

FINAL REPORT
BIODIVERSITY (FLORA) SURVEY
FOR VARIRATA NATIONAL PARK
MAY 2018



Conservation and Environment
Protection Authority



Report Prepared by:
Allen Allison and Angus Fraser
Indo-Pacific Conservation Alliance
P.O. Box 17056, Honolulu, Hawaii, USA.
5th May 2018



Japan International
Cooperation Agency

DOCUMENT STATUS & ISSUE HISTORY

(c) Indo-Pacific Conservation Alliance, (IPCA), P.O. Box 17056, Honolulu, Hawaii 96817

Any document issued as an Alphabetic Revision (REV A), is an uncontrolled document issued to the client for review and comment in accordance to agreed document review procedures. Documents issued as a Numerical Revision (REV 1) is a 'FINAL' and must be dated and signed by relevant IPCA signatories as an assurance that the document has incorporated any proposed amendments to the mutual satisfaction of IPCA and the Client during the agreed document review procedure.

REV No.	Author	Reviewer	Signature	Approved for Issue	Signature	Date
REV H: DRAFT	A Allison					14 May 2018
REV 1: FINAL	A Fraser & A Allison	A Allison		A Allison		26 SEP 2018
REV 2: FINAL	A Fraser & A Allison	A Allison		A Allison		28 SEP 2018
REV 3: FINAL	A Fraser & A Allison	A Allison		A Allison		29 SEP 2018
REV 4: FINAL	A Fraser & A Allison	A Allison		A Allison		09 OCT 2018

EXECUTIVE SUMMARY

The Japan International Cooperation Agency (JICA) in conjunction with Papua New Guinea's Conservation and Environment Protection Authority (CEPA) formally partnered in June 2015 to develop and implement a landmark biodiversity conservation initiative for Protected Areas in PNG's Central Province (JICA, 2018). This initiative is formally referred to by JICA & CEPA as: 'The Project for Biodiversity Conservation through Implementation of the PNG Policy on Protected Areas' (herein referred to as the 'Project').

The Project has been specifically developed to align with PNG's existing Policy on Protected Areas (PPA, 2014) and the UNESCO's Man and Biosphere Program, which adopts a strong focus on improving the livelihood of people while concurrently promoting sustainable resource conservation practices. The key objective of the Project is to establish an effective 'Conservation Management Framework' for Protected Areas through a combination of institutional strengthening, capacity building, landholder engagement, sound science and investment in infrastructure (JICA, 2018).

In February 2017, the Indo-pacific Conservation Alliance (IPCA) was commissioned by JICA on behalf of CEPA to undertake Biodiversity Surveys of fauna and flora within VNP to document the Park's key taxa and concurrently provide a thorough appraisal of the Park's current ecological condition and habitat quality.

Biodiversity surveys were conducted over a twelve period commencing in mid April 2017 and were concluded in early April 2018. This has enabled the unique opportunity to collect rigorous data sets for key taxa allowing for seasonal (monsoon and dry season) variability. The results of these surveys comprise a comprehensive assessment of biota in VNP.

Project Objectives

Seven key Project objectives established through contract and consultation between JICA and IPCA broadly framed the parameters of the Biodiversity Surveys. They comprise:

- (i) Assess species richness of key taxa that occur within the park and buffer zone through conduct of a detailed literature review and intensive field survey program;
- (ii) Prepare a habitat classification map of key vegetation types within the park using satellite imagery and results from field surveys;
- (iii) Prepare species inventories for key taxa;
- (iv) Produce Field Guide Brochures for key taxa commonly encountered within the park (birds, mammals, invertebrates, plants, amphibians and reptiles);
- (v) Provide opportunity to capacity build with CEPA staff, which was extended to train local Koiari to assist in the conduct of biodiversity field surveys; and
- (vi) Prepare an Invasive Species Management Plan for introduced taxa (primarily Rusa Deer and invasive plants) that occur within and adjacent to VNP.
- (vii) Prepare a Monitoring Plan that identifies and prioritises monitoring programs which will provide Park Managers with information critical to improving the environmental management of VNP.

