in Figure 8.1.

Presently, SST is rising at over 0.25 ^{o}C per decade. The rise began in the 1960-70s and previously noted reductions of shallow coral in the 1996 research visit (85) might be explained by this rising temperature. The rate of SST warming is also accelerating.

These data allow statistical treatments which estimate the frequency of a repeat occurrence of the lethal 1998 temperature. This model projects that temperatures reached in 1998 will occur annually beginning sometime between 2025 and 2030. However, repeat occurrences of much less than annually will lead to a permanent crisis in reef condition. It is possible, and it is hoped, that corals and other reef life may adapt, acclimate or evolve to resist this, and this is an active area of research. It seems unlikely that they can: they did not adapt to resist 1998 despite the gradual start of warming 30 years earlier, for example.

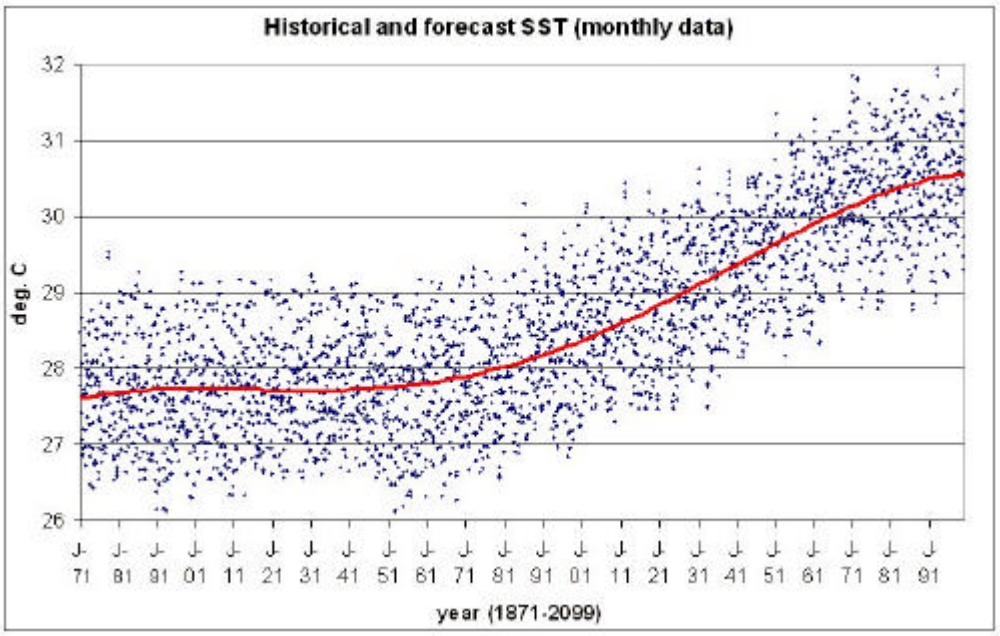


Figure 8.1 Blended temperature series from historical (HadISST 1871-1999) and forecast (HadCM3 (1950-2099) data. Red line is a best fit average annual temperature.

Overlapping dates were used to adjust forecast data to intercept historical data. Statistical methods using normalisation and residuals corrected annual oscillation of forecast data. HadISST data have extensive verification (101) though the method of combining them is work still in progress.

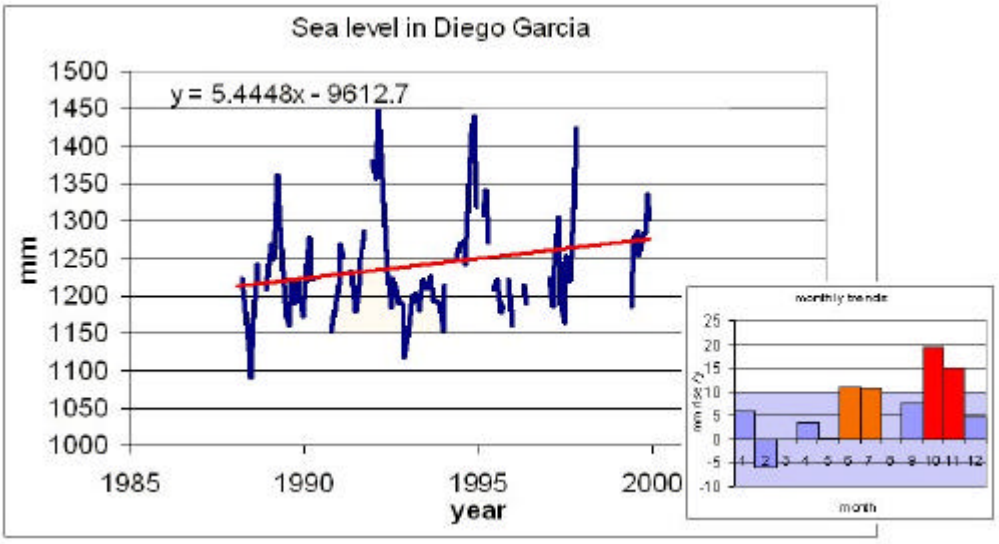


Figure 8.2 Sea level rise in Diego Garcia (167). Red line is the linear best fit. The equation indicates an average 5.44 mm rise per year since 1985.

Inset: Monthly pattern of sea level rise; most takes place in October / November (red). June / July (orange) is also a time of rise (actually less variable annually than October / November). Pale blue is a region of statistical uncertainty.

Consequences are likely to be widespread conversion of thriving and accreting reefs to dead coral platforms and rubble, the latter derived from coral colonies as continuing storms and naturally occurring eroding organisms break them down (89, 100). Reef growth rate is likely to fall behind reef erosion rate, and may already have done so in some places. Also, most of the shallow, thick stands of staghorn coral which provided an initial breakwater in many areas, were eliminated in 1998, so these shallow seaward areas (mainly on southwest and northwest facing reefs in Chagos) almost certainly now provide much less resistance to waves, whose energy is thus dissipated nearer shore. The caveat, as noted, is that corals may adapt rapidly to these rising temperatures.

Sea level rise

Average sea level (SL) is predicted to rise by 0.2 – 0.5 cm per year globally (166). In Diego Garcia it has been a little greater than this (Figure 8.2), averaging 0.54 cm annually since 1986 (167), which is similar to values from the nearby Maldives (102). Sea level rise is accelerating, however (165, 166). Greatest rises appear to occur during the Southeast Trades and during its switch to North-westerly winds in October and November (inset, Figure 8.2).

Reef flats are positioned at the mean low tide level, so as sea level rises, the flats will become less effective in attenuating waves, whose energy will increasingly become dissipated on island shores.

Reef flats here probably will not grow upwards to match sea level as the latter rises. For many islands, height above high tide level is minimal (Figure 8.3). For unknown reasons, there are more submerged or 'drowned' atolls in this group than there are islanded atolls (90) despite the past 11,000 years of apparently healthy coral growth. We should not assume that reef growth will be any faster in the future if their corals are

Figure 8.3: Ile Gabrielle and Ile Monpatre in Peros Banhos, at high tide on a calm day. Theses islands are separated from each other along their length (i.e. along the atoll circumference). Clearance above high tide is small.

killed by repeated warming events. This is likely to lead to erosion of island shores.

Maximum elevation of the islands in the northern atolls, Egmont, and Great Chagos Bank is only 1-2 metres in most cases, and less in several small islands. Some substantially higher dunes exist in Diego Garcia. These maximum elevations are restricted mainly to relatively narrow rims around island perimeters; most islands have a central depression which dips near to sea level or even below it. Nine examples of island profiles were shown in (94, 95), with two new examples (Figure 8.4) in Salomon and Peros Banhos (56). Diego Garcia also has generally similar concave profiles (34, 118). Thus island erosion is not likely to be a gradual attrition of island edge as would be the case on typical convex islands. In Chagos, erosion of the rim, which effectively serves as a dam for central parts, would likely lead to broaching, followed by flooding of disproportionately large areas. Early examples of the likely effects may be seen in Figure 8.5.

