East Point Reserve Biodiversity Assessment

Prepared by: EcOz Environmental Services

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Executive Summary

East Point Reserve is an environmental, recreational and historical reserve located on a peninsula approximately six kilometres north of the Darwin city centre. EcOz Environmental Services (EcOz) was commissioned by the City of Darwin in 2013 to undertake a biodiversity survey of East Point Reserve, with a particular focus on the urban bushland.

The ecological importance of East Point Reserve is identified as:

- The monsoon vegetation communities.
- Habitat maintaining a possibly isolated Agile Wallaby population.
- Habitat supporting significant numbers of migratory shorebirds.

To ascertain current biodiversity values EcOz conducted a baseline fauna and habitat survey of East Point Reserve. The survey comprised a desktop biodiversity review covering all of the reserve, and two field surveys (wet and dry season) within the urban bushland. Wallaby counts were also undertaken using a simplified method.

Flora

Seven monsoon forest patch types can be defined within East Point Reserve. In total, 79 plant species from 40 different families were recorded in the survey sites averaging 20 – 27 species per site. This is greater than the surveyed mean number of species within monsoon rainforest in Northern Australia of approximately 52 species. A comprehensive weeds list for the entire reserve encompasses 77 species of weeds; during field work fifteen introduced flora species were recorded. This includes one weed of national significance (i.e. subject to national management) – *Jatropha gossypifolia*, and two Class B species (i.e. growth and spread to be controlled) – *Senna obtusifolia* and *Hyptis suaveolens*.

Current plantings in order to revegetate cleared areas within the East Point Reserve have been successful, resulting in dense monsoon forest patches composed of a broad range of suitable species currently in place. However, the uniform age of trees within the upper stratum could lead to a pulse mortality event where a high number of trees die within a short time period, resulting in large gaps in the upper stratum. A large disturbance event such as this could make the forest vulnerable to weed invasion or pioneer native species.

Fauna

A total of 229 fauna species are known from East Point Reserve, including 17 new species records as a result of the field surveys for this report. In addition to threatened shorebird species, the threatened Floodplain Monitor (*Varanus panoptes*) occurs within the reserve, and suitable habitat exists for both Mitchell's Water Monitor (*Varanus mitchelli*) and Atlas Moth (*Attacus wardi*). Current surveys indicated there is little difference between the remnant and revegetated rainforest faunal assemblages. A few rainforest bird species – owls and raptors – are absent from East Point Reserve, and this is likely due to the structure and the shape of the rainforest patches. Strategic revegetation within the revegetated rainforest patch, as well as active management of the revegetated patch should increase the amount of optimal rainforest habitat, both to the benefit of existing species and possibly creating suitable habitat for absent species.

A total of 21 migratory shorebird species have been recorded roosting and feeding at the point – some of these are listed threatened species in the Northern Territory (NT). Using a set of Federal criteria developed to assess the importance of habitat for migratory shorebird species in Australia, East Point Reserve qualifies as an important habitat – in terms of total number of shorebirds, total number of species, and the maximum local population sizes of certain species.

A maximum count of 114 wallabies was made in the May 2013 survey. The number of wallaby species counted should not be compared to previous counts or population size estimates because of the difference in

survey methodology. Although not giving an actual population size, regular surveys adopting the simplified methodology used for these surveys will give an indication of changes in population over time.

Recommendations

The report concludes by making a series of recommendations that may improve and secure biodiversity within the East Point Reserve. These are to:

- Increase the current extent of rainforest through strategic revegetation of internal grassed areas to reduce edge effects.
- Undertake a pre- and post-revegetation census of key benefiting species – e.g. Rainbow Pitta – to assess the degree of success in reducing edge effects.
- Plant Atlas Moth larvae food plants – *Croton habrophyllus* into areas of patch edge revegetation, *Litsea glutinosa* into the centre of revegetation patches.
- Revegetate patch edges where Poinciana trees have been removed.
- Control key weed species by including relevant stakeholders in the development of a coordinated approach to weed management.
- Design and undertake revegetation monitoring using key indicators to provide a clear direction and outcome for all future plantings within the reserve.
- Use locally-sourced seed to propagate nursery stock for revegetation.
- Install an Osprey nesting artificial platform.
- Undertake a marine biodiversity survey on the coral reef adjacent to East Point (but not within City of Darwin jurisdiction).
- Undertake monthly wallaby counts.
- Acquire and/or secure the area used by roosting shorebirds adjacent to the reserve that is zoned Vacant Crown Land.

Table of Contents

Tables

Figures

Appendices

Appendix A – All terrestrial fauna records (from historic records and field surveys)

Appendix B – All fauna species recorded during 2013 fauna surveys

Appendix C – Photographs of fauna recorded during the survey

Appendix D – Reintroduction of the Atlas Moth (*Attacus wardi*) to the East Point Reserve

Appendix E – Vegetation survey plot descriptions

Appendix F – Vegetation structure and composition within survey plots

Appendix G – East Point Reserve flora species list

Acknowledgements

Thank you to the City of Darwin East Point Reserve staff for their input and facilitation. Special thanks to Anita Meadows for her enthusiastic and helpful participation in the flora and wallaby surveys. Thanks also to Stewart Grant for sharing his in depth knowledge on management of the reserve.

Thank you to all the volunteers who participated in the installation of trap lines.

Thanks are also due to member of the Northern Territory Field Naturalists Club and Frogwatch for help during the spotlighting surveys and morning trap checks.

1 Introduction

1.1 Background

East Point Reserve is an environmental, recreational and historical reserve located on a peninsula approximately six kilometres north of the Darwin city centre (see Figure 1-1 and Figure 1-2).

The reserve is approximately 200 hectares – comprising a human-made salt water lake, urban bushland containing various remnant vegetation communities, developed parkland recreation areas, military heritage sites and museum, an equestrian club, a restaurant, and the flying field of a model airplane club.

1.2 Purpose

The East Point Reserve Plan of Management (Clouston 2000) warned that "on its own, the Reserve has limited long term viability [for] faunal habitat without careful management". It was pointed out that little baseline information is available on the remnant vegetation communities and on species' populations (excluding wallabies) in East Point Reserve.

To rectify this, the Plan of Management recommended, *inter alia*, two actions:

1. Undertake a survey of remnant vegetation throughout the Reserve. Map extent and clearly define health and possible negative impacts.
2. Establish baseline data on [fauna] species diversity, populations and distribution as a basis for ongoing monitoring and review.

In light of these recommendations, and to help inform an approach to site management and revegetation, EcOz Environmental Services ('EcOz') was commissioned by the City of Darwin in 2013 to undertake a biodiversity survey of East Point Reserve, with a particular focus on the urban bushland.

This report details the methodology and analyses the results of the survey.

Figure 1-1. Aerial image of East Point Reserve

Figure 1-2. Map indicating the location of East Point Reserve within the City of Darwin

1.3 Scope

EcOz conducted a baseline fauna and habitat survey of East Point Nature Reserve to ascertain current biodiversity values. The survey comprised two components:

1. A desktop biodiversity review covering all of the reserve.
2. Two field surveys (wet and dry season) within the urban bushland as defined by the City of Darwin (i.e. the rainforest and grassland as shown in Figure 1-3). The foci of these surveys were:
    a) Comparing the habitat of the remnant monsoon rainforest patches with the regenerating ones.
    b) Undertaking a count of the Agile Wallaby (*Macropus agilis*) population within the reserve.
    c) Assessing the potential for reintroducing Atlas Moth (*Attacus atlas*) into the reserve.

These were identified by EcOz as representing City of Darwin's priority for terrestrial biodiversity management. This report documents and analyses the results from the first two foci; the Atlas Moth habitat assessment is reported separately (see Appendix D).

Given the proximity of East Point Reserve to Darwin, and the large amount of community interest in the area, EcOz engaged and collaborated with the local community when undertaking the surveys. A number of volunteers from Darwin Field Naturalists Club and Charles Darwin University were involved in fauna spot-lighting. Students from Wulagi Primary School visited the field site as part of CSIRO's Scientists in Schools program.

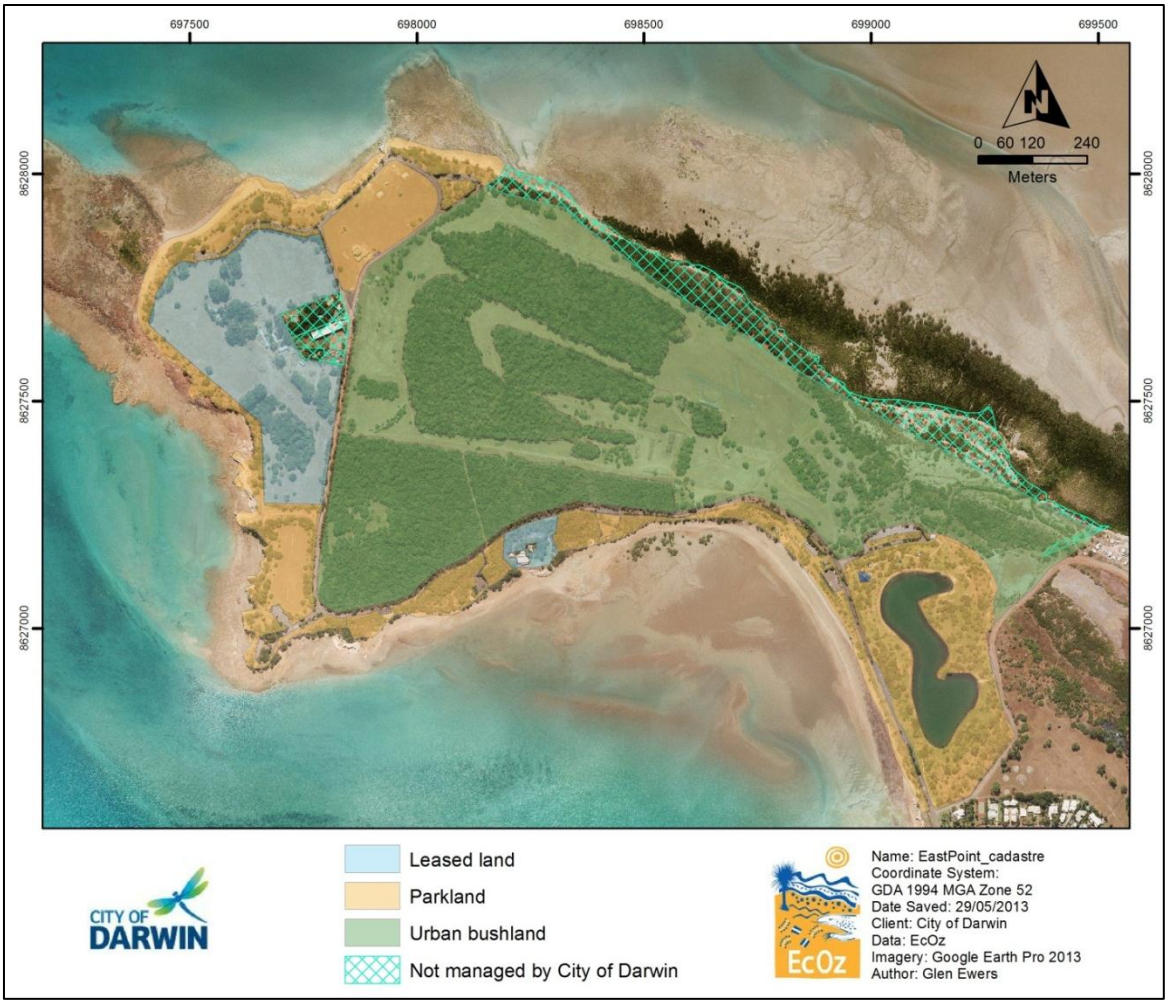


Figure 1-3. Map of East Point Reserve boundaries and land types

2 Ecological significance of East Point Reserve[1]

East Point Reserve lies within the Darwin Harbour Site of Conservation Significance (SOCS). This area is regarded as a SOCS primarily because of its extensive mudflats, diverse mangrove environments, and marine fauna (Harrison et al. 2009). The terrestrial values and limited mangrove habitat within the East Point area, however, do not contribute significantly to these SOCS values.

It is stated in the Plan of Management that the "environmental significance for East Point Reserve is primarily its link to the wider environmental area of Ludmilla Creek and the Kulaluk area… The focus of this natural system is Ludmilla Creek and its associated mangrove fringing communities." It is the opinion of the authors of this report, however, that the size and relative isolation of the monsoon rainforest habitat of East Point Reserve is more important than the mangrove habitat (most of which lies on Crown Land outside of the reserve). In addition, the ecological importance of East Point is as habitat maintaining a possibly isolated Agile Wallaby population and as habitat supporting significant numbers of migratory shorebirds. The littoral and marine habitats within and surrounding the reserve, specifically the coral reef (City of Darwin 2013b) are also significant, but are not within the scope of this investigation.

2.1 Monsoon rainforest[2]

Across the Top End small patches of monsoon rainforest occur as discrete floristic and structural assemblages, scattered within a vast expanse of mostly eucalypt-dominated savannah (Russell-Smith and Lee 1992). They are characterised by a dense canopy of mixed species with a high proportion of deciduous plants and vines (Wilson et al. 1990). Monsoon rainforest is regarded as a sensitive vegetation community in the NT and, as such, is afforded extra governmental protection. The Territory has the largest area of monsoon forest in Australia, yet it only covers 0.2 per cent of the land area (DLRM 2013). Rainforest patches are mostly small, with 72% of patches sampled in a comprehensive regional survey less than 10 ha, and 64% less than 5 ha (N = 1219; Russell-Smith 1991); though these estimates may significantly under-represent smaller patches (Russell-Smith and Lee 1992).

East Point was once covered almost entirely by monsoon rainforest; current extent is approximately 20% of the reserve (Franklin et al. 2010). This is comprised of patches of remnant (14.0 ha) and revegetated monsoon rainforest (22.9 ha) – see Figure 2-1. Russell-Smith (1991) has grouped monsoon rainforests into 16 floristic types according to availability of perennial moisture, substrate and proximity to coast. The East Point communities fall within Group 9 (dry coastal):

> *A very large group of semi-deciduous rain forests and vine thickets associated with a variety of well- to excessively-drained coastal and sub-coastal landforms...*

The scarcity of water at East Point is reflected in the abundance of deciduous and semi-deciduous trees. Group 9 rainforests have a mean number of species per patch of 51.7 ± 3.2 (Russell-Smith 1991).

[1] The East Point Reserve Plan of Management details background environmental information such as the land units, soil types and hydrology. This report therefore does not contain such information. Instead it seeks to augment and supplement the information in the Plan of Management with regards to vegetation, habitat and fauna.

[2] Rainforest in northern monsoonal Australia is referred to interchangeably as 'monsoon vine forest', 'monsoon vine thicket', 'dry rainforest' or 'monsoon rainforest'. For consistency, following Russell-Smith (1991), this vegetation type will be referred to as monsoon rainforest.

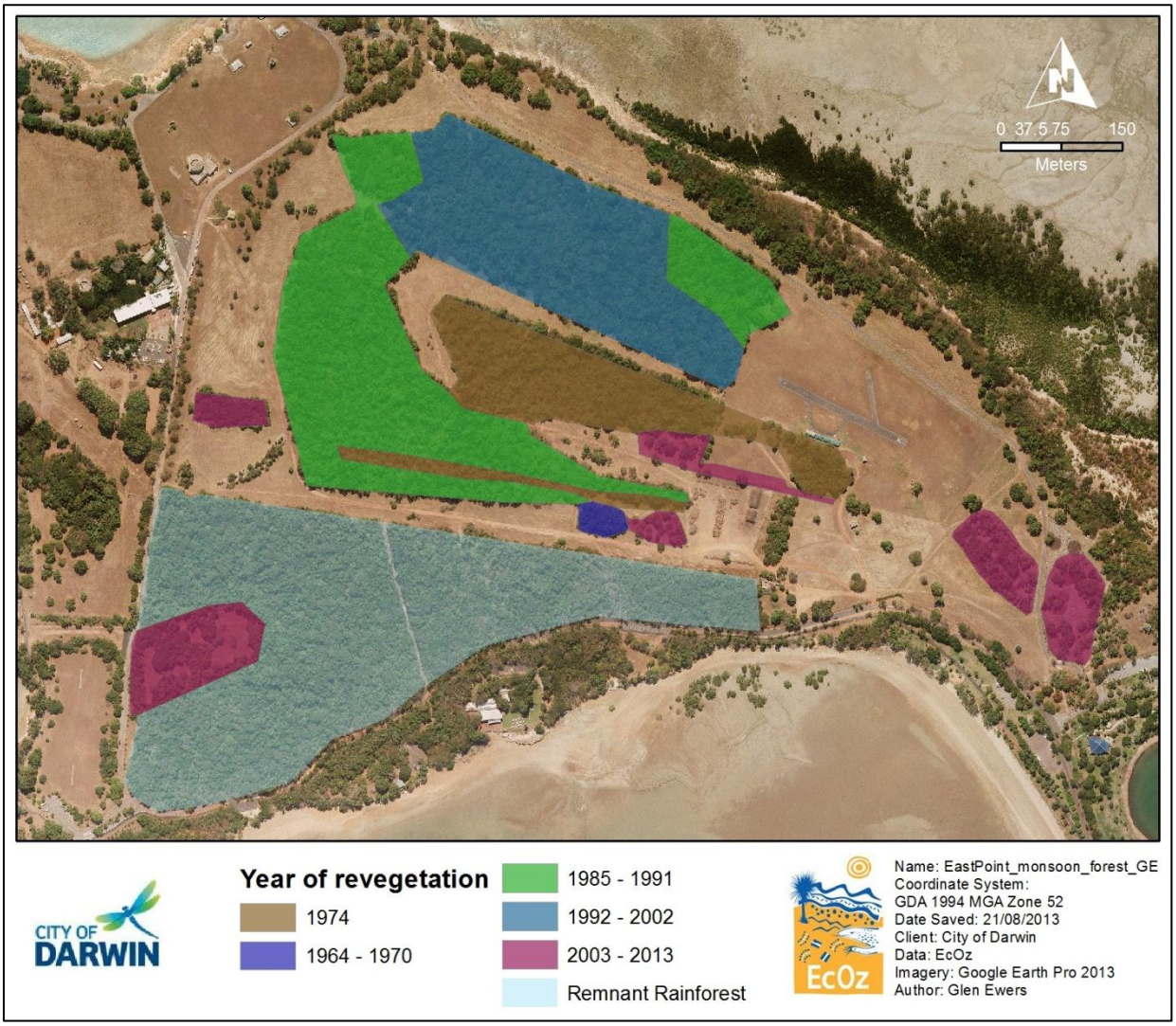


Figure 2-1. Map of monsoon rainforest extent at East Point Reserve

The East Point Reserve rainforest is one of three large coastal rainforest communities in the City of Darwin (see Figure 2-2). The nearest community is in the Kulaluk Lease area across Ludmilla Creek. This area has not been well surveyed. Further north are the two Casuarina Coastal Reserve patches. These are more accessible by the public and hence many fauna observations have been recorded. Many bird species would likely travel between these three communities; however, for other fauna and for flora not dispersed by birds, these communities are essentially 'islands' of habitat.

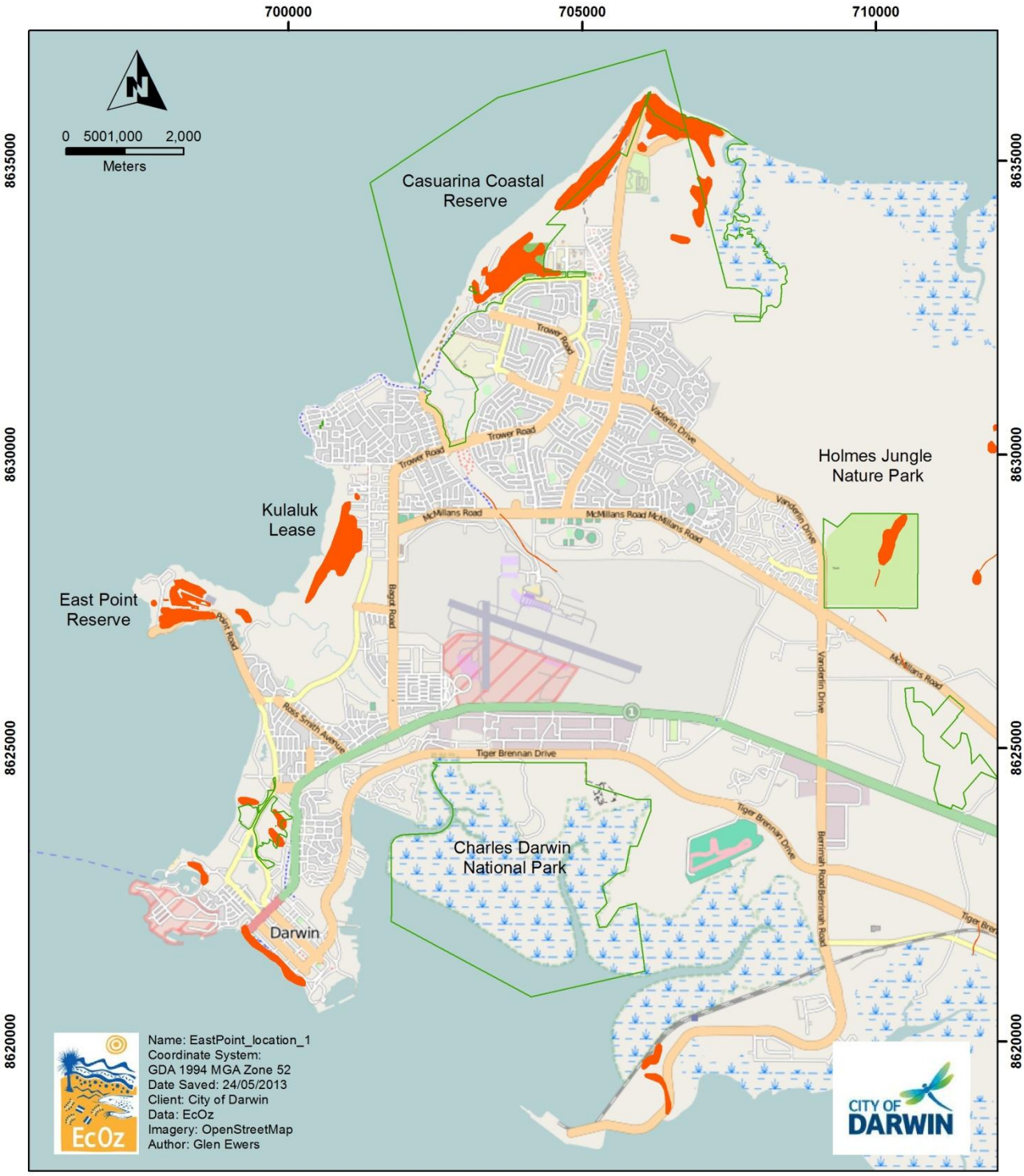


Figure 2-2. Map showing monsoon forest (orange) in the vicinity of East Point

Franklin et al. (2010) document how East Point Reserve has undergone significant land use changes over the last several decades (see Figure 2-3). The Australian military was the first occupant to modify the vegetation at East Point. Military construction commenced in 1932 and peaked from 1939 to 1943, during which time almost half the rainforest was cleared. Monsoon rainforest was subsequently burnt annually, transforming these areas to grassy woodland.

A significant portion of forest was also cleared for a golf course between 1955 and 1963. This included the clearing of all remaining monsoon forest on the northern third of the peninsula. The golf course was closed in 1974; the same year that Cyclone Tracy inflicted severe damage to the forest.

From 1974 onwards separate areas of the peninsula have been rehabilitated. The Northern Territory Government revegetated a patch in the centre of the peninsula and the Northern Territory University replanted *Acacia auriculiformis* trees in a nearby patch. City of Darwin took over management of East Point Reserve in 1984 and commenced a revegetation program in 1985. A water main and irrigation points were installed for rehabilitated forest patches. Control measures were implemented for major weed species.

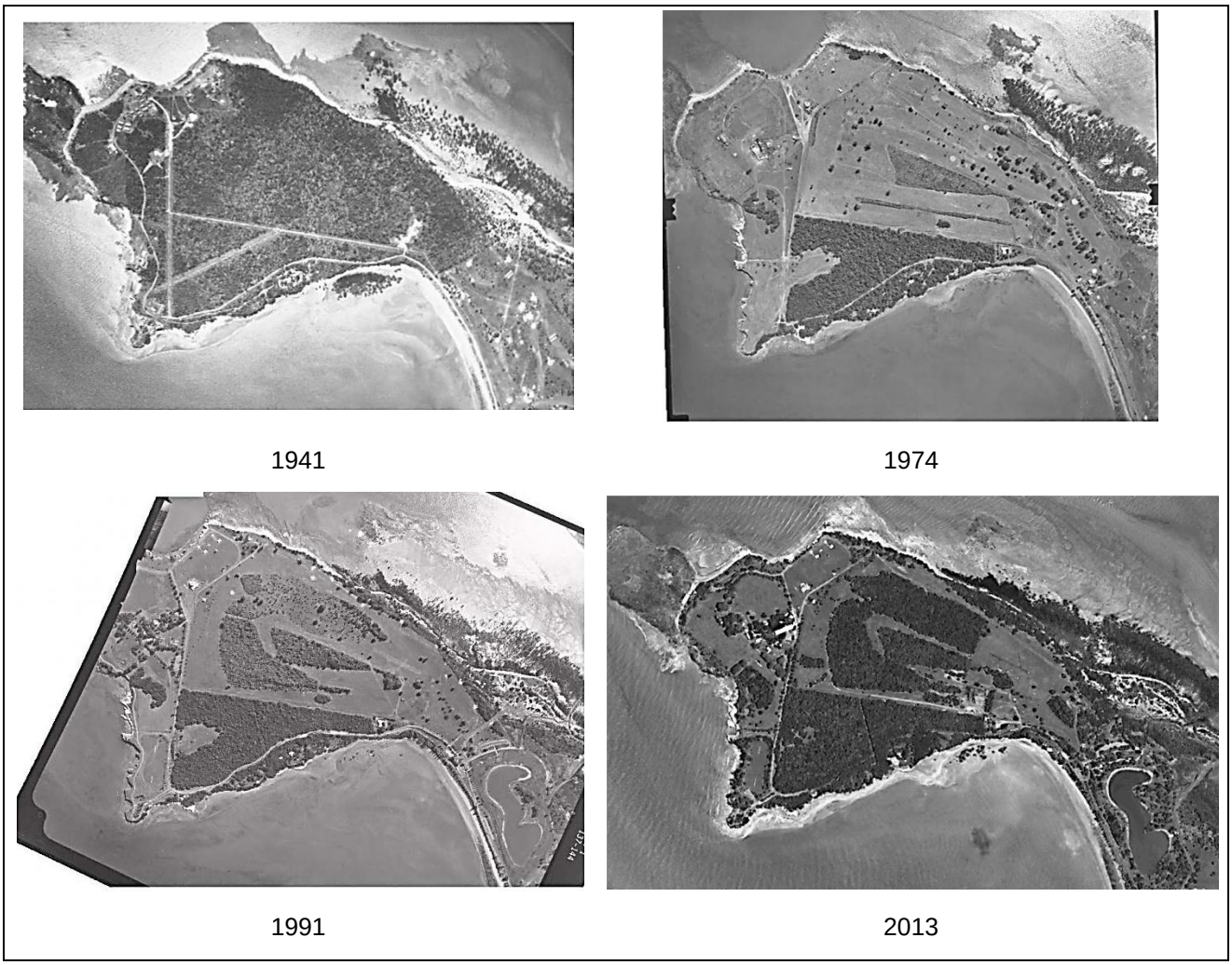


Figure 2-3. Aerial photographs showing historical changes in extent of monsoon rainforest at East Point (from Griffiths et al. 2005 and GoogleEarth)

2.2 Wallabies

East Point Reserve is known for its population of Agile Wallabies (*Macropus agilis*) that have become somewhat habituated to human presence. By day the wallabies rest in the shade and security of the monsoon rainforest, emerging at dusk to feed in the surrounding grasslands. In the dry season, when there is less grass available, wallabies also forage within the rainforest.