This standalone document presents key findings associated with the project objectives detailed in items (i) to (iii) for the botanical survey (flora) component of scope. Reporting requirements for items (iv), (vi) and (vii) have been prepared as separate standalone documents (IPCA, 2018a; 2018c; 2018d).

Visitor Amenity

Varirata National Park (VNP) is the most visited protected area in the country and represents a conservation success story. It is strongly supported by surrounding landowners and is patronised by a broad cross section of people. VNP provides a network of trails, popular swimming holes, camping and picnic areas, and scenic lookouts that provide sweeping views of Port Moresby and the escarpment.

The park currently receives a modest number of visitors comprising local Koiari, Port Moresby residents seeking recreational opportunities for picnics, bushwalking and camping, lotu lain (church parishioners), bushwalkers, eco-tourists (particularly local and international birdwatchers), and visiting scientists. It is also used regularly as a field site for tertiary education by local universities.

Its close proximity to Port Moresby provides enormous potential for a broad demographic to experience VNP's biodiversity and appreciate the broader environmental values provided by the Park.

Cultural Landscape

The buffer zone surrounding the park remains a traditional Koiari hunting ground with hunters targeting wallaby, deer, wild pig and cassowary. Koiari Burial grounds, rock engravings and cave paintings located on the lower slopes of the park buffer zone ensures the park and surrounding area remain part of an important cultural landscape that warrants protection.

Other Environmental Values

In addition to VNP's established biodiversity and cultural values, the Park's relatively high forest cover mitigates against runoff, sedimentation of waterways and erosion. Neighbouring communities downstream of the park are reliant on naturally occurring spring water as their primary source of drinking water. So to the wider Port

Moresby populous, which benefits from the Park's catchment and its contribution to water quality and water supply for the Port Moresby power grid courtesy of the Rouna 1 and Sirinumu Dam hydropower schemes.

Vegetation Associations & Key Habitats

The Park contains three key vegetation associations comprising the following five key habitats:

- (i) Primary rainforest (medium-crowned lowland hill forest) including old re-growth forest (approximately 80% of the Park);
- (ii) Secondary forest dominated by Casuarina (*Gymnostoma papuana*) (approximately 18% of the Park);
- (iii) Eucalypt savannah (<2% of the Park);
- (iv) Aquatic habitats (streams and lakes); and
- (v) Disturbed habitats (landscaped gardens, roadside verges and other disturbed areas).

Medium-crowned lowland hill forest includes a rich diversity of tree species with oaks (*Fagaceae*), particularly *Castanopsis acuminatissima* and *Lithocarpus celibicus* often occurring along ridgelines. Forest structure is typically characterised by a closed canopy 25-30 m high, a dense understory of shrubs, small trees and lianas.

Secondary forest communities are dominated by Casuarina (*Gymnostoma papuana*) and the extent of these forests within the Park is remarkable. Through natural forest succession this habitat has expanded by more than 200 hectares in less than 50 years. Close proximity of a forest seed bank, an absence of fire and limited poaching of forest resources have largely facilitated the successful expansion of secondary forests within VNP.

At less than 2% of the Park's area, eucalypt savannah is poorly represented despite being a common habitat at low elevations in

Central Province. It is however, important ecologically as several species with a restricted range in PNG only occur in these habitats. They include Ghost Gum (*Corymbia papuana*), Grey Gum (*E. tereticornis*) White Gum (*E. alba*), Weeping Paperbark (*Melaleuca leucadendron*) and the cycad (*Cycas campestris*), which is a regional endemic. Increasing the Park's footprint to cover a greater area of eucalypt savannah would comprise a valuable conservation initiative.

The aquatic habitats within the Park comprise Nairogo Creek and its tributaries, and the Lake Lifilikatabu complex. Several species are restricted in their distribution throughout the Park given their dependence on aquatic habitats. These include a species of sedge (*Eleocharis* sp.) from the lake and *Neonauclea* sp a medium sized riparian shrub and a native species from the genus *Impatiens*, which are largely confined to watercourses within the park.

Disturbed habitats including landscaped gardens of the Park's picnic areas and roadside verges are dominated by weed species and naturalised grasses.

