THE CHRISTMAS ISLAND REHABILITATION PROGRAMME

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SHEPHERD, A. 1994. The Christmas Island Rehabilitation Programme. Christmas Island is an Australian territory in the Indian Ocean. Phosphate mining operations have resulted in clearing of about one-quarter of the island's rainforest. Christmas Island National Park, declared in 1980, now covers 63% of the island's area. Following the closure of the phosphate mining operation in 1987, the Australian Nature Conservation Agency commenced a rehabilitation programme. The main objective of the programme is to rehabilitate and protect remaining habitats of the endangered seabird, Abbott's booby (*Sula abbotti*). The rehabilitation method is described.

Key words: Rehabilitation - restoration - *Sula abbotti* - Christmas Island - phosphate mining

SHEPHERD, A. 1994. Program Pemulihan Pulau Christmas. Pulau Christmas ialah sebuah tanah jajahan Australia di Lautan Hindi. Kegiatan melombong fosfat di sana telah membersihkan satu perempat daripada hutan hujan pulau itu. Taman Negara Pulau Christmas yang telah diisytiharkan pada 1980 kini meliputi 63% dari kawasan pulau tersebut. Setelah kegiatan melombong fosfat diberhentikan pada 1987, Agensi Pemuliharaan Alam Semula jadi Australia telah memulakan satu program pemulihan. Objektif utama program tersebut ialah memulih dan melindungi habitat burung laut yang semakin pupus iaitu Abbott's booby (*Sula abbotti*). Kaedah pemulihan tersebut dihuraikan.

Introduction

Christmas Island is an Australian Territory, 360 km south of Java and 1400 km north west of Perth (Figure 1). The island is approximately 135 km^2 in area.

Christmas Island is the tip of a volcanic cone which approached the surface of the ocean about 60 million years ago. A coral limestone cap formed on top of the submerged volcanic cone and subsequent uplift and weathering has given the island its typical stepped appearance (Figure 2). The island has a rugged shoreline making access by sea difficult in all but a few selected locations such as the settlement area.

The island was settled in 1888 by the British. Rock samples taken shortly after settlement confirmed that rich phosphate deposits existed on the island. Phosphate on Christmas Island is of avian origin. By 1895 the first commercial phosphate left the island. At first, phosphate was extracted by hand from between the limestone pinnacles so thoroughly that no soil remained between the pinnacles for plant recolonisation. In many mined areas little regrowth exists even now.