During the 1980s Agile Wallabies (*Macropus agilis*) numbers flourished due to the installation of drinking troughs and extensive drip irrigation systems associated with tree planting schemes. The consequence was damage to the remnant forest and revegetated areas. In 1991 a PhD study by Simon Stirrat investigated aspects of the ecology of Agile Wallabies as well as their impacts on the vegetation of East Point Reserve. A summary report by Stirrat (1994) made management recommendations for the control of the wallaby population.

The study found that wallabies do have a significant impact on vegetation productivity and species representation in cleared and open woodland areas. The most significant change in vegetation caused by wallaby overgrazing is the spread of noxious weeds in cleared areas of the reserve. Grazing of annual grasses by wallabies was found to be gradually depleting the seed bank and preventing flowering. Overgrazing was causing parts of the reserve to be barren by the end of the dry season, causing the spread of herbaceous plants, including the weeds.

In comparison, the report concluded that wallabies do not significantly affect the establishment of seedlings in the monsoon rainforest areas and regeneration areas. They were rarely observed browsing on plants within the rainforest; most foraging time was spent searching the leaf litter.

The wallaby population returned to much lower densities in the 1990s, following the closure of most watering points (Franklin et al. 2010). Numbers were believed to be between 200 – 300 individuals in 2004.

2.3 Migratory shorebirds

Migratory shorebirds are those that spend the summer in Australia and use the East Asian-Australasian flyway to fly to breeding grounds in the northern hemisphere summer. This flyway stretches over twenty countries from within the Arctic Circle in Siberia and western Alaska, through north and south-east Asia, to Australia and New Zealand. Juveniles may spend winter in Australia for the first few years of their lives. This group of birds is of special interest because of anthropogenic-threatening processes occurring in their stop-over feeding grounds in the Yellow Sea.

Darwin Harbour supports nationally significant aggregations of shorebirds, though numbers are modest compared to other parts of northern Australia (Chatto 2003). At East Point large aggregations start to occur on rocky shorelines in the north and north-east of the conservation reserve around late January. This coincides with the northward migration period during which migratory shorebirds depart in a very short period and numbers decline rapidly, with departure typically occurring in late March and early April (Geering *et al.* 2007). The build-up of shorebirds at East Point just prior to this period suggests that it may be a final staging point prior to northern hemisphere migration.

Migratory shorebirds depend upon staging sites as places to feed before undertaking their next leg of migration. The last staging site is considered to be of critical importance as birds replenish their energy reserves for the final leg of their journey, where they are likely to meet harsh climatic conditions. The loss of staging sites is one of the most significant conservation issues for these birds. East Point provides an ideal site for migratory shorebirds with the combination of intertidal mudflats for feeding, rocky shoreline for roosting during regular high tides, and rocky cliffs for roosting during king tides. Public access to these areas is through land managed by City of Darwin, even if the migratory shorebird habitat is not.

3 Methodology

3.1 Desktop

Prior to conducting on-ground surveys, the most up-to-date understanding of the ecological context for East Point Reserve was established through a desktop search collating information from previous studies and existing datasets. The data enquiry included broad scale reviews of vegetation mapping, the existing flora and fauna records, and known distributions and preferred habitats for flora and fauna species. The following sources were used:

Datasets managed by the NT Department of Land and Resource Management:

- Northern Territory Flora & Fauna Atlas – a dataset point recording locations for fauna species (and other details) identified through biological surveys (either as validated incidental observations or voucher specimens) conducted in the Northern Territory under a Wildlife Permit.
- Museum and Art Gallery of the Northern Territory database – a dataset for vouchered fauna specimens.
- Northern Territory Holtze database – a dataset for vouchered plant specimens.

Australian Government Data Enquiry Tools:

- EPBC Protected Matters Search Tool – an online enquiry tool managed by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities which interrogates a range of existing flora and fauna data, as well as predictive modelling to speculate on the presence of species within a particular search area.

Other Datasets or Enquiry Tools:

- Atlas of Living Australia – a database on all the known species in Australia aggregated from a wide range of data providers; museums, herbaria, community groups, government departments, individuals and universities.
- Birdata – a database created through community input and managed by BirdLife Australia which records the distribution (location) and abundance of bird species across Australia using set range of survey methods.
- Shorebird 2020 Database – a database of all shorebird surveys lodged with BirdLife Australia.

Surveys:

- Anita Meadows, a City of Darwin employee at East Point Reserve, undertook bird surveys in 2007 as part of her university studies. These helped inform the abundance categorisations of birds in Appendix 1.

Existing vegetation mapping for the Northern Territory is very limited and, when applied to the small area occupied by East Point Reserve, was not informative – hence its exclusion from this report.

3.2 Field surveys

3.2.1 Flora

A field survey of the rainforest flora and vegetation of East Point Reserve was conducted over five days during March 2013. To determine the number and location of vegetation survey plots, monsoon forest patch boundaries were drawn from aerial imagery, with an on-ground reconnaissance survey used to inform differences in vegetation structure and composition.

Design

Eight plots were set up in various age structures of the monsoon rainforest to investigate vegetation mapping and habitat characteristics within a 20 m x 20 m study plots (see Figure 3-1 and Table 3-1). All sites were traversed by botanists on foot to examine, describe and map the vegetation.

Table 3-1. Location of flora and fauna sites

Site No.	Longitude	Latitude
1	8627313	698438.5
2	8627584	698262.1
3	8627244	697843.0
4	8627244	697997.3
5	8627534	697891.7
6	8627693	698018.5
7*	8627209	697928.2
8*	8627147	697856.2

* Flora sites only

Each site was photographed and a detailed community description made. Quantitative assessment of the vegetation was conducted using standard field methods for the vegetation assessment in the Northern Territory as specified by the Department of Land and Resource Management. National Vegetation Information Systems standards were followed for the field methodology.

Figure 3-1. Location of flora (1-8) and fauna (1-6) survey sites

Scope of flora survey

All upper, mid and lower stratum flora species were recorded, including exotic and weed species. Particular effort was made to determine the presence of any plant of conservation significance listed under Northern Territory and/or Commonwealth legislation. Plant species were identified in the field as accurately as possible using the *Field Key for the Monsoon Rainforest Flora of the Darwin Region* (Booth et al. 2001). Any unknown species were collected for identification by the Northern Territory Herbarium. Incidental records of weeds within the reserve were noted.

For each site the following parameters were recorded:

- Site location: GPS coordinates and general description.
- Habitat information: Landform pattern and element, vegetation patch size, aspect, slope, surface soil type (broad category only), estimated soil depth, estimated drainage capacity and percentage ground cover for standing biomass, litter, bare earth and pebble/rock/outcrop, presence of fallen logs, mistletoe, flowering plants and termite mounds (and their type). Landform observations follow Speight (2009) in the *Australian Soil and Land Survey Field Handbook*.
- Status of disturbance: The time since the last fire and scorch height, the presence and extent (estimated cover) of weed species, and the presence and stability of erosion.
- Broad structural information: The estimated crown separation ratio, the estimated percentage canopy cover or ground cover for the main three vegetation strata, their height range and average height.

- Floristic and structural formation: A full list of species present along with canopy heights and percentage cover for each species in the strata. The species nomenclature for plants follows the *Checklist for Vascular Plants for the Northern Territory* (Short et al. 2011).
- Basal sweep: Estimates of basal area for over-storey species using a basal wedge (for both live and dead trees) to given an estimate of species dominance.

The methods of gathering data against the key attributes align with those recommended in Brocklehurst et al. (2007); however some minor modifications were applied. These modifications include: percentage cover estimates were based on foliage cover in the upper, mid and lower stratum (the percentage of the sample site occupied by vertical projection of foliage and branches) to best represent light availability during the wet season growth period. Tree heights were estimated rather than measured with a clinometer, due to the confines of the forest. Observations and categories for soil characteristics and depth were simplified.

Classification of monsoon rainforest patches

The classification of monsoon forest patches within the East Point Reserve was developed according to definition of vegetation cover in the upper stratum as outlined by Hnatiuk et al. in the vegetation chapter of *Australian Soil and Land Survey Field Handbook* (Speight 2009). This vegetation attribute was chosen to best represent the amount of light available to vegetation within the mid-stratum, an important factor in whether pioneer species have sufficient light within the forest to become established. Greater foliage cover results in less light penetrating to the forest floor, providing little opportunity for pioneer species to establish. Vegetation cover definitions are as follows:

- Dense – 70% or greater foliage cover in the upper stratum
- Mid-dense – greater than 30% and less than 70% foliage cover in the upper stratum

Growth stage was also included to differentiate original intact vegetation from more recently established monsoon forest revegetation. The following classifications were applied to revegetation sites:

- Advanced (greater than 10 m upper stratum height)
- Early (less than 10 m upper stratum height)
- Immature (less than four years since patch establishment)

Clearing and edge revegetation has also been identified in areas that have been cleared in the past where natural recolonisation of native vegetation has resulted – either in areas of patch edge revegetation or, in some cases, a mosaic of clearing and small revegetation patches.

3.2.2 Fauna

The wet season survey was conducted from March 18 – 21 and consisted of a three-night trapping program, active fauna searches, and a habitat survey of six sites. The dry season survey was conducted from July 24 – 27 and consisted of a three-night trapping program (but without pitfalls) at the same six sites that were surveyed in the dry season, as well as active fauna searches.

Design

Survey sites were selected to provide an accurate basis for comparison of faunal assemblages between remnant rainforest and revegetated rainforest. Three fauna trapping sites were selected in each of the remnant and revegetated rainforest patches (see Figure 3-1). Different micro-habitats were selected within each rainforest type, with sites occurring in dense rainforest, mid-dense rainforest and recently revegetated areas.

The layout of traps at each survey quadrat is based on the standard NT Fauna Survey Guidelines (2011), with some modification to account for the dense vegetation of the monsoon rainforest. Each trapping site comprised:

- Twenty Elliot traps

- Four pitfall traps
- Eight funnel traps

Pitfall traps were 20 L white plastic buckets which were dug to ground level and set with 10 m of drift-fence. Where possible, the pits were located close to the ecotone in the transition area between closed forest and more open areas. Funnel traps were set on the end of the drift fence. Silver reflective thermafoil (roof insulation) were set over pits and funnel traps to protect animals from dehydration and predation from raptors. The pits and funnels were opened for the duration of the survey (three nights and three days) and were checked early each morning and mid-afternoon.

The Elliott traps were baited each afternoon, opened overnight, checked in the morning, and then closed for the duration of the day. Trapping occurred for a three night period, and the bait used was a mixture of quick oats, peanut butter, and sardines in oil. Bait was removed from traps during the day to reduce ant attraction to the trapping area.

All trapped animals were identified and released near the capture point. The purpose of this survey was to investigate species diversity rather than population size so the mark-capture-recapture method was not used.

Pitfall traps were not used during the dry season survey because the limited range from the wet season trapping results did not justify the man-hours required to install them. The species caught in pitfall traps during the wet were species that were also commonly seen spotlighting or in other trap types.

Bird surveys

Birds were surveyed within each of the selected survey sites over two consecutive mornings. One morning survey was dedicated to surveying the remnant rainforest areas (Sites 1, 3 and 4) whilst the following morning survey was dedicated to surveying the revegetated areas (Sites 2, 5 and 6). Surveys were carried out over approximately 45 minutes using binoculars and call recognition during the early morning. The survey was conducted whilst walking in transect between the three separate fauna sites.

Additional bird searches were conducted in separate representative habitats across the peninsula including woodland, mangrove and rocky shoreline habitats. The rocky shoreline was surveyed at high tide using a spotting scope to identify migratory shorebirds.

Bat surveys

Bat species present were assessed by using Anabat SM2BAT+ Bat Detector, which was set up to record data either overnight or for the early part of the evening (for one night only) at a central location within three of the survey areas.

Dr Kyle Armstrong from Specialised Zoological analysed all bat call sequences and provided a summary of bat species present.

Nocturnal searches

Nocturnal searches were carried out across three nights with the help of several volunteers. Nocturnal searches were conducted using torches and headlights on a walking track walking through remnant monsoon rainforest.

Incidental observations

Opportunistic fauna observations while in the reserve were also recorded in an ‘incidentals’ list.

Wallaby surveys

Stirratt (1994) observed that during the wet season wallabies congregated on the fringes of the forest between 4:30 and 5:00 pm, and at dusk moved quickly to their night time grazing areas. In the morning wallabies moved back to areas close to the forest by about 5:30 to 6:00 am, with most remaining in the open until about 8:00 am. In the dry season, fewer wallabies aggregated in open areas in the evenings and mornings, remaining in dense vegetation until about 6:30 to 7:00 pm, then moving quickly to night feeding areas, and returning as quickly to the forest by about 7:00 to 7:30 am.

Regular wallaby surveys (averaging two per year) were undertaken by Tony Griffiths and CDU students from 1999 until 2011. The survey method used was walked line-transects (varying from approximately 2.0 to 3.5 kilometres total length). It is unknown whether the same transects were used each survey. Estimates of total number and density were produced by distance sampling using DISTANCE software. Most of the surveys were undertaken from 6:30 to 8:00 am, although some were as late as 8:30 to 11:00 am.

In the majority of Griffith's surveys, less than 40 wallabies were counted in total. It is important to note that a requirement of distance sampling is that a reasonable number of detections is required for adequate analysis (Marsden 1999); the recommendation being at least 60 to 80 sightings (Buckland et al. 1993). This is to reduce the effects of stochastic factors.

Besides resulting in arguably insufficient counts for robust analysis, previous surveying methodology had a number of other shortcomings:

1. It was using a technique designed particularly to count fauna / flora whose detectability diminishes rapidly with distance (i.e. in a forest). The grassed areas are laid out such that, from central transect points, wallabies at East Point are conspicuous when grazing in a grassed area.
2. It was relatively time-consuming (when including analysis of results).
3. To generate results required specialist knowledge and software, and is hence not easily replicable.
4. It gave an abundance estimate with very high standard errors (e.g. for the March 2007 survey the agile wallaby population was estimated to be 160 ± 111 – in other words between 39 – 271 wallabies).
5. It was overly complicated given what is known about the ecology of Agile Wallabies; namely that during the night they are highly likely to only be found in grassed areas (especially during the Wet season), and that they are highly conspicuous in that habitat.

In light of the above information, the methodology for this survey was simplified. A single line transect route (3.7 km) was created that traversed all suitable grazing habitat (see Figure 3-2). From this route all grazing areas were visible, including the entire model aeroplane runway area which is fenced off. This transect was driven regularly from 5:30 until 8:30 pm, and then 5:30 to 7:00 am – averaging 20 minutes per circuit in daylight, 40 minutes at night. This broad timeframe was adopted to determine when is optimal for maximising counts of wallabies. A spotter, using binoculars and a spotlight, recorded all wallabies encountered. Surveys were undertaken in early May and mid-July with the assistance of Anita Meadows from City of Darwin.

Figure 3-2. Map of survey transect for wallaby surveys

4 Results

4.1 Flora

4.1.1 Vegetation communities

All flora sites can be broadly described as dry monsoon forest, except for Site 3 which is monsoon melaleuca forest (it was the only site to have *Melaleuca leucadendra* present). Using the classifications described in Section 3.2.1 seven monsoon forest patch types have been defined within the reserve. Descriptions of monsoon forest patch types and the area they represent within the reserve are shown in Table 4-1 and depicted in Figure 4-1.

Table 4-1. East Point Reserve monsoon forest patch types and the area they represent

Monsoon forest patch type	Total area (ha)	% of total forest
Dense remnant	10.1	27.5
Mid-dense remnant	3.9	10.5
Dense advanced revegetation	16.3	44.0
Mid-dense advanced revegetation	3.9	11.0
Clearing and edge revegetation	1.5	4.0
Dense early revegetation	0.6	1.5
Immature revegetation	0.6	1.5
Total	**36.9**	**100.0**

Site 7 is located on the edge of three different vegetation communities; however, the site's flora species composition is similar to that of the mature sites, hence it has been classified as a mature site. Site 3 has been previously cleared and runs along a drainage channel where a patch of *Melaleuca leucadendra* resides. It is likely that seasonal inundation of the area surrounding the drainage channel has provided ideal conditions for the establishment of this species within the revegetation area.

Full vegetation descriptions, including weeds, vegetation structure, dominate species composition and growth phase are provided for each site in Appendix E. A table outlining the vegetation structure and composition is shown in Appendix F.

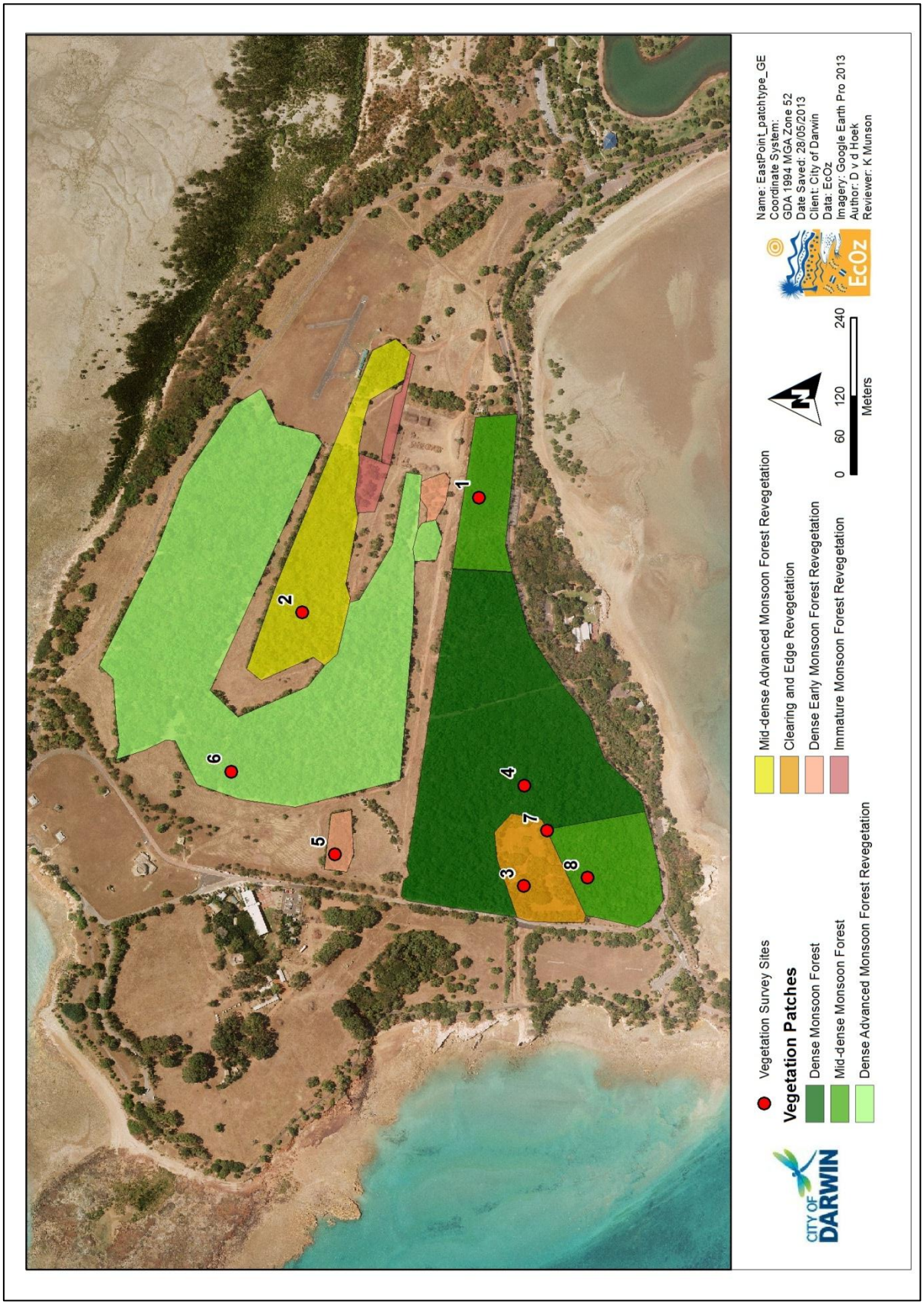


Figure 4-1. Map of East Point Reserve monsoon forest patch types and vegetation survey locations

4.1.2 Flora structure and composition

In total, 79 plant species from 40 different families were recorded in the survey sites averaging 20 – 27 species per site. This is greater than the surveyed mean number of species within monsoon rainforest in Northern Australia of approximately 52 species (Russell-Smith 1991). However, including introduced species, 32 plant species were found to occur at only one site.

Appendix G records all of the plant species identified during the March 2013 survey and also includes all additional records for the East Point Reserve from the Atlas of Living Australia. The most prolific families recorded were Fabaceae with eight species, followed by Malvaceae with five species. The most widely dispersed species (found on seven out of eight sites) were *Mallotus philippensis, Acacia auriculiformis*, *Micromelum minutum, Exocarpos latifolius* and *Cupaniopsis anacardioides.*

Both the remnant and revegetation sites have, on average, a height classification of tall; however, upper stratum of the revegetation sites is denser (see Table 4-2).

Table 4-2. Vegetation structure of surveyed plots

Site	Height	Density	Percentage coverage per stratum				Species richness				
			Upper	Mid-1	Mid-2	Lower	Upper	Mid-1	Mid-2	Lower	Total
Remnant rainforest sites											
1	Med	Mid	50	70	20	20	2	11	11	3	24
4	Tall	Dense	70	60	30	3	4	12	6	5	24
7	Tall	Mid	50	40	40	5	3	7	16	3	24
8	Tall	Mid	60	70	20	5	2	15	7	6	25
Mean	**Tall**	**Mid**	**58**	**60**	**28**	**8**	**3**	**11**	**10**	**4**	**24**
Revegetated rainforest sites											
2	Tall	Mid	50	50	10	10	3	17	7	4	27
3	Tall	Dense	70	55	20	5	3	8	9	7	24
5	Med	Dense	70	50	5	1	2	9	3	6	20
6	Tall	Dense	70	60	20	40	2	10	7	5	20
Mean	**Tall**	**Dense**	**65**	**54**	**14**	**14**	**2**	**11**	**7**	**6**	**23**

Both revegetation and remnant sites had a combination of dense and mid dense sites. All sites had an upper stratum coverage range of 50 – 70%, regardless of growth stage and vegetation type. Revegetation sites had less coverage for mid-1 and mid-2 strata compared to remnant sites. Apart from an outlier for each of the remnant and revegetation sites, all sites had low coverage for the lower stratum.

The large amount of ground cover at Site 6 could be accounted for by an abundance of *Micromelum minutum* (35%) regeneration. This species is common in the mid stratum within monsoon rainforest in Northern Australia.

There is little difference between revegetation and remnant sites species counts for upper, mid-1 and lower strata. There is, however, a greater range of species in the mid-2 stratum for the remnant sites – 6 to 16 species compared to 3 to 7 in the revegetation sites. A number of species were only recorded within the

remanent monsoon rainforest site (see Table 4-3). This includes the two Atlas moth larval food plants *Croton habrophyllus* and *Litsea glutinosa.*

Table 4-3. Species present only in mature sites

Botanical name	Form	Dominance
Capparis sepiaria	Vine	Present all mature sites with 1-5 individuals
Diospyros calycantha	Tree	Present site VS-3
Drypetes deplanchei	Tree	Present site VS-2
Croton habrophyllus	Shrub/Tree	Present 3 sites
Litsea glutinosa	Shrub/Tree	Present 3 sites
Bombax ceiba	Tree	Present VS-1 and VS-8

In summary, remnant sites had a greater species count in the mid-2 stratum, smaller number of weed species present, and six unique plant species across all sites.

4.1.3 Weeds

City of Darwin has a comprehensive weeds list for the entire reserve which encompasses 77 species of weeds. During field work, fifteen introduced flora species were recorded (Table 4-4). One weed of national significance (i.e. subject to national management) – *Jatropha gossypifolia* – was present on Site 6. Two Class B species (i.e. growth and spread to be controlled) – *Senna obtusifolia* and *Hyptis suaveolens* – were observed at Site 3.

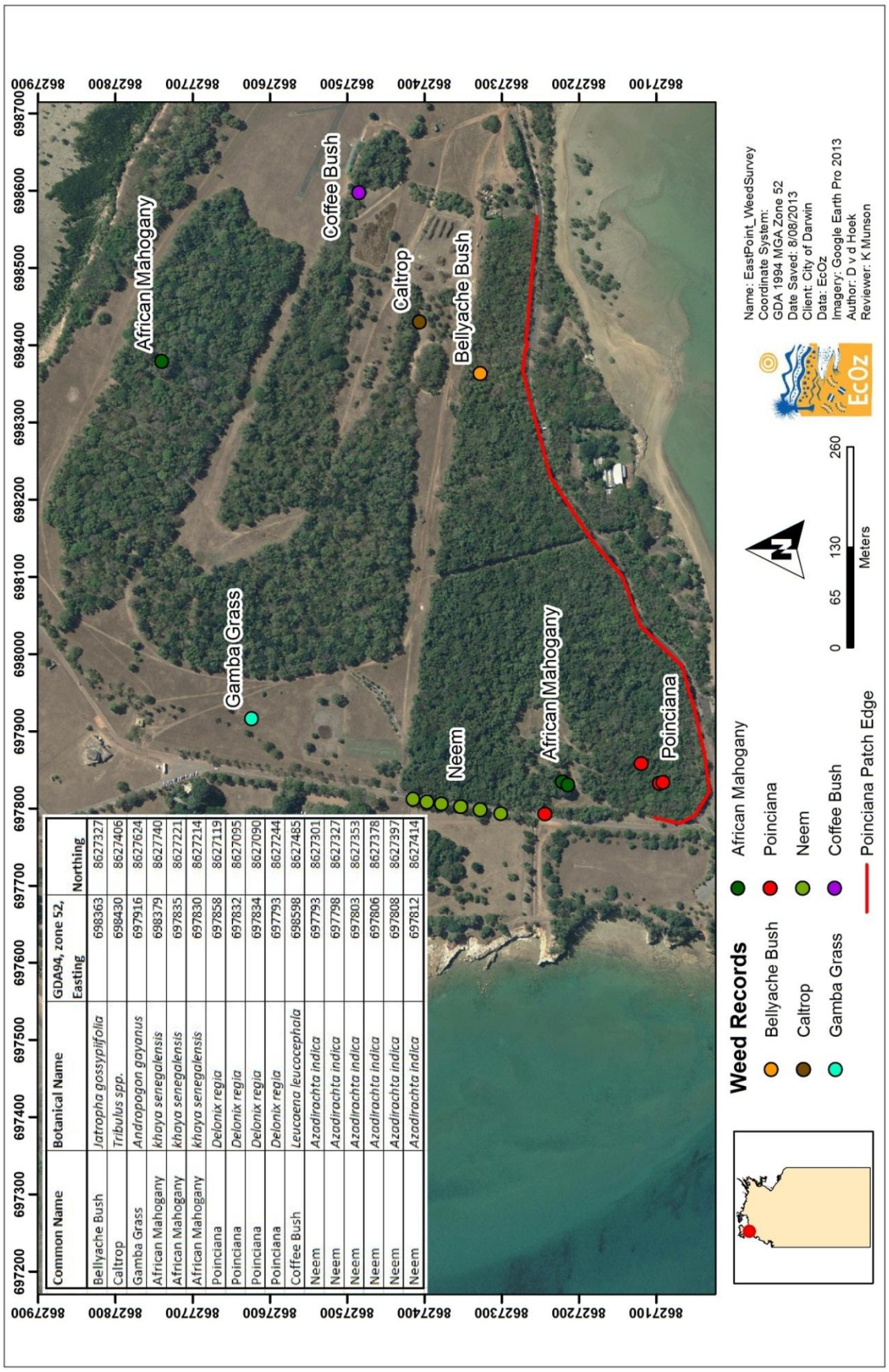
Table 4-4. Introduced flora species at East Point survey sites

Family	Botanical name	Life form	Status	# of sites
ACANTHACEAE	*Andrographis paniculata*	Herb	-	**3**
ASTERACEAE	*Eleutheranthera ruderalis*	Herb	-	**2**
CONVOLVULACEAE	*Merremia aegyptia*	Vine	-	**1**
EUPHORBIACEAE	*Jatropha gossypifolia*	Shrub	WONS*	**1**
EUPHORBIACEAE	*Micrococca mercurialis*	Herb	-	**1**
FABACEAE	*Senna obtusifolia*	Shrub	Class B	**1**
FABACEAE	*Leucaena leucocephala*	Shrub/Tree	-	**3**
FABACEAE	*Delonix regia*	Tree	-	**1**
LAMIACEAE	*Hyptis suaveolens*	Herb	Class B	**1**
MELIACEAE	*Khaya senegalensis*	Tree	-	**1**
MELIACEAE	*Azadirachta indica*	Tree	-	**3**
PASSIFLORACEAE	*Passiflora foetida*	Vine	-	**2**
PASSIFLORACEAE	*Passiflora suberosa*	Vine	-	**3**
RUTACEAE	*Murraya koenigii*	Tree	-	**1**
VERBENACEAE	*Stachytarpheta sp.*	Shrub	-	**2**

*WONS = Weed of National Significance

A map showing weed locations is shown in Figure 4-2. The exotic Poinciana tree (*Delonix regia*) was observed within one vegetation survey site. Incidental observations were made of a high abundance of this tree along the southern edge of the remnant monsoon rainforest. African Mahogany (*Khaya senegalensis*) and Neem Tree (*Azadirachta indica*) are also tree species that can potentially invade monsoon rainforest. A number of large trees have been mapped around the reserve.

A large patch of Coffee Bush (*Leucaena leucocephala*) has also been identified on the Crown Land between East Point Reserve and Ludmilla Creek. Potential for spread is low because the population is isolated from the monsoon rainforest by a managed grass area. Isolated clumps of Gamba Grass (*Andropogon gayanus*) were observed within the grass areas.



Common Name	Botanical Name	GDA94, zone 52, Easting	Northing
Bellyache Bush	*Jatropha gossypiifolia*	698363	8627327
Caltrop	*Tribulus spp.*	698430	8627406
Gamba Grass	*Andropogon gayanus*	697916	8627624
African Mahogany	*Khaya senegalensis*	698379	8627740
African Mahogany	*Khaya senegalensis*	697835	8627221
African Mahogany	*Khaya senegalensis*	697830	8627214
Poinciana	*Delonix regia*	697858	8627119
Poinciana	*Delonix regia*	697832	8627095
Poinciana	*Delonix regia*	697834	8627090
Poinciana	*Delonix regia*	697793	8627244
Coffee Bush	*Leucaena leucocephala*	698598	8627485
Neem	*Azadirachta indica*	697793	8627301
Neem	*Azadirachta indica*	697798	8627327
Neem	*Azadirachta indica*	697803	8627353
Neem	*Azadirachta indica*	697806	8627378
Neem	*Azadirachta indica*	697808	8627397
Neem	*Azadirachta indica*	697812	8627414

Figure 4-2. Map of weeds in the East Point Reserve rainforest

4.2 Fauna

4.2.1 Species

A total of 229 fauna species are known from the East Point Reserve. A break-down of the species recorded from the desktop and field surveys are shown in Table 4-5. A full list of species is in Appendix A.

Table 4-5. Species records for East Point Reserve (desktop and field surveys)

Class	Total	Field survey	Introduced	New records from field	% total from field
Amphibians	4	2	1	2	50%
Birds	189*	92	1	8	49%
Mammals	10	8	2	5	80%
Reptiles	26	12	2	2	46%

* Includes 26 vagrants

Monsoon rainforest

A total of 49 vertebrate fauna species were recorded in the remnant rainforest vegetation comprising of 35 species of bird, seven reptiles, six mammals and one amphibian. In comparison, a total of 47 vertebrate fauna species were recorded in the revegetated forest habitat comprising of 37 species of bird, four reptiles, five mammals, and one amphibian.

This includes a number of new records for the area, which are significant given the high number of existing records for East Point (due to its public accessibility). Some of these are common species, perhaps representing a propensity for such species to be under-reported. The new records were:

- Grey Goshawk (*Accipiter novaehollandiae*)
- Australian Owlet-nightjar (*Aegotheles cristatus*)
- Black-faced Woodswallow (*Artamus cinereus*)
- Cicadabird (*Coracina tenuirostris*)
- Black-necked Stork (*Ephippiorhynchus asiaticus*)
- Eastern Koel (*Eudynamys orientalis*)
- Tawny Frogmouth (*Podargus strigoides*)
- Weebill (*Smicrornis brevirostris*)
- Green Tree Frog (*Litoria caerulea*)
- Cane Toad (*Rhinella marina*)
- Gould's Wattle Bat (*Chalinolobus gouldii*)
- Northern Brown Bandicoot (*Isoodon macrourus*)
- Grassland Melomys (*Melomys burtoni*)
- Black Flying Fox (*Pteropus alecto*)
- Little Red Flying-fox (*Pteropus scapulatus*)
- Swanson's Snake-eyed Skink (*Cryptoblepharus cygnatus*)
- Floodplain Monitor (*Varanus panoptes*)

Differences in trapping success between the wet and dry seasons are too small for any conclusions to be reached (see Table 4-6). The absence of pitfall trapping during the dry season contributed to fewer fauna being trapped during that particular survey. The main difference in trapping success between the two surveys was the absence of Grassland Melomys (*Melomys burtoni*) records during the dry season following five captures during the wet season survey.

Table 4-6. Trap success during surveys*

Scientific name	Common name	Site	Method	Season
Carlia gracilis	Slender Rainbow Skink	1	pit	wet
Carlia gracilis	Slender Rainbow Skink	1	pit	wet
Carlia gracilis	Slender Rainbow Skink	2	pit	wet
Heteronotia binoei	Bynoe's Gecko	1	pit	wet
Melomys burtoni	Grassland Melomys	3	pit	wet
Lophognathus temporalis	Northern Water Dragon	6	pit	wet
Carlia gracilis	Slender Rainbow Skink	1	funnel	wet
Carlia gracilis	Slender Rainbow Skink	1	funnel	dry
Carlia gracilis	Slender Rainbow Skink	2	funnel	dry
Carlia gracilis	Slender Rainbow Skink	3	funnel	dry
Glaphyromorphus douglasi	Douglas' Skink	5	funnel	wet
Glaphyromorphus douglasi	Douglas' Skink	6	funnel	wet
Isoodon macrourus	Northern Brown Bandicoot	2	elliot	dry
Melomys burtoni	Grassland Melomys	1	elliot	wet
Melomys burtoni	Grassland Melomys	3	elliot	wet
Melomys burtoni	Grassland Melomys	6	elliot	wet
Melomys burtoni	Grassland Melomys	6	elliot	wet
Trichosurus vulpecula	Common Brushtail Possum	3	elliot	dry

*Pitfall traps were not used during the dry season fauna survey

Surrounding habitat

Several species recorded during the wet and dry season surveys were observed in, or over, the grassland habitat surrounding the monsoon rainforest patches. These include:

- Magpie Goose (*Anseranas semipalmata*)
- Bush Stone-curlew (*Burhinus grallarius*)
- Agile Wallaby (*Macropus agilis*)
- Black Kite (*Milvus migrans*)
- White Ibis (*Threskiornis molucca*)
- Straw-necked Ibis (*Threskiornis spinicollis*)
- Masked Lapwing (*Vanellus miles*)
- Floodplain Monitor (*Varanus panoptes*)

Black Kites (*Milvus migrans*) were observed foraging over grassland habitat during the wet and dry season surveys. The presence of the species in the Darwin area during the 2012-13 wet season is an anomaly as it usually migrates south following the onset of monsoonal rains. Magpie Geese (*Anseranas semipalmata*) were observed feeding on grasses during the wet season survey, but were absent during the dry season when the species retreats to sub-coastal floodplains. Bush Stone-curlews (*Burhinus grallarius*) were observed sheltering under shrubs adjacent to grassland during the day. The species uses open grass areas at night where it forages, performs courtship dances, and calls (Birdlife Australia 2013). The species is listed as Near Threatened in the Northern Territory. Masked Lapwing (*Vanellus miles*) were recorded during the wet and dry season. This ground-nesting bird is notorious for swooping on people who unwittingly find themselves too close to a nest.

Of note was the presence of a juvenile Brahminy Kite (*Haliastur indus*) and nearby nest in *Rhizophora stylosa* forest close to the end of the mangrove boardwalk. The nest is located within a Grey Mangrove

(*Avicennia marina*) tree. Two juveniles have fledged from the nest during the most recent breeding period of the early wet season (around December/January). Brahminy Kites are a relatively common sight throughout Darwin and have been recorded breeding in suburban parks, though mangroves are more typical habitat for the species.

A number of Brown Goshawks (*Accipiter fasciatus*) were observed within the reserve during the wet and dry season surveys, including adults, juveniles and immature individuals. The species is known to breed in parklands in the adjacent Fannie Bay suburb. A nest of the species could not be located despite some searching; however, it is suspected that it may breed in a stand of African Mahoganies (*Khaya senegalensis*) within the equestrian enclosure.

4.2.2 Migratory shorebirds

The BirdLife Australia database contains records from 132 shorebird surveys undertaken at East Point between 1983 and 2013, with the vast majority from 2009 to 2011. Historically the surveys were undertaken at two sites (see Figure 4-3), but in 2009 BirdLife Australia combined these into a single shorebird count area with the consequence that 47 of the surveys are for the entire site.

Figure 4-3. Map showing Shorebird 2020 survey sites at East Point

A summary of historical survey results for Sites A and B, and for all surveys (combining Site A, Site B and all of East Point surveys), is given in Table 4-7. Whilst each site averages a similar number of species per count, Site B averages about double the number of shorebirds per survey, and also has a significantly greater maximum number of birds counted in a survey. Not surprisingly Wet season surveys yield more birds and more species than in the Dry season – this is coincident with the migratory behaviour of these species.

Table 4-7. Summary of shorebird counts at East Point

	Site A	Site B	All	Wet	Dry
Total no. species	17	19	21	21	18
No. of surveys	37	48	132	83	49
Maximum no. species in a survey	13	15	16	16	16
Maximum no. birds in a survey	404	1654	2091	2091	348
Average no. species per survey	6.9	8.3	8.5	10.0	6.1
Average no. birds per survey	117	229	268	382	77

A breakdown of species recorded at each site is provided in Table 4-8. The most abundant species at each site are Great Knot, Greater Sand Plover, Grey-tailed Tattler, Lesser Sand Plover and Ruddy Turnstone. These are all species with a preference for roosting on rocks at high tide, and coincide with the species Chatto (2003) identified as being the most abundant shorebirds in the region (with the omission, in this instance, of Bar-tailed Godwit which prefer roosting on sandy substrates). Further analysis reveals that Site A has double the proportion of Grey-tailed Tattler and Ruddy Turnstone compared with Site B, and 1.5 times the proportion of Greater Sand Plover. In contrast, Site B has double the proportion of Great Knots. The number and relative abundance of species are similar between sites. Whilst not occurring in as large numbers as the more abundant species, Whimbrel, Pacific Golden Plover, Common Sandpiper and Terek Sandpiper were often counted in surveys.

Table 4-8. Comparison of shorebird species between survey sites

		Great Knot	Greater Sand Plover	Grey-tailed Tattler	Ruddy Turnstone	Red-necked Stint	Lesser Sand Plover	Pacific Golden Plover	Black-tailed Godwit	Bar-tailed Godwit	Whimbrel	Terek Sandpiper	Grey Plover	Common Sandpiper	Red Knot	Eastern Curlew	Sanderling *	Common Greenshank	Oriental Plover ^	Curlew Sandpiper *	Sharp-tailed Sandpiper ^	Broad-billed Sandpiper ^
Site A	**Total**	931	1474	527	351	187	220	184	49	24	124	140	10	75	6	28	0	5	0	0	0	1
	Surveys present	54%	78%	76%	65%	46%	62%	54%	14%	19%	62%	57%	14%	46%	5%	24%	0%	14%	0%	0%	0%	3%
	Average no. per survey	47	51	19	15	11	10	9	10	3	5	7	2	4	3	3	0	1	0	0	0	1
Site B	**Total**	5196	2194	644	454	272	612	378	381	216	167	96	241	91	35	3	5	17	0	4	1	0
	Surveys present	56%	81%	81%	81%	48%	71%	73%	15%	42%	75%	54%	48%	65%	8%	2%	8%	13%	0%	4%	2%	0%
	Average no. per survey	192	56	17	12	12	18	11	54	11	5	4	10	3	9	3	1	3	0	2	1	0
Combined	**Total**	17928	7126	2127	1480	1254	1189	1122	590	506	487	440	434	330	306	56	42	33	6	5	2	1
	Surveys present	65%	83%	84%	77%	55%	72%	70%	17%	36%	76%	63%	36%	67%	12%	13%	5%	14%	1%	2%	2%	1%
	Average no. per survey	208	65	19	15	17	13	12	27	11	5	5	9	4	19	3	6	2	6	2	1	1

* counted less than five times in total

^ counted once only

4.2.3 Other threatened species

The International Union for the Conservation of Nature (IUCN) nominates a set of criteria used to define categories of risk of extinction. These criteria and categories are used by both the NT Government to identify threatened species and habitat which are listed under the *Territory Parks and Wildlife Conservation Act* (NT) (*TPWC Act*), and the Commonwealth Government to identify national threatened species under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (*EPBC Act*).

The desktop and field surveys revealed three threatened species (not including migratory shorebirds mentioned above) that either have been recorded within the East Point Reserve or which have not been recorded within the reserve but are found locally in similar habitat (Table 4-9).

In addition, the Atlas of Living Australia contains two records of the threatened Gouldian Finch (*Erythrura gouldiae*) for East Point from the 1970s. These are extraordinary sightings well out of this species' preferred range and habitat, and could represent escaped caged birds rather than wild vagrants.

Table 4-9. Threatened species within East Point Reserve (NB: no nationally threatened species)

Species	*TPWC Act* status	Habitat and distribution	Threatening processes
Reptiles			
Floodplain Monitor *Varanus panoptes*	Vulnerable	**Habitat**: Broad range of habitats from riparian to savannah woodlands (Christian 2004). **Distribution:** This species is found across northern Australia with a disjunct population in Western Australia (Christian 2004*).* *Recorded at East Point Reserve.*	This species experiences significant declines due to cane toad poisoning (Doody *et al.* 2009).
Mitchell's Water Monitor *Varanus mitchelli*	Vulnerable	**Habitat:** In mostly freshwater riparian areas, it has also been found on the edges of mangroves (Schultz & Doody 2004). **Distribution:** This species occurs in the Top End and Kimberley regions (Schultz & Doody 2004). *Not recorded at East Point Reserve, although suitable secondary habitat exists.*	This species experiences significant declines due to cane toad poisoning (Doody *et al.* 2009.)
Invertebrates			
Atlas Moth *Attacus wardi*	Vulnerable	**Habitat:** This species is only known from coastal monsoon vine forest, where the larval stages feed on the key plant species at the edges of the forest (Lane *et al.* 2010). **Distribution:** This species is restricted to remnant coastal monsoon vine forest in north western Australia. Currently it is known from the Tiwi Islands, Darwin, Cobourg Peninsula, and Lesuer Island in Western Australia (Braby & Nielsen 2011). *Previously recorded at East Point, but now locally extinct.*	It is currently thought that inappropriate fire regimes (Lane *et al.* 2010) and habitat loss/fragmentation associated with coastal development has led to a decline in this species (Braby & Nielsen 2011).

4.2.4 Introduced animals

One Dingo (*Canis lupus dingo*) was observed at the mulch heap close to Site 1 during the wet season survey. No Dingoes were observed during the dry season survey. Wild dogs have been observed within the reserve and Fannie Bay area recently. A trapping program has been undertaken by the council to remove wild dogs from the area (City of Darwin 2013).

Feral cats (*Felis catus*) have been cited in previous management plans as a threat to the native fauna at East Point (Clouston 2000). No cats were recorded during the fauna surveys; however, this animal is notoriously difficult to detect. The presence of nearby residencies would make it likely that pet cats would occasionally stray in to the area; however, whether the animal breeds at East Point is uncertain.

The introduced Cane Toad (*Rhinella marinus*) was found to be present during both surveys at low densities. Asian House Geckos (*Hemidactylus frenatus*) were also present throughout the rainforest. The Flowerpot Blind Snake (*Ramphotyphlops braminus*), an introduced blind snake, has been previously recorded for East Point, but was not found during the current survey.

4.2.5 Wallabies

Results for the May survey are in Table 4-10 and for the July survey are in Table 4-11. A maximum count of 114 wallabies was made in May during the 2000-2045 survey.

Table 4-10. Wallaby counts during May survey

Time	Number	Comments
1720-1740	1	-
1750-1810	2	-
1830-1850	5	Dusk (sunset at 1830)
1900-1945	72	57 of these in one group
2000-2045	114	83 of these in one group (same site as above), 27 in adjacent grassed area
0530-0615	71	56 of these in one group (same site as above)

Table 4-11. Wallaby counts during July survey

Time	Number	Comments
1730-1750	65	Including two groups of 18 (one on aerodrome field and one in interior clearing)
1800-1825	32	-
1845-1920	52	Dusk (sunset at 1835)
1930-2030	80	Largest group was 24 on the same site as in the May survey.
0600-0650	62	Largest group was 14.
0700-0720	13	Sunrise at 0708

Two notable points from the wet season survey were that wallabies only became conspicuous well after sunset, and that they congregated in one grazing area (see Figure 4-4). The grass here did not appear any greener or longer than elsewhere in the reserve. In comparison, in the dry season survey wallabies were conspicuous before the sun had set and were more dispersed.

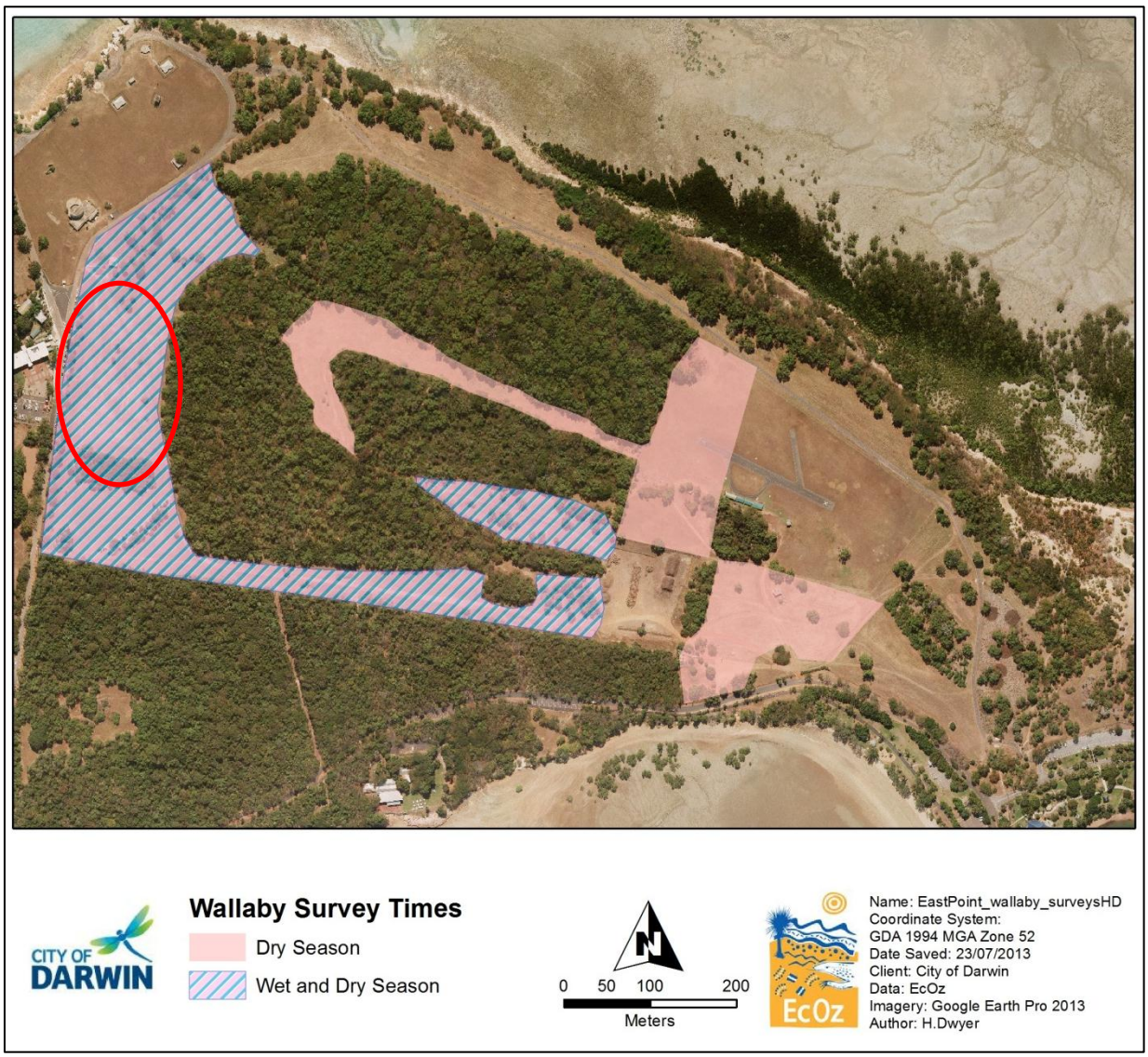


Figure 4-4. Map indicating areas of usage by wallabies during the two surveys

(NB: The circled area is where the majority of May survey wallabies were counted)

5 Discussion

The Plan of Management identified the major ecological threats as being the "fragmentation and deterioration of remnant vegetation and associated wildlife, due to feral cats, weed infestation and other human impacts." The authors of this report agree that fragmentation and deterioration are the major threats; with the former a precursor to the latter. As discussed in more detail below, larger patches of habitat are better able to retain structural integrity in the face of a wide range of threats. In contrast, smaller patches require more active management.

5.1 Flora

Comparison of vegetation structure and composition from remnant vegetation and revegetation plots shows that both plots show a similar number of species in the upper and lower stratums with a lower species richness observed within the mid stratum of revegetation sites. Remnant patches are also expected to have a more uneven age of trees in the upper stratum, providing openings for species in the lower and mid stratum. It is likely that this allows for greater species diversity within the lower and mid stratum due to the greater range of light availability within these layers of the rainforest. Over time, the current upper stratum within revegetation patches is predicted to thin out as trees die, providing an opening for plants in the lower and mid stratum to take up resource availability by filling gaps within the upper and mid stratum. It is likely that a more uneven aged growth stage will develop and the upper stratum is expected to thin out. Cover in the upper stratum could increase over time depending on the change of dominant species over time.

5.1.1 Revegetation success

Given that revegetation patches have been manually planted, vegetation composition across the planting area is largely dependent on where species were planted. This could vary widely across the planting area, resulting in large changes in vegetation structure and composition within vegetation patches identified within this report.

All revegetation plots surveyed displayed a similar level of species diversity as remnant vegetation plots within the upper and lower stratums. Species compositions identified within revegetation plots form communities that are likely to continue persisting on a self-sustaining trajectory, requiring minimum ongoing management inputs. However, a more detailed assessment of revegetation success would require the design and implementation of an ongoing monitoring program, which is outside the scope of this report.

Current plantings in order to revegetate cleared areas within the East Point Reserve have been successful, resulting in dense monsoon forest patches composed of a broad range of suitable species currently in place. However, the uniform age of trees within the upper stratum could lead to a pulse mortality event where a high number of trees die within a short time period, resulting in large gaps in the upper stratum. A large disturbance event such as this could make the forest vulnerable to weed invasion or pioneer native species. A more controlled thinning of the upper stratum, in particular pioneer species like *Acacia auriculiformis*, may allow other species to gain a more long term foothold within the upper stratum. Thinning the upper stratum would also act to accelerate the community towards a more advanced uneven aged growth stage.

5.1.2 Habitat quality and weeds

Only five flora species were recorded within remnant intact monsoon forest patches but were not recorded within revegetation sites. This includes the two known Atlas Moth larval food plants, *Croton habrophyllus* and *Litsea glutinosa*, of which the former was recorded within a small patch of well-established revegetation during targeted surveys for that species. The absence of these two species from revegetation patches makes these areas unsuitable habitat for the Atlas Moth, a species which could be reintroduced into the

reserve. All future revegetation within the reserve should consider the planting of these species when and where appropriate.

The vegetation survey identified only minimal weed impacts within monsoon forest in the reserve. However, a number of large exotic trees were identified that have the potential to invade monsoon forest communities. Over time or in response to a disturbance event (i.e. cyclone) these trees can form a significant portion of the upper stratum within a monsoon forest patch, resulting in native species being outcompeted. These tree species and locations have been outlined in Section 4.1.3.

Due to the public nature of the park there is always the possibility for the unintentional transportation of weeds. City of Darwin has endeavoured to maintain and eradicate any pest species in accordance with their weed management plan and will continue to review the plan for relevance.

5.2 Fauna

5.2.1 General

No discernible differences could be detected between faunal assemblages in revegetated and remnant rainforest patches. A similar number and diversity of fauna species were recorded in the remnant rainforest, and in the revegetated rainforest. This result suggests that the revegetated rainforest has been successfully colonised by most of the fauna occurring within East Point, including rainforest specialists. Likewise, no significant differences could be detected between wet season and dry season rainforest fauna assemblages with a total of 44 species recorded during both surveys. Of note was the absence of Grassland Melomys (*Melomys burtoni*) and Northern Water Dragon (*Lophognathus temporalis*) during the dry season, both of which were recorded on numerous occasions during the wet season. This is likely a reflection of changed behaviour that influences the detectability of both species, rather than migration away from the area.

Amphibian diversity in East Point appears to be low, with only four species recorded in the reserve. This likely reflects the lack of freshwater on site. Despite some rain during the wet season survey only one native species – Green Tree Frog (*Litoria caerulea*) – was recorded. The Greater Darwin area is home to 20 species of frogs (Steve Richards NT Museum pers. comm.) so it is likely that more species occur within the reserve than have been recorded. Further surveys targeting the first rainfall events of the wet season is recommended to adequately assess the amphibian fauna of East Point Reserve.

Numerous Black Flying-foxes (*Pteropus alecto*) were observed feeding on fruits and flowers during nocturnal surveys. Little Red Flying-foxes (*Pteropus scapulatus*) were observed feeding in the flowering *Maranthes corymbosa* during the dry season survey. The abundance of this species in the Darwin area is seasonal, and it is considered a long-range migrant into the region (Vardon and Tidemann 1999). Additionally, one species of bat, Gould's Wattled Bat (*Chalinolobus gouldii*), was recorded by the bat detector. Other species of micro-bat were recorded by the bat detector; however, several species in northern Australia cannot be distinguished on the basis of their echolocation calls alone and therefore an unambiguous identification was not possible. One long-eared bat species *(Nyctophilus* sp.) was also recorded.

Overall reptile diversity in East Point appears to be low, with only 26 species recorded in the reserve. Despite significant survey and trapping effort only ten species of reptiles were recorded in total. All of the species recorded during the survey appear to be common. Three species – Slender Rainbow Skink (*Carlia gracilis*), Douglas' Skink (*Glaphyromorphus douglasi*), and Northern Water Dragon (*Lophognathus temporalis*) – are thriving in the revegetated sections of monsoon forest. Notable absences from the field survey were the pythons (three species) and elapid snakes (four species) that have previously been recorded in the reserve. It is possible that these species are in quite low densities and thus are harder to observe in a standard three night survey. Alternatively, the invasion of Cane Toads may be to blame. Further survey work will continue to add to the species list for this reserve, especially if it is timed to occur during the first rainfall events of the wet season.

5.2.2 Birds

More so than for other vertebrate groups, the avian species composition of monsoon rainforest patches is distinct from that of the Eucalyptus open forests and woodlands which typically surround them (Woinarski 1993). This is largely a consequence of the higher proportion in rainforests of plant species which bear fleshy fruits (Taylor & Dunlop 1985). Plant species with bird-dispersed propagules are the most numerous in monsoon rainforest communities (Russell-Smith and Dunlop 1987). The Pied Imperial-pigeon (*Ducula bicolor*) is the most significant dispersal vector for this group (Russell-Smith and Dunlop 1987) by virtue of its migratory habit, occurrence in large numbers, and large size which enables it to eat most fruits. The Rose-crowned Fruit Dove (*Ptilinopus regina*) may also be inferred as an equally important dispersal agent, with perhaps a broader dietary spectrum than *Ducula* since it is naturally a resident throughout the year.

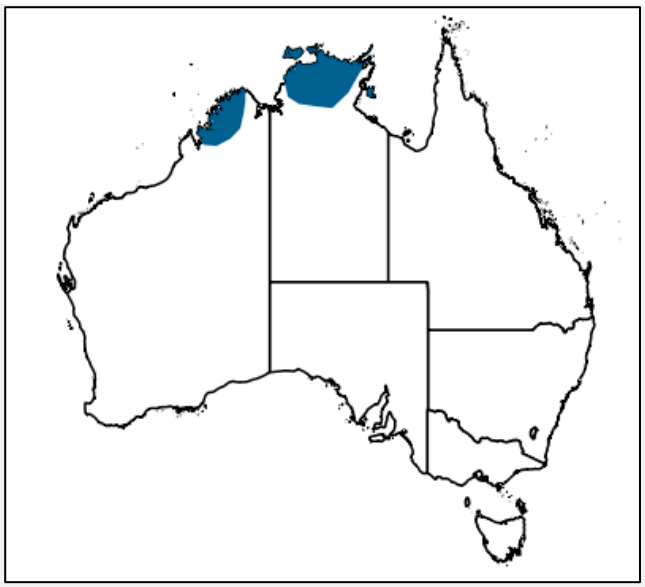
Coastal monsoon rainforest is the preferred or obligate habitat for a number of bird species (see Table 5-3), and four of these species can be regarded as restricted to that habitat (Orange-footed Scrubfowl, Rose-crowned Fruit-dove, Rainbow Pitta and Little Shrike-thrush). However, Orange-footed Scrubfowl and, to a lesser degree, Rose-crowned Fruit-dove have successfully adapted to foraging in Darwin suburban gardens and parklands.

Case Study – Rainbow Pitta (*Pitta iris*)

Of the four coastal monsoon rainforest-restricted bird species, the Orange-footed Scrubfowl is the most charismatic, the Rose-crowned Fruit-dove the most colourful, but it is the enigmatic and beautiful Rainbow Pitta (Figure 5-1) that birdwatchers are most hoping to glimpse. This species spends its day scratching amongst the leaf litter in search on invertebrates, especially earthworms. It mostly roosts and nests in trees.

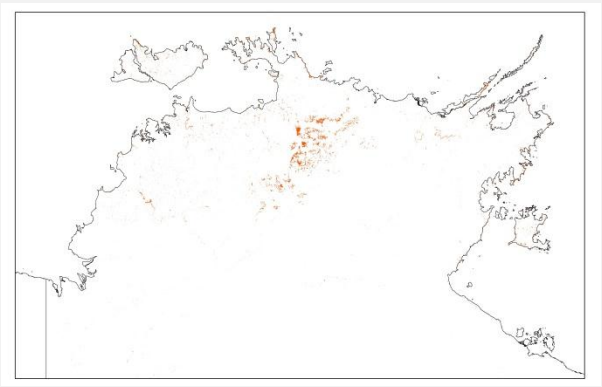
Figure 5-1. Picture of Rainbow Pitta
(*From Wikimedia Commons*)

Although not a threatened bird, the Rainbow Pitta's dependence on monsoon rainforest makes it vulnerable because of the small extent and increasing fragmentation of that habitat type (see maps below).



Map showing distribution of Rainbow Pitta

[source Atlas of Living Australia]



Map showing distribution of NT rainforest

Rainbow Pitta were recorded during the wet season survey but were not detected during the dry season survey, likely due to the species being a wet season breeder and more vocal at that time of the year. Rainbow Pitta is one of few bird species in northern Australia that shows close association with monsoon rainforests (Woinarski 1993). The species is highly sought after by birdwatchers due to their stunning colouration and somewhat cryptic nature. A study by Zimmerman and Noske (2003) of Rainbow Pitta breeding ecology at East Point, Fogg Dam and Holmes Jungle found 11 nests (in 25 ha), 69 nests (in 20 ha) and 5 nests (in 25 ha) respectively, with active nests never closer than 45 m from each other. That three rainforests with similar areas should have significantly different totals is interesting and warrants further investigation. Influencing factors could include shape of patch (see below), proximity to development, composition of surrounding habitat, and/or presence of introduced predators.

5.2.3 Threatened species

The parkland areas of East Point are home to a population of Floodplain Monitors (*Varanus panoptes*) which are listed as Vulnerable under the *TPWC Act*. When Cane Toads invaded Darwin, East Point as a peninsula with little freshwater was a natural refuge (D. Trembath pers comms).

During the survey, adults were observed throughout the reserve, but only in the parkland. In the past year ReptileWatch, a community group has started a mark-recapture program on *V. panoptes*. This program will monitor this species to determine whether it is still in decline because of the introduction of cane toads to East Point (D. Trembath pers comms). Our surveys confirmed that Cane Toads are still present in East Point. Currently East Point is surrounded by a toad-proof fence, but toads can move into the reserve through the access road which cannot be fenced. The City of Darwin should continue to work with groups such as ReptileWatch to determine best practice in keeping the Cane Toad population low in East Point.

During the survey it was also noted that East Point has habitat along the coastal edge to support populations of the Mitchell's Water Monitor (*Varanus mitchelli*) which is listed as Vulnerable under the *TPWC Act*. As a population of this species is known from the grounds of the Museum and Art Gallery of the Northern Territory and also the Nightcliff Foreshore it is predicted that this species is probably also present in East Point. More survey work is needed to confirm this and, if present, the Cane Toad control that is in affect for the Floodplain Monitors will be of benefit to the Mitchell's Water Monitors.

5.2.4 Migratory shorebirds

All migratory shorebirds are protected under the *EPBC Act*, although none are listed as threatened *per se*. In 2012 the Northern Territory Government amended the list of threatened fauna to include a number of migratory shorebirds whose populations are decreasing, primarily because of impacts of feeding habitat overseas. The statuses of the migratory shorebirds recorded at East Point are listed in Table 5-1, which also lists the maximum counts of each species recorded at East Point.

Table 5-1. Status, maximum counts from all historic data, and *EPBC Act* important habitat criteria (0.1% of the flyway population) for shorebird species at East Point

Common name	Scientific name	TPWC status	0.1% of pop'n	Site A max.	Site B max.	All max.
Great Knot	*Calidris tenuirostris*	VU	375	206	**1362**	**1800**
Greater Sand Plover	*Charadrius leschenaultii*	VU	110	**185**	**170**	**185**
Grey-tailed Tattler	*Tringa brevipes*	NT	50	**56**	**56**	**56**
Ruddy Turnstone	*Arenaria interpres*	NT	35	**37**	**50**	**59**
Red-necked Stint	*Calidris ruficollis*	LC	325	82	55	123
Lesser Sand Plover	*Charadrius mongolus*	VU	140	22	120	120
Pacific Golden Plover	*Pluvialis fulva*	LC	100	30	50	60
Black-tailed Godwit	*Limosa limosa*	NT	160	36	98	98
Bar-tailed Godwit	*Limosa lapponica*	VU	160	6	32	53
Whimbrel	*Numenius phaeopus*	NT	100	12	62	62
Terek Sandpiper	*Xenus cinereus*	LC	60	25	14	27
Grey Plover	*Pluvialis squatarola*	NT	125	4	27	27
Common Sandpiper	*Actitis hypoleucos*	LC	250	15	12	15
Red Knot	*Calidris canutus*	VU	220	5	14	170
Eastern Curlew	*Numenius madagascariensis*	VU	38	8	3	8
Sanderling	*Calidris alba*	LC	22	0	2	**34**
Common Greenshank	*Tringa nebularia*	LC	60	1	7	7
Oriental Plover	*Charadrius veredus*	LC	70	0	0	6
Curlew Sandpiper	*Calidris ferruginea*	VU	180	0	3	3
Sharp-tailed Sandpiper	*Calidris acuminata*	LC	160	0	1	1
Broad-billed Sandpiper	*Limicola falcinellus*	NE	25	1	0	1

*Values in **red** exceed 0.1% of the flyway population and thereby fulfil the EPBC Act important habitat criteria*

LC = Least Concern; NE = Not Evaluated (vagrant); NT = Near Threatened; VU = Vulnerable

The *EPBC Act* Policy Statement 3.21 outlines a set of criteria for assessing the importance of habitat for migratory shorebird species in Australia. The criteria define important habitat for migratory shorebirds as sites that support any of the following:

- **At least 0.1 per cent of the flyway population of a single species:** Site A qualifies by supporting sufficient Greater Sand Plover, Grey-tailed Tattler and Ruddy Turnstone. Site B supports sufficient Greater Sand Plover, Great Knot, Grey-tailed Tattler and Ruddy Turnstone. The single record (verified) for the entire area of 34 Sanderling also constitutes greater than 0.1% of the flyway population of that species.

- **At least 2000 migratory shorebirds:** There are two survey counts of greater than 2000 shorebirds for the entire area, both in 2013.
- **At least 15 migratory shorebird species:** Both sites have more than 15 species recorded – 17 for Site A, 19 for Site B, and 21 for both sites combined. A single survey in 2012 yielded 16 species and seven surveys have recorded 14 species.

Clearly under these criteria East Point qualifies as an important habitat for migratory birds.

5.2.5 Wallabies

It is important to note that the number of wallabies counted in the two surveys does not assume that all wallabies present at East Point were counted. In the absence of a detectability function it is not possible to accurately extrapolate from the number counted to determine total population size. Moreover, the number counted should not be compared to previous counts or population size estimates because of the difference in survey methodology.

Although not giving an actual population size, regular surveys adopting the simplified methodology used for these surveys will give an indication of changes in population over time. This assumes that a similar proportion of the total population of wallabies are counted each time; this seems reasonable given that wallabies need to feed daily and, in the wet season especially, are content to graze visibly in open areas.

Acknowledging that only two wallaby surveys were undertaken, preliminary observations that warrant further investigation are:

- During the dry season sprinklers are utilised to irrigate patches of grass for the benefit of wallabies. However, there did not appear to be an increase of wallaby density in proximity to these watered areas.
- The abundance of wallabies corresponded with their proximity to rainforest – none were observed in the grassed areas across the road at the historical military site, nor at the Lake Alexander end (see Figure 4-4). Few were observed along the northern bike path – perhaps because of the presence of the path. This observation, however, could be a product of surveying at the beginning and end of their night time feeding, when wallabies may be retreating to their daytime resting spots in the rainforest, having foraged in more open areas in the middle of the night.
- There was a smaller maximum count of wallabies in the dry season (80 compared with 114). This likely reflects the observation by Stirrat (1994) that due to the lower productivity of grassed areas in the dry, wallabies spend more time foraging in the leaf litter of the rainforest.

Reviewing survey methodology, the use of a vehicle did not appear to disturb wallabies much more than when approached on foot. The optimum survey time was approximately an hour after sunset.

5.3 Monsoon rainforest

The East Point Reserve monsoon rainforest is smaller and more isolated than what it was prior to human settlement in Darwin. As mentioned in Section 2.1, monsoon rainforest in the Top End typically occurs in small patches. However, the extent of rainforest at East Point is 20% of what it was historically, and was even less 40 years ago. It is also likely that there were more rainforest patches in Darwin then compared with today, and that this number may decrease further. For instance, the nearest rainforest patch to East Point is in the Kulaluk Lease area which is under threat from coastal development.

The increased fragmentation in Darwin's monsoon rainforests – through the reduction in the number of patches, and reduction in the extent of remaining patches, will have had a two-fold effect on biodiversity.

Firstly, smaller patches have large edge-to-area ratios and hence are more vulnerable to edge effects (see, e.g., Murcia 1995). Such effects include invasion by weeds and open country species, exposure to wind and sunlight (which change micro-climates, reduce soil moisture and encourage lower canopy plant species), and

increased vulnerability to fire (because of more understorey). In essence, the edge of a patch is different habitat to that of the interior, and likely sub-optimal habitat for rainforest species. For the East Point Reserve rainforest, this effect is likely somewhat reduced because of the management strategies in place that minimise fire and weeds.

Although the area of remnant rainforest is 66% that of the revegetated rainforest, if an edge effect of 20 m is assumed (and it could well be greater), then the area of effective (or optimal) habitat for the remnant rainforest is 73% that of the revegetated rainforest – see Figure 5-2. This is because the remnant rainforest is a more intact patch with a lower edge-area ratio. Additionally, as Figure 5-2 shows, the edge effect fragments the patches of optimal habitat nested within the revegetated rainforest, and many of these fragments are small.

This leads to the second effect of reduced patch size, namely that as patch size decreases so too does the proportion of species and number of individuals present (Newton, 1998). Types of species likely to disappear include those that live at naturally low densities (especially high order predators such as raptors), and those that are poor dispersers and so reluctant or unable to cross between habitat fragments.

Woinarski (1993) found that in 88 patches of various monsoon rainforest floristic types, bird species diversity was lower in small patches than in large patches, especially for species closely associated with monsoon rainforests, and many of these species were also less common in edge habitat (see Table 5-2). In that study no Rose-crowned Fruit-dove, Rainbow Pitta or Arafura (Rufous) Fantail were detected in edge habitat. Of thirteen factors for which there was a correlation with species' distributions, bird species diversity in general was related most closely to patch size in lowland (including coastal) sites.

Figure 5-2. Map indicating potential edge effect (20 m) on current rainforest patches

Table 5-2. Monsoon rainforest birds which are less prevalent in small patches and/or edge habitat – adapted from Woinarski (1993)

Species	Less common in small patches	Less common / absent in edges
Rainbow Pitta*	X	X
Little Shrike-thrush	X	X
Shining Flycatcher	X	
Green-backed Gerygone*	X	X
Spangled Drongo	X	
Orange-footed Scrubfowl*	X	
Rose-crowned Fruit-dove	X	X
Torresian Imperial Pigeon	X	X
Grey Whistler*	X	
Arafura (Rufous) Fantail*	X	X

*for these species patch size was the most important character

It can be assumed that the East Point Reserve rainforest contains less native species now compared with when it covered the point. The monsoon rainforest within Casuarina Coastal Reserve, stretching north from Dripstone Cliffs around to Buffalo Creek (see Figure 2-2 above), presents a habitat analogue to East Point Reserve for which there are many faunal records. The patch sizes of rainforest in Casuarina Coastal Reserve are greater than those at East Point. Table 5-3 contains the avian species for which coastal monsoon rainforest can be regarded as preferred or obligate habitat, and highlights which avian species are absent from either East Point Reserve or Casuarina Coastal Park or both. Of particular note is the paucity of the specialist raptors – Pacific Baza and Grey Goshawk – and absence of Rufous Owl.

A likely reason for the paucity of specialist forest raptors is the structure of the East Point rainforest. The rainforest is dense, and the lack of an open middle and lower canopy makes it unsuitable for hunting. The lack of large old trees for nesting and freshwater resources is also likely to inhibit raptors from permanently occupying the area. Brown Goshawks were sighted in rainforest areas; however, individuals were always sighted at the forest edge.

Grey Goshawk and Pacific Baza have been sighted at East Point, and Rufous Owl may be an occasional visitor. Grey Goshawk occurs in most forest types, especially tall closed forests, including rainforests. The species has been observed hunting at East Point and is known to breed in the nearby Ludmilla mangroves (Riddell, 2011). Pacific Baza typically occurs in leafy habitat in rainforest fringes. During the dry season survey an individual was sighted in woodland from where it took flight to forage over the rainforest canopy. Rufous Owl was not recorded in either the wet or dry season, though the species is elusive. It is occasionally sighted in Darwin suburbs, and has previously bred in the botanical gardens. The abundance of Brush-tailed Possums, birds and bats suggest that abundant suitable prey occurs at the reserve; however, the lack of a suitably large hollow close to freshwater may prevent permanent occupancy.

Table 5-3. Records in East Point Reserve (EPR) and Casuarina Coastal Park (CCP) of birds for which coastal monsoon rainforest is the preferred or obligate.

Common name	Scientific name	Records	
		EPR	CCP
Pacific Baza	*Aviceda subcristata*	few	few
Grey Goshawk	*Accipiter novaehollandiae*	few	few
Orange-footed Scrub Fowl*	*Megapodius reinwardt* [c]	many	many
Rose-crowned Fruit-dove*	*Ptilinopus regina* [ac]	some	many
Pied Imperial-pigeon	*Ducula bicolor* [a]	many	many
Emerald Dove	*Chalcophaps indica* [bc]	few	many
Brush Cuckoo	*Cacomantis variolosus*	some	some
Little Bronze-cuckoo	*Chalcites minutillus*	some	some
Eastern (Common) Koel	*Eudynamys scolopacea*	few	some
Large-tailed Nightjar	*Caprimulgus macrurus*	many	many
Rufous Owl	*Ninox rufa*	none	one
Rainbow Pitta*	*Pitta iris* [c]	many	many
Cicadabird	*Coracina tenuirostris* [b]	one	few
Varied Triller	*Lalage leucomela* [b]	many	many
Grey Whistler	*Pachycephala simplex*	many	many
Little Shrike-thrush*	*Colluricincla megarhyncha*	some	some
Shining Flycatcher	*Myiagra alecto*	some	many
Arafura (Rufous) Fantail	*Rhipidura dryas*	some	many
Green-backed Gerygone	*Gerygone chloronota*	many	many
Helmeted Friarbird	*Philemon buceroides* [b]	some	many
White-gaped Honeyeater	*Lichenostomus unicolor* [b]	many	many
Yellow Oriole	*Oriolus flavocinctus*	many	many
Figbird	*Sphecotheres viridis*	many	many
Spangled Drongo	*Dicrurus bracteatus*	many	many

*Restricted to monsoon rainforest

a. Obligate frugivores
b. Opportunistic frugivores
c. Obligate inhabitants

6 Recommendations

6.1 Flora

6.1.1 Revegetation

The ongoing management of the East Point Reserve monsoon forest provides opportunity to improve the suitability of habitat available for the reintroduced Atlas Moth population. Habitat improvement for this species can be incorporated into the following management areas:

- Revegetation of current cleared grassy area
- Revegetation of current monsoon forest patch edge
- Revegetation of areas cleared of weeds and/or exotic species

The following revegetation management outcomes are likely to result in improved Atlas Moth habitat:

- The planting of *Croton habrophyllus* and additional species recorded within vegetation survey site VS7 on the edge of future revegetation patches.
- The planting of *Litsea glutinosa* and additional species identified within vegetation survey site VS1, VS4 and VS8 on the inside of revegetation patches.

Further revegetation strategies outlining specific locations for future plantings are provided below in Section 6.1.3 and 6.2.1 with additional information provided in and the Atlas Moth Report provided in Appendix D.

Recommendation

Planting of *Croton habrophyllus* into areas of patch edge revegetation.

Planting of *Litsea glutinosa* into the centre of revegetation patches.

Where possible, seed stock required for revegetation should be collected from within East Point Reserve to maintain the local genetic providence of flora species. Seed should be propagated and grown in a nursery until plants are established enough to plant within specified revegetation areas. Currently revegetation areas are irrigated for the first dry season of establishment after which point they are established enough to undergo local climatic conditions.

Recommendation

Use locally-sourced seed to propagate nursery stock for revegetation.

6.1.2 Monitoring revegetation

Monitoring of revegetation should take place once a clear revegetation strategy has been defined. The strategy should consider the following factors:

- Purpose of revegetation, i.e. creation of specific habitat.
- Location of planting areas, i.e. extension of patch edges, planting within weed control areas.
- Species composition and location of species within the planting area.
- Management of plantings, i.e. irrigation, thinning of pioneer species.

Once these factors have been considered and revegetation design put in place, a monitoring program can be developed to determine whether revegetation communities are tracking towards the desired outcomes.

Vegetation variables such as structure and composition should be collected within both revegetation sites and analogue control sites that are representative of the desired vegetation community.

Recommendation

Design and undertake revegetation monitoring using key indicators to provide a clear direction and outcome for all future plantings within the reserve.

Controlled thinning of the upper stratum tree species, in particular pioneer species like *Acacia auriculiformis*, to accelerate the vegetation community towards a more advanced uneven aged growth stage (as per Section 5.1.1).

6.1.3 Weeds

A weed survey undertaken as part of the 2013 East Point Biodiversity Assessment identified a large number of the exotic tree Poinciana (*Delonix regia*) growing along the southern edge of the remnant monsoon forest patch (see Figure 4-2). Removal of this species will create an opportunity to replant these areas with Croton habrophyllus to increase the area and quality of Atlas Moth habitat within the reserve. Further recommendations on revegetation edge habitat after weed removal is provided in Appendix D.

African Mahogany (*Khaya senegalensis*) and Neem Tree (*Azadirachta indica*) are also tree species that can potentially invade monsoon rainforest. A number of large trees have been mapped around the reserve. These trees should be targeted for removal from monsoon forest areas with the reserve.

Isolated clumps of Gamba Grass (*Andropogon gayanus*) were observed within the grass areas. This Class B weed should be controlled with periodic slashing to reduce the potential fuel load of this species. Spot spraying of individual plants with a recommended herbicide should take place to reduce the ongoing spread of this species.

Other Class B weeds such as *Hyptis suaveolens* and *Senna obtusifolia* already undergo routine control through the application of herbicide and a continuation of this management will reduce the spread of these species throughout the reserve.

Recommendation

Revegetate patch edges where Poinciana trees have been removed.

Control African Mahoganies and Neem Trees within the reserve.

Slash and spray Gamba Grass clumps within grass areas to reduce spread of this species.

Continued control of Class B weed species to prevent further spread of these species.

Work with relevant stakeholders (including the equestrian centre, aero-modellers club, and museum) to develop a coordinated approache to weed management.

6.2 Fauna

6.2.1 Strategic revegetation

The fauna species assemblages within the remnant and revegetated monsoon rainforest patches do not appear to differ significantly. However, as already noted, some species that would be expected to be in such habitat are absent. Additionally, it is not known how vulnerable the current populations of rainforest restricted species are to natural or stochastic impacts. It is therefore recommended that the extent of East Point rainforest be increased through strategic revegetation.

The area of revegetated rainforest that comprises optimal habitat for rainforest restricted species is likely reduced because of edge effects, and this is greatly intensified by the cleared 'swoosh' of land within. This has been historically left as grassland to provide foraging habitat for wallabies. Revegetating this section and the adjacent clear area by the mulch piles, as shown in Figure 6-1, would add more habitat than just the 2.7 ha area replanted – it would reduce edge effects and therefore increase effective habitat area by 6.5 ha. It would also link together the otherwise fragmented patches of optimal habitat that are shown in Figure 5-2. Monitoring of indicator species populations (e.g. Rainbow Pitta) could be undertaken to measure success.

Wallabies and goannas should still have sufficient foraging habitat in the grasslands surrounding the revegetated rainforest (including the model plane aerodrome); however, as suggested in Section 6.2.4 below, further wallaby surveys should be undertaken to determining important foraging areas.

It is acknowledged that this advice contradicts the suggested revegetation strategy in the East Point Reserve Plan of Management (Clouston 2000). In that strategy the locations of open grassland for wallaby foraging are either contained within the rainforest (creating fragmentation of that habitat and concealing this popular tourist attraction) or else, for the patch in the north-west of the point, are separated from their daytime resting areas by a road.

The partially cleared area at the western end of the remnant rainforest should not be fully revegetated as it comprises excellent Atlas Moth habitat (see separate Atlas Moth report).

Prior to implementing this recommendation, a census of key benefiting species – e.g. Rainbow Pitta – should be undertaken in the current revegetated patches. This would be an ideal honours student project. After the edge effect reduction revegetation has been done, repeat the census in the entire resultant patch during various stages of revegetation maturity, to assess the degree of success.

Recommendation

Increase the current extent of rainforest through strategic revegetation of internal grassed areas to reduce edge effects.