Timing and rates of erosion of island rims is impossible to estimate at present, especially along sections facing storms. The monitoring of rates of erosion may be one of the most the most crucial elements of all.

Storm activity

Modelling of storm events has recently shown that storms and overtopping by waves of these islands will increase the risk of flooding (57). With their concave profiles, increased overtopping onto Chagos islands would flow centrally, sinking into water tables. The study concluded that with respect to future inhabitation: "... overtopping and the subsequent flooding is potentially a very serious problem…" (57). It also showed, in several graphs, the volumes of overtopping

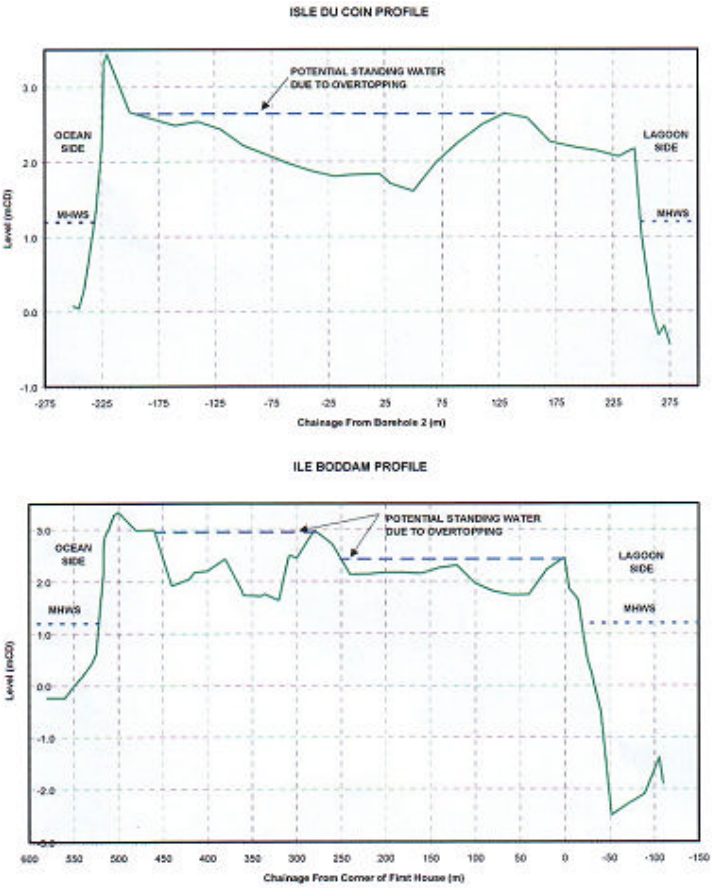


Figure 8.4 Profiles of two previously settled islands of the northern atolls (from 56).

Top: Ile de Coin (Peros Banhos atoll), and

Bottom: Ile Boddam (Salomon atoll).

These profiles have a general similarity to 9 examples from Egmont and Great Chagos Bank shown in (93, 94).

Note also the island area liable to salt water flooding from wave overtopping (dotted blue lines). Rims of these islands are 1-2 m above mean high tide as profiled here. As these islands are similar to other better surveyed islands, some parts of these rims will be higher, some lower. It is the lowest (seaward) parts which are likely to be the critical or weakest points. Certain meteorological conditions can increase high tide substantially.

Figure 8.5 Depressions in two Chagos islands, filled with water.

Top: Ile Anglais, Salomon, this may be fresh water following heavy rain, and indicates a depression to, or possibly below, present sea level.

Bottom: Diego Garcia islet with a broached rim and seawater ponds.

water under different scenarios, including during 1:50 and 1:1000 year storm events. These authors suggest that much of the islands can be considered at risk, and that much of any development would need to be confined along their rims.

Rainfall and water tables

These atolls are extremely wet, with 2,500 to 4,000 mm rainfall each year. Rainfall is currently impossible to model accurately, but models suggest little gross change, possibly with greater variability (166). The maintenance of water tables, and the length of time they may be sustained, might depend much more on sea water encroachment if erosion of island rims takes place. The turnover time of fresh water in water lenses of Ile Boddam and Ile de Coin in the northern atolls is about one year (57), so island vegetation may readily survive some periods of drought, based on fresh water input alone, though smaller islands will have a smaller buffering capacity. The southernmost Diego Garcia may well become drier than the other atolls, but its lens is much larger.

Changes of annual rainfall by, say, 2020 or 2040 are likely to be small, though annual fluctuations may increase.

The main climatic controls

In general, rising sea surface temperatures which kill the reef life, sea levels and storm overtopping will probably be the main climate controls on Chagos. The temperature rise will lead to progressively deteriorating

reef condition and island erosion. The results may first be seen by a continued decline in reef quality and by erosion of shorelines. These are all active areas of research at present in several parts of the world, as well as in Chagos itself.

Relevance to BIOT

It could be argued that the issues addressed here are global, and lie outside the ability of BIOT government (indeed any single government) to manage in ways other than by, for example, 'plugging holes'. This is partly correct, but two important issues arise.

First is not to underestimate change that can be made or manipulated in future. 'Plugging holes' provides immediate (even if temporary) solutions. Buying time is extremely important in the present context.

Second is the need to respond quickly, to minimise problems and provide protection where it lies within the managing regime's ability to do so.

Monitoring and protected area designation

Expansion of the system of protected areas has been proposed (Section 3). This is not an exercise of drawing static lines on a map; it must be flexible and responsive to new observations, which would only be possible given a continuance of bi-annual (at least) monitoring and observation in several fields. This exactly parallels, and should co-ordinate with, suggestions made for Diego Garcia in the NRMP (Section 7).

Where these field surveys discover surviving areas of corals, for example, or spawning aggregation of certain fishes, adaptation or expansion of the protected area boundaries needs to be made quickly. In this way much more habitat can be preserved, and elimination of the species avoided. In some cases, lagoon corals showed good survivorship and their strict protection may be critical. Another example, noted in 2001, was that deeper parts of reefs in the two northern atolls survived the ravages of 1998 much better than did their shallow areas, and much better than areas of any depths seen in the southern atolls (including Diego Garcia). The prime need is to include those surviving, deeper seaward reef slopes in the north into protected areas, to afford maximum protection. These will be the nursery grounds needed for the future.

Such actions will ease future problems and prolong survival considerably. For them to work, monitoring remains key.

Changes to our response to climate effects are perfectly possible and, given human ingenuity, nothing should be written off now. It has been unusual for a management plan to adopt very much flexibility, and where they have, they may stand accused of being 'fire-fighting plans' rather than management plans. 'Fire-fighting', however, is proving to be a valuable element in our response to global changes. Knowledge of where and how to fire-fight is needed, and this comes from regular monitoring and from ability to manage.

9 Legal provisions

This summarises BIOT law which is concerned with, or touches on, conservation. It is arranged by topic. Annex 1 (on disk) contains more detail, and a summary by Instrument of the legally binding provisions.

International agreements and BIOT

The Convention on Biological Diversity, was signed by the UK government in 1992. This is a key Convention, but has not yet been extended to BIOT.

Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention) (162) was extended to BIOT in January 1999 when the UK announced at the Conference of the Parties to Ramsar its intention to designate most of the archipelago as a Ramsar site. Diego Garcia's lagoon, Restricted Area and the atoll's territorial waters were designated in 2001. The government has indicated that it cannot give a timescale for other areas at present.

International Convention for the Regulation of Whaling. The Indian Ocean Sanctuary was established by the IWC in 1979, covering the entire Indian Ocean, including BIOT waters. Commercial whaling is prohibited irrespective of any decisions of the IWC which may call for the resumption of whaling.