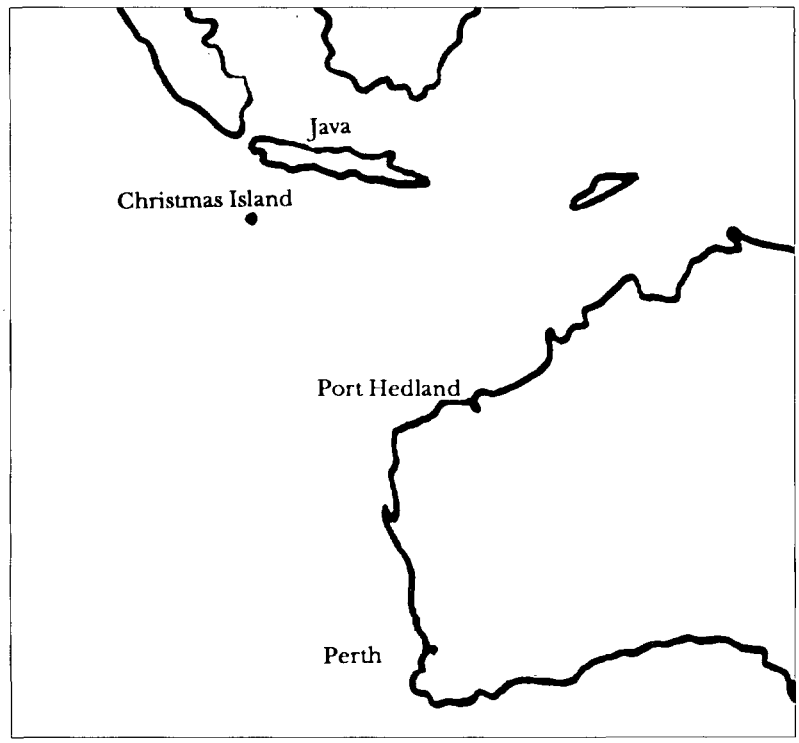

Figure 1. Location of Christmas Island

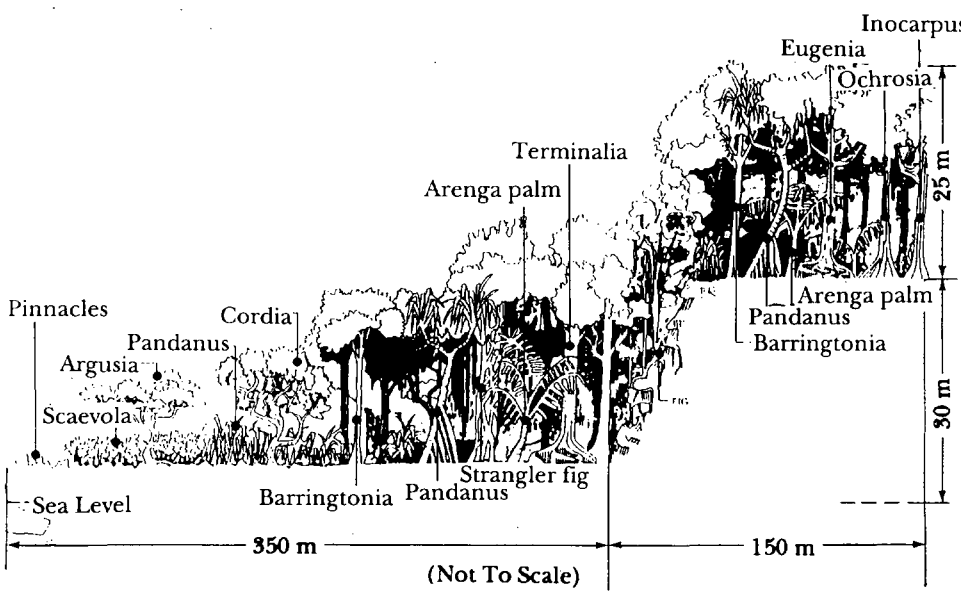

Figure 2. Cross section of Christmas Island

In 1949, the Australian and New Zealand Governments purchased the rights to the mining company. The British Phosphate Company managed operations. From 1960 to the mid 1980s advances in extraction methods led to a trebling of the rate of clearing. When mining ceased, there were 70 mined clearings in different parts of the island, covering 24% of the total area or 32 km^2.

The mining process on Christmas Island involved clearing of rainforest, extraction of Grade A phosphate material, stockpiling of less phosphate rich soil material (known as Grade B stockpiles) and conveying Grade A material to bulk carriers following treatment.