VNP's Botanical Diversity

PNG's tropical forests sit within the greater 'Papuasia Region' and are widely recognised as a major centre of plant diversity (Takeuchi, 2003b). Estimates of the New Guinea Island's plant diversity are significant and range from 11,000 (Collins et al. 1991) for PNG to 20,000-25,000 species for West Papua (Supriatna 1999).

Preparation of a species checklist for the known flora of PNG is currently in progress and comprises approximately 1,800 genera and 13,500 species of vascular plants (James, pers.comm). There is no doubt that these figures will rise given significant knowledge gaps associated with PNG's flora which remains poorly collected (Takeuchi, 2003b).

The first listing of vascular plant species from the Park is presented in this report and

currently contains 157 vascular plant families, 581 genera and 1,126 species. The checklist does include a number of taxa identified only to morpho-species. It is therefore likely that some of these are duplicates, however it is estimated that approximately 150 species of ferns, at least eight species of conifers, and between 700 and 900 species of flowering plants occur within VNP.

In broader context, the diversity of flora represented by species accounts from the Park to date is extraordinary. This survey has demonstrated that VNP, which currently only covers 1,063 ha and has negligible range in elevation (630 to 833 m) contains representatives from most of PNG's plant families, nearly a third of the vascular plant genera, and nearly 10% of PNG's vascular plant species. This represents a remarkable proportion of PNG's plant biodiversity. It is also expected that with further targeted field surveys, additional species records for flora will most certainly be added to the Park's checklists with the potential for describing species new to science considered to be very high.

Species with Scheduled Conservation Significance

Six species of plants scheduled with conservation significance under the IUCN Red List are included in the Checklist.

One species is classified as Critically Endangered (*Halfordia papuana*) while a second species; *Flindersia pimenteliana* is scheduled as Endangered. *Halfordia papuana* is a synonym for *H. kendack*, which is widely distributed throughout PNG occurring in Morobe, Western Highlands, Eastern Highlands, Southern Highlands, Western, Central and New Britain Provinces. The IUCN assessment for this species requires revision because this plant is not considered to be under threat.

Neither *H. kendack* or *F. pimenteliana* were collected from the Park during the current surveys, although *F. pimenteliana* was

previously confirmed by Hopkins & Hisao (1994) as occurring within the Park.

Similarly, the distribution of *F. pimenteliana* is also widespread throughout PNG as this tree species occurs with medium crowned hill forest. The listing of this species in the IUCN Red List is also considered questionable.

Of the remaining four species (*Cycas campestris*; *Hopea forbesii*; *Myristica globosa*; and *Helicia albiflora*) all are scheduled as Endangered.

H. albiflora is commonly associated with *Castanopsis* and *Nothofagus* forest communities and has a broad distribution across PNG. Little is known regarding the population status of *Myristica globosa* and both species are considered to be 'low risk' under the 'Near Threatened' category.

Cycas campestris is endemic to PNG with its range largely confined to low altitudes in the Central Province. Habitat loss and frequent fire regimes are the primary threats to this species. Given that VNP contains less than 2% of eucalypt savannah habitat increasing the Park's footprint to include a greater proportion of savannah would be a tangible measure in affording a greater level of protection to this regionally endemic species.

The Dipterocarps (Family Dipterocarpaceae) are highly sought after by the logging industry given their high value as timber species. *Hopea forbesii* is native to the island of New Guinea (including West Papua) and has a broad distribution within PNG from Milne Bay Province to the Sepik and Western Provinces. It has been subjected to an estimated 25% decline in population in the last three generations due to loss of habitat and logging. These impacts have been most severe in Central and Milne Bay Provinces. As such, the IUCN indicate that this species is borderline 'Vulnerable'.

Introduced Species

The introduced flora of VNP includes 51 species with six serious invasive species. The remaining 45 species of introduced plants within Park are common non-invasive weeds and include the species of grasses that comprise the lawns around the picnic and housing areas and as well as many of the common weeds found which also occur in road verges and currently pose little threat to the native biota of VNP.