The UN Convention on the Law of the Sea (UNCLOS) of 1982, entered into force in 1994 (169). It provides the legal basis for establishment of territorial seas (to 12 nautical miles), contiguous zones (to 24 nm) and EEZs (to 200 nm). States must make a claim to extend its territorial sea from 3 to 12 nm; BIOT has not claimed this, but has claimed the 200 nm EEZ. Foreign fishing vessels have right of passage, but not to fish while doing so. States may determine catches and must ensure that stocks are not endangered. States must preserve and protect the marine environment and promote scientific research.

The UN Agreement for the Implementation of the Provisions of the UNCLOS relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks entered into force from 11 December 2001. BIOT was specifically included. States must protect biodiversity as well as accommodate artisanal and subsistence fishers, based on best information and economic requirements, taking an ecosystem approach. Effective monitoring, surveillance, and exchange of information is required through regional arrangements, and other States within a region may board and inspect vessels should the flag State fail to act on a notified likely violation.

The Indian Ocean Tuna Commission (153), established within the FAO, aims to promote cooperation among its Members and ensure sustainable tuna fisheries. Resolutions to date deal with observers, statistical reporting, and mechanisms to promote compliance by non-Contracting Party vessels.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) restricts trade in species listed in three Appendices (157). Appendix I covers endangered species, II species that may become endangered unless trade is regulated; III covers species that any party wishes to regulate, so requires international cooperation to control trade. A permit is required for trade in species listed in Appendix I or II (see Annex).

The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) (159) also lists

species in two Appendices: I for species requiring strict protection, and II for those which would benefit from international collaboration. States are encouraged to co-operate in and support research on migratory species; to provide immediate protection for species in Appendix I, and to conclude Agreements for species in Appendix II. For BIOT the most significant group is marine turtles, thus a Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia was signed by the UK in March 2002. A Conservation and Management Plan linked to this contains 24 programmes and 105 specific activities aimed at reducing threats, conservation, exchanging data, increasing public awareness, promoting regional cooperation, and seeking resources for implementation. Regarding birds, Chagos lies at the extreme end of a migration pathway from central and northern Asia to India and the Indian Ocean Islands. Thus current discussions regarding creation of a Central Asian – Indian Flyway Agreement are relevant, and the BIOT government is considering partaking in such an agreement.

BIOT Legislation

Protected areas

Present legislation designates Strict Nature Reserves, Special Reserves and Restricted Areas under national legislation, and Ramsar Sites under international legislation (Table 2.1). The Protection and Preservation of Wild Life Ordinance 1970, empowers the Commissioner to designate Strict Nature Reserves and Special Reserves.

Strict Nature Reserves are defined by The Protection and Preservation of Wild Life Ordinance 1970 and by the Strict Nature Reserve Regulations 1998. The latter gives effect to the former. No person may:

"a – enter, traverse, camp in or reside…;

b – fly…at an altitude lower than is…specified…;

c – engage in...any form of hunting or fishing; any undertaking connected with forestry; agriculture; any excavations, levelling of the ground or construction; any work involving the alteration of the configuration of the soil or the character of the vegetation; any act…which pollutes any source of water…or sea area within the reserve; or any act…likely to harm or disturb the fauna or flora…

d – knowingly introduce…any non-indigenous wild life"

The 1998 Regulations expand the term "island" to include "the internal waters of that island and to the territorial sea appurtenant to that island and to any reef or bank situated therein". However Gazette Notice No 13 of 1998 (see page 11) grants exemptions to activities licensed under the fisheries legislation, effectively removing any protection this "territorial sea" definition may have provided.

Special Reserves are defined under The Protection and Preservation of Wild Life Ordinance 1970 as "areas in which any particular species of wild life requires protection and in which all other interests and activities shall, whenever possible, be subordinate to that end." No areas have been designated to date.

Restricted areas are defined under the Diego Garcia

Table 2.1 List of presently protected areas. See also maps in section 3.

Diego Garcia Restricted Area
(includes Diego Garcia Nature Reserve Area and the following Special Conservation Areas: Barton Point, East Island, Middle Island, West Island, and the lagoon areas from Rambler Bay to the Main Passage)

Diego Garcia Ramsar Site

The Three Brothers and Resurgent Islands Strict Nature Reserve

Danger Island Strict Nature Reserve

Cow Island Strict Nature Reserve

Nelson Island Strict Nature Reserve

Peros Banhos Atoll Strict Nature Reserve
(All islands to the east of a line drawn between the easternmost point of land on Moresby Island and the easternmost point of land on Fouquet Island).

Conservation (Restricted Area) Ordinance 1994. They may not be entered without a permit. Clearer definitions and restrictions were first provided in a Public Notice of 1997 which established the Restricted Area of Diego Garcia, defined as "all of the main island outside the Specific Area, the four Islets at the mouth of the lagoon and the areas within the lagoon as shown" (on an attached map). This Notice further defines a Nature Reserve Area and a Strict Conservation Area. All access requires permits, but these are to be routinely given for "a – sightseeing, b – swimming Lagoon Side during daylight hours, c – wading Oceanside, d – Collection of DEAD shells and DEAD coral" in the Nature Reserve Area. A broader set of activities may be undertaken in the Nature Reserve Area with additional written permission: "a – overnight stays, b – swimming or Surfing Oceanside, c – fishing, d – camping away from the Rest and Recreation site, e – Arrival and Departure by boat". Access is more strictly controlled in the Strict Conservation Area, and is only to be given for a limited set of activities including sailing in lagoon areas (but not anchoring or mooring), and for observation of wildlife by bona fide naturalists/ environmental observers. The Public Notice establishing this area is regularly re-released to ensure its continued profile.

Fisheries

Commercial fisheries are restricted in some parts of the archipelago via the licensing system. Tuna vessels may not operate within 12 nm of land, and nearshore commercial vessels are not permitted to fish in the lagoons of the islanded atolls.

Commercial fisheries require licensing. Legislation covers access to the fishery, and gear, and there is provision for restrictions by season, location (restricted areas) and fishing gears.

The Fisheries (Conservation and Management) Ordinance 1998 (148) repealed and revised much previous legislation. It defines fishing waters as "the internal waters of the Territory; the territorial sea of the Territory; and the Fisheries Conservation and Management Zone". Effectively this is all areas to the EEZ. It states the Director of Fisheries, appointed by the Commissioner "has charge of the administration of this Ordinance and of any regulation made under section 21 and…is responsible for : a –conservation of fish stocks, b –assessment of fish stocks…, c – development and management of fisheries; d – monitoring, surveillance and control of fishing… h – making of such reports to the Commissioner as he may require".

Enforcement is the duty of Fisheries Protection Officers who will include persons appointed by the Commissioner, every Peace Officer, every Import and Export Control Officer and senior military personnel (S4)

Specific provisions prohibit: "any explosive, poison or other noxious substance for the purpose of killing, stunning or disabling fish" or of having such substances. (S5) and use, or possession with intent to use, "prohibited fishing gear", including "a - any net whose mesh size is smaller than the prescribed minimum…; b - any other type of fishing gear which does not conform to the standards prescribed for that type of gear; and c - any fishing gear which is prohibited by regulations made under section 21." (S6). "Fishing by a fishing boat within the fishing water is prohibited unless carried out in accordance with a licence" (S7-1). Licences may place restrictions on "the area within which fishing is authorised;…the period;" the catch in terms of "description, quantities, sizes or presentation"; and on "the method of fishing".

These provisions do not apply "to persons who are lawfully present in the Territory if…the fishing is for sport and not for sale, barter or other profit; the fishing is…carried out by an attended line…; there is…no

more than two such lines in use under the control of any one person, each line having no more than three hooks attached to it…; and the fishing is not…carried out in any area of the Territory which is specified…to be an excepted area…". These exceptions do not apply "to any fishing carried out by a fishing boat (other than one based in and operating around Diego Garcia) in circumstances where the persons fishing from that boat have paid…for the right to do so or to be on board the boat…" (S7 – 10,11)

Several rules exist regarding notification of fishing, reporting of catches, stowage of non-permitted fishing gear, transhipment of fish to other vessels (which must also be licensed), powers of enforcement and seizure of vessels and goods.