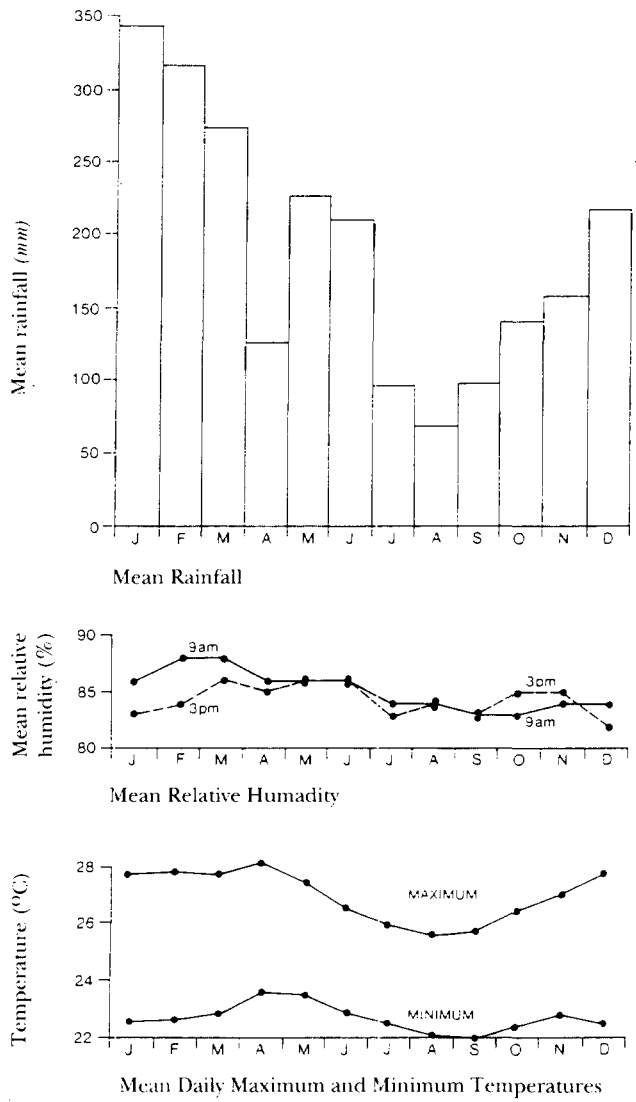

Figure 3. Climatic data for Christmas Island

Christmas Island National Park, declared in 1980 under National Parks and Wildlife Conservation Act 1975, is managed by the Australian Nature Conservation Agency (ANCA) and covers an area of around 8850 ha or 63% of the area of the island.

Clearing on the island continued until 1987 when the mining operation was phased out following Government announcements that mining was becoming uneconomic and a growing realisation that endangered species were under threat.

The ANCA now manages the Christmas Island Rehabilitation Programme on behalf of the Australian Government Department of the Environment. The programme commenced in 1988 following the closing down of a phosphate mining operation on the island. Areas to be rehabiljtated within the National Park cover some 364 ha and are scattered across the island.

Climate

The island has a tropical climate which is subject to northwest monsoons from December to April and southeast trade winds for the rest of the year (Figure 3). Mean temperatures are 22 - 26 °C during the dry season, 23 - 28 °C during the wet season. Humidity is 80% in the dry season and 87% in the wet season. Monthly rainfall varies from around 60mm in August to 350 mm in January.

Objective of the project

In 1987, the Federal Government assigned A$0.5 million to ANCA specifically for use in rehabilitating mining areas. The main objective of the programme is to rehabilitate and protect remaining habitats of the endangered seabird, Abbott's booby (*Sula abbotti*). This objective corresponds with that of the Christmas Island National Park Plan of Management 1986 (ANPWS 1986), to preserve the Park in its natural condition and protect wildlife within the park.

The Abbott's booby is the rarest and most restricted in distribution of all gannets and boobies. It once ranged over the Indian Ocean, but now exists only on Christmas Island. In 1987 it was estimated that only 2000 breeding pairs remained.

The species has been adversely affected by mining, particularly in the central and western parts of the Island. By 1974, 25% of its habitat and 15% of the population had been destroyed. The Abbott's booby was particularly vulnerable to extinction due to

- the slow reproduction rate (15-18 months)
- the returning of the birds to the same nest sites each year
- the already limited population
- the fact that many important phosphate reserves were known to be within the bird's habitat areas

ANCA and the Phosphate Mining Company Incorporated (PMCI) agreed in 1982 to jointly fund a six-year monitoring programme.

The effect on Abbotts booby, in brief, was that in those areas affected by mining

- abandonment of nests increased;
- there were increased windspeeds in the upper canopy where Abbott's booby nests, eggs and chicks could be physically dislodged;
- the long term survival of the tree structure was threatened. The taller trees are important for Abbott's booby because their wing shape is not suited to takeoff from the ground or from shorter trees;
- it was shown that reduced breeding success corresponded with increased nest density;
- Abbott's booby nesting and breeding success was reduced in areas up to 300 m away from mined clearings (Figure 4).