The six species of ecological concern comprise: Lantana (*Lantana camara*), Spiderwort (*Tradescantia* spp.) the African Tulip Tree (*Spathodea campanulata*) and Hemp Vine (*Mikania micrantha*). The remaining two species *Clidemia* (*Miconia crenata*) and Spiked Pepper (*Piper aduncum*) are well established in the Park. *Clidemia* in particular is a dominant groundcover in secondary forests with potential to significantly impact floristic diversity and processes of forest succession. The Invasive Species Management Plan (IPCA, 2018d) and Environmental Monitoring Plan (IPCA, 2018a) detail further recommendations regarding the challenges associated with containing and managing these species in the Park.

At least four species of introduced and highly invasive plants also currently occur in areas surrounding the Park – on the Sogeri Plateau or in the Laloki Valley. These species include: Giant Sensitive Plant (*Mimosa pigra*), Sanchezia (*Sanchezia speciosa*), White Angel's Trumpet (*Brugmansia candida*) and the Mexican Sunflower (*Tithonia diversifolia*). All are characteristically aggressive and have the potential to cause significant ecological impacts to the native floristic assemblages of the Park. Preventing establishment of these species in VNP is a significantly preferable option ecologically and economically as opposed to attempting to manage infestations within the Park should they become established.

Ecological Value of VNP

The expansion of secondary and primary forests combined with having largely avoided the negative ecological and social impacts associated with broad scale deforestation, and regular fire regimes typical in areas adjacent to large metropolitan centres across the country has ensured that the Park's ecological integrity has been largely maintained since it's gazettal in 1973. This is remarkable given the Park's close proximity to Port Moresby and surrounding communities, which have concurrently undergone significant increases in population during the same period.

The Park's incredibly rich biodiversity, environmental values, cultural significance and educational and ecotourism potential dictates that Varirata National Park represents an outstanding natural asset of high ecological value in PNG's protected area portfolio.

Results of the Botanical Biodiversity Survey provide critical knowledge required to assist in the development of sound science based resource management strategies crucial to achieving the primary Project Objective of establishing a 'Conservation Management Framework' for Varirata National Park.

TABLE OF CONTENTS

EXECUTIVE SUMMARY I

Project Objectives..... I

Visitor Amenity..... II

Cultural Landscape II

Other Environmental Values II

Vegetation Associations & Key Habitats..... II

VNP’s Botanical Diversity..... III

Species with Scheduled Conservation Significance III

Introduced Species IV

Ecological Value of VNP V

1. INTRODUCTION..... 1

 1.1. Management Priorities for Varirata National Park 1

 1.2. Biodiversity Survey Objectives & Scope 1

 1.3. Overview of Varirata National Park..... 2

 1.3.1. Key Vegetation Associations..... 4

 1.3.2. Visitor Facilities and Use..... 4

2. METHODOLOGY 6

 2.1. Biodiversity Field Survey Personnel 6

 2.2. Botanical Survey Collections 6

 2.3. Land Cover..... 7

 2.4. Literature Review 7

 2.5. Community Outreach Program 9

3. RESULTS..... 10

4. BOTANICAL BIODIVERSITY IN VNP 11

 4.1. Key Vegetation Associations 11

 4.2. Eucalypt Savannah 11

 4.3. Secondary Forest..... 14

 4.4. Primary Forest (Medium crowned lowland hill forest) 20

 4.5. Aquatic Habitat 24

 4.5.1. Streams..... 24

 4.5.2. Lakes..... 25

4.6. Disturbed Habitat.....	26
4.7. Species with Scheduled Conservation Significance.....	26
4.7.1. Critically Endangered & Endangered.....	27
4.7.2. Near Threatened.....	28
4.8. Endemic Species.....	29
4.9. Important Species.....	29
4.9.1. Sogeri Velvet Bean (<i>Mucuna macropoda</i>).....	29
4.9.1. Birthwort (<i>Aristolochia momandol</i>).....	29
4.9.2. Tulip (<i>Gnetum gnemon</i>).....	30
4.9.3. PNG Oak (<i>Castanopsis acuminatissima</i>).....	30
4.9.4. Fruiting Trees.....	30
4.10. Introduced Species.....	31
4.11. Potential Invasive Species.....	32
4.12. Composition and Species Richness of Vascular Plant Flora.....	33
4.12.1. Phenology.....	35
4.13. Natural History Field Guide Brochures.....	36
5. CONCLUSIONS.....	37
5.1. Key Vegetation Associations.....	37
5.2. Species Richness.....	38
5.3. Species with Conservation Significance.....	38
5.4. Introduced Flora & Invasive Species.....	39
5.5. Ecological Value of Varirata National Park.....	39
6. REFERENCES.....	40
7. GLOSSARY OF TERMS.....	60
8. ACKNOWLEDGEMENTS.....	61

LIST OF TABLES

Table 1: Dominant plant families by biomass in primary forests of Varirata National Park.....	20
Table 2: Common weeds in VNP.....	26
Table 3: Plant Families ranked according to species richness, VNP	34

TABLE OF FIGURES

Figure 1: Location of VNP, Papua New Guinea	3
Figure 2: Satellite Image of VNP	3
Figure 3: Port Moresby from the Main Lookout, VNP	5
Figure 4: Lower Laloki Valley & Mt Lawes from the VNP Main Lookout	5
Figure 5: Eucalypt savannah below the VNP Main Lookout	5
Figure 6: Main Lookout, elevation 833 meters, VNP	5
Figure 7: IPCA's Koiari Biodiversity Survey Team	6
Figure 8: Plant collection sites for the botanical Biodiversity Survey.....	7
Figure 9: Bali Korohi and Monobe Kisea sorting pressed botanical specimens.....	7
Figure 10: Land use in VNP and surrounding areas.	8
Figure 11: Monthly rainfall in VNP.....	11
Figure 12: Eucalypt Savannah, VNP	12
Figure 13: Eucalypt Savannah and Secondary Forest ecotone, VNP	12
Figure 14: Eucalypt Savannah with White Gum and Grey Gum, VNP.....	12
Figure 15: <i>Corymbia papuana</i> , VNP.....	12
Figure 16: <i>Eucalyptus tereticornis</i> flower buds, VNP	12
Figure 17: <i>Eucalyptus alba</i> woodland, VNP	12
Figure 18: Weeping Paperbark (<i>Melaleuca leucadendron</i>), VNP.....	13
Figure 19: Kangaroo Grass (<i>Themeda triandra</i>), VNP	13
Figure 20: Cogon Grass (<i>Imperata cylindrica</i>), VNP	13
Figure 21: Tropical Banksia (<i>Banksia dentata</i>).....	13
Figure 22: <i>Banksia dentata</i> in inflorescence, VNP	13
Figure 23: Cycad (<i>Cycas campestris</i>), VNP	13
Figure 24: Pitcher Plan (<i>Nepenthes mirabilis</i>), VNP	14
Figure 25: Large tracts of Eucalypt Savannah burn during the dry season, VNP	14
Figure 26: Grass fires along the VNP escarpment	14
Figure 27: Gymnostoma (<i>Gymnostoma papuana</i>) foliage and seedpods, VNP.....	15
Figure 28: Secondary forest dominated by <i>Gymnostoma papuana</i> , Lake Lifikatabu, VNP	15

Figure 29: Sumac (*Rhus taitensis*) is prominent in mixed second growth forest, VNP 15

Figure 30: Fig trees are a common element in secondary forest, VNP 15

Figure 31: *Euodia* sp secondary forest, VNP 15

Figure 32: Poaching of forest resources, VNP 16

Figure 33: Comparison of savannah grasslands in 1973 and 2017 17

Figure 34: Early successional native shield fern (*Sticherus* sp), VNP 18

Figure 35: Shield Fern (*Sticherus* sp) comprising a dominant ground cover, VNP 18

Figure 36: Entrance to VNP in 1992..... 18

Figure 37: Entrance to VNP, 2017..... 18

Figure 38: *Clidemia* (*Miconia crenata*) in flower, VNP..... 19

Figure 39: Shield Fern (*Sticherus* sp.) and *Clidemia* (*Miconia crenata*), VNP..... 19

Figure 40: *Clidemia* (*Miconia crenata*) dominant in secondary forest, VNP..... 19

Figure 41: *Rubus* (*Rubus* sp.) VNP..... 19

Figure 42: Spiked Pepper (*Piper aduncum*), VNP 20

Figure 43: Aerial photograph of primary forest along VNP’s Western Escarpment 20

Figure 44: Strangling figs (*Ficus spp*) are a common element in primary forests, VNP 20

Figure 45: Re-growth primary forest along the Scarp Track, VNP 21

Figure 46: Aerial photograph of primary forest at Gare’s Lookout, VNP..... 21

Figure 47: Aerial photograph of primary and secondary forest ecotone, VNP 21

Figure 48: Orchids are abundant and diverse in VNP 22

Figure 49: Tulip (*Gnetum gnemon*) a common gymnosperm in VNP 22

Figure 50: PNG Oak (*Castanopsis acuminatissima*), near Gare’s Lookout, VNP 22

Figure 51: A large PNG Oak (*Castanopsis acuminatissima*), Scarp Track, VNP 22

Figure 52: PNG Oak (*Castanopsis acuminatissima*) in fruit 22

Figure 53: Distribution of *Castanoipsis*-dominated forests in VNP 23

Figure 54: Primary re-growth riparian vegetation along Nairogo Creek, VNP..... 24

Figure 55: *Alocasia* sp. and *Heliconia* sp. adjacent to a tributary of Nairogo Creek, VNP 24

Figure 56: Nairogo Creek in secondary forest, VNP..... 24

Figure 57: *Neonauclea* sp. in inflorescence, VNP 24

Figure 58: New Guinea *Impatiens* sp., VNP 24

Figure 59: Nairogo Creek tributary in Primary Forest, VNP 25

Figure 60: Dense stands of Kanda (*Calamus* sp.) along a tributary of Nairogo Creek, VNP 25

Figure 61: Aerial photo of the Lake Lifilikatabu complex and secondary forest, VNP 25

Figure 62: Upper Lake Lifilikatabu in the dry season, VNP 25

Figure 63: Pandanus (*Pandanus* sp.) bordering upper Lake Lifilikatabu, VNP 25

Figure 64: Sedges (*Eleocharis* sp.) in upper Lake Lifilikatabu..... 26

Figure 65: Landscaped gardens around the Main Picnic Area, VNP 26

Figure 66: Roadside verge of entrance road into the Park, VNP 26

Figure 67: IUCN Red List Conservation Categories 27

Figure 68: *Halfordia papuana*, Critically Endangered under the IUCN Red List 28

Figure 69: *Flindersia pimenteliana*, Endangered under the IUCN Red List..... 28

Figure 70: Common Blossom Bat (*Syconycteris australis*) feeding on *Mucuna macropoda*, VNP 29

Figure 71: *Aristolochia momandol* in secondary forest, VNP 30

Figure 72: Birdwing Butterfly (*Ornithoptera priamus*)..... 30

Figure 73: Fruit of *Dysoxylum pettigrewianum* (Family Meliaceae). 31

Figure 74: *Ficus* sp., probably *Ficus rhizophoriphylla*, located near the Lodge, VNP 31

Figure 75: *Syzygium* sp., Primary forest, VNP 31

Figure 76: African Tulip Tree (*Spathodea campanulata*), VNP 32

Figure 77: Lantana (*Lantana camara*), VNP 32

Figure 78: Spiderwort (*Tradescantia* sp.) surrounding Clidemia (*Miconia crenata*), VNP 32

Figure 79: Hemp Vine (*Mikania micrantha*) in flower, VNP 32

Figure 80: Mexican Sunflower (*Tithonia diversifolia*) 32

Figure 81: Giant Sensitive Plant (*Mimosa pigra*), lower Laloki Valley 33

Figure 82: *Sanchezia* (*Sanchezia speciosa*), Kokoda Track..... 33

Figure 83: White Angel’s Trumpet (*Brugmansia candida*)..... 33

Figure 84: Tropical forest tree species diversity 34

Figure 85: Percentage of trees in primary forest with fruit in VNP 35

LIST OF APPENDICIES

Appendix 1. Scope of Work..... 63

Appendix 2. