British Indian Ocean Territory Ecosystem Action Plan (EAP)
NATIVE WOODLAND

Figure 1. Coastal native woodland on the Egmont Islands, Chagos Archipelago. Despite most of the archipelago's native woodland being cleared for coconut farming over the past 200 years, relict stands of coastal native trees still exist and provide havens for breeding seabirds.

SUMMARY

IUCN habitat classification: 1.6 Subtropical/Tropical Moist Lowland Forest

Description: Taxonomy and species distribution follow POWO (1). Subtropical/Tropical Moist Lowland Forest within this EAP is defined as native woodland in which at least one of the following native tree species are the dominant community: *Ochrosia oppositifolia* (Lam.) K.Schum., *Cocos nucifera* L., *Cordia subcordata* Lam., *Calophyllum inophyllum* L., *Hernandia nymphaeifolia* (C.Presl.) Kubitzki, *Barringtonia asiatica* (L.) Kurz, *Intsia bijuga* (Colebr.) Kuntze, *Ceodes grandis* (R.Br.) D.Q.Lu, *Guettarda speciosa* L. and *Heliotropium arboreum* (Blanco) Mabb.. The mangrove *Lumnitzera racemosa* Willd. is native to the Chagos Archipelago but is not considered in this EAP. *C. nucifera* is native but has been extensively farmed throughout the entire archipelago in plantations (IUCN Vegetation Category 14.3), these abandoned monoculture stands are not considered native woodland. Along shorelines and on islands where storm surges have clearly pushed coconuts inland enabling colonisation, such as on Diego Garcia around Barton Point, South Brother and Nelson's

Island, they are considered native. Native woodland covers 11.53 km^2 of the terrestrial landmass (*c*. 23% of the total landmass of the archipelago) of which 9.6 km^2 is found on Diego Garcia. Native trees provide critical nesting habitat for red-footed booby (*Sula sula*) and lesser noddy (*Anous tenuirostris*), both of which are present in internationally significant numbers triggering IUCN Important Bird and Biodiversity Area (IBA) status for the hosting islands [2]. There is irrefutable evidence that native woodland was once much more extensive in the Chagos Archipelago and most of their loss was caused due to clearing of native woodland for coconut plantations, with smaller losses for hardwood timber [3, 4]. Restoration or rehabilitation of damaged or degraded habitat is an environmental goal within the management plan for the Chagos Archipelago [5]. Island ecological rehabilitation through converting former coconut plantations to native woodlands (and other ecosystems) should be a top priority for the BIOT Administration.

Threats: The principle threat of deforestation for coconut plantations has passed due to the closure of the plantation business in the Chagos Archipelago by the early 1970s [3]. As a result of the plantation era, it is assessed that, excluding the anomaly of the military facility of Diego Garcia ~63% of island vegetation cover is now abandoned coconut plantation [6]. Encroachment by abandoned plantations on the remaining tracts of native woodland provides a present-day low-level threat. Black rats (*Rattus rattus*) are present on all islands that were farmed for coconut and dramatically limit woodland regeneration [13] and present the greatest extant threat to all ecosystems of the archipelago [14]. Non-native/invasive vascular plants pose a threat to native woodlands, especially *Leucaena leucocephala* (Lam.) de Wit and, *Casuarina equisetifolia* L that has spread throughout the archipelago. The most likely source of non-native/invasive plants into the eco-sensitive islands of the northern atolls is from Diego Garcia where biosecurity to prevent further invasion is paramount. Climate variation and associated unpredictable weather events and sea-level rising potentially provide a catastrophic future for all islands of the archipelago.