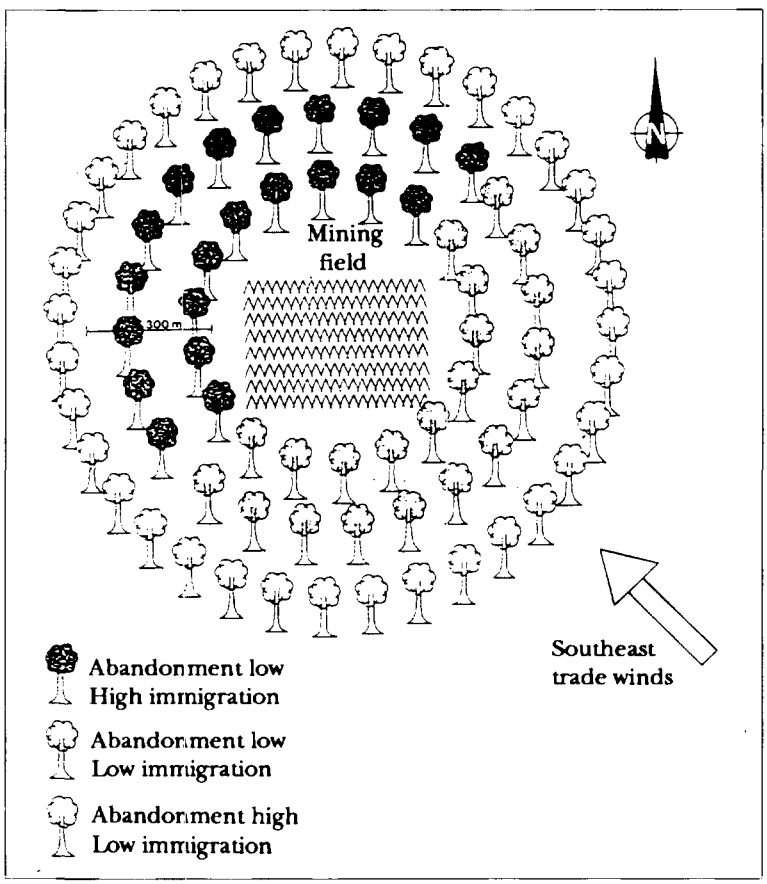

Figure 4. Changes in nesting of Abbott's booby near mined clearings

The restoration of the original forest structure is desirable in the long term. However, the main objectives of the programme are to use a range of native species to ensure the re-establishing of canopy as soon as possible, to build up adequate windbreak effects across mined fields and to establish suitable conditions in the fields for growth of a mixture of forest species through natural regeneration.

Commencing rehabilitation work

When ANCA commenced the rehabilitation programme in 1988 there was no functioning nursery on the island, little suitable equipment available and limited conclusive data on the most suitable method for rehabilitation work, although some studies had been carried out by staff (Carew-Reid 1987). Much of the machinery and equipment used for mining was either in poor repair or had been taken off the island.

ANCA established a production nursery in the ex-PMCI nursery. The nursery was overgrown, rundown and not particularly suited as a mass production nursery. All the equipment necessary to re-establish the nursery, from pots to nursery vehicles, was purchased on the mainland and shipped to the island. A contract nursery manager was engaged to propagate and grow seedlings for use in the field and to later provide a report of his findings (Hart 1991).

ANCA has let contracts for field preparation and for planting. Between 1989 and 1991, 75 000 seedlings were planted.

Initially the programme was funded through the A$0.5 million assigned by the Federal Government. A new mining contract was let by the Federal Government in 1990. This mining operation does not involve further clearing of rainforest, using instead existing stockpiles of Grade B material. From 1991, ANCA has been dependent on royalties from this new mining operation for funds. ANCA receives A$1.50 per tonne of phosphate exported from the existing stockpiles. Over the next two years, A$600 000 is expected to be made available to ANCA for rehabilitation purposes.

Method

Choice of fields for rehabilitation

Up to 363 ha of the National Park has been identified for rehabilitation. ANCA is currently replanting only 20 ha annually (Figure 5). It is therefore a long term task, and for this reason certain fields have been given higher priority. Those with closest proximity to habitat areas of Abbott's booby, good access for vehicles for rehabilitation, minimal site preparation requirements (i.e. minimal weeds, good on-site soil stockpiles), highest visibility to the public, etc. are given the highest priority for rehabilitation. The size of sites ranges from around 15 to 50 ha. To date, ANCA has also tended to concentrate rehabilitation on smaller sites so that once planting is finished vehicular access can be limited or closed off and roads rehabilitated.

Site conditions at the beginning of rehabilitation

Many of the fields have no topsoil left and the surface is bare limestone. Surveys are carried out to determine the existing contours, size of stockpiles, roads and the location of any significant features.

Specification of the works required

Using the surveys undertaken, ANCA draws up specifications of the required earthworks operations for preparation of the sites for later planting. The earthworks contracts have to date all been undertaken by island based groups.

As necessary, limestone pinnacles are bulldozed to provide access for earthmoving machinery. Soil stockpiles left from the mining operation on each site are used to form 10 m wide x 1 m deep beds for planting. Beds are formed at 25 m centres, depending on terrain, across the prevailing wind direction to maximise the reduction in windspeed across the fields. Where possible, the backfill beds also follow the contours. Drainage swales are constructed to slow surface flow. Stockpiles are not used for backfill if significant native regrowth has established.

Soil and underlying rock pavements are deep and shallow ripped. Deep ripping is carried out to a depth of around 450 mm.

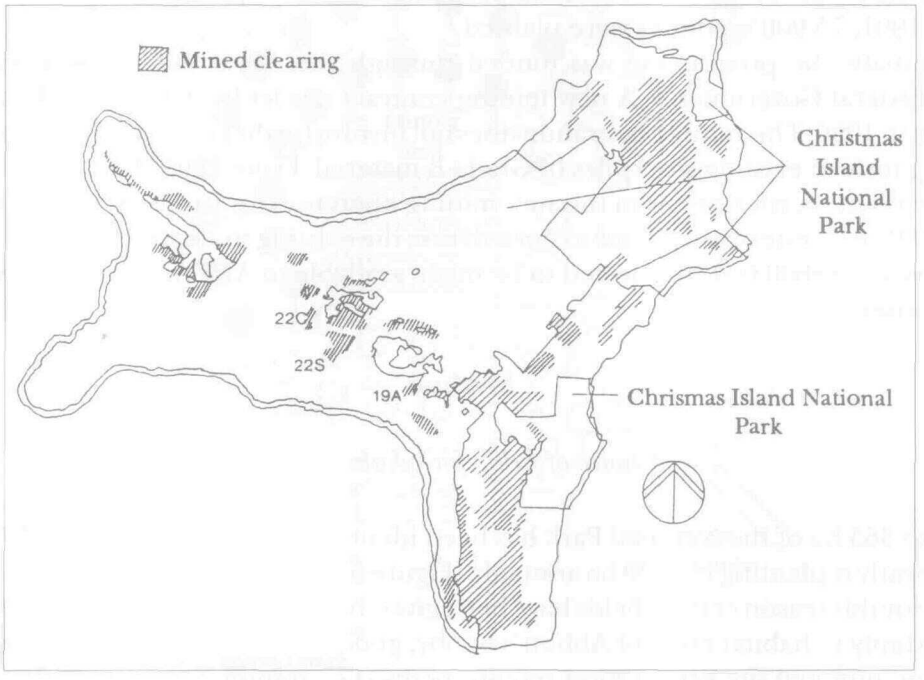

Figure 5. Mined clearings in Christmas Island National Park

Planting

Species are planted by hand during the wet season. Plantings are arranged in blocks of 10 rows of seven plants. The following species have been used to date:

Barringtonia racemosa
Berria cordifolium
Calophyllum inophyllum
Celtis timoerensis
Claoxylon polot
Cordia subcordata
Dysoxylon gaudichaudium
Erthrina sp
Ficus microcarpa
Guettarda speciaosa
Hernandia ovigera
Hibiscus tiliaceus
Inocarpus fagifera
Leea angulata
Melochia umbellata
Muntingia callaguru
Macaranga tanarius
Melia azedarach
Ochrosia ackeringae
Planchonella nitida
Pandanus elatus
Pipturus argentinus
Pisonia grandis
Pongamia pinnata
Scaevola sericea
Syzypium operculatum
Terminalia catappa
Tristiropsis acutangula

In each block, plants are in rows 1.5 m apart and at 1 m centres. Rows are staggered to reduce wind tunnelling between plants. Typically up to 35 planting layouts are trialled, each layout repeated 5 to 10 times in different parts of the field.