Undertake a pre- and post-revegetation census of key benefiting species – e.g. Rainbow Pitta – to assess the degree of success in reducing edge effects.

Figure 6-1. Map indicating reduced edge effect from strategic revegetation in the remnant rainforest

6.2.2 Raptors

The diversity and number of raptors that occur at East Point is relatively high considering the size of the reserve and the fact that it occurs on a peninsula (and hence is not surrounded by much suitable habitat). A total of seven diurnal raptors and one nocturnal raptor were recorded across the wet and dry season fauna surveys; however, of these only one species is known to breed (Brahminy Kite), with a further two likely to breed (Brown Goshawk and Barking Owl) within the reserve.

One raptor species that may be enticed to occupy the reserve is the Eastern Osprey (*Haliaeetus cristatus*). The species is often sighted foraging close to the East Point shoreline and is known to nest on a communications tower near the city as well as at Charles Darwin University. The species has previously nested at Ludmilla Creek and may occur at the nearby Kulaluk community (Goodfellow 2005). The proximity of these nesting locations is unlikely to deter the species from nesting at East Point; rather the inhibiting factor is likely to be a lack of suitable nesting platform.

Artificial platform have been successfully used in coastal Australian towns to encourage Osprey nesting. In Broome artificial platforms were installed by a power company to prevent the species from using telephone and power line poles. The installation of artificial platforms is an option for the council to consider and can be facilitated through communication with local conservation organisations (NT Conservation Volunteers), bird clubs (NT Field Naturalists), NT Government (Parks and Wildlife Commission), and Power and Water.

Additional revegetation of the reserve may encourage more raptors to occupy, and perhaps breed in, the reserve. This is more likely to occur if woodland habitat is promoted adjacent to rainforest patches, to provide additional nesting and foraging options, rather than the current vegetation structure of open grassland adjacent to closed rainforest. However, such a structure would greatly increase the risk of fire impacting the monsoon forest edge, and would also reduce wallaby grazing habitat.

Recommendation

Install an Osprey nesting artificial platform.

6.2.3 Marine survey

The offshore coral reef that is exposed at low tide, whilst not within City of Darwin jurisdiction, is potentially affected by the management of East Point Reserve. It presents an ideal opportunity for a survey involving community support. Local naturalists groups, such as the NT Field Naturalists and experts from the NT Museum and Art Gallery have previously undertaken excursions to this area and have existing knowledge of the species present. As this area is regularly exposed at low tide it is possible to survey the exposed corals and aquatic fauna in the tide pools to add to the existing species list for East Point. It is recommended that a preliminary survey of the fish resident in the tide pools along with the exposed coral is carried out during the lowest tides of the year. The surveys should be done both during the day and the night to account for the many nocturnal fish species present on the reef.

Recommendation

Undertake a marine biodiversity survey on the coral reef adjacent to East Point (but not within City of Darwin jurisdiction).

6.2.4 Wallabies surveys

Wallaby surveys using the simple methods adopted for this report should be undertaken to monitor the population. Questions to be answered are:

1. How stable is the wallaby population (year-to-year)?
2. Where are the important foraging areas for wallabies?
3. Are wallabies showing preference for irrigated areas?
4. Are the wallabies having a deleterious impact to vegetation?

Surveys could be done monthly an hour after sunset and would take less than an hour. Each survey would require two staff, a spotlight, binoculars and a tray-back vehicle. Surveyors should record both location and abundance, to give an indication of relative importance of each section of grassed area. Data can be entered into a simple database. During the first year of surveying, a survey undertaken perhaps four times a year at midnight would assist in determining whether wallabies extend their foraging range during the night and therefore utilise areas that they were not recorded in during the dusk and dawn surveys.

Recommendation

Undertake monthly wallaby counts.

6.2.5 Shorebirds

Generally the long length of high tide roosting habitat available to shorebirds at East Point is protected from disturbance because of its steepness or distance from popular areas. However, any extra protection and interpretation signage that can be put in place around key roosting spots – particularly those utilised at very high tides – is recommended.

The Vacant Crown land along Ludmilla Creek that adjoins East Point Reserve contains some important roosting areas. In terms of simplifying the management of disturbance to shorebirds, it would be advantageous to have, at the very least, the section of that land westward from where the mangroves end transferred to Freehold title in the name of City of Darwin.

Recommendation

Acquire and/or secure the area used by roosting shorebirds adjacent to the reserve that is zoned Vacant Crown Land.

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Appendix A – All terrestrial fauna records (from historic records and field surveys)

NB: 'Parkland' includes grassland and other treed areas that aren't rainforest. 'Vagrant' refers to records of species not normally found in the region or associated with the habitat type.

Family	Common Name	Scientific Name	Preferred habitat	Relative abundance
AMPHIBIANS				
BUFONIDAE	Cane Toad	*Rhinella marina*	Parkland/rainforest	Introduced
HYLIDAE	Green Tree-frog	*Litoria caerulea*	Parkland/rainforest	Common
HYLIDAE	Rocket Frog	*Litoria nasuta*	Parkland/rainforest	Uncommon
LIMNODYNASTIDAE	Marbled Frog	*Limnodynastes convexiusculus*	Parkland/rainforest	Uncommon
BIRDS				
ACANTHIZIDAE	Green-backed Gerygone	*Gerygone chloronota*	Mangroves	Common
ACANTHIZIDAE	Large-billed Gerygone	*Gerygone magnirostris*	Rainforest	Common
ACANTHIZIDAE	Mangrove Gerygone	*Gerygone levigaster*	Mangroves	Common
ACANTHIZIDAE	White-throated Gerygone	*Gerygone albogularis*	Parkland	Uncommon
ACANTHIZIDAE	Weebill	*Smicrornis brevirostris*	Parkland	Uncommon
ACCIPITRIDAE	Black Kite	*Milvus migrans*	Parkland	Common
ACCIPITRIDAE	Brahminy Kite	*Haliastur indus*	Parkland/rainforest	Common
ACCIPITRIDAE	Brown Goshawk	*Accipiter fasciatus*	Parkland/rainforest	Common
ACCIPITRIDAE	Eastern Osprey	*Pandion cristatus*	Coast	Common
ACCIPITRIDAE	Grey Goshawk	*Accipiter novaehollandiae*	Rainforest	
ACCIPITRIDAE	Pacific Baza	*Aviceda subcristata*	Rainforest	Uncommon
ACCIPITRIDAE	Square-tailed Kite	*Lophoictinia isura*	Parkland	Vagrant
ACCIPITRIDAE	Whistling Kite	*Haliastur sphenurus*	Parkland	Common
ACCIPITRIDAE	White-bellied Sea-eagle	*Haliaeetus leucogaster*	Coast	Common
ACROCEPHALIDAE	Australian Reed-warbler	*Acrocephalus australis*	Lake	Uncommon
AEGOTHELIDAE	Australian Owlet-nightjar	*Aegotheles cristatus*	Parkland	Vagrant
ANATIDAE	Green Pygmy-goose	*Nettapus pulchellus*	Lake	Uncommon
ANATIDAE	Radjah Shelduck	*Tadorna radjah*	Lake	Uncommon
ANATIDAE	Wandering Whistling-duck	*Dendrocygna arcuata*	Lake	Uncommon
ANHINGIDAE	Australasian Darter	*Anhinga novaehollandiae*	Lake/coast	Common
ANSERANATIDAE	Magpie Goose	*Anseranas semipalmata*	Parkland	Common
APODIDAE	Fork-tailed Swift	*Apus pacificus*	Aerial	Common
ARDEIDAE	Cattle Egret	*Ardea ibis*	Parkland	Vagrant
ARDEIDAE	Eastern Great Egret	*Ardea modesta*	Lake	Uncommon
ARDEIDAE	Eastern Reef Egret	*Egretta sacra*	Coast	Common
ARDEIDAE	Great-billed Heron	*Ardea sumatrana*	Mangroves	Uncommon
ARDEIDAE	Intermediate Egret	*Ardea intermedia*	Lake	Uncommon
ARDEIDAE	Little Egret	*Egretta garzetta*	Lake	Uncommon
ARDEIDAE	Nankeen Night Heron	*Nycticorax caledonicus*	Lake	Uncommon
ARDEIDAE	Pied Heron	*Egretta picata*	Lake	Uncommon
ARDEIDAE	Striated Heron	*Butorides striata*	Mangroves/coast	Common

Family	Common Name	Scientific Name	Preferred habitat	Relative abundance
ARDEIDAE	White-faced Heron	*Egretta novaehollandiae*	Lake	Uncommon
ARDEIDAE	White-necked Heron	*Ardea pacifica*	Lake	Vagrant
ARTAMIDAE	Black Butcherbird	*Cracticus quoyi*	Mangroves	Uncommon
ARTAMIDAE	Black-faced Woodswallow	*Artamus cinereus*	Parkland	Uncommon
ARTAMIDAE	Grey Butcherbird	*Cracticus torquatus*	Parkland	Vagrant
ARTAMIDAE	Pied Butcherbird	*Cracticus nigrogularis*	Parkland	Uncommon
ARTAMIDAE	White-breasted Woodswallow	*Artamus leucorynchus*	Parkland	Common
BURHINIDAE	Beach Stone-curlew	*Esacus magnirostris*	Coast	Common
BURHINIDAE	Bush Stone-curlew	*Burhinus grallarius*	Parkland	Common
CACATUIDAE	Cockatiel	*Nymphicus hollandicus*	Parkland	Vagrant
CACATUIDAE	Galah	*Eulophus roseicapilla*	Parkland	Uncommon
CACATUIDAE	Little Corella	*Cacatua sanguinea*	Parkland	Uncommon
CACATUIDAE	Red-tailed Black-cockatoo	*Calyptorhynchus banksii*	Parkland	Uncommon
CAMPEPHAGIDAE	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	Parkland	Common
CAMPEPHAGIDAE	Cicadabird	*Coracina tenuirostris*	Rainforest	Uncommon
CAMPEPHAGIDAE	Varied Triller	*Lalage leucomela*	Rainforest/parkland	Common
CAMPEPHAGIDAE	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	Parkland	Uncommon
CAMPEPHAGIDAE	White-bellied Cuckoo-shrike	*Coracina papuensis*	Parkland	Common
CAMPEPHAGIDAE	White-winged Triller	*Lalage sueurii*	Parkland	Uncommon
CAPRIMULGIDAE	Large-tailed Nightjar	*Caprimulgus macrurus*	Rainforest	Common
CHARADRIIDAE	Greater Sand Plover	*Charadrius leschenaultii*	Coast	Common
CHARADRIIDAE	Grey Plover	*Pluvialis squatarola*	Coast	Common
CHARADRIIDAE	Lesser Sand Plover	*Charadrius mongolus*	Coast	Common
CHARADRIIDAE	Masked Lapwing	*Vanellus miles*	Parkland	Common
CHARADRIIDAE	Oriental Plover	*Charadrius veredus*	Parkland	Uncommon
CHARADRIIDAE	Pacific Golden Plover	*Pluvialis fulva*	Coast	Common
CHARADRIIDAE	Red-capped Plover	*Charadrius ruficapillus*	Coast	Uncommon
CICONIIDAE	Black-necked Stork	*Ephippiorhynchus asiaticus*	Coast	Uncommon
CISTICOLIDAE	Golden-headed Cisticola	*Cisticola exilis*	Lake	Vagrant
COLLURICINCLIDAE	Rufous Shrike-thrush	*Colluricincla megarhyncha*	Rainforest	Uncommon
COLUMBIDAE	Bar-shouldered Dove	*Geopelia humeralis*	Parkland/rainforest	Common
COLUMBIDAE	Emerald Dove	*Chalcophaps indica*	Rainforest	Uncommon
COLUMBIDAE	Peaceful Dove	*Geopelia striata*	Rainforest/parkland	Common
COLUMBIDAE	Pied Imperial-pigeon	*Ducula bicolor*	Rainforest	Common
COLUMBIDAE	Rock Dove	*Columba livia*	Parkland	Vagrant
COLUMBIDAE	Rose-crowned Fruit-dove	*Ptilinopus regina*	Rainforest	Common
CORACIIDAE	Dollarbird	*Eurystomus orientalis*	Rainforest	Common
CORVIDAE	Torresian Crow	*Corvus orru*	Parkland	Uncommon
CUCULIDAE	Brush Cuckoo	*Cacomantis variolosus*	Rainforest	Common
CUCULIDAE	Channel-billed Cuckoo	*Scythrops novaehollandiae*	Rainforest	Uncommon
CUCULIDAE	Eastern Koel	*Eudynamys orientalis*	Rainforest	Uncommon
CUCULIDAE	Little Bronze-cuckoo	*Chalcites minutillus*	Rainforest/mangroves	Common
CUCULIDAE	Oriental Cuckoo	*Cuculus optatus*	Rainforest	Uncommon
CUCULIDAE	Pheasant Coucal	*Centropus phasianinus*	Parkland	Uncommon

Family	Common Name	Scientific Name	Preferred habitat	Relative abundance
DICRURIDAE	Spangled Drongo	*Dicrurus bracteatus*	Rainforest	Common
ESTRILDIDAE	Chestnut-breasted Mannikin	*Lonchura castaneothorax*	Parkland	Uncommon
ESTRILDIDAE	Crimson Finch	*Neochmia phaeton*	Lake	Uncommon
ESTRILDIDAE	Double-barred Finch	*Taeniopygia bichenovii*	Parkland	Common
ESTRILDIDAE	Gouldian Finch	*Erythrura gouldiae*	Parkland	Vagrant
ESTRILDIDAE	Long-tailed Finch	*Poephila acuticauda*	Parkland	Uncommon
ESTRILDIDAE	Yellow-rumped Mannikin	*Lonchura flaviprymna*	Parkland	Vagrant
EUROSTOPDIDAE	Spotted Nightjar	*Eurostopodus argus*	Parkland	Vagrant
FALCONIDAE	Australian Hobby	*Falco longipennis*	Parkland	Uncommon
FALCONIDAE	Nankeen Kestrel	*Falco cenchroides*	Parkland	Uncommon
FALCONIDAE	Brown Falcon	*Falco berigora*	Parkland	Uncommon
FREGATIDAE	Great Frigatebird	*Fregata minor*	Coast	Vagrant
FREGATIDAE	Lesser Frigatebird	*Fregata ariel*	Coast	Vagrant
GLAREOLIDAE	Australian Pratincole	*Stiltia isabella*	Parkland	Uncommon
HAEMATOPODIDAE	Australian Pied Oystercatcher	*Haematopus longirostris*	Coast	Common
HAEMATOPODIDAE	Sooty Oystercatcher	*Haematopus fuliginosus*	Coast	Common
HALCYONIDAE	Blue-winged Kookaburra	*Dacelo leachii*	Parkland	Uncommon
HALCYONIDAE	Collared Kingfisher	*Todiramphus chloris*	Mangroves	Common
HALCYONIDAE	Forest Kingfisher	*Todiramphus macleayii*	Parkland	Common
HALCYONIDAE	Red-backed Kingfisher	*Todiramphus pyrrhopygius*	Parkland	Common
HALCYONIDAE	Sacred Kingfisher	*Todiramphus sanctus*	Parkland/mangroves	Common
HIRUNDINIDAE	Barn Swallow	*Hirundo rustica*	Aerial	Vagrant
HIRUNDINIDAE	Tree Martin	*Petrochelidon nigricans*	Aerial	Common
LARIDAE	Black-naped Tern	*Sterna sumatrana*	Coast	Vagrant
LARIDAE	Bridled Tern	*Onychoprion anaethetus*	Coast	Vagrant
LARIDAE	Caspian Tern	*Hydroprogne caspia*	Coast	Common
LARIDAE	Common Tern	*Sterna hirundo*	Coast	Uncommon
LARIDAE	Crested Tern	*Thalasseus bergii*	Coast	Common
LARIDAE	Gull-billed Tern	*Gelochelidon nilotica*	Coast	Common
LARIDAE	Lesser Crested Tern	*Thalasseus bengalensis*	Coast	Common
LARIDAE	Little Tern	*Sternula albifrons*	Coast	Common
LARIDAE	Roseate Tern	*Sterna dougallii*	Coast	Vagrant
LARIDAE	Silver Gull	*Chroicocephalus novaehollandiae*	Coast	Common
LARIDAE	Whiskered Tern	*Chlidonias hybrida*	Coast	Common
MEGALURIDAE	Tawny Grassbird	*Megalurus timoriensis*	Parkland	Vagrant
MEGAPODIIDAE	Orange-footed Scrubfowl	*Megapodius reinwardt*	Rainforest	Common
MELIPHAGIDAE	Bar-breasted Honeyeater	*Ramsayornis fasciatus*	Parkland	Vagrant
MELIPHAGIDAE	Blue-faced Honeyeater	*Entomyzon cyanotis*	Parkland	Uncommon
MELIPHAGIDAE	Brown Honeyeater	*Lichmera indistincta*	All	Common
MELIPHAGIDAE	Dusky Honeyeater	*Myzomela obscura*	Rainforest/mangroves	Common
MELIPHAGIDAE	Grey-headed Honeyeater	*Lichenostomus keartlandi*	Rainforest/parkland	Uncommon
MELIPHAGIDAE	Helmeted Friarbird	*Philemon buceroides*	Rainforest/parkland	Uncommon
MELIPHAGIDAE	Little Friarbird	*Philemon citreogularis*	Rainforest/parkland	Uncommon
MELIPHAGIDAE	Red-headed Honeyeater	*Myzomela erythrocephala*	Mangroves/rainforest	Common

Family	Common Name	Scientific Name	Preferred habitat	Relative abundance
MELIPHAGIDAE	Rufous-banded Honeyeater	*Conopophila albogularis*	Mangroves/parkland	Common
MELIPHAGIDAE	Silver-crowned Friarbird	*Philemon argenticeps*	Rainforest/parkland	Uncommon
MELIPHAGIDAE	White-gaped Honeyeater	*Lichenostomus unicolor*	Rainforest	Common
MELIPHAGIDAE	White-throated Honeyeater	*Melithreptus albogularis*	Parkland	Uncommon
MEROPIDAE	Rainbow Bee-eater	*Merops ornatus*	Parkland	Common
MONARCHIDAE	Broad-billed Flycatcher	*Myiagra ruficollis*	Mangroves	Common
MONARCHIDAE	Leaden Flycatcher	*Myiagra rubecula*	Rainforest	Common
MONARCHIDAE	Magpie-lark	*Grallina cyanoleuca*	Parkland	Common
MONARCHIDAE	Restless Flycatcher	*Myiagra inquieta*	Rainforest/parkland	Common
MONARCHIDAE	Shining Flycatcher	*Myiagra alecto*	Rainforest/mangroves	Common
MOTACILLIDAE	Australasian Pipit	*Anthus novaeseelandiae*	Parkland	Common
NECTARINIIDAE	Mistletoebird	*Dicaeum hirundinaceum*	Parkland	Uncommon
ORIOLIDAE	Australasian Figbird	*Sphecotheres vieilloti*	Rainforest	Common
ORIOLIDAE	Olive-backed Oriole	*Oriolus sagittatus*	Rainforest	Uncommon
ORIOLIDAE	Yellow Oriole	*Oriolus flavocinctus*	Rainforest	Common
PACHYCEPHALIDAE	Grey Whistler	*Pachycephala simplex*	Rainforest	Common
PACHYCEPHALIDAE	Mangrove Golden Whistler	*Pachycephala melanura*	Mangroves	Uncommon
PACHYCEPHALIDAE	Rufous Whistler	*Pachycephala rufiventris*	Parkland	Uncommon
PACHYCEPHALIDAE	White-breasted Whistler	*Pachycephala lanioides*	Mangroves	Uncommon
PANDIONIDAE	Eastern Osprey	*Pandion cristatus*	Coast	Uncommon
PARDALOTIDAE	Striated Pardalote	*Pardalotus striatus*	Parkland	Common
PELECANIDAE	Australian Pelican	*Pelecanus conspicillatus*	Lake	Uncommon
PETROICIDAE	Lemon-bellied Flycatcher	*Microeca flavigaster*	Parkland/mangroves	Common
PETROICIDAE	Mangrove Robin	*Peneoenanthe pulverulenta*	Mangroves	Uncommon
PHALACROCORACIDAE	Little Pied Cormorant	*Microcarbo melanoleucos*	Coast/lake	Uncommon
PHALACROCORACIDAE	Pied Cormorant	*Phalacrocorax varius*	Coast/lake	Common
PITTIDAE	Rainbow Pitta	*Pitta iris*	Rainforest	Common
PODARGIDAE	Tawny Frogmouth	*Podargus strigoides*	Rainforest/parkland	Common
PODICIPEDIDAE	Australasian Grebe	*Tachybaptus novaehollandiae*	Lake	Uncommon
POMATOSTOMIDAE	Grey-crowned Babbler	*Pomatostomus temporalis*	Parkland	Uncommon
PROCELLARIIDAE	Wedge-tailed Shearwater	*Ardenna pacifica*	Coast	Vagrant
PSITTACIDAE	Rainbow Lorikeet	*Trichoglossus haematodus*	Parkland	Common
PSITTACIDAE	Red-winged Parrot	*Aprosmictus erythropterus*	Parkland	Common
PTILONORHYNCHIDAE	Great Bowerbird	*Ptilonorhynchus nuchalis*	Parkland	Uncommon
RALLIDAE	Buff-banded Rail	*Gallirallus philippensis*	Lake	Uncommon
RHIPIDURIDAE	Arafura Fantail	*Rhipidura dryas*	Rainforest	Uncommon
RHIPIDURIDAE	Mangrove Grey Fantail	*Rhipidura phasiana*	Mangroves	Uncommon
RHIPIDURIDAE	Northern Fantail	*Rhipidura rufiventris*	Parkland/rainforest	Common
RHIPIDURIDAE	Willie Wagtail	*Rhipidura leucophrys*	Parkland	Common
SCOLOPACIDAE	Asian Dowitcher	*Limnodromus semipalmatus*	Coast	Uncommon
SCOLOPACIDAE	Bar-tailed Godwit	*Limosa lapponica*	Coast	Common
SCOLOPACIDAE	Black-tailed Godwit	*Limosa limosa*	Coast	Uncommon
SCOLOPACIDAE	Broad-billed Sandpiper	*Limicola falcinellus*	Coast	Uncommon
SCOLOPACIDAE	Common Greenshank	*Tringa nebularia*	Coast/mangroves	Common

Family	Common Name	Scientific Name	Preferred habitat	Relative abundance
SCOLOPACIDAE	Common Sandpiper	*Actitis hypoleucos*	Coast	Common
SCOLOPACIDAE	Curlew Sandpiper	*Calidris ferruginea*	Coast	Uncommon
SCOLOPACIDAE	Eastern Curlew	*Numenius madagascariensis*	Coast	Common
SCOLOPACIDAE	Great Knot	*Calidris tenuirostris*	Coast	Common
SCOLOPACIDAE	Grey-tailed Tattler	*Tringa brevipes*	Coast	Common
SCOLOPACIDAE	Little Curlew	*Numenius minutus*	Coast	Uncommon
SCOLOPACIDAE	Marsh Sandpiper	*Tringa stagnatilis*	Coast	Uncommon
SCOLOPACIDAE	Pectoral Sandpiper	*Calidris melanotos*	Coast	Vagrant
SCOLOPACIDAE	Red Knot	*Calidris canutus*	Coast	Uncommon
SCOLOPACIDAE	Red-necked Phalarope	*Phalaropus lobatus*	Lake	Vagrant
SCOLOPACIDAE	Red-necked Stint	*Calidris ruficollis*	Coast	Common
SCOLOPACIDAE	Ruddy Turnstone	*Arenaria interpres*	Coast	Common
SCOLOPACIDAE	Sanderling	*Calidris alba*	Coast	Uncommon
SCOLOPACIDAE	Sharp-tailed Sandpiper	*Calidris acuminata*	Coast	Uncommon
SCOLOPACIDAE	Swinhoe's Snipe	*Gallinago megala*	Lake	Uncommon
SCOLOPACIDAE	Terek Sandpiper	*Xenus cinereus*	Coast	Uncommon
SCOLOPACIDAE	Wandering Tattler	*Tringa incana*	Coast	Vagrant
SCOLOPACIDAE	Whimbrel	*Numenius phaeopus*	Coast	Common
STRIGIDAE	Barking Owl	*Ninox connivens*	Parkland	Common
STRIGIDAE	Southern Boobook	*Ninox novaeseelandiae*	Parkland	Uncommon
SULIDAE	Brown Booby	*Sula leucogaster*	Coast	Uncommon
THRESKIORNITHIDAE	Australian White Ibis	*Threskiornis molucca*	Parkland	Common
THRESKIORNITHIDAE	Glossy Ibis	*Plegadis falcinellus*	Parkland	Vagrant
THRESKIORNITHIDAE	Straw-necked Ibis	*Threskiornis spinicollis*	Parkland	Common
TIMALIIDAE	Yellow White-eye	*Zosterops luteus*	Mangroves/rainforest	Common
TYTONIDAE	Eastern Grass Owl	*Tyto longimembris*	Parkland	Vagrant
MAMMALS (terrestrial)				
CANIDAE	Dingo	*Canis lupus*	All	Uncommon
FELIDAE	Cat	*Felis catus*	All	Uncommon
MACROPODIDAE	Agile Wallaby	*Macropus agilis*	Rainforest/parkland	Common
MURIDAE	Dusky Rat	*Rattus colletti*	Rainforest	Common
MURIDAE	Grassland Melomys	*Melomys burtoni*	Rainforest	Common
PERAMELIDAE	Northern Brown Bandicoot	*Isoodon macrourus*	Rainforest/parkland	Common
PHALANGERIDAE	Common Brushtail Possum	*Trichosurus vulpecula*	Rainforest/parkland	Common
PTEROPODIDAE	Black Flying-fox	*Pteropus alecto*	Rainforest	Common
PTEROPODIDAE	Little Red Flying-fox	*Pteropus scapulatus*	Rainforest	Uncommon
VESPERTILIONIDAE	Gould's Wattled Bat	*Chalinolobus gouldii*	Parkland	Unknown
VESPERTILIONIDAE	*Unknown Long-eared Bat*	*Nyctophilus sp.*	-	-
REPTILES (terrestrial)				
AGAMIDAE	Frilled Lizard	*Chlamydosaurus kingii*	Parkland	Common
AGAMIDAE	Northern Water Dragon	*Lophognathus temporalis*	Parkland/rainforest	Common
CHELONIIDAE	Flatback Turtle	*Natator depressus*	Coastal	Uncommon
CHELONIIDAE	Green Turtle	*Chelonia mydas*	Coastal	Uncommon
COLUBRIDAE	Brown Tree Snake	*Boiga irregularis*	Rainforest	Uncommon

Family	Common Name	Scientific Name	Preferred habitat	Relative abundance
COLUBRIDAE	Green Tree Snake	*Dendrelaphis punctulata*	Rainforest	Uncommon
COLUBRIDAE	Slaty-grey Snake	*Stegonotus cucullatus*	Rainforest	Uncommon
ELAPIDAE	Marble-headed Whip Snake	*Demansia olivacea*	Parkland	Uncommon
ELAPIDAE	Moon Snake	*Furina ornata*	Rainforest	Uncommon
ELAPIDAE	Spine-bellied Seasnake	*Lapemis curtus*	Coastal	Uncommon
ELAPIDAE	Northern Brown Snake	*Pseudonaja nuchalis*	Parkland	Uncommon
ELAPIDAE	Northern Bandy-bandy	*Vermicella intermedia*	Rainforest	Uncommon
GEKKONIDAE	Asian House Gecko	*Hemidactylus frenatus*	Rainforest	Common
GEKKONIDAE	Bynoe's Gecko	*Heteronotia binoei*	Parkland/rainforest	Common
GEKKONIDAE	Northern Dtella	*Gehyra australis*	Parkland	Common
PYTHONIDAE	Children's Python	*Antaresia childreni*	Parkland	Uncommon
PYTHONIDAE	Water Python	*Liasis mackloti*	Rainforest	Uncommon
PYTHONIDAE	Carpet Python	*Morelia spilota*	Rainforest	Uncommon
SCINCIDAE	Slender Rainbow-skink	*Carlia gracilis*	Rainforest	Common
SCINCIDAE	Swanson's Snake-eyed Skink	*Cryptoblepharus cygnatus*	Parkland	Common
SCINCIDAE	Spalding's Ctenotus	*Ctenotus spaldingi*	Parkland	Uncommon
SCINCIDAE	Douglas' Skink	*Glaphyromorphus douglasi*	Rainforest	Common
SCINCIDAE	Northern Blue-tongued Skink	*Tiliqua scincoides intermedia*	Rainforest	Uncommon
TYPHLOPIDAE	Flowerpot Blind Snake	*Ramphotyphlops braminus*	Rainforest	Uncommon
VARANIDAE	Floodplain Monitor	*Varanus panoptes*	Parkland	Common
VARANIDAE	Spotted Tree Monitor	*Varanus scalaris*	Parkland	Uncommon

Appendix B – All fauna species recorded during 2013 fauna surveys

Scientific Name	Common Name	Remnant Rainforest		Revegetated Rainforest	
		Wet	Dry	Wet	Dry
Birds					
Accipiter fasciatus	Brown Goshawk	X		X	X
Aegotheles cristatus	Australian Owlet-nightjar			X	
Aviceda subcristata	Pacific Baza				X
Cacomantis variolosus	Brush Cuckoo	X		X	
Caprimulgus macrurus	Large-tailed Nightjar	X	X	X	X
Chalcites minutillus	Little Bronze-Cuckoo	X	X		X
Colluricincla megarhyncha	Rufous Shrike-thrush				X
Conopophila albogularis	Rufous-banded Honeyeater	X		X	X
Coracina novaehollandiae	Black-faced Cuckoo-shrike		X		
Coracina papuensis	White-bellied Cuckoo-shrike		X		X
Coracina tenuirostris	Cicadabird			X	
Eudynamys orientalis	Eastern Koel	X		X	
Eurystomus orientalis	Dollarbird	X		X	
Dicrurus bracteatus	Spangled Drongo	X	X	X	X
Geopelia humeralis	Bar-shouldered Dove	X	X	X	X
Geopelia striata	Peaceful Dove	X			X
Gerygone magnirostris	Large-billed Gerygone	X	X	X	X
Grallina cyanoleuca	Magpie-lark			X	
Lalage leucomela	Varied Triller	X	X	X	X
Lichenostomus unicolor	White-gaped Honeyeater	X	X	X	X
Lichmera indistincta	Brown Honeyeater	X	X		X
Megapodius reinwardt	Orange-footed Scrubfowl	X	X	X	X
Merops ornatus	Rainbow Bee-eater	X	X	X	X
Microeca flavigaster	Lemon-bellied flycatcher		X	X	
Myiagra alecto	Shining Flycatcher	X	X	X	X
Myzomela erythrocephala	Red-headed Honeyeater	X		X	X
Myzomela obscura	Dusky Honeyeater	X			X
Oriolus flavocinctus	Yellow Oriole	X	X	X	X
Oriolus sagittatus	Olive-backed Oriole		X		X
Pachycephala simplex	Grey Whistler	X		X	X
Pardalotus striatus	Striated Pardalote	X	X		X
Philemon argenticeps	Silver-crowned Friarbird	X			X
Philemon buceroides	Helmeted Friarbird	X			
Pitta iris	Rainbow Pitta	X			
Podargus strigoides	Tawny Frogmouth	X			

Scientific Name	Common Name	Remnant Rainforest		Revegetated Rainforest	
		Wet	Dry	Wet	Dry
Rhipidura dryas	Arafura Fantail		X		X
Rhipidura rufiventris	Northern Fantail	X	X	X	X
Smicrornis brevirostris	Weebill				X
Sphecotheres vieilloti	Australasian Figbird	X	X	X	X
Todiramphus macleayii	Forest Kingfisher	X		X	X
Todiramphus sanctus	Sacred Kingfisher				X
Zosterops luteus	Yellow White-eye				X
Reptiles					
Carlia gracilis	Slender Rainbow Skink	X	X	X	X
Chlamydosaurus kingii	Frilled Lizard	X			
Cryptoblepharus cygnatus	Swanson's Snake-eyed Skink	X			
Dendrelaphis punctulata	Common Tree Snake				X
Glaphyromorphus douglasi	Douglas' Skink			X	
Hemidactylus frenatus	Asian House Gecko	X	X		
Heteronotia binoei	Bynoe's Gecko	X	X		
Lophognathus temporalis	Northern Water Dragon	X		X	
Morelia spilota	Carpet Python		X		
Amphibians					
Litoria caerulea	Green Tree-frog	X	X	X	
Mammals					
Chalinolobus gouldii	Gould's Wattled Bat		X		
Isoodon macrourus	Northern Brown Bandicoot	X	X	X	X
Macropus agilis	Agile Wallaby	X	X	X	X
Melomys burtoni	Grassland Melomys	X		X	
Nyctophilis sp.	Unknown Long-eared Bat		X		
Pteropus alecto	Black Flying Fox		X		X
Pteropus scapulatus	Little Red Flying Fox	X			
Trichosurus vulpecula	Common Brushtail Possum	X	X	X	X

Appendix C – photographs of fauna recorded during the survey

Large-tailed Nightjar (*Caprimulgus macrurus*)

Lemon-bellied Flycatcher (*Microeca flavigaster*)

Rufous Shrike-thrush (*Colluricincla megarhyncha*)

Carpet Python (*Morelia spilota*)

Figure 7-1. Photographs of fauna species recorded in monsoon rainforest habitat

Great Bowerbird (*Chlamydera nuchalis*)

Floodplain Monitor (*Varanus panoptes*)

Brown Goshawk (*Accipiter fasciatus*)

Eastern Reef Egret (*Egretta sacra*)

Figure 7-2. Photographs of Incidental Fauna Sightings

Common Sandpiper (*Actitis hypoleucos*)

Yellow White-eye (*Zosterops luteus*)

Brahminy Kite juvenile (*Haliastur indus*)

Broad-billed Flycatcher (*Myiagra ruficollis*)

Figure 7-3. Photographs of birds recorded in mangrove habitat

Whimbrel (*Numenius phaeopus*)

Black-tailed Godwit (*Limosa limosa*) and Great Knots (*Calidris tenuirostris*)

Ruddy Turnstone (*Arenaria intepres*) and Great Knots (*Calidris tenuirostris*)

Greater Sand Plover (*Charadrius leschenaultii*)

Figure 7-4. Photographs of migratory shorebirds at East Point

Appendix D – Report on the reintroduction of the Atlas Moth (*Attacus wardi*) to East Point Reserve

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Reintroduction of the Atlas Moth (*Attacus wardi*) to East Point Reserve

Prepared by: EcOz Environmental Services

Prepared for: City of Darwin



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Executive Summary

Introduction

East Point Reserve is an environmental, recreational and historical reserve located on a peninsula approximately six kilometres north of the Darwin city centre. EcOz Environmental Services (EcOz) was commissioned by the City of Darwin in 2013 to undertake a biodiversity survey of East Point Reserve, including providing advice on the management of the reserve. Part of this is the potential reintroduction of the Atlas Moth (*Attacus wardi*), a species listed as Vulnerable under the NT *Territory Parks and Wildlife Conservation Act* (*TPWC Act*). This report examines the suitability and management requirements for the reintroduction of the Atlas Moth into East Point Reserve. It has also been provided as an appendix to the main East Point Reserve Biodiversity Assessment Report.

Background

The potential reintroduction of the Atlas Moth to East Point Reserve is focused within the patches of monsoon forest present on the site. The Atlas Moth (*Attacus wardi*) was first discovered within the Port Darwin area in 1908 at a time when large patches of monsoon forest and monsoon vine thicket were present, thus providing the habitat necessary to support the Atlas Moth population. Over time much of this habitat, including the plant species that the Atlas Moth larvae depend on for a food source, have been cleared to make way for the development. The Atlas Moth has since become extinct from the Darwin area.

The Atlas Moth starts its life as an egg laid by a gravid (i.e. pregnant) female moth on the leaf of a food plant. Currently only two food plants have been identified, *Croton habrophyllus* and *Litsea glutinosa*. A trial program is currently being investigated by Geoff Martin to raise Atlas Moths in captivity from eggs laid by captured gravid females.

Results

A general monsoon forest vegetation survey and a targeted Atlas Moth habitat survey were both undertaken in the late wet season of 2013.

The survey identified the potential for between 498 and 994 *C. habrophyllus* and between 3217 and 5327 *L. glutinosa* plants to inhabit both the dense monsoon forest and the mid-dense monsoon forest within the East Point Reserve remnant monsoon forest. Habitat surveys determined that within East Point Reserve monsoon forest there are approximately 14.5 ha of Atlas Moth habitat, of which 2.1 ha is Highly Suitable habitat.

Recommendations

Croton habrophyllus should be included on the edge of future revegetation patches and *Litsea glutinosa* should be included on the inside of future revegetation patches.

Revegetation after the removal of Poinciana trees, saplings and seedlings should aim to reinstate a vegetation structure and composition similar to survey site VS7, including planting *Croton habrophyllus*.

Trials should be undertaken to determine the success of sourcing established seedlings of both *C. habrophyllus* and *L. glutinosa* from areas of lower priority habitat within the reserve and transplanting them into areas of higher priority habitat.

Future revegetation of the East Point Reserve should avoid further planting within Habitat Patch 2 as the interface between this area and Habitat 1 provides ideal edge habitat for *C. habrophyllus.*

Table of Contents

Tables

Figures

Acknowledgements

Thanks to Geoff Martin who provided important information on the life history, proposed husbandry and reintroduction of the Atlas Moth. Front cover photos are also credited to Geoff. Thanks to Stuart Grant and Anita Meadows for providing information on past management and proposed future management for the East Point Reserve.

1 Introduction

East Point Reserve, located in Darwin in the Northern Territory, is an important recreation area for the people of Darwin. Management of East Point Reserve was taken over by the City of Darwin in 1984. The entire reserve covers almost 200 ha, of which 30 ha is either remnant or mature revegetated dry monsoon forest (City of Darwin 2013). Prior to the development of Darwin, numerous pockets of monsoon forest were present within the area. Now a small number of patches of monsoon forest vegetation are managed within parks and reserves, including the East Point Reserve. Thus this area should be an important focus for the management and conservation of the natural environment within the Darwin region.

City of Darwin engaged EcOz Environmental Services in 2013 to undertake a detailed biodiversity survey of East Point Reserve, including providing advice on the management of the reserve. Part of this is the potential reintroduction of the Atlas Moth (*Attacus wardi*), a species listed as Vulnerable under the NT *Territory Parks and Wildlife Conservation Act* (*TPWC Act*). This report examines the suitability and management requirements for the reintroduction of the Atlas Moth into East Point Reserve. It has also been provided as an appendix to the main East Point Reserve Biodiversity Assessment Report.

1.1 Focus area

The potential reintroduction of the Atlas Moth to East Point Reserve is focused within the patches of monsoon forest present on the site. Assessment of historical aerial images of the reserve and the vegetation structure and composition has identified a variety of patch types present within the reserve (Griffiths, *et al.* 2005). A map showing the revegetation stages and approximate establishment dates is shown in Figure 1-1.

1.2 Scope

The purpose of this study is to determine:

- The location and approximate densities of the larval food plants *Croton habrophyllus* and *Litsea glutinosa* within the East Point Reserve monsoon forest.
- Whether, therefore, the East Point Reserve monsoon forest is suitable for the reintroduction of the Atlas Moth.
- Recommendations for the ongoing management of monsoon forest patches to maintain and improve Atlas Moth habitat for potential reintroduction.

Figure 1-1. East Point Reserve monsoon forest patches and revegetation history

2 Background

The Atlas Moth (*Attacus wardi*) was first discovered by F.P. Dodd within the Port Darwin area in 1908 (Hirst 2012). At this time large patches of monsoon forest and monsoon vine thicket were present providing the habitat necessary to support the Atlas Moth population. Over time much of this habitat, including the plant species that the Atlas Moth larvae depend on for a food source, have been cleared to make way for the development of Darwin city. Insecticides sprayed around Darwin during World War II are also thought to have had an impact on the population. The Atlas Moth has since become extinct from the Darwin area (Hirst 2012).

Clearing of monsoon forest vegetation started to take place at East Point in response to the military presence there between 1943 and 1945. Further clearing took place between 1945 and 1963 to make way for a golf course (Franklin *et al.* 2010). A large patch of monsoon forest has been retained covering an area approximately 14 ha on the southern edge of the East Point reserve. Revegetation projects began within the reserve in 1974 to increase the area of monsoon vine forest vegetation at the reserve bringing the total area of monsoon forest to just under 37 ha.

Populations of the Atlas Moth have been recently located near Darwin in dry monsoon forest at Gunn Point and Dundee Beach, with larvae feeding on the leaves of two known native species. The first plant identified was *Croton habrophyllus* – a deciduous pioneer species favouring monsoon forest openings and the edge of patches. More recently the evergreen *Litsea glutinosa* was also identified as a larval food plant (*pers. comm.* Martin 2013). This species is very common as a mid-storey shrub/tree within dry monsoon forests in the Top End.

2.1 Life cycle of the Atlas Moth

The Atlas Moth starts its life as an egg laid by a gravid (i.e. pregnant) female moth on the leaf of a food plant. Currently only two food plants have been identified, *Croton habrophyllus* and *Litsea glutinosa*. The eggs are laid in the wet season during a period of high rainfall and relative humidity, with each female laying between 80 to 100 eggs (*pers. comm*. Martin 2013). Eggs are predated on by numerous insects including wasps and ants and mortality is high with only around 10% of eggs reaching the pupa stage (Hirst 2012). Laying takes place once moths emerge from their cocoons and then mate after heavy seasonal rains set in, between late November and December (*pers. comm.* Martin 2013). Depending on the weather conditions a wet season may have two egg laying periods (Hirst 2012), therefore emergence can take place anywhere from late November to May, with the majority of moths emerging in March during the second cycle (Hirst 2012). The eggs hatch soon after laying and the larvae feeds on the leaves of the host plant for around seven weeks. The larvae then enter the pupa stage, protected within a cocoon made from leaves of the host plant and secured to a twig with silken thread. Once emerged, the female will remain perched on her cocoon until a male moth is drawn to her by the release of pheromones (*pers. comm.* Martin 2013). Having mated, the female will then fly late at night to find numerous ideal locations to lay her eggs. Adult moths have no mouth parts and only live for around 6 days, limiting their ability to widely disperse.

The dry weather conditions associated with the Top End dry season generally begin in May and are characterised by a period of low rainfall and relative humidity. However, conditions within the monsoon forest still remain relatively cool and with a slightly elevated level of humidity, allowing pupae to remain protected within the cocoon attached to the host plant over the period of the dry season. The onset of wet season rains in November or December sees an emergence of moths and a continuation of the life cycle (*pers. comm.* Martin 2013). Studies suggest that the Atlas Moth is restricted to coastal monsoon vine forest patches with a minimum size of 8 ha (Lane *et al*. 2010).

2.2 Proposed reintroduction of the Atlas Moth

A trial program is currently being investigated by Geoff Martin, an Atlas Moth enthusiast, to raise Atlas Moths in captivity from eggs laid by captured gravid females. This captive breeding program could then provide 15 to 20 captive-raised gravid females for release into East Point Reserve monsoon forest at a later date. Captive rearing of moths is proposed in order to reduce the level of egg mortality experienced in the natural setting, which can be as high as 90% due to predation (*pers. comm.* Martin 2013).

The collection of gravid females will be undertaken between 11pm and 5am after the onset of heavy rains forecast for late November or December. A number of sites including Gunn Point and Dundee Beach will be searched to locate moths for capture; moths have been seen to be locally common in patches of suitable habitat. Females are identified as being larger than males and will not begin flying from the cocoon until after mating with a visiting male. Therefore, females captured on the wing are potentially gravid unless the egg clutch has already been laid (*pers. comm.* Martin 2013).

Gravid females are taken into captivity and allowed to lay their eggs onto propagated larval host plants within a controlled environment free from egg predators (Figure 2-1). The larvae are raised for 7 weeks until they form the pupa stage with the formation of a cocoon (see Figure 2-2). Emergence from the cocoon is somewhat random so male moths will need to be housed in a large enclose until a suitable mate has emerged. When a female emerges mating can commence, after which the gravid female could be released at a suitable location within the East Point Reserve monsoon forest to lay her. Pupae remaining dormant over the dry season will be kept in an artificial environment with a climate similar to that found within local monsoon forests to ensure the pupa neither emerges if kept too moist, or desiccates if kept too dry (*pers. comm.* Martin 2013).

Figure 2-1. Moth egg remains on host leaf

Figure 2-2. Moth pupa stage cocoon

3 Methodology

3.1 Vegetation survey

3.1.1 Monsoon forest patch survey

Monsoon forest patch boundaries were drawn from historic (Griffiths *et al.* 2005) and more recent aerial imagery (GEP 2013). An onground reconnaissance survey was also used to determine differences in vegetation structure and composition, and thereby inform the number and location of vegetation survey plots.

A total of eight survey sites were chosen for vegetation mapping and habitat characterisation and comprised of an area of 20 m by 20 m (Figure 4-1). The full range of attributes recorded for a vegetation survey site contributing towards vegetation mapping includes:

- **Site location**: Global Positioning System (GPS) coordinates and general description;
- **Habitat information**: Landform pattern and element, vegetation patch size, aspect, slope, surface soil type (broad category only), estimated soil depth, estimated drainage capacity and percentage ground cover for standing biomass, litter, bare earth and pebble/rock/outcrop, presence and type of fallen logs, mistletoe, flowering plants and termite mounds;
- **Status of disturbance**: The time since the last fire and scorch height as well as the presence and extent (estimated cover) of weed species and the presence and stability of erosion;
- **Broad structural information**: The estimated crown separation ratio, the estimated percentage canopy cover or ground cover for the main three vegetation strata and their height range and average height;
- **Floristic and structural formation**: For vegetation mapping a full list of species present is compiled along with canopy heights and percentage cover for each species in the strata; and
- **Basal sweep**: Estimates of basal area for over-storey species using a basal wedge (for both live and dead trees) to given an estimate of species dominance.

For habitat characterisation and ground-truthing existing land systems mapping the level of data collection aligns with a check site as described in Brocklehurst *et al.* (2007). The above attributes were applied with some exceptions: for the floristic component only the dominant species (i.e. those contributing greater than 1% cover) and their cover and height recorded. For habitat characterisation comments are added to the floristics component to indicate which species are flowering or fruiting.

The methods of gathering data against the key attributes align with those recommended in Brocklehurst *et al.* (2007), however some minor modifications were applied. These modifications include: percentage cover estimates were based on foliage cover in the upper, mid and lower stratum (the percentage of the sample site occupied by vertical projection of foliage and branches) to best represent light availability during the wet season growth period. Tree heights were estimated rather than measuring with a clinometer due to the confines of the forest, and simplified observations and categories for soil characteristics and depth.

Landform observations follow Speight (2009) in the Australian Soil and Land Survey Field Handbook.

Incidental records for weeds were noted in all of the survey areas and their surrounds and particular attention was paid to existing road corridors.

Plant species were identified in the field as accurately as possible using the Field key for the Monsoon Rainforest Flora of the Darwin Region (Booth *et al.* 2001). Where species could not be identified in the field voucher specimens were taken and pressed for later identification at the NT Herbarium.

The species nomenclature for plants follows the Checklist for Vascular Plants for the Northern Territory (Short *et al.* 2011).

The classification of monsoon forest patches within the East Point Reserve was developed according to definition of vegetation cover in the upper stratum as outlined by Hnatiuk, *et al*. (2009) in the Australian Soil and Land Survey Field Handbook. This vegetation attribute was chosen to best represent the amount of light available to vegetation within the mid-stratum, an important factor in whether the pioneer species *Croton habrophyllus* has sufficient light within the forest to establish suitable habitat for the Atlas Moth. Vegetation cover definitions are as follows:

- Dense – 70% or greater foliage cover in the upper stratum
- Mid-dense – greater than 30% and less than 70% foliage cover in the upper stratum

Growth stage was also included to differentiate original intact vegetation from more recently established monsoon forest revegetation and includes the following additional classifications:

- Advanced Monsoon Forest Revegetation (> 10 m upper stratum height)
- Early Monsoon Forest Revegetation (< 10 m upper stratum height)
- Immature Monsoon Forest Revegetation (< 4 years since patch establishment)

Monsoon forest patch classifications were then applied to the identified monsoon forest patches types with maps produced using ArcGIS 10 for presentation within the report. These patch types were then used to define areas within the Atlas Moth habitat survey.

3.1.2 Atlas Moth habitat survey

The Atlas Moth habitat survey was focused on identifying patches of monsoon forest vegetation containing significant densities of the larval food plant *Croton habrophyllus.* Given the common occurrence of *Litsea glutinosa* observed within the original intact monsoon forest this species only received minimal survey effort within the second survey.

A transect method was used to survey each patch type. An onsite check determined a survey sight distance of approximately 7m within the monsoon forest. The transect layout was developed within ArcGIS 10 and then uploaded to a handheld GPS unit for use in the field. Transect lines were surveyed using a hand held GPS unit with two environmental scientists searching a 5 m corridor either side of the line, for a total search area of 600 m² for each transect line. Transect lines were spaced 25m apart to ensure individuals were not resurveyed in subsequent transects. The sighting of a *Croton habrophyllus* plant within the transect area was recorded on the GPS. The survey comprised three components:

1. The initial survey (Stage 1 Transects) consisted of 28 transect lines 60 m in length. Eight transects were located within the dense monsoon forest, the mid-dense monsoon forest and the dense advance monsoon forest revegetation patch boundaries. Given the reduced area of the mid-dense advanced monsoon forest revegetation patch only four transects were located within the patch.

2. The results of the transect surveys identified that the occurrence of *C. habrophyllus* is restricted to the original intact patches of monsoon forest located on the southern side of the reserve. Therefore, a patch edge survey was undertaken, confined to the outside boundary edge of the dense monsoon forest, the mid-dense monsoon forest and associated clearing and edge revegetation. The southern patch edge of the dense advanced monsoon forest was also searched to determine if *C. habrophyllus* had spread from the neighbouring original intact monsoon forest patch.

3. The patch edge survey located a high density of *Croton habrophyllus* adult trees in the south west corner of the monsoon forest. As a consequence, a second *C. habrophyllus* survey (Stage 2 Transects) was undertaken in the area of rainforest identified as being within the most suitable patch of Atlas Moth habitat. This involved an additional three transect lines located within the dense monsoon forest and five located within the mid-dense monsoon forest.

Thus, a total of 36 transect lines were traversed, of which 11 were in the dense monsoon forest and 13 in the mid-dense monsoon forest (see Figure 3-1).

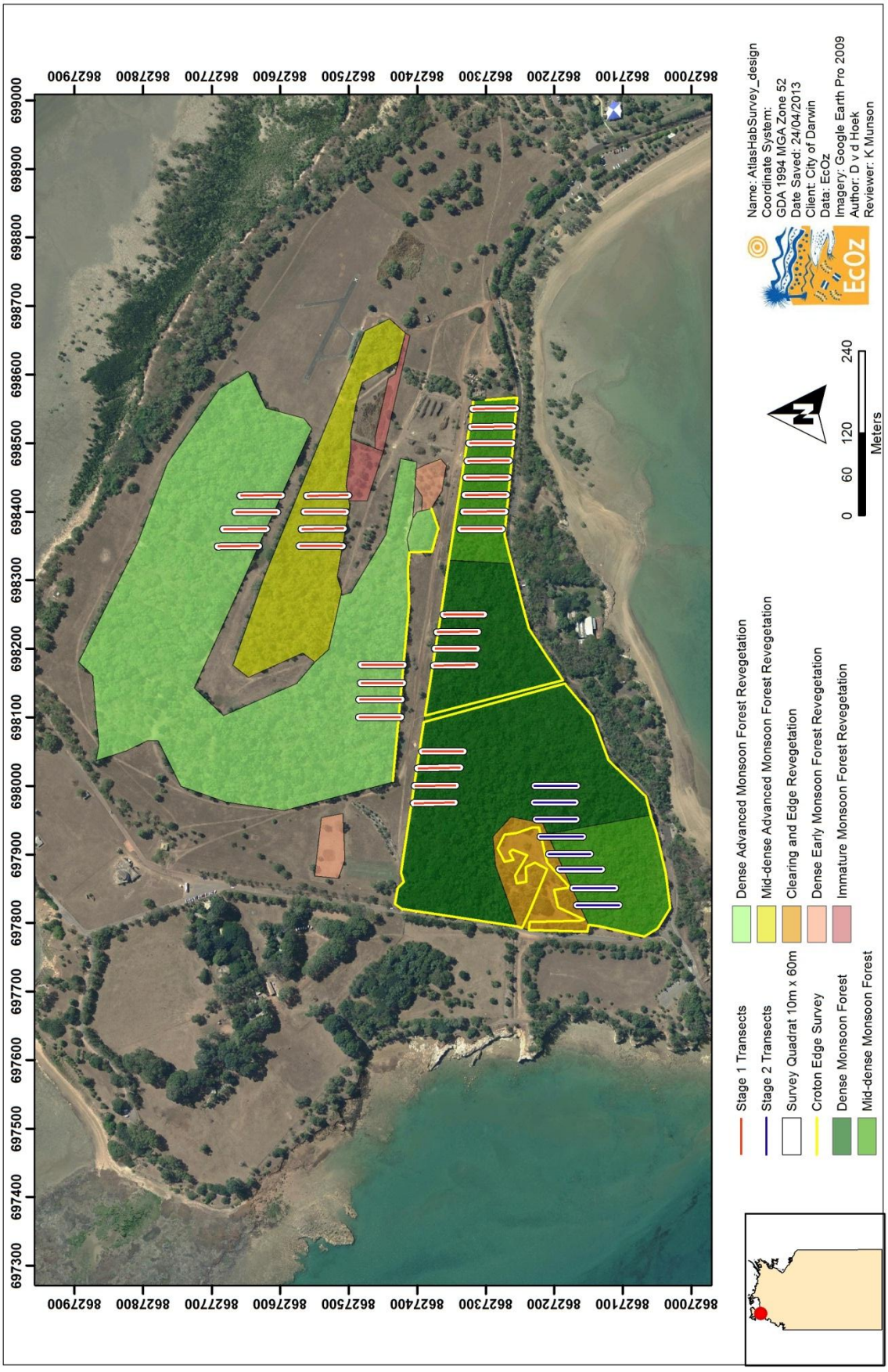

Figure 3-1. East Point Reserve Atlas Moth habitat survey design

4 Results

4.1 Monsoon forest patch survey

A total of seven monsoon forest patch types have been defined within the reserve. The description of monsoon forest patch types and the area they represent within the reserve is shown below in Table 4-1.

Table 4-1. East Point Reserve monsoon forest patch types and the area they represent

Monsoon forest patch type	Total Area (m²)	% of the Monsoon Forest
Dense monsoon forest	101 258	27.5%
Mid-dense monsoon forest	38 797	10.5%
Dense advanced monsoon forest revegetation	162 556	44%
Mid-dense advanced monsoon forest revegetation	39 297	11%
Clearing and edge revegetation	15 015	4%
Dense early monsoon forest revegetation	5 581	1.5%
Immature monsoon forest revegetation	5 576	1.5%
Total	**368 080**	**100%**

These vegetation patches have been mapped and are shown in Figure 4-1. Full vegetation descriptions, including, weeds, vegetation structure, dominate species composition and growth phase is provided for each site in Appendix E of the main East Point Biodiversity Assessment Report. Notes on the presence of the Atlas Moth food plants *Croton habrophyllus* and *Litsea glutinosa* are also included.

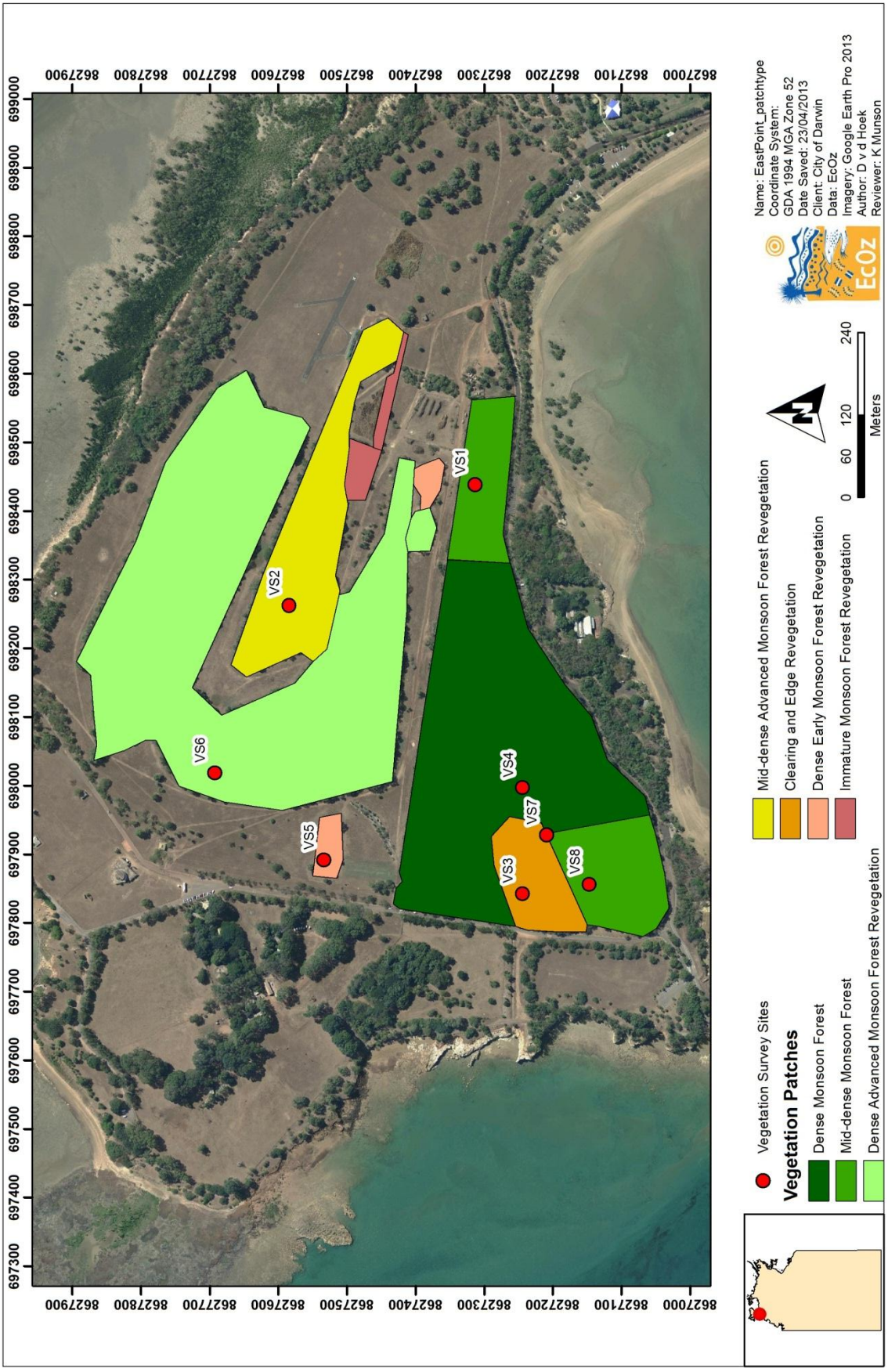

Figure 4-1. East Point Reserve monsoon forest patch types and vegetation survey locations

4.2 Atlas Moth habitat survey

The area of each patch type and the location of recorded plants is shown in Figure 4-2. The approximate number of plants (including the standard error) has been calculated for each area using the results of the survey (see Table 4-2). This has identified the potential for between 498 and 994 *C. habrophyllus* to inhabit the East Point Reserve monsoon forest.

Table 4-2. Results of the *Croton habrophyllus* transect survey

Croton habrophyllus				
Patch type	**Dense monsoon forest**	**Mid-dense monsoon forest**	**Dense advanced monsoon forest revegetation**	**Mid-dense advanced monsoon forest revegetation**
Area surveyed (m²)	6 600	7 800	4 800	2 400
Number of plants located	12	106	0	0
Plants per m²	0.002 ± 0.0013	0.014 ± 0.003	0	0
Total patch area m²	101 258	38 797	160 287	39 297
% of patch surveyed	6.5%	20.0%	2.9%	6.1%
Estimated number of plants in patch	202 ± 131	543 ± 116	0	0

The location of *C. habrophyllus* patch edge records shows that the majority of plants were located in the clearing and edge revegetation associated with the original intact forest (7.47 per 100 m) compared to the mid-dense monsoon forest (3.36 per 100 m) and only 0.39 per 100 m along the dense monsoon forest edge (see Figure 4-1). Plants were also located along the edge of a historic patch of revegetation that was established sometime after 1964 but was well established in aerial photographs by 1974 (Franklin *et al.* 2010). This small patch of dense advanced monsoon forest revegetation (2 169 m²) was the only patch of revegetated forest where *C. habrophyllus* was located (see Figure 4-2).

Table 4-3. The patch type, length of survey, and average number of crotons located in each area

Patch Type	**Length of Edge Surveyed (m)**	**Crotons per 100m**
Dense monsoon forest	1529	0.39
Mid-dense monsoon forest	802	3.36
Clearing and edge revegetation	749	7.47
Dense advanced monsoon forest revegetation	433	1.30

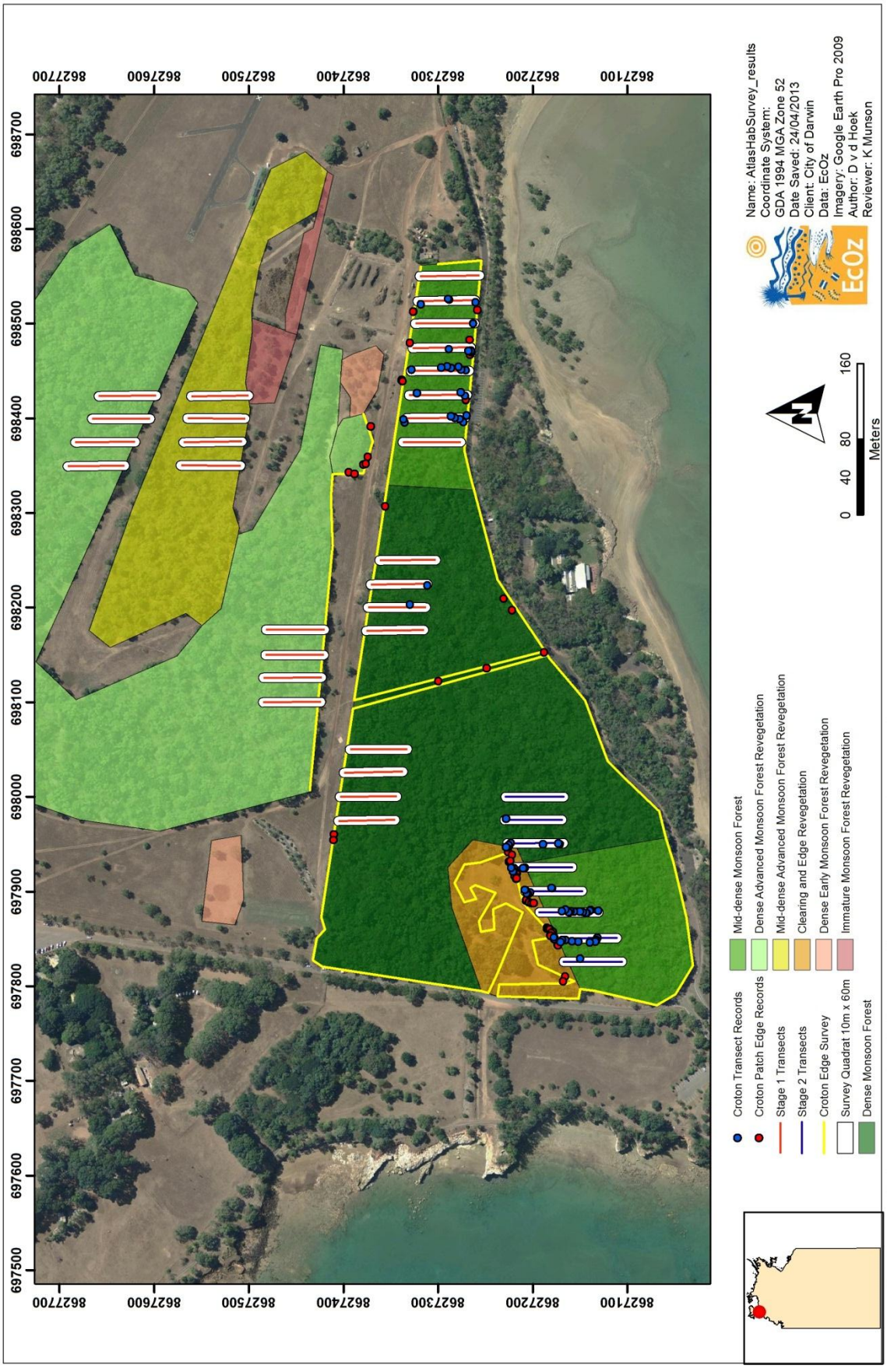

Figure 4-2. *Croton habrophyllus* records from the transect and patch edge surveys

Vegetation survey sites undertaken to determine monsoon forest patch type definitions located the presence of *C. habrophyllus* at a number of sites including VS1 (mid-dense monsoon forest), VS7 (clearing and edge revegetation) and VS8 (mid-dense monsoon forest), (see Figure 4-1). *Croton habrophyllus* surveyed within the vegetation survey sites tended to be juvenile plants averaging around 1 m in height when surveyed inside the patch. Mature adult trees averaging around 5 m high were recorded on the northern patch edge of VS7 (see Appendix E of the main East Point Reserve Biodiversity Assessment Report). Incidental sightings of plants on the southern edge near VS1 tended to be juvenile plants.

The alternative Atlas Moth larval food plant *Litsea glutinosa* was also located within vegetation survey sites VS1 (mid-dense monsoon forest), VS4 (dense monsoon forest) and VS8 (mid-dense monsoon forest). This species was surveyed within the upper and lower mid-stratum with an average height of 5 m in upper mid-stratum and 1.5 m in the lower mid-stratum. *L. glutinosa* was typically observed scattered (< 1% foliar cover) throughout the mid-stratum however a cover of 5% was recorded in the lower mid-stratum of site VS4 (dense monsoon forest). No *L. glutinosa* plants were located in any of the revegetation patches during the survey.

The high density of *Croton habrophyllus* within the clearing and edge revegetation (inclusive of VS7), resulted in the development of the Stage 2 Transects (see Figure 3-1). The stage 2 survey has identified that the adjoining mid dense monsoon forest has a relatively high density (0.014 ± 0.003 plants per m²) of *C. habrophyllus*. The patch edge survey and mapping vegetation surveys have identified large adult trees averaging 5 m high at VS7 with a density of 26 plants per 100 m along the north facing edge of the Clearing and Edge Revegetation patch (see Figure 4-2). The high suitability of Atlas Moth habitat within this area prompted further surveys of the more common *Litsea glutinosa,* along the Stage 2 Transects. The locations of *L. glutinosa* records within the survey area are shown in Figure 4-3, and the results of the survey are shown in Table 4-4. The survey results have identified the potential for between 3217 and 5327 *L. glutinosa* plants to inhabit both the dense monsoon forest and the mid-dense monsoon forest within the East Point Reserve monsoon forest.

Table 4-4. Results of the *Litsea glutinosa* transect survey

Litsea glutinosa		
Patch type	**Dense**	**Mid-dense monsoon forest**
Area surveyed (m²)	1800	3000
Number of plants located	61	72
Plants per m²	0.033 ± 0.0082	0.024 ± 0.0058
Total patch area m²	101 258	38 797
% of patch surveyed	1.7%	7.7%
Estimated number of plants in patch	3341 ± 830	931 ± 225

Figure 4-3. *Litsea glutinosa* records from the Stage 2 transect surveys

5 Discussion

The results of the survey have been used to categories the Atlas Moth habitat suitability of various vegetation patches identified within the East Point Reserve monsoon forest. The attributes of habitat patches identified in Figure 5-1 are detailed below in Table 5-1.

Table 5-1. Atlas Moth habitat patches within the East Point Reserve

Habitat patch number	Suitability	Vegetation patch type	Habitat attributes	Area of habitat (ha)
1	Highly suitable	Mid-density monsoon forest	Juvenile *Croton habrophyllus* (average height 1. 4m) with approximately 294 ± 63 plants present. Juvenile and adult *Litsea glutinosa* (average height 1.2m juvenile and 6m adult) with approximately 504 ± 117 plants present.	2.1
2	Suitable	Clearing and edge revegetation	Adult *Croton habrophyllus* (average height 5m) only found along the southern (north facing) edge of the patch with 56 plants along the 215m patch edge. Adjoining patch 1.	-
3	Suitable	Mid-density monsoon forest	Juvenile *Croton habrophyllus* (average height 1m) with approximately 238 ± 51 plants present. A small number of adult plants located on the northern edge. Juvenile and adult *Litsea glutinosa* (average height 1m juvenile and 5m adult) with approximately 408 ± 95 plants present	1.7
4	Suitable	Dense advanced monsoon forest revegetation	Small revegetation patch with *Croton habrophyllus* surveyed on the edge of the patch. The only revegetation patch with Atlas Moth larval food plants present	0.2
5	Moderately suitable	Dense monsoon forest	Small number of *Croton habrophyllus* surveyed both within and on the edge of the patch. Approximately 210 ± 137 plants present within the patch and only a small number surveyed on the patch edge. Large number of *Litsea glutinosa* within patch averaging around 4m in height. Approximately 3465 ± 861 plants present	10.5
Total				**14.5**

The habitat surveys undertaken have determined that within East Point Reserve monsoon forest there is approximately 14.5 ha of Atlas Moth habitat of which comprises of:

- 2.1 ha of Highly Suitable habitat located at Habitat Patch 1
- 1.9 ha of Suitable habitat at Habitat Patches 3 and 4
- 10.5 ha of Moderately Suitable habitat at Habitat Patch 5

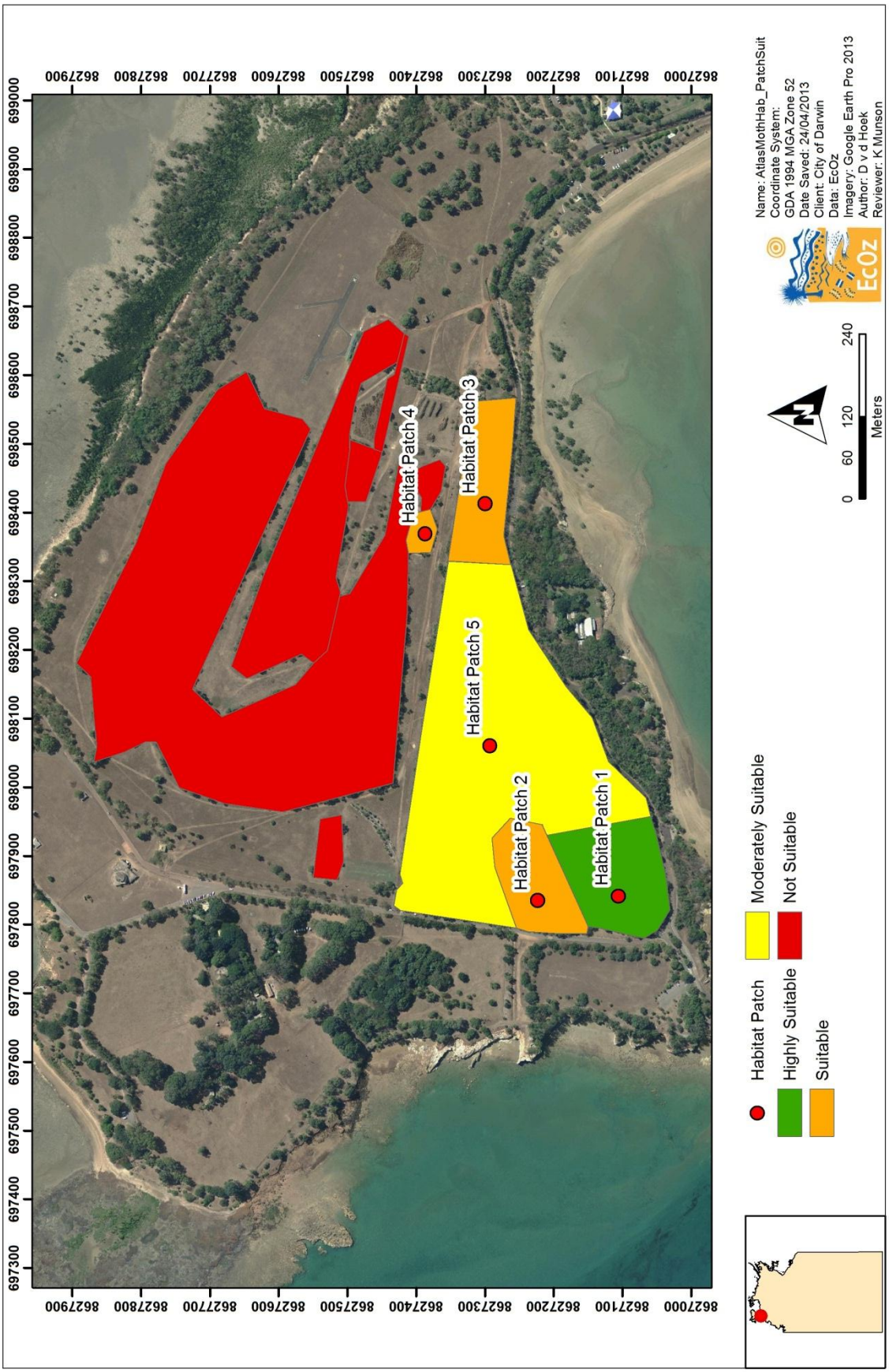

Figure 5-1. Atlas Moth habitat patch suitability

6 Recommendations

6.1 Improvement of Atlas Moth habitat

The ongoing management of the East Point Reserve monsoon forest provides opportunity to improve the suitability of habitat available for the potential reintroduction of Atlas Moths. Habitat improvement for this species can be incorporated in the following management areas:

- Revegetation of current cleared grassy area.
- Revegetation of current monsoon forest patch edge.
- Revegetation of areas cleared of weeds and/or exotic species.

The following revegetation management outcomes are likely to result in improved Atlas Moth habitat:

- The inclusion of *Croton habrophyllus* on the edge of future revegetation patches (as well as other edge species such as those recorded within vegetation survey site VS7).
- The inclusion of *Litsea glutinosa* on the inside of future revegetation patches (as well as other interior species such as those recorded within vegetation survey sites VS1, VS4 and VS8).

6.2 Revegetation stock

Trials should also be undertaken to determine the success of sourcing established seedlings of both *C. habrophyllus* and *L. glutinosa* from areas of lower priority habitat within the reserve and transplanting them into areas of higher priority habitat. Seedling stock would first need to be potted up and established within a nursery to increase establishment rate of plants. The transplantation of *C. habrophyllus* from within habitat patches to the edge of patches would greatly increase the growth rate and reproduction potential of plants currently within the reserve.

6.3 Revegetation areas

6.3.1 Weed control areas

A weed survey undertaken as part of the 2013 East Point Biodiversity Assessment identified a large number of the exotic tree Poinciana (*Delonix regia*) growing along the southern edges of Habitat Patch 1, Habitat Patch 5 and Habitat Patch 3. This species has been highlighted for removal within areas of intact monsoon forest located on the landward side of the access road with trees to be left in place on the seaward side. It is recommended that removal of this species begins to take place along the southern side of Habitat Patch 1. Revegetation of the site after the removal of Poinciana trees, saplings and seedlings should aim to reinstate a vegetation structure and composition similar to vegetation survey site VS7, including planting *Croton habrophyllus*. Ongoing targeted removal of Poinciana seedlings will be required within the revegetation area. Care must be taken to ensure that no non-target species are impacted during follow-up removal of Poinciana seedlings.

6.3.2 Areas to avoid further revegetation

Future revegetation of the East Point Reserve should avoid further planting within Habitat Patch 2 as the interface between this area and Habitat 1 provides ideal edge habitat for *C. habrophyllus.* Further planting within this area could act to shade and out-compete this species. The two large African Mahoganies recorded within this area during the survey should still be removed, but not replaced with additional plants. Ongoing follow-up work should take place to ensure any seedlings and saplings are controlled.

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Appendix E – Vegetation survey plot descriptions

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Site – VS1,
Vegetation Description: Medium height, mid-dense, *Grewia breviflora* and *Peltophorum pterocarpum* trees
(GDA94, zone 52, 698439E, 8627313N)

Vegetation Type: Dry Monsoon Forest
Growth stage: Mature phase
Weeds: *Leucaena leucocephala*
Other Notes: Immature *Croton habrophyllus* inside patch, small number of mature individuals on patch edge. Mature *Litsea glutinosa* scattered within mid-stratum

Dominant species (> 1% cover)

Upper: 50% cover, height 8 – 10 m
Grewia breviflora (35%), Peltophorum pterocarpum (15%)
Species richness = 2

Mid 1: 70% cover, height 2 – 8 m
Drypetes deplanchei (40%), Aidia racemosa (20%)
Species richness = 11

Mid 2: 20% cover, height 0.5 – 2 m
Micromelum minutum (10%), Drypetes deplanchei (5%
Species richness = 11

Lower: 20% cover, height <0.5 m
Micromelum minutum (10%), Diospyros rugosula (5%)
Species richness = 3

Total species richness = 24

Site – VS2
Vegetation Description: Tall, mid-dense, *Acacia auriculiformis* and *Terminalia microcarpa* trees
(GDA94, zone 52, 698263E, 8627584N)

Vegetation Type: Dry Monsoon Forest
Growth stage: Advanced revegetation
Weeds: *Andrographis paniculata, Passiflora suberosa, Leucaena leucocephala*
Other Notes: *Croton habrophyllus* and *Litsea glutinosa* not present within revegetation patch. Patch established 1974

Dominant species (> 1% cover)

Upper: 50% cover, height 10 – 14 m
Acacia auriculiformis (20%), Terminalia microcarpa (20%), Sterculia quadrifida (10%)
Species richness = 3

Mid 1: 50% cover, height 2 – 8 m
Micromelum minutum (30%), Exocarpos latifolius (8%), Wrightia pubescens (8%)
Species richness = 17

Mid 2: 10% cover, height 0.5 – 2 m
Micromelum minutum (6%), Flacourtia territorialis (2%)
Species richness = 7

Lower: 10% cover, height <0.5 m
Micromelum minutum (8%), Andrographis paniculata (1%)
Species richness = 4

Total species richness = 27

Site – VS3

Vegetation Description: Tall, dense, *Acacia auriculiformis* trees, with medium mid-dense *Melaleuca leucadendra* tree mid-storey
(GDA94, zone 52, 697843E, 8627244N)

Vegetation Type: Monsoon Melaleuca Forest
Growth stage: Advanced revegetation, uneven age
Weeds: *Senna obtusifolia (class B), Hyptis suaveolens (class B, Khaya senegalensis, Azadirachta indica, Stachytarpheta sp., Andrographis paniculata, Passiflora foetida, Passiflora suberosa*
Other Notes: *Croton habrophyllus* and *Litsea glutinosa* not present within revegetation patch. *Melaleuca leucadendra* recruiting in the mid-stratum. No dominant species in the lower stratum. Patched established between 2003 and 2013

Dominant species (> 1% cover)

Upper: 70% cover, height 8 – 15 m
Acacia auriculiformis (55%), Melaleuca leucadendra (10%), Terminalia microcarpa (5%)
Species richness = 3

Mid 1: 55% cover, height 3 – 8 m
Melaleuca leucadendra (40%), Alstonia actinophylla (3%), Exocarpos latifolius (2%)
Species richness = 8

Mid 2: 20% cover, height 0.5 – 3 m
Diospyros calycantha (3%)
Species richness = 9

Lower: 5% cover, height <0.5 m
None
Species richness = 7

Total species richness = 24

Site – VS4

Vegetation Description: Tall, dense *Terminalia microcarpa* and *Acacia auriculiformis* trees
(GDA94, zone 52, 697997E, 8627244N)

Vegetation Type: Dry Monsoon Forest
Growth stage: Mature phase
Weeds: None
Other Notes: *Croton habrophyllus* not present within survey area. Rare incidental sightings made within the dense forest. *Litsea glutinosa* common (5% cover) within the lower mid-storey. No dominant species in the lower stratum

Dominant species (> 1% cover)

Upper: 70% cover, height 12 – 18 m
Terminalia microcarpa (30%), Acacia auriculiformis (20%), Albizia lebbeck (15%), Polyalthia australis (5%)
Species richness = 4

Mid 1: 60% cover, height 4 – 12 m
Diospyros calycantha (20%), Millettia pinnata (15%), Polyalthia australis (10%), Drypetes deplanchei (10%), Diospyros compacta (5%)
Species richness = 12

Mid 2: 30% cover, height 1– 4 m
Ixora timorensis (5%), Litsea glutinosa (5%), Diospyros compacta (5%),
Species richness = 6

Lower: 3% cover, height <1 m
None
Species richness = 5

Total species richness = 24

Site – VS5

Vegetation Description: Medium height, dense *Acacia auriculiformis* trees

(GDA94, zone 52, 697891E, 8627534N)

Vegetation Type: Dry Monsoon Forest
Growth stage: Early revegetation
Weeds: *Azadirachta indica, Stachytarpheta sp., Passiflora foetida, Passiflora suberosa*
Other Notes: *Croton habrophyllus* and *Litsea glutinosa* not present within revegetation patch. No dominant species in the lower mid-stratum or lower stratum. Patch established 2008.

Dominant species (> 1% cover)

Upper: 70% cover, height 8 – 9 m
Acacia auriculiformis (60%), Alphitonia excelsa (10%)
Species richness = 2

Mid 1: 50% cover, height 2 – 8 m
Cordia subcordata (30%), Dodonaea platyptera (15%), Carallia brachiata (5%)
Species richness = 9

Mid 2: 5% cover, height 0.5 – 2 m
None
Species richness = 3

Lower: 1% cover, height <0.5 m
None
Species richness = 6

Total species richness = 20

Site – VS6

Vegetation Description: Tall, dense, *Acacia auriculiformis* and *Diospyros maritima* Trees

(GDA94, zone 52, 698018E, 8627693N)

Vegetation Type: Dry Monsoon Forest
Growth stage: Advanced revegetation
Weeds: *Jatropha gossypiifolia (class B), Azadirachta indica, Murraya koenigii*
Other Notes: *Croton habrophyllus* and *Litsea glutinosa* not present within revegetation patch. Patch established between 1985 and 1991.

Dominant species (> 1% cover)

Upper: 70% cover, height 10 – 14 m
Acacia auriculiformis (30%), Diospyros maritima (30%)
Species richness = 2

Mid 1: 60% cover, height 2 – 10 m
Micromelum minutum (30%), Wrightia pubescens (20%), Peltophorum pterocarpum (5%), Grewia brevifolia (5%)
Species richness = 10

Mid 2: 20% cover, height 0.5 – 2 m
Micromelum minutum (10%)
Species richness = 7

Lower: 40% cover, height <0.5 m
Micromelum minutum (35%)
Species richness = 5

Total species richness = 20

Site – VS7

Vegetation Description: Tall, mid-dense *Terminalia microcarpa* and *Peltophorum pterocarpum* trees

(GDA94, zone 52, 697929E, 8627209N)

Vegetation Type: Dry Monsoon Forest

Growth stage: Advanced revegetation, Patch edge

Weeds: *Andrographis paniculata, Leucaena leucocephala*

Other Notes: Mature *Croton habrophyllus* present on patch edge. *Litsea glutinosa* not present within revegetated patch edge.

Dominant species (> 1% cover)

Upper: 50% cover, height 8 – 14 m
Terminalia microcarpa (25%), Peltophorum pterocarpum (15%), Acacia auriculiformis (10%)
Species richness = 3

Mid 1: 40% cover, height 3 – 8 m
Exocarpos latifolius (15%), Croton habrophyllus (10%), Peltophorum pterocarpum (5%), Acacia auriculiformis (5%)
Species richness = 7

Mid 2: 40% cover, height 0.5 – 3 m
Strychnos lucida (20%), Opilia amentacea (10%)
Species richness = 16

Lower: 5% cover, height <0.5 m
Terminalia microcarpa (1%)
Species richness = 3

Total species richness =24

Site – VS8

Vegetation Description: Tall, Mid-dense *Terminalia microcarpa* and *Acacia auriculiformis* trees

(GDA94, zone 52, 697856E, 8627147N)

Vegetation Type: Dry Monsoon Forest

Growth stage: Mature phase

Weeds: *Delonix regia* (Poinciana) nearby

Other Notes: Immature *Croton habrophyllus* inside patch. *Litsea glutinosa* scattered within mid-stratum

Dominant species (> 1% cover)

Upper: 60% cover, height 10-15 m
Terminalia microcarpa (40%), Acacia auriculiformis (20%)
Species richness = 2

Mid 1: 70% cover, height 3 – 10 m
Terminalia microcarpa (20%), Drypetes deplanchei (10%), Cryptocarya exfoliata (10%), Grewia breviflora (5%), Croton arnhemicus (5%), Strychnos lucida (5%)
Species richness = 15

Mid 2: 20% cover, height 1 – 3 m
Strychnos lucida (6%), Diospyros compacta (4%), Ixora timorensis (2%),
Species richness = 7

Lower: 5% cover, height <1 m
Micromelum minutum (1%), Opilia amentacea (1%), Diospyros calycantha (1%)
Species richness = 6

Total species richness =25

Appendix F – Vegetation structure and composition within survey plots

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Family	Botanical Name	NT status	VS1	VS2	VS3	VS4	VS5	VS6	VS7	VS8
ACANTHACEAE	*Andrographis paniculata*	Introduced		G-1	G-b				G-a	
ANNONACEAE	*Polyalthia australis*	lc				U-5/ M-10	M-a			
ANNONACEAE	*Uvaria glabra*	lc	M-a							
APOCYNACEAE	*Alstonia actinophylla*	lc			M-3	M-a				
APOCYNACEAE	*Gymnanthera oblonga*	lc			G-a					
APOCYNACEAE	*Tabernaemontana orientalis*	lc		M-b					M-a	
APOCYNACEAE	*Wrightia pubescens subsp. pubescens*	lc		M-8		G-a	M-b	M-20		
ARACEAE	*Amorphophallus paeoniifolius**	Introduced								G-a
ASTERACEAE	*Eleutheranthera ruderalis*	Introduced					G-b		G-c	
BORAGINACEAE	*Cordia subcordata*	lc					M-30			
CANNABACEAE	*Celtis philippensis*	lc	M-b			M-a		M-a		
CANNABACEAE	*Trema tomentosa*	lc		M-a						
CAPPARACEAE	*Capparis sepiaria*	lc	M-a			M-a			M-a	M-a
CHRYSOBALANACEAE	*Maranthes corymbosa*	lc			G-a					
COMBRETACEAE	*Terminalia microcarpa*	lc		U-20/M-a	U-5/M-a	U-30			U-25/ G-c	U-40/ M-20
CONVOLVULACEAE	*Merremia aegyptia*	Introduced					G-a			
EBENACEAE	*Diospyros maritima*	lc			M-a			U-30		

Family	Botanical Name	NT status	VS1	VS2	VS3	VS4	VS5	VS6	VS7	VS8
EBENACEAE	*Diospyros calycantha*	lc			M-3	M-20			M-b	M-a
EBENACEAE	*Diospyros compacta*	lc		M-a		M-5		M-a		M-a
EBENACEAE	*Diospyros rugosula*	lc	G-5					M-a	M-b	M-2/ G-1
EUPHORBIACEAE	*Jatropha gossypifolia*	Weed NOS						present		
EUPHORBIACEAE	*Croton arnhemicus*	lc	M-a		G-a					M-5
EUPHORBIACEAE	*Croton habrophyllus*	lc	M-a						M-10	M-a
EUPHORBIACEAE	*Micrococca mercurialis*	Introduced					G-b			
EUPHORBIACEAE	*Mallotus philippensis*	lc	M-a	M-a	M-a	M-a		M-a	M-5	M-a
FABACEAE	*Senna obtusifolia*	Class B			present					
FABACEAE	*Leucaena leucocephala*	introduced	present	present					present	
FABACEAE	*Delonix regia*	Introduced							present	
FABACEAE	*Abrus precatorius*	lc								G-a
FABACEAE	*Albizia lebbeck*	lc				U-15				
FABACEAE	*Acacia auriculiformis*	lc		U-20	U-55	U-20	U-60	U-30	U-10/ M-5	U-20
FABACEAE	*Millettia pinnata*	lc				M-15	M-a			M-a
FABACEAE	*Peltophorum pterocarpum*	lc	U-15/M-a		M-b			M-5	U-15 / M-5	
FLAGELLARIACEAE	*Flagellaria indica*	lc	M-a	M-b		M-a				M-b
LAMIACEAE	*Hyptis suaveolens*	Class B			present					

Family	Botanical Name	NT status	VS1	VS2	VS3	VS4	VS5	VS6	VS7	VS8
LAURACEAE	*Cryptocarya exfoliata*	lc								M-10
LAURACEAE	*Litsea glutinosa*	lc	M-b			M-5				M-a
LOGANIACEAE	*Strychnos lucida*	lc	M-b	G-a	M-a				M-20	M-5
MALVACEAE	*Bombax ceiba*	lc	M-a							M-a
MALVACEAE	*Corchorus aestuans*	lc					G-b			
MALVACEAE	*Grewia breviflora*	lc	U-35	M-a				M-5		M-5
MALVACEAE	*Hibiscus tiliaceus*	lc							M-a	
MALVACEAE	*Sterculia quadrifida*	lc		U-10	G-a		M-a			
MELIACEAE	*Khaya senegalensis*	Introduced			present					
MELIACEAE	*Azadirachta indica*	Introduced			present		M-a	present		
MENISPERMACEAE	*Pachygone ovata*	lc		M-a	G-a	M-a	G-a	G-a		
MORACEAE	*Ficus scobina*	lc		M-a				M-a		
MYRTACEAE	*Melaleuca leucadendra*	lc			U-10/ M-40					
MYRTACEAE	*Syzygium armstrongii*	lc					M-a			
MYRTACEAE	*Syzygium suborbiculare*	lc					M-a			
OPILIACEAE	*Cansjera leptostachya*	lc							M-a	
OPILIACEAE	*Opilia amentacea*	lc		M-a	M-a	G-a		M-b / G-b	M-10	G-1
PASSIFLORACEAE	*Passiflora foetida*	Introduced			present		present			

Family	Botanical Name	NT status	VS1	VS2	VS3	VS4	VS5	VS6	VS7	VS8
PASSIFLORACEAE	*Passiflora suberosa*	Introduced		present	present		present			
PHYLLANTHACEAE	*Antidesma ghesaembilla*	lc		M-a	M-a					
PHYLLANTHACEAE	*Breynia cernua*	lc		M-a	M-a	G-a	M-a		M-a	
PHYLLANTHACEAE	*Flueggea virosa subsp. melanthesoides*	lc	M-a		M-a			M-a	M-a	
PUTRANJIVACEAE	*Drypetes deplanchei*	lc	M-45	M-a		M-10				M-10
RHAMNACEAE	*Alphitonia excelsa*	lc					U-10			
RHAMNACEAE	*Ziziphus oenopolia*	lc	M-a	M-a	G-a				M-a	
RHIZOPHORACEAE	*Carallia brachiata*	lc					M-5			
RUBIACEAE	*Aidia racemosa*	lc	M-20	M-a						M-a
RUBIACEAE	*Ixora timorensis*	lc	M-a		M-a	M-5			M-a	M-2
RUBIACEAE	*Pavetta brownii var. brownii*	lc						M-a		
RUTACEAE	*Murraya koenigii*	introduced						present		
RUTACEAE	*Glycosmis trifoliata*	lc							M-b	
RUTACEAE	*Micromelum minutum*	lc	M-10/ G-10	M-30/G-8		G-a	G-a	M-40/ G-35	M-b	G-1
SALICACEAE	*Flacourtia territorialis*	lc	M-b	M-2						
SANTALACEAE	*Exocarpos latifolius*	lc	M-a	M-8	M-2	M-a		G-b	M-15	G-a
SAPINDACEAE	*Cupaniopsis anacardioides*	lc	M-a	M-a	M-a	M-a		M-a	M-a	M-a
SAPINDACEAE	*Dodonaea platyptera*	lc					M-15			

Family	Botanical Name	NT status	VS1	VS2	VS3	VS4	VS5	VS6	VS7	VS8
SAPOTACEAE	*Pouteria sericea*	lc						M-a		
SIMAROUBACEAE	*Brucea javanica*	lc						M-a		
SMILACACEAE	*Smilax australis*	lc				M-a				
TACCACEAE	*Tacca leontopetaloides*	lc	G-a	G-a				G-a		
VERBENACEAE	*Stachytarpheta sp.*	Introduced			present		present			
VITACEAE	*Ampelocissus acetosa*	lc	M-a	M-b						
VITACEAE	*Cissus adnata*	lc			M-a					
VITACEAE	*Cissus reniformis*	lc		M-a		G-a	M-b		M-a	
Total			**24**	**27**	**24**	**24**	**20**	**20**	**24**	**25**

Note: *number displays percentage coverage for the site*

** denotes weed species*

a: 1-5 plants

b: 5-50 plants

c: 50 plants

G: Lower Stratum

M: Mid Stratum

U: Upper Stratum

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Appendix G – East Point Reserve flora species list

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FAMILY	Botanical name	ALA	Field	Weed Class
ACANTHACEAE	*Andrographis paniculata*	*	*	Exotic
ACANTHACEAE	*Barleria lupulina*	*		
ACANTHACEAE	*Hypoestes floribunda*	*		
ACANTHACEAE	*Hypoestes floribunda var. varia*	*		
ACANTHACEAE	*Ruellia tuberosa*	*		
AIZOACEAE	*Sesuvium portulacastrum*	*		
AMARANTHACEAE	*Alternanthera sp.*	*		
AMARANTHACEAE	*Celosia argentea*	*		
ANNONACEAE	*Cyathostemma glabrum*	*		
ANNONACEAE	*Miliusa brahei*	*		
ANNONACEAE	*Polyalthia australis*	*	*	
ANNONACEAE	*Uvaria glabra*		*	
APOCYNACEAE	*Alstonia actinophylla*	*	*	
APOCYNACEAE	*Cascabela thevetia*	*		
APOCYNACEAE	*Cynanchum carnosum*	*		
APOCYNACEAE	*Gymnanthera oblonga*	*	*	
APOCYNACEAE	*Ichnocarpus frutescens*	*		
APOCYNACEAE	*Marsdenia geminata*	*		
APOCYNACEAE	*Marsdenia velutina*	*		
APOCYNACEAE	*Parsonsia velutina*	*		
APOCYNACEAE	*Secamone elliptica*	*		
APOCYNACEAE	*Tabernaemontana orientalis*	*	*	
APOCYNACEAE	*Tylophora flexuosa*	*		
APOCYNACEAE	*Wrightia pubescens*	*		
APOCYNACEAE	*Wrightia pubescens subsp. pubescens*	*	*	
ARACEAE	*Amorphophallus paeoniifolius*	*	*	
ASPARAGACEAE	*Asparagus racemosus*	*		
ASPARAGACEAE	*Sansevieria trifasciata*	*		
ASTERACEAE	*Bidens pilosa*	*		
ASTERACEAE	*Eleutheranthera ruderalis*		*	Exotic
ASTERACEAE	*Pluchea rubelliflora*	*		
ASTERACEAE	*Sphaeromorphaea australis*	*		
BIXACEAE	*Cochlospermum fraseri subsp. fraseri*	*		
BORAGINACEAE	*Cordia dichotoma*	*		
BORAGINACEAE	*Cordia subcordata*	*	*	
BURSERACEAE	*Canarium australianum*	*		
CANNABACEAE	*Celtis australiensis*	*	*	
CANNABACEAE	*Trema tomentosa*	*	*	
CANNABACEAE	*Trema tomentosa var. aspera*	*		
CAPPARACEAE	*Capparis sepiaria*	*	*	
CARYOPHYLLACEAE	*Polycarpaea violacea*	*		
CHENOPODIACEAE	*Halosarcia*	*		
CHRYSOBALANACEAE	*Maranthes corymbosa*	*	*	

FAMILY	Botanical name	ALA	Field	Weed Class
CLEOMACEAE	*Cleome viscosa*	*		
COMBRETACEAE	*Quisqualis indica*	*		
COMBRETACEAE	*Terminalia microcarpa*	*	*	
CONVOLVULACEAE	*Evolvulus nummularius*	*		
CONVOLVULACEAE	*Ipomoea abrupta*	*		
CONVOLVULACEAE	*Ipomoea macrantha*	*		
CONVOLVULACEAE	*Ipomoea pes-caprae subsp. brasiliensis*	*		
CONVOLVULACEAE	*Ipomoea quamoclit*	*		
CONVOLVULACEAE	*Ipomoea triloba*	*		
CONVOLVULACEAE	*Merremia aegyptia*		*	Exotic
CONVOLVULACEAE	*Operculina riedeliana*	*		
CONVOLVULACEAE	*Xenostegia tridentata*	*		
CUCURBITACEAE	*Luffa aegyptiaca*	*		
CYPERACEAE	*Bulbostylis barbata*	*		
CYPERACEAE	*Cyperus scariosus*	*		
CYPERACEAE	*Fimbristylis cymosa*	*		
CYPERACEAE	*Fimbristylis dichotoma*	*		
CYPERACEAE	*Fimbristylis polytrichoides*	*		
DIOSCOREACEAE	*Dioscorea transversa*	*		
EBENACEAE	*Diospyros calycantha*	*	*	
EBENACEAE	*Diospyros compacta*	*	*	
EBENACEAE	*Diospyros maritima*		*	
EBENACEAE	*Diospyros rugosula*	*	*	
ELAEOCARPACEAE	*Elaeocarpus arnhemicus*	*		
EUPHORBIACEAE	*Bridelia tomentosa*	*		
EUPHORBIACEAE	*Croton arnhemicus*	*	*	
EUPHORBIACEAE	*Croton habrophyllus*	*	*	
EUPHORBIACEAE	*Croton schultzii*	*		
EUPHORBIACEAE	*Jatropha gossypifolia*	*	*	Class B/C
EUPHORBIACEAE	*Mallotus nesophilus*	*		
EUPHORBIACEAE	*Mallotus philippensis*	*	*	
EUPHORBIACEAE	*Micrococca mercurialis*	*	*	
FABACEAE	*Abrus precatorius subsp. precatorius*	*	*	
FABACEAE	*Acacia auriculiformis*	*	*	
FABACEAE	*Acacia holosericea*	*		
FABACEAE	*Adenanthera pavonina*	*		
FABACEAE	*Albizia lebbeck*	*	*	
FABACEAE	*Alysicarpus ovalifolius*	*		
FABACEAE	*Alysicarpus vaginalis*	*		
FABACEAE	*Canavalia rosea*	*		
FABACEAE	*Cathormion umbellatum*	*		
FABACEAE	*Dalbergia sissoo*	*		
FABACEAE	*Delonix regia*	*		

FAMILY	Botanical name	ALA	Field	Weed Class
FABACEAE	*Delonix regia*		*	Exotic
FABACEAE	*Desmanthus virgatus*	*		
FABACEAE	*Desmodium pycnotrichum*	*		
FABACEAE	*Indigofera tinctoria*	*		
FABACEAE	*Leucaena leucocephala*		*	Exotic
FABACEAE	*Macroptilium lathyroides var. semierectum*	*		
FABACEAE	*Millettia pinnata*	*	*	
FABACEAE	*Peltophorum pterocarpum*	*	*	
FABACEAE	*Rhynchosia australis*	*		
FABACEAE	*Rhynchosia minima*	*		
FABACEAE	*Senna obtusifolia*	*	*	Class B/C
FABACEAE	*Zornia disticha*	*		
FLAGELLARIACEAE	*Flagellaria indica*	*	*	
HERNANDIACEAE	*Gyrocarpus americanus*	*		
KHAYA	*khaya senegalensis*		*	Exotic
LAMIACEAE	*Clerodendrum costatum*	*		
LAMIACEAE	*Clerodendrum inerme*	*		
LAMIACEAE	*Hyptis suaveolens*		*	Class B/C
LAMIACEAE	*Leonotis nepetifolia*	*		
LAMIACEAE	*Premna acuminata*	*		
LAMIACEAE	*Premna odorata*	*		
LAMIACEAE	*Premna serratifolia*	*		
LAMIACEAE	*Vitex acuminata*	*		
LAMIACEAE	*Vitex trifolia var. trifolia*	*		
LAURACEAE	*Cassytha filiformis*	*		
LAURACEAE	*Cryptocarya exfoliata*		*	
LAURACEAE	*Litsea glutinosa*	*	*	
LINDERNIACEAE	*Lindernia ciliata*	*		
LOGANIACEAE	*Mitrasacme connata*	*		
LOGANIACEAE	*Strychnos lucida*	*	*	
LORANTHACEAE	*Amyema mackayensis*	*		
LYTHRACEAE	*Ammannia multiflora*	*		
LYTHRACEAE	*Pemphis acidula*	*		
LYTHRACEAE	*Sonneratia alba*	*		
MALVACEAE	*Bombax ceiba*		*	
MALVACEAE	*Corchorus aestuans*	*	*	
MALVACEAE	*Gossypium hirsutum*	*		
MALVACEAE	*Grewia breviflora*	*	*	
MALVACEAE	*Grewia oxyphylla*	*		
MALVACEAE	*Helicteres isora*	*		
MALVACEAE	*Hibiscus tiliaceus*	*	*	

FAMILY	Botanical name	ALA	Field	Weed Class
MALVACEAE	*Malvastrum coromandelianum*	*		
MALVACEAE	*Melochia corchorifolia*	*		
MALVACEAE	*Sida acuta*	*		
MALVACEAE	*Sterculia quadrifida*	*	*	
MALVACEAE	*Thespesia populneoides*	*		
MELIACEAE	*Azadirachta indica*	*	*	Exotic
MELIACEAE	*Melia azedarach*	*		
MENISPERMACEAE	*Pachygone ovata*	*	*	
MENISPERMACEAE	*Tinospora smilacina*	*		
MOLLUGINACEAE	*Mollugo pentaphylla*	*		
MORACEAE	*Antiaris toxicaria subsp. macrophylla*	*		
MORACEAE	*Ficus scobina*	*	*	
MORACEAE	*Ficus virens var. virens*	*		
MORACEAE	*Trophis scandens*	*		
MORACEAE	*Trophis scandens subsp. scandens*	*		
MYRISTICACEAE	*Myristica insipida var. insipida*	*		
MYRTACEAE	*Corymbia polycarpa*	*		
MYRTACEAE	*Melaleuca leucadendra*		*	
MYRTACEAE	*Syzygium armstrongii*		*	
MYRTACEAE	*Syzygium suborbiculare*		*	
NYCTAGINACEAE	*Boerhavia repens*	*		
OLEACEAE	*Jasminum didymum*	*		
OLEACEAE	*Jasminum didymum subsp. didymum*	*		
OLEACEAE	*Jasminum elongatum*	*		
OPILIACEAE	*Cansjera leptostachya*	*	*	
OPILIACEAE	*Opilia amentacea*	*		
PASSIFLORACEAE	*Passiflora foetida*	*	*	Exotic
PASSIFLORACEAE	*Passiflora suberosa*	*	*	Exotic
PHRYMACEAE	*Peplidium maritimum*	*		
PHYLLANTHACEAE	*Antidesma ghaesembilla*	*	*	
PHYLLANTHACEAE	*Breynia cernua*	*	*	
PHYLLANTHACEAE	*Flueggea virosa subsp. melanthesoides*	*	*	
PHYLLANTHACEAE	*Glochidion xerocarpum*	*		
PLUMBAGINACEAE	*Aegialitis annulata*	*		
POACEAE	*Bambusa arnhemica*	*		
POACEAE	*Cenchrus ciliaris*	*		
POACEAE	*Chloris barbata*	*		
POACEAE	*Chloris lobata*	*		
POACEAE	*Cynodon radiatus*	*		
POACEAE	*Eragrostis minor*	*		
POACEAE	*Eulalia annua*	*		
POACEAE	*Ischaemum australe var. australe*	*		
POACEAE	*Leptochloa fusca subsp. fusca*	*		

FAMILY	Botanical name	ALA	Field	Weed Class
POACEAE	*Megathyrsus maximus var. coloratus*	*		
POACEAE	*Spinifex longifolius*	*		
POACEAE	*Sporobolus coromandelianus*	*		
POACEAE	*Sporobolus virginicus*	*		
POACEAE	*Themeda arguens*	*		
POLYGONACEAE	*Antigonon leptopus*	*		
PORTULACACEAE	*Portulaca australis*	*		
PORTULACACEAE	*Portulaca oleracea*	*		
PORTULACACEAE	*Portulaca pilosa*	*		
PUTRANJIVACEAE	*Drypetes deplanchei*	*	*	
RHAMNACEAE	*Alphitonia excelsa*		*	
RHAMNACEAE	*Colubrina asiatica*	*		
RHAMNACEAE	*Colubrina asiatica var. asiatica*	*		
RHAMNACEAE	*Ziziphus mauritiana*	*		
RHAMNACEAE	*Ziziphus oenopolia*	*	*	
RHIZOPHORACEAE	*Bruguiera exaristata*	*		
RHIZOPHORACEAE	*Carallia brachiata*		*	
RHIZOPHORACEAE	*Ceriops australis*	*		
RHIZOPHORACEAE	*Rhizophora stylosa*	*		
RUBIACEAE	*Aidia racemosa*	*	*	
RUBIACEAE	*Guettarda speciosa*	*		
RUBIACEAE	*Ixora timorensis*	*	*	
RUBIACEAE	*Morinda citrifolia*	*		
RUBIACEAE	*Pavetta brownii*	*		
RUBIACEAE	*Psychotria nesophila*	*		
RUBIACEAE	*Spermacoce articularis*	*		
RUTACEAE	*Glycosmis trifoliata*	*	*	
RUTACEAE	*Micromelum minutum*	*	*	
RUTACEAE	*Murraya koenigii*	*	*	Exotic
SALICACEAE	*Flacourtia territorialis*	*	*	
SANTALACEAE	*Exocarpos latifolius*	*	*	
SANTALACEAE	*Santalum album*	*		
SAPINDACEAE	*Allophylus cobbe*	*		
SAPINDACEAE	*Cupaniopsis anacardioides*	*	*	
SAPINDACEAE	*Dodonaea platyptera*	*	*	
SAPINDACEAE	*Ganophyllum falcatum*	*		
SAPOTACEAE	*Mimusops elengi*	*		
SAPOTACEAE	*Pouteria sericea*		*	
SIMAROUBACEAE	*Brucea javanica*	*	*	
SMILACACEAE	*Smilax australis*	*	*	
SPHENOCLEACEAE	*Sphenoclea zeylanica*	*		
TACCACEAE	*Tacca leontopetaloides*		*	
VERBENACEAE	*Lantana camara*	*		

FAMILY	Botanical name	ALA	Field	Weed Class
VERBENACEAE	*Stachytarpheta cayennensis*	*	*	Class B/C
VERBENACEAE	*Stachytarpheta sp.*	*	*	B/C
VITACEAE	*Ampelocissus acetosa*	*	*	
VITACEAE	*Cayratia trifolia*	*		
VITACEAE	*Cissus adnata*		*	
VITACEAE	*Cissus reniformis*	*	*	
ZYGOPHYLLACEAE	*Tribulus cistoides*	*		
ZYGOPHYLLACEAE	*Tribulus terrestris*	*		