Section 21 enables the Commissioner to "make such regulations as he considers necessary for the purposes of this Ordinance", including "the conditions subject to which licences are to be…granted; the fees to be charged for licences…; the equipment to be carried on board fishing boats;…" and various measures covering reporting, observing and licensing.

Fishing Regulations 1993 provide details on the reporting of catches and for the appointment of an "observer" to join vessels and take details of catches.

The Fishing (Prohibited Gear) Regulations 2000 prohibits: "a – any net which, for the purpose of fishing, is set or operated otherwise than by a fishing boat…; b – any trap, including…any pot, barrier or fence; c – any gear for grappling or wounding, including…any harpoon, spear or arrow;…" Permits may be issued for using nets in other circumstances, and a general provision permits use of hand-held cast nets for the purpose of bait fishing in Diego Garcia. These may only be used away from areas of actively growing coral and their use must be approved by the Moral, Welfare and Recreation organisation of the US Forces.

Current restrictions under the licensing regime

The licensing regime of the above may be used to limit and control this fishery. A number of regulations have been developed by MRAG Ltd, within the context of Licensing Briefings with the BIOT government which have taken place most years.

The main provisions regarding tuna and near-shore commercial fisheries licenses are that fishing gear be deployed to target only the stated target species (either "tunas, tuna like species and those species that are generally caught incidental thereto" or "inshore water species and those species that are generally caught incidental thereto"); and that fishing gear is deployed in a manner that avoids or minimises by-catch.

For tuna, fishing vessels may not operate within 12 nm from the nearest land.

Current policy and regulation of the commercial near-shore fishery, based on the licensing regime, include some controls developed in consultation with the bilateral British Mauritian Fisheries Commission (BMFC):

- Up to six 80-day licenses may be issued each season;
- Fishing is restricted to 1 April to 31 October;
- Fishing is only permitted with hooks and lines, though hand-held cast-nets may be used for catching fish bait;
- The use of steel wire on fishing lines is prohibited;
- Fishing is prohibited within any lagoons (Diego Garcia, Egmont, Salomon, and Peros Banhos);
- Officers or crew may not land on any island without a permit (excepting the case of bona-fide Chagossians who may land).

There is no clear definition of the boundary of the "lagoon", which could lead to quite extensive fishing in lagoon channels.

Commercial fishing is allowed in Strict Nature Reserve areas. This is based on an agreement from the BMFC stating that changes to the fishery regime should be undertaken after consultation with the fishing communities (not the BMFC). This was not done when the Strict Nature Reserves were established so it was decided not to apply this legislation to this fishery (C. Mees, pers. comm., 28/9/02). This informal minuted agreement may conflict with the Strict Nature Reserves regulations.

Gazette Notice No 13 of 1998 states: "On Oct 17 1998 the Commissioner granted written permission under section 5 of Protection and Preservation of Wildlife Ordinance 1970 for any person, notwithstanding any other provisions of that Ordinance, or any provisions of the Strict Nature Reserve Regulations 1998, to do any act which he is authorised to do by, or by virtue of, a license granted, or having effect as if granted, under the Fisheries (Conservation and Management) Ordinance 1991." In effect, this counters the intent of the Strict Nature Reserve legislation and to date the licensing procedure has ignored the Strict Nature Reserve restrictions.

Voluntary fishing agreements and BIOT

There have been several UN Resolutions and "soft law" agreements. One is a drift-nets moratorium on all "large-scale pelagic driftnet fishing" at the end of 1992.

The FAO Code of Conduct for Responsible Fisheries is voluntary, but often cited. It sets out "principles and international standards of behaviour for responsible [fishing] practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity". To this end a number of International Plans of Action (IPOAs) have been made.

The IPOA for the Conservation and Management of Sharks is one such: "States should adopt a national plan of action for conservation and management of shark stocks (*Shark-plan*) if their vessels conduct directed fisheries for sharks or if their vessels regularly catch sharks in non-directed fisheries". This Shark-plan should ensure, *inter alia* that "shark catches…are sustainable", it should "assess threats to shark populations; identify…vulnerable or threatened shark stocks; …minimize unutilized incidental catches of sharks; contribute to the protection of biodiversity and ecosystem structure and function; minimize waste and discards from shark catches…(for example, requiring the retention of sharks from which fins are removed);…"

There is also an IPOA for Reducing Incidental Catch of Seabirds in Longline Fisheries, which states that countries should investigate this problem and, if necessary, establish a National Plan of Action to address it.

Non-fisheries species and BIOT

Further provisions provide protection for species not subject to conventional harvest, and injunctions against species introductions.

The Protection and Preservation of Wild Life Ordinance 1970 (131) empowers the Commissioner to enact legislation to protect wildlife [including coral], prohibit the purchase, sale or export of wild life, and prohibit the introduction of wildlife.

The Wild Life Protection Regulations of 1984 (135) makes it an offence to:

- "intentionally to kill, injure or attempt to kill or injure, or to take or be in possession of, any animal" with the exception of "any fish or marine product lawfully taken in accordance with the [Fisheries Ordinance 1991 or subsequent laws replacing this] …or vermin or other pest or insect in the interests of public health"
- "to take or be in possession of any live seashell,

live coral…or any…which has been taken alive"

- "intentionally to destroy, damage or take any bird's nest while the nest is in use or being built, or any bird's egg or turtle's egg"

The Wild Life Protection (Amendment) Regulations 2000 extends this list to include possession of "a dead animal or any part of an animal or of a dead animal".

The Green Turtles Protection Regulations 1968 apply although turtles are also covered under the above, and state that "No person shall harpoon, kill, destroy or take possession of any turtle [means the green turtle or *tortue de mer*] for any reason whatsoever."

Trade of species in BIOT

The Prohibited Imports and Exports Order, 1984 (136) prohibits the exportation of: "wild animals, whether alive or dead; Live seashells or seashells which have been taken alive; Live coral or coral which has been taken alive; Wild birds' nests; Birds' eggs; Turtles' eggs; Flora, coral or seashells specified under the Wild Life Protection Regulations, 1984". Restrictions on coral were further altered by the Prohibited Imports and Exports Control (Amendment) Order 1999 to read "Coral, whether alive or dead".

The Trade in Endangered Species (Control) Ordinance 2001 (151) provides for the application of CITES, appointing the Administrator as the "Management Authority", and requiring that advice be taken from a scientific "…person or authority as the Commissioner may from time to time appoint".

Species introductions in BIOT

The introduction of species does not appear to be expressly prohibited other than in Strict Nature Reserves.

Marine pollution in BIOT

The prevention of oil pollution, and the finance to support clean-up, are covered under several laws.

The Oil Pollution (Compulsory Insurance) Regulations, 1976, (133) which refers back to the Merchant Shipping (Oil Pollution) Act 1971 and requires certification of insurance against liability for oil pollution.

The Prevention of Oil Pollution Ordinance 1994, (142) makes it an offence to cause an oil spill, and it is also a duty to report any discharge.

The Merchant Shipping (Oil Pollution) (British Indian Ocean Territory) Order 1997 (144) extends sections of the Merchant Shipping Act 1995 to BIOT. It assigns liability for oil spills, and the costs of their control and clean-up. A certificate of insurance is required for "any ship carrying in bulk a cargo of more than 2000 tons of oil". This Order also ensures compliance with the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1992, and establishes conditions under which that Fund may be used.

The Merchant Shipping (Liability and Compensation for Oil Pollution Damage) (Transitional Provisions) (Overseas Territories) Order 1997 (145) extends those sections of the Merchant Shipping Act 1995 to all Overseas Territories, giving effect to the rules governing liability and compensation linked to the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1992

Other marine pollution is covered under The Environment Protection (Overseas Territories) Order 1988, extended to BIOT by The Environment Protection (Overseas Territories) (Amendment) Order 1999. "This Order extends…the provisions of Parts II and IV of the

Food and Environment Protection Act 1985" which aims "to replace the Dumping at Sea Act 1974 (c. 20) with fresh provision for controlling the deposit of substances and articles in the sea…[and] under the seabed, and for connected purposes".

A licence is required for:

- depositing substances or articles within the territorial waters or fisheries zone;
- scuttling vessels in these waters;
- loading of vessels in territorial waters with substances or articles for depositing in the sea.

A licence is required for incineration at sea on any British vessel, or on any vessel within territorial waters. The Governor has responsibility for granting licences and charging fees, but will make provision for the protection of the marine environment and human health. Although not clearly specified, this legislation might cover the emptying of ballast water. It may also be used to address land-based sources of pollution, notably sewage outfalls and the release of hot water or brine e.g. from desalination plants.

Atmospheric pollution in BIOT

Penal Code: Ordinance No. 5 of 1981 (134) includes, among its offences, pollution of the atmosphere "making it noxious to the health".

The Ozone Layer Protection Ordinance 1994 (140) brings the Montreal Protocol into effect controlling "the manufacture, importation and exportation of certain substances and products", namely man-made, ozone-depleting substances.

Landscape protection in BIOT

Penal Code: Ordinance No. 5 of 1981 lists activities including pollution of "any river, stream, spring or reservoir"; the lighting of "a fire in any forest, plantation or field…without having previously obtained written permission"; the carrying of "fire or a lighted naked torch or candle…in any street, road, way, lane, track, footpath, square or open space…or in any forest, plantation or field, except…with the permission of the Commissioner's Representative"; and disposal of "any litter or refuse…on the foreshore or in any public place"

Restrictions on access in BIOT

Although not necessarily conceived for conservation purposes, restrictions on access may benefit the natural environment. Aside from restrictions on fishing vessels, a number of regulations restrict access or activities in BIOT waters, particularly to the Strict Conservation Areas. As noted, the Immigration Ordinance of 2000 permits Chagossians to land on any island except Diego Garcia.

The Outer Islands (Services for Visiting Vessels) Ordinance 1993 (139) covers all vessels apart from government or UK or US military vessels, and any others certified exempt by the Commissioner's Representative. Under this "no vessel shall moor at any place in the outer islands without the consent of the Commissioner's Representative", but "consent…shall be deemed to have been given in any case where the master of the vessel has, in response to a demand made by a Visiting Vessels Control Officer, paid in full the mooring-charge payable in respect of that mooring."

Note that the term 'moor' is used, but 'anchoring' is meant, as moorings are not provided.

British Indian Ocean Territory Waters (Regulation of Activities) Ordinance 1997 (143) regulates activities, which include "any form of exploration or survey of, or research into, any aspect of the waters of the Territory or the seabed or subsoil beneath those waters or the living or non-living resources of those waters or of that seabed or subsoil, whether….for reward or in pursuit

of scientific knowledge, or for pleasure…". Any such activities require the consent of the Commissioner or of an authorised officer.

10 Bibliography

1. Anderson RC, Sheppard CRC, Spalding MD, Crosby R (1998) Shortage of Sharks at Chagos. Shark News, newsletter of the IUCN Shark Specialist Group 10:1-3
2. Baldwin, E.A. 1975 ed. *Joint Services Expedition to Danger Island*. MOD Publication, London
3. Barnett, L.K. and Emms, C. 1997.Herpetological observations in the Chagos Archipelago, British Indian Ocean Territory. *British Herpetological Society Bulletin* 59:6-12
4. Barnett, L.K. and Emms, C. 1997. Odonata observations on the Chagos Archipelago, British Indian Ocean Territory: a review and update. *Notulae Odonatologicae* 4:153-164
5. Barnett, L.K. and Emms, C. 1998. An annotated check-list of the Chagos Archipelago Terrestrial Fauna (omitting birds) recorded during the 1996 'Friends of the Chagos' expedition. *Phelsuma* 6: 41-52.
6. Barnett, L.K. and Emms, C. 1999. The insects of the Chagos Archipelago, pp. 241-256: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
7. Barnett, L.K., Emms, C. and Clarke, D. 1999. The coconut or robber crab *Birgus latro* in the Chagos Archipelago and its captive culture at London Zoo, pp. 273-284: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
8. Barnett, L.K., Emms, C. Holdway, J.D. The moths of the Chagos Archipelago, with notes on their biogeography. *Journal of Natural History* 33: 1021-1038.1999.
9. Bellamy, D.J. 1979. *Half of Paradise*. Cassell London, pp 180.
10. Bellamy, D.J., Hirons M.J., Sheppard, C.R.C. 1975. Scientific report of reef research. In: Baldwin, E.A. ed Joint Services Expedition to Danger Island. MOD Publication, London, chapter 6.
11. Bourne, G.C. 1988. The atoll of Diego Garcia and the coral formations of the Indian Ocean. *Proceedings of the Royal Society of London* 43:440.
12. Bourne, W.R.P. 1971. The birds of the Chagos group. *Atoll Research Bulletin* 149:175-207.
13. Bruner, P.L. 1996. Avifaunal survey of USNSF Diego Garcia, BIOT. In: *Natural Resources Management Plan, Diego Garcia*.
14. Clark, A.M. and Taylor, J.D. 1971 Echinoderms from Diego Garcia. *Atoll Research Bulletin* 149:89.
15. Cross S., Pienkowski, M. 1998. *The Convention on Biological Diversity and the UK Overseas Territories*. WWF-UK, pp36.
16. Curtis, W.F. 1976. The visit of RFA Reliant to the Chagos Archipelago, 6-10 October 1974. *Sea Swallow* 25: 11-13.
17. Dinesen, Z.D. 1977. The coral fauna of the Chagos Archipelago. *Proceedings 3rd International Symposium Coral Reefs, Miami 1*: 155-161.
18. Doak, E.L., Lyzenga, D.R. and Polcyn, F.C. 1979. Remote bathymetry by landsat in the Chagos Archipelago. *Environmental Research Institute of Michigan* pp. 31.
19. Drew, E.A. 1980. Seagrasses in the Chagos Archipelago. *Aquatic Botany* 9: 179-184.
20. Drew, E.A. undated. Diversity of the algal genus Halimeda in the Chagos Archipelago, central Indian Ocean. Manuscript. 8pp.
21. Dumbraveanu, D. and Sheppard, C.R.C. 1999. Areas of substrate at different depths in the Chagos Archipelago, pp. 35-44: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
22. Dutton, R.A. 1980. The herpetology of the Chagos Archipelago. *British Journal of Herpetology*, 6: 133-134.
23. Dutton, R.A. 198 . Observations on turtles in the Chagos Archipelago, and the potential of that area as an important nesting ground for Eretmochelys imbricata. ??
24. Eisenhauer, A., Heiss, G.A., Sheppard, C.R.C. and Dullo, W-C. 1999. Reef and island formation and late holocene sea-level changes in the Chagos Islands, pp. 21-34: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
25. Emery, A.R., Winterbottom, R. 1979. A dying paradise. *Rotunda* 12:2-10.
26. Emery, A.R., Winterbottom, R. 1980. A technique for fish specimen photography in the field. *Canadian Journal Zooology* 58: 2158-2162.
27. Everaarts, J.M., Booij, K., Fischer, C.V., Mass, Y.E.M. and Nieuwenhuize, J. 1999. Assessment of the environmental health of the Chagos Archipelago, pp. 305-326: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
28. FAO (2000) The state of world fisheries and aquaculture. Food and Agriculture Organization of the United Nations, Rome, Italy.
29. Gardiner, J.S. 1936. The reefs of the Western Indian Ocean. I. Chagos Archipelago II. The Mascarene region. *Transactions of Linnean Society, London* Vol XIX, pp. 393-436.
30. Griffiths, J.D. ed. *Chagos: The 1978/79 expedition*. MOD Publication, London, pp. 1-52.
31. Haeger, S.D. 1980. Flushing study for Diego Garcia using a numerical hydrodynamical model. Manuscript for Naval Oceanography Command, St Louis.
32. Hirons, M.J., Bellamy, D.J., Sheppard, C.R.C. 1976. Birds of the Chagos Bank. *Nature*, 260:387.
33. Howells, M.J. 1983. The birds of Diego Garcia. *Sea Swallow*, 32:42-47.
34. Hunt. C.D. Hydrogeology of Diego Garcia. * *Geology and hydrogeology of Carbonate Islands, Developments in Sedimentology*. 54: 909-931.
35. Hutson, A.M. 1975. Observations on the birds of Diego Garcia. *Atoll Research Bulletin*, 175.
36. Jolliffe, A.S. and Basson, P.W. 1999. The subtidal distribution of macroalgae on the coral reefs of the Chagos Archipelago: a preliminary study, pp. 137-150: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
37. Mees CC, Pilling GM, Barry C (1997) A review of the 1997 BIOT inshore fishery and management strategy. Background paper UK01 for the Third Meeting of the British/Seychelles Fisheries Commission Scientific Sub Committee Meeting, 25-26 September, 1997. MRAG/ BIOT. 16pp.

38. Mees, C.C., Pilling, G.M. and Barry, C.J. 1999. Commercial inshore fishing activity in the British Indian Ocean Territory, pp. 327-346: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
39. Mees CC, King A, Pilling GM, Barry CJ 1999. British Indian Ocean Territory - Fisheries Conservation and Management Zone. The inshore fishery in 1998, with summary details of the recreational fishery of Diego Garcia. Marine Resources Assessment Group Report, May, 1999.
40. Mees CC, Barry CJ, King A (2000) British Indian Ocean Territory (Chagos Archipelago) Fisheries Conservation and Management Zone: the 1999 inshore and recreational fisheries. A summary report to the Friends of Chagos, BIOT Administration, Foreign and Commonwealth Office. Marine Resources Assessment Group, London. 17pp.
41. Mees CC and Polunin, N. 1994.
42. McGee, T. 1987. An initial study of basin residency time and sediment transport with the Diego Garcia lagoon. manuscript for Commanding Officer, Naval Support Facility, Diego Garcia.
43. Miller, H.A. 1997. A study of water flow, residency times and climatology for the Diego Garcia lagoon. manuscript for Naval Pacific Meterology and Oceanography Depatchment, Diego Garcia.
44. Moresby, R. 1884. Untitled. *Transactions of Bombay Geographical Society*. Vol I: pp. 306- 310.
45. Mortimer, J.A. 2000. *Diego Garcia marine Turtle Conservation Assessment, British Indian Ocean Territory.* Final report, FFI International. Pp 64.
46. Mortimer, J.A. and Broderick, D. 1999. Population genetic structure and developmental migrations of sea turtles in the Chagos Archipelago and adjacent regions inferred from mtDNA sequence variation, pp.185-194: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
47. Mortimer, J.A. and Crain, D.A. 1999. Sex steroid concentrations in immature hawsbill turtles *eretmochelys imbricata* in the Chagos Archipelago, pp. 159-176: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
48. Mortimer, J.A. and Day, M. 1999. Sea turtle populations and habitats in the Chagos Archipelago, pp. 159-176: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
49. MRAG Ltd (2001) Report of the 2000-2001 Tuna Scientific Observer Programme, British Indian Ocean Territory, December 2001 to February 2002. A Report to the Commissioner for the British Indian Ocean Territory, March 2002. Marine Resources Assesment Group Ltd, London. 61p.
50. MRAG Ltd (2002) Report of the 2001-2002 Tuna Observer Program, British Indian Ocean Territory, December 2001 to February 2002. A Report to the Commissioner for the British Indian Ocean Territory, April 2002. Marine Resources Assesment Group Ltd, London. 58p.
51. Murray, J.W. 1994. Larger foraminifera from the Chagos Archipelago: their significance for Indian Ocean biogeography. *Marine micropalaeontology*, 24: 43-55.
52. Murray, J.W. 1999. Review of benthic foraminiferal distributions on Chagos, pp. 151-158: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
53. Murray, J.W., Smart, C.W. 1994. Distribution of smaller benthic foraminifera in the Chagos Archipelago, Indian Ocean. *Journal of micropalaeontology*, 13: 47-53.
54. Oldfield S. and Sheppard C.R.C. 1997. Ecological support of conservation in the dependent territories. *Journal Applied Ecology*. 34:1111-1121.
55. Pearce J (1999) British Indian Ocean Territory - Fisheries Conservation and Management Zone. Summary of the offshore tuna fisheries. Friends of Chagos Background Paper, prepared by Marine Resources Assessment Group Ltd., London. 12pp.
56. Pearce J, Ansell N (2002) Friends of Chagos Offshore Fishery Background Paper 2001. Unpublished report. Marine Resources Assesment Group Ltd. 19pp.
57. Posford Haskoning. 2002. Feasibility study for resettlement of Chagos atolls. Posford Haskoning, Peterborough, UK
58. Price, A.R.G. 1999. Broadscale coastal environmental assessement of the Chagos Archipelago, pp. 285-296: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
59. Pugh, D.T., Rayner, R.F. 1981. The tidal regimes of three Indian Ocean atolls and some ecological implications. *Estuarine Coastal and Shelf Science*, 13: 389-407.
60. Randall, J.E., Emery, A.R. 1983. A new labrid fish of the genus *Cirrhilabrus* from the Chagos Archipelago, Indian Ocean. *Journal Aquaculture and Aquatic Science*, 3: 21-24.
61. Rayner, R.F. 1982. The circulation and water exchange properties of Salomon Atoll Chagos Archipelago. *Proceedings 6th International Scientific Symposium, World Underwater Federation 1980*. NERC publ, London.
62. Rayner, R.F. 1983. *Aspects of the oceanography of two mid Indian Ocean coral Atolls*. Ph.D. Thesis, University of Salford, UK.
63. Rayner, R.F., Drew, E.A. 1984. Nutrient concentrations and primary productivity at the Peros Banhos and Salomon Atolls in the Chagos Archipelago. *Estuarine Coastal and Shelf Science*, 18: 121-132.
64. Readman, J.W., Tolosa, I., Bartocci, J., Cattini, C., Price, A.R.G. and Jolliffe, A. 1999. Contaminant levels and the use of molecular organic markers to characterise the coastal environment of the Chagos Archipelago, pp. 297-304: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
65. Reinicke, G.B. and Van Ofwegan, L.P. 1999. Soft corals alcyonacea: octocorallia from shallow water in the Chagos Archipelago: species assemblages and their distribution, pp. 67-90: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
66. Russell, G. 1981. Report on the marine vegetation of Egmont Is. Chagos Bank Indian Ocean. In: Fogg, G.S., Jones, W.E. eds *Proceedings of 8th International Seeweed Symposium Menai Science Lab, UK*. pp 464-468.
67. Salm, R.V. 1980. *The genus-area relation of corals on reefs of the Chagos Archipelago, Indian Ocean*. Ph.D. Thesis, Johns Hopkins University, pp 125.
68. Salm, R.V. 1984. Ecological boundaries for coral reef reserves: Principles and guidelines. *Environmental Conservation*, 11: 209-215.
69. Seaward, M.R.D. 1999. Cryptogamic flora of the Chagos Archipelago, pp. 207-224: in in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2* Westbury Publishing. pp. 351
70. Sheppard, A.L.S. 1984. The molluscan fauna of Chagos

Indian Ocean and an analysis of its broad distribution patterns. *Coral Reefs*, 3: 43-50.
71. Sheppard, C.R.C. 1979. Status of three rare animals on Chagos. *Environmental Conservation*, p 310.
72. Sheppard, C.R.C. 1979. Interspecific aggression between reef corals with reference to their distribution. *Marine Ecology Progress Series* 1: 237-147.
73. Sheppard, C.R.C. 1980. New life on forsaken Chagos Isles. *Geographical Magazine* Vol LII 12 pp 825-829.
74. Sheppard, C.R.C. 1980. The coral fauna of Diego Garcia lagoon, following harbour construction. *Marine Pollution Bulletin* 11: 227-230.
75. Sheppard, C.R.C. 1980. Coral cover, zonation and diversity on reef slopes of Chagos atolls, and population structures of the major species. *Marine Ecology Progress Series* 2: 193-205.
76. Sheppard, C.R.C. 1981. ed Report on Scientific work completed on Joint Services Chagos Research Expedition 1978/9. In: Griffiths J.D. ed *Chagos: The 1978/79 expedition.* MOD Publication, London, pp 1-52.
77. Sheppard, C.R.C. 1981. The reef and soft-substrate coral fauna of Chagos, Indian Ocean. *Journal Natural History*, 15: 607-621.
78. Sheppard, C.R.C. 1981. The groove and spur structures of Chagos atolls and their coral zonation. *Estuarine Coastal and Shelf Science*, 12: 549-560.
79. Sheppard, C.R.C. 1981. Roles of interspecific and intraspecific competition in coral zonation. *Progress in Underwater Science*, 6: 57-60.
80. Sheppard, C.R.C. 1982. *Natural History of the Coral Reef*. Blandford Press, Poole, pp. 164.
81. Sheppard, C.R.C. 1987. Coral species of the Indian Ocean and adjacent seas: a synonymised compilation and some regional distribution patterns. *Atoll Research Bulletin* 307:1-32.
82. Sheppard, C.R.C. 1996. Report of 1996 Chagos Research Expedition. BIOT Administration.
83. Sheppard, C.R.C. 1997. *The Sea Shores of Chagos*. Friends of the Chagos.
84. Sheppard, C.R.C. 1998. Biodiversity patterns in Indian Ocean corals, and effects of taxonomic error in data. *Biodiversity and Conservation* 7:847-868
85. Sheppard, C.R.C. 1999. Changes in coral cover on reefs of Chagos over eighteen years, pp. 91-100: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
86. Sheppard, C.R.C. 1999. Changes in some weather patterns in Chagos over twenty-five years, pp. 45-52: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
87. Sheppard, C.R.C. 1999. Corals of Chagos, and the biogeographical role of Chagos in the Indian Ocean, pp. 53-66: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
88. Sheppard, C.R.C. 1999. Coral Decline and Weather Patterns over 20 years in the Chagos Archipelago, central Indian Ocean. *Ambio* 28:472-478
89. Sheppard, C.R.C. 1999. Coral mortality in the Chagos Archipelago. In: Linden, O, Sporrong, N. (Eds.) *Coral Reef Degredation in the Indian Ocean*. World Bank and Swedish International Development Agency. pp 27-32.
90. Sheppard, C.R.C. 2000. The Chagos Archipelago. In Sheppard, C.R.C. Ed *Seas at the Millennium: An Environmental Evaluation*. Elsevier. Vol 2 pp. 221-232.
91. Sheppard, C.R.C. 2000. The Chagos Archipelago. In: McClanahan, T. Sheppard, C.R.C. and Obura, D. eds. *Coral Reefs of the Western Indian Ocean, Ecology and Conservation*, Oxford University Press, New York .
92. Sheppard, C.R.C. 2000. Coral Reefs of the Western Indian Ocean : an Overview. In: Mc.Clanahan, T., Sheppard, C.R.C. Obura, D. *Coral Reefs of the Western Indian Ocean: Ecology and Conservation*. Oxford University Press.
93. Sheppard, C.R.C. 2001. Rubble Trouble. *Diver Magazine* pp *
94. Sheppard, C.R.C. 2002. Island profiles, coral death, erosion and sea level rise in Chagos. Chagos News, 19: 9-12.
95. Sheppard, C.R.C. 2002. Island profiles, coral death, erosion and sea level rise in Chagos . In: Linden, O and Souter, eds. *Coral Reef Degradation in the Indian Ocean. Status reports and project presentations*. Cordio, Stockholm University, Sweden. pp 26-35.
96. Sheppard, C.R.C., Dinesen, Z.D., Drew, E.A. 1984. Taxonomy, ecology and physiology of the geographically restricted Scleratinian species *Ctenella chagius* Matthai. *Bulletin of Marine Science*, 33: 905-918.
97. Sheppard, C.R.C. and Seaward, M.R.D. 1999. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
98. Sheppard, C.R.C., Seaward, M.R.D., Klaus, R. and Topp, J.M.W. 1999. The Chagos Archipelago: an introduction, pp, 1-20: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
99. Sheppard, C.R.C., Wells, S.M. *Directory of Coral Reefs, Volume 2. Indian Ocean Red Sea and Gulf.* UNEP/IUCN publication, Cambridge, UK. Chagos chapter pp 37-46.
100. Sheppard, C.R.C., Spalding, M., Bradshaw, C., Wilson, S. 2002. Erosion *vs*. recovery of coral reefs after 1998 El Niño: Chagos reefs, Indian Ocean. *Ambio* 31: 40-48.
101. Sheppard, C.R.C., Rayner, N.A. 2002. Utility of the Hadley Centre sea-Ice and Sea Surface Temperature data set (HadISST1) in two widely contrasting coral reef areas. *Marine Pollution Bulletin* 44: 303-308.
102. Singh, O.P., Ali Khan, T.M., Aktar, F., Sarker, M.A. 2001. Recent sea level and sea surface temperature changes along the maldives coast. *Marine Geodesy* 24:204-218.
103. Spalding, M. 1997. *Reef Fishes of the Chagos* . Friends of the Chagos.
104. Spalding, M.D. 1999. Biodiversity patterns in Chagos reef fishes, pp. 119-136: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
105. Spalding MD (2000) The Status of Commercially Important Reef Fishes of the Chagos Archipelago. A report for the British Indian Ocean Territories Administration, Foreign and Commonwealth Office, London. 42pp.
106. Spalding MD (In press) Partial recovery of sharks in the Chagos Archipelago. Shark News, newsletter of the IUCN Shark Specialist Group
107. Spalding, M.D. Raviolious C and Green EP. 2001. Atlas of Coral Reefs. UNEP/WCMC.
108. Stoddart, D.R. (1971). Rainfall on Indian Ocean Coral Islands. *Atoll Research Bulletin* 149:1-21.
109. Stoddart, D.R., Taylor, J. (1971). Geology and ecology of Diego Garcia atoll, Chagos Archipelago. *Atoll Research Bulletin* 149:1-237. (contains much basic information, species lists etc. of Diego Garcia atoll)
110. Symens, P. 1996. *Status and Conservation of Seabirds in the Chagos Archipelago, BIOT*. MSc thesis, University of Warwick.
111. Symens, P. 1999. Breeding seabirds of the Chagos Archipelago, pp. 257-272: in Sheppard, C.R.C. and Sea-

ward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
112. Topp, J.M.W. 1988. An annotated check list of the flora of Diego Garcia, British Indian Ocean Territory. *Atoll Research Bulletin*, 313:1-21.
113. Topp, J.M.W. and Sheppard, C.R.C. 1999. Higher plants of the Chagos Archipelago, pp. 225-240: in Sheppard, C. R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
114. Topp, J.M.W. 1993-2002. Annual reports of the Conservation Advisor to BIOT Administration. All are manuscripts.
115. Topp, J.M.W. The British Indian Ocean Territory: A Natural Paradise. *Sanctuary* 26: 36-39.
116. UNEP 1985. The management and conservation of renewable marine resources in the South Asian Seas Region. UNEP Regional Seas Studies and Reports. 62. pp 60.
117. UNEP 1985. The management and conservation of renewable marine resources in the Indian Ocean region: Overview. UNEP Regional Seas Studies and Reports. 60. pp 78.
118. US Navy. 1997. *Natural Resources Management Plan, US Navy Support Facility, Diego Garcia.*
119. Wheeler JFG, Ommanney FD (1953) Report on the Mauritius-Seychelles Fisheries Survey 1948-1949. Colonial Office, Fishery Publications 1:1-145
120. US Naval Oceanography Command Detachment, Diego Garcia. 1986. A study of an ocean current encountered while entering and leaving Diego Garcia. US Navy Oceanography Command, St Louis.
121. Whitton, B.A., Whitton, B.A., Donaldson, A., Bellamy, D.J. and Sheppard, C.R.C. 1977. Terrestrial and swamp algae from three islands in the Chagos Archipelago, Indian Ocean. *Atoll Research Bulletin*, 217: 1-6.
122. Williams, S.T., Knowlton, N. and Weigt, L.A. 1999. Indopacific molecular biogeography of the coral-dwelling snapping shrimp *Alphes lottini* Decapoda: Caridea: Alpheidae, pp. 195-206: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
123. Winterbottom, R. 1984. A review of the gobiid fish genus *Trimma* from the Chagos Archipelago, central Indian Ocean, with the description of seven new species. *Canadian Journal Zoology*, 62: 695-715.
124. Winterbottom, R. 1984. Two new gobiid fish species in Priolepis and Trimma from the Chagos Archipelago, central Indian Ocean. *Canadian Journal Zoology*, 63: 747-754.
125. Winterbottom, R. and Anderson, R.C. 1997. An annotated checklist of the fishes of the Chagos Archipelago. *Ichthyological Bulletin, Grahamstown, South Africa*, no 66.
126. Winterbottom, R. and Anderson, R.C. 1999. Fishes of the Chagos Archipelago, pp. 101-118: in Sheppard, C.R.C. and Seaward, M.R.D. Eds. *Ecology of the Chagos Archipelago. Linnean Society Occasional Publications, 2*. Westbury Publishing. pp. 351.
127. Winterbottom, R. and Emery, A.R. 1981. A new genus and two new species of gobiid fishes Perciformes from the Chagos Archipelago, Central Indian Ocean. *Environmental Biology of Fishishes* , 6: 139-149.
128. Winterbottom, R. and Emery, A.R. 1986. Review of the Gobioid fishes of the Chagos Archipelago, Central Indian Ocean. *Royal Ontario Museum, Life Sciences Contributions*, pp 82.
129. Winterbottom, R., Emery A.R. and Holm, E. 1989. An annotated checklist of the fishes of the Chagos Archipelago. *Royal Ontario Museum, Life Sciences contributions*, pp. 226.

BIOT Environment and Conservation Laws

130. The Protection and Preservation of Wild Life Ordinance 1968. (Ordinance No. 2 of 1968)
131. The Protection and Preservation of Wild Life Ordinance 1970 (Ordinance No 1 of 1970)
132. The Merchant Shipping (Oil Pollution) (Overseas Territories) Order, 1975 (Statutory Instrument No 4 of 1976)
133. The Oil Pollution (Compulsory Insurance) Regulations, 1976 (Refers back to the Merchant Shipping (Oil Pollution) Act 1971)
134. Penal Code: Ordinance No. 5 of 1981
135. The Wild Life Protection Regulations 1984 (S.I. No 6 of 1984)
136. The Prohibited Imports and Exports Order, 1984 (S.I. No 7 of 1984)
137. Imports and Exports Control Ordinance, 1984 (Ordinance No 13 of 1984)
138. Fishing Regulations, 1993 (S.I. No 3 of 1991)
139. Outer Islands (Services for Visiting Vessels) (Ordinance No 4 of 1993)
140. Ozone Layer Protection Ordinance 1994 (Ordinance No 3 of 1994)
141. Diego Garcia Conservation (Restricted Area) (Ordinance No 6 of 1994)
142. Prevention of Oil Pollution Ordinance 1994 (Ordinance No 7 of 1994)
143. British Indian Ocean Territory Waters (Regulation of Activities) (Ordinance No 3 of 1997)
144. The Merchant Shipping (Oil Pollution) (British Indian Ocean Territory) Order 1997 (Extends sections of the Merchant Shipping Act 1995 to BIOT)
145. The Merchant Shipping (Liability and Compensation for Oil Pollution Damage) (Transitional Provisions) (Overseas Territories) Order 1997
146. Public Notice 1997. Updated in Annex A to Public Notice 14/02 dated 9 August 2002
147. The Environment Protection (Overseas Territories) Order 1988. [As originally legislated this did not cover BIOT, but was extended to BIOT by The Environment Protection (Overseas Territories) (Amendment) Order 1999].
148. The Fisheries (Conservation and Management) (Ordinance No 4 of 1998)
149. Strict Nature Reserve Regulations 1998 (S.I. No 4 of 1998)
150. The Fishing (Prohibited Gear) Regulations 2000 S.I. No 3 of 2000)
151. The Trade in Endangered Species (Control) (Ordinance No 3 of 2001)
152. Convention on Wetlands of International Importance especially as Waterfowl Habitat (RAMSAR)

Web sites

153. Agreement for the Establishment of the Indian Ocean Tuna Commission http://www.seychelles.net/iotc/
154. Convention concerning the Protection of the World Cultural and Natural Heritage http://whc.unesco.org/toc/toc_index.htm
155. Convention for the Protection of the Ozone Layer http://www.unep.ch/ozone/treaties.shtml
156. Convention on Biological Diversity http://www.biodiv.org/
157. Convention on International Trade in Endangered Species of Wild Fauna and Flora http://www.cites.org/
158. Convention on Long Range Transboundary Air Pollution

http://www.unece.org/env/lrtap/
159. Convention on the Conservation of Migratory Species of Wild Animals http://www.unep-wcmc.org/cms/index.htm
160. Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal http://www.unep.ch/basel/
161. Convention on Transboundary Effects of Industrial Accidents http://www.unece.org/env/teia/intro.htm
162. Convention on Wetlands of International Importance especially as Waterfowl Habitat (RAMSAR). Http://www, ramsar.org
163. Framework Convention on Climate Change http://unfccc.int/
164. International Coral Reef Initiative (ICRI) http://www.icriforum.org/secretariat/pdf/icri-framework.pdf
165. Hadley Centre: Climate Predictions http://www.metoffice.gov.uk/research/hadleycentre/models/modeldata.html
166. Intergovernmental Panel on Climate Change. http://www.ipcc.ch
167. Mean sea level data. http://www.pol.ac.uk/psmsl/psmsl_individual_stations.html
168. Submission of environmental award for Diego Garcia http://web.dandp.com/n45/FY01CNO_ EnvAwards/Natural_Resources_Conservation/Small_Installation/NSF_Diego_Garcia_NR_ Small_Installation.pdf
169. United Nations Convention on the Law of the Sea http://www.un.org/Depts/los/index.htm and UNCLOS, summary of provisions. http://www.oceanlaw.net/texts/summaries/loscfish.htm
170. US Navy 2001. Final Governing Standards Diego Garcia. https://www.denix.osd.mil/denix/DOD/Library/Intl/FGS/final-gov-stds-dod.html

Friends of the Chagos publications

171. Sheppard, C.R.C. 1997. *The Sea Shores of Chagos*. Friends of the Chagos. 16 pp
172. Spalding, M 1999. *Fishes of Chagos*. Friends of the Chagos. 16 pp
173. Symens, P. 1999. *Birds of Chagos*. Friends of the Chagos. 16 pp
174. Topp J.M.W. 1997. *Plants of Chagos*. Friends of the Chagos. 16 pp
175. Friends of the Chagos Cd rom. 2002. Circa 750 images of the archipelago.

Protected areas references (not BIOT)

176. Norse, Elliott A. (chief author) 1,604 other scientists 1998. Troubled Waters: A Call for Action. Released at the US Capitol, January 6, 1998. See details in next citation (p 44), and Roberts CM 2002. How much of the sea should be protected from fishing in marine reserves? *Ecological Applications*.
177. Roberts C.M. and Hawkins J. 2000. Fully protected marine reserves: a guide. WWF. Washington.