Species are laid out with the faster-growing and most wind-tolerant plants such as *Muntingia* and *Macaranga* on the windward side of the block and also scattered throughout between slower-growing species. Species are generally grown from seed and raised in the nursery to seedling stage.

Ten grams of a granular slow-release balanced fertiliser (Osmocote) are placed at the base of each hole prior to planting. This is the only commercial fertiliser used. Plants are not mulched but maintenance such as watering and weeding of planting holes is carried out for three months after the completion of planting. Slashing of weeds such as *Mimosa* has also been carried out as ongoing maintenance.

Species for rehabilitation have been chosen with the prime objective of re-establishing canopy cover over fields, which in turn will create the right microclimate at soil level for further infill planting and natural regeneration of other species.

In 1990, 29 species were trialled, of which only one, *Muntingia callabura,* was exotic. Of the species used in 1990, *Cordia* sp., *Muntingia* sp. and *Macaraga* sp. were the most commonly used due to their ability to create shade rapidly for other species and also for their windbreak characteristics.

Muntingia sp., while out-competing some species, has proven invaluable because of its fast growth and bushy habit. It is also an important food source for the Christmas Island imperial pigeon and several other species. The movement of the imperial pigeon between remaining forests and the rehabilitation site ensures native pioneer species seed arrives in a protected environment.

The Christmas Island red crab plays an important part in the overall rehabilitation process. The red crab will not live in an area unless there is an unbroken canopy of shade. Once this has been achieved in rehabilitation areas, the crab moves in and

speeds up the process of plant growth and soil development by burying litter, aerating the soil and feeding on seeds of some species. In some cases, such as *Inocarpus* sp. and *Tristiropsis* sp. indications are that seeds require the red crab to eat their outer shell before they can germinate. However, with many other species, the red crab is also thought to destroy the seeds before they can germinate.

Monitoring program

A monitoring programme has been instigated to measure the success of the rehabilitation programme, with 30% of trees measured in an area planted in each field.

Results

To date around A$900 000 has been spent on the rehabilitation program. The cost for raising and planting of individual seedlings is around A$5 each and the per hectare cost is around A$15 000. Sites with existing stockpiles of soil are being rehabilitated first so the cost to rehabilitate per hectare may increase as soil cartage distances increase.

The Christmas Island Rehabilitation Programme has been in existence for only four years. Although rehabilitation works had been carried out prior to 1988, few conclusive results can be drawn as yet. In 1991, ANCA commissioned Mr Geoff Tracey to carry out an assessment of rehabilitation techniques and to make recommendations on future work. The ongoing monitoring programme will provide baseline data on tree growth and will determine cultivation regimes for future rehabilitation works.

Several major conclusions can be drawn from the experience of ANCA on Christmas Island to date, namely:

- Survival rates are generally high. Over 90% of the 1989 plantings have survived to two years of age. The initial close spacings will therefore need to be increased to two metres to allow plants raised to be used over more extensive areas and to allow access between rows for slashing and spraying of weeds.
- Spacing between backfill beds will be decreased from 25 m to 10 to 15 m. Soil eroded from backfill beds and washed down into limestone will facilitate further natural regeneration in sheltered areas between the beds.
- The deep ripping of soils will continue as soil compaction has proven to be a major factor in the failure of some rehabilitation work.
- Planting of fast-growing, shade-providing and wind-tolerant exotic species is beneficial provided they only dominate during early years.
- Follow-up maintenance such as the slashing of weeds and repair of drainage swales, etc. is important to the survival of seedlings, particularly in the first three to six months after planting.

Overview

The isolation of Christmas Island, with the inherent difficulty in obtaining and maintaining equipment and resources, has clearly hampered the success of the programme. Royalties from mining have not yet generated sufficient funds for the long term aims of the programme to be fully implemented.

However, the Christmas Island Rehabilitation Programme has achieved a great deal in the four years since it commenced. It will be some years before ANCA would be in a position to accurately assess whether the objective of reinstating and protecting Abbott's booby habitat areas has been achieved.

A recent report by ANCA staff on Christmas Island titled "Plant growth survivorship in the Christmas Island rainforest rehabilitation programme" details the results of field monitoring operations to date.

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