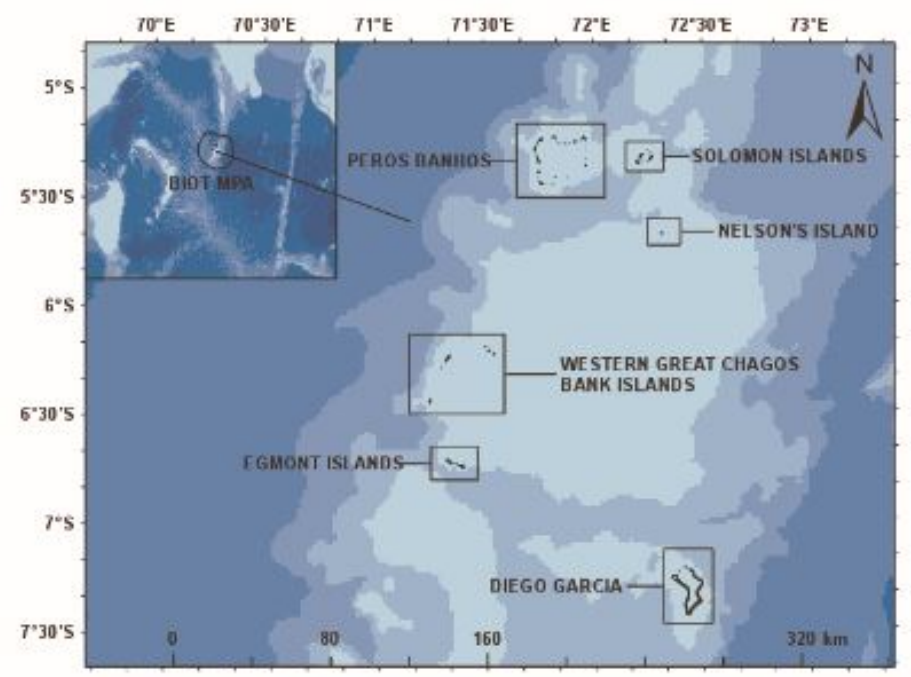

Figure 2. The Chagos Archipelago (British Indian Ocean Territory - BIOT) showing the atolls and key isolated islands. MPA = Marine Protected Area.

DISTRIBUTION

Distribution Total Extent: *c* 11.53 km^2.

Relict tracts of native woodland are still present in all atolls of the Chagos Archipelago (Fig. 2). The biggest stand by an order of magnitude is found on the largest island, Diego Garcia, which holds ~83% of all the archipelago's native woodland. Nesting in the coastal trees on this island are ≈ 10,000 breeding pairs of red-footed booby; the second largest colony in the Indian Ocean [7]. Other significant tracts of native woodland > 0.1 km^2 are found on the Sudest complex (0.33 km^2) and Lubine complex (0.16 km^2), Egmont Islands; Takamaka (0.17 km^2) and Fouquet (0.12 km^2), Solomon Islands; Manoel (0.16 km^2), Peros Banhos and, South Brother (0.14 km^2), Eagle Island (0.14 km^2) and Danger Island (0.11 km^2), Great Chagos Bank. The native woodland on South Brother and Danger Island (and Nelson's Island), islands that never hosted plantations, contain concentrated stands of coconut that is deemed to have spread inland naturally. Along the fronds and in the crowns of these trees, internationally significant populations of lesser noddy breed [7].

ECOLOGY

Ecosystem characteristics – Physical: As tropical moist lowland forest, the native woodland is dependent upon low variability in annual temperature and high levels of rainfall. In the Chagos Archipelago mean monthly temperature varies from a maximum of 30.75°C in March to a minimum of 28.03°C in August, an annual range of 2.7°C [15]. The atolls of the archipelago are the wettest in the Indian Ocean regularly receiving 4–5,000 mm/annum of

rainfall though this can be variable over time [16]. Rainfall distribution is approximately bimodal, generally with peaks in January-February and October [16]. Further research is required into the functionality of native woodland ecosystems.

Ecosystem characteristics – Biological: The ecology of native woodland in the Chagos Archipelago has not been studied to date. It is presumed that the prime ecosystem drivers are breeding and roosting seabirds, that input nutrients from marine ecosystems that subsequentially fertilise the woodland soil and the nearby littoral and inshore ecosystems [8]. Land crabs are abundant omnivores on all islands. In tropical coastal forest they are key ecosystem engineers, influencing, for example, woodland species composition and soil dynamics [e.g. 9] and are an essential component of native woodland ecosystems in the Chagos Archipelago. There are no vertebrate pollinators (e.g. bats [11], birds [12], *etc*.) and invertebrate communities are depauperate [10]. Confirmed pollinators are from the orders Lepidoptera and Hymenoptera and possibly, some Coleoptera. Native woodlands are also depauperate in floral biodiversity having 11 species of tree and approximately 25 other vascular plant species [17, 18].

CONSERVATION STATUS

On islands that were historically intensely farmed, most native woodland habitat was cleared and has been replaced by now abandoned monoculture stands of coconut. On every island that had plantations, black rats were introduced [6]. Islands that have abandoned coconut plantations and invasive rats hold very little biodiversity and are of poor conservation value. The one anomaly to this rule is the largest atoll:, Diego Garcia. Despite being intensively farmed for coconuts for two centuries and being rat-infested [3] a large tract of native woodland, much coastal, remains on the eastern arm of the main island. By the 1970s, breeding seabirds on the main island had all but disappeared following relentless persecution [3] but following the Diego Garcia Conservation (Restricted Area) Ordinance 1994 that prohibits entry to all environmentally sensitive areas, including most of the remaining native woodland, one species of seabird capable of protecting its eggs and young from rats has prospered. There are (2018 data) in the region of 10,000 breeding pairs of red-footed booby in the Restricted Area making this the second largest colony in the Indian Ocean [7]. This area is also protected under the Ramsar Convention [19] and is an IUCN designated Important Bird and Biodiversity Area (IBA) [2]. Except for Diego Garcia atoll, all islands of the Chagos Archipelago are within the Category 1 (Strict No-Take) Chagos Marine Protected Area. Inside the MPA, of the islands holding tracts of native woodland >0.1 km^2, two are also IBAs (South Brother and Danger Island) and these islands plus Manoel in Peros Banhos are Strict Nature Reserves where access is usually only granted to MPA enforcement patrols and visiting scientists. As an additional protection level, access to the entire Chagos Archipelago is severely restricted and visits to the northern atolls (Fig. 2) by fee paying yachts is by permit only with access to limited, designated moorings and islands [19].

CURRENT THREATS

At a local level, in the present day, native woodland is now directly impacted by a native plant interaction and alien invasive species. Potential breaches of biosecurity from Diego Garcia to the northern atolls remains an ever-present threat. On a global scale, climate variation and associated sea level rising potentially will have dire consequences for native woodland, but the exact extent and impact is uncertain.

Native Plant Interaction

Coconut *Cocos nucifera* L.: Coconut is a naturally occurring tree in the Chagos Archipelago [1] that is essential to the stability of beach-crests. It is present on every island with a substrate capable of supporting a sprouting nut. Historically, throughout the entire archipelago, native habitat was cleared to make way for coconut plantations [3] and it is assessed that > 63% of island cover (excluding Diego Garcia that has been dramatically ecologically altered to accommodate the military facility) is now coconut dominated [6]. The non-natural plantations are of poor biodiversity value. For example, of the 18 species of breeding seabird in the archipelago none regularly nest in coconut plantations [6, 11, 12]. The natural expansion of former plantations through falling nuts has the capacity to encroach and outcompete native woodland, as is happening to the mangrove ecosystems on Moresby and Eagle Island. **Impact –- Low (Historic – High)**

Alien Invasive Species

Vascular Plants – Two alien invasive species, *Leucaena leucocephala* (Lam.) de Wit and *Casuarina equisetifolia* L. are impacting native woodland in the Chagos Archipelago. The former is restricted to invasiveness only on Diego Garcia, the latter to several islands in the northern atolls, especially those that held plantations [18, 6]. Other species such as *Hibiscus tiliaceus* L. are spreading north from their presumed origin of Diego Garcia [18]. These non-native/invasive species have the capacity to ecologically outcompete native woodland vascular plants to local extinction. **Impact - High**

Vertebrates - Black rat detrimentally impact tropical oceanic island ecosystems on invasion [14]. Their impact upon native woodland has not been studied in the Chagos Archipelago but like other oceanic island ecosystems, their predation of seabirds, invertebrates (pollinators, detritivores *etc*.) seedlings, seeds and flowers will be causing an unnatural ecosystem shift. **Impact – High**

Biosecurity - Spread of non-native plant species from Diego Garcia to the northern atolls: The military facility on the largest island of Diego Garcia is now the principle access point for non-native species to the Chagos Archipelago. It is thought there are ~240 species of non-native plant on this island [18], many arriving since the construction of the military facility in the early 1970's. The potential for an alien invasive species to be transported from this island to the eco-sensitive, rat-free islands of the northern atolls is real and ever-present. **Impact – High**

Global Mean Sea Level Rise (GMSLR): Projected GMSLR for 1.5°C of global warming has an indicative range of 0.26 – 0.77m, relative to 1986–2005 [20], though a short series of sea level data from the Chagos indicates a rise currently of 5.5 mm per year [21]. All islands in the Chagos Archipelago are those of typical atolls, with a low elevation of generally < 2m (3, 4). Based upon the above figures, with an even rise in global temperature of 1.5°C, most of the archipelago would be submerged in *c*. 360 years. Many models of global warming predict higher temperature rises in shorter timeframes that would bring forward the date the archipelago would disappear underwater. **Impact – Unknown**

Climate variation: Research on the effect of climate variation on oceanic island ecosystems is lacking, though it certainly will impact and alter them to some extent. Research on a global scale is required to address these uncertainties. **Impact – Unknown**.

General – Lack of information on ecosystem functionality of native woodland: Despite native woodland being an important breeding habitat for two species of seabird that are present in internationally significant numbers in the Chagos Archipelago, except for inventorying the plant species of this ecosystem, there has been no research into its functionality. The lack of information on for example, its present health, the drivers and engineers, and biotic and abiotic interactions within the ecosystem are a cause for concern, especially when changes to the ecosystem may occur in the future through climate variation. **Impact** - **Unknown**.

RELEVANT POLICIES AND LEGISLATION

International: The area of Diego Garcia that holds most of the archipelago's native woodland is a Ramsar site [19], it is also designated as an IUCN Important Bird and Biodiversity Area (IBA) [2]. Two other islands that contain native woodland tracts >0.1 km^2 are also IBAs (South Brother and Danger Island) [2]. Except Diego Garcia atoll and the surrounding seas out to three nautical miles, the entirety of BIOT is Category 1 (Strict No-Take) Marine Protected Area.

Local: The three designated IBAs plus Manoel are Strict Nature Reserves. The Strict Nature Reserve Regulations 1998 provide the islands with legal protection. Under these Regulations, it is an offence for anyone to enter any of the Reserves, or to carry out activities there, without the written permission of the BIOT Administration [19].

ACTION NEEDED

Coherent island ecological rehabilitation management plan: Eradicating/controlling invasive species will not in itself increase biodiversity on islands dominated by abandoned coconut plantations. Eradicating rats is the top priority for all ecosystems in the archipelago, however, for biodiversity gains to occur across taxon and biomes, this must be accompanied by the conversion of abandoned plantations to functioning "natural" ecosystems. Abandoned coconut plantations are biodiversity sinks that house few native species and have incredibly low biodiversity values (referred to as coconut chaos). For example, less than 1% of the total number of seabirds in the Chagos Archipelago breed in plantations but,

excluding Diego Garcia, this habitat covers ≈ 63% of the terrestrial landmass [6]. To increase biodiversity across the archipelago a programme of rat eradication and invasive plant management accompanied by the conversion of abandoned plantations to native woodland (and other ecosystems) is required.

Figure 3. Coconut chaos. Excluding Diego Garcia, abandoned, non-natural, Coconut *Cocos nucifera* L. plantations (coconut chaos) cover approximately 63% of the terrestrial land mass of the Chagos Archipelago. Despite covering such a large area this biome offers very little biodiversity value. For example, of the 18 species of breeding seabird none regularly nest in coconut plantations.

Biosecurity of Northern atolls: The major route of non-native and invasive species in to the Chagos Archipelago is via the airport and port on Diego Garcia. The most likely modern route of non-native and invasive species to the northern atolls is from Diego Garcia. Within the eleven conservation and environmental priorities the BIOT Administration has identified is "Protecting BIOT from invasive flora and fauna" [19]. Protecting the northern atolls from invasive species emanating from the invasive hot spot of Diego Garcia should be given the highest priority within the biosecurity measures being implemented in the Territory.

Engage in climate monitoring: "Climate change is a key stressor in BIOT, one which must be carefully monitored with a view to identifying the implications it may have on conservation management. As BIOT has almost none of the usually common, localised impacts such as sewage discharge, overfishing and shoreline alteration, it is a very valuable location where the effects of climate change can be understood separately from those caused by local stressors, thereby providing a point of comparison for the rest of the world" [5]. The BIOT Administration has recognised the value of the Chagos Archipelago as a global research centre for climate change and is encouraging academic institutions, independent researchers and NGOs to engage in climate science within the Territory. One of the objectives of the environmental focus of BIOTA is "Understanding and mitigating against the

effects of global climate change where possible" [19]. The call for climate research by BIOTA requires broadcasting to as wide a net as possible and research supported where possible and practical at the earliest opportunity.

Conduct research: BIOTA has recognised the requirement to better understand the delicate ecosystems of the terrestrial environment and have as an environmental objective **"**Understanding more about BIOT's unique terrestrial environment" [19]. Research, especially at the ecosystem level is required urgently to assist in countering future threats at the global (e.g. climate change) and local (e.g. invasive species management) scale. As priority, a systematic botanical survey of the northern atolls, focusing on the extent of non-native/invasive vascular plants is required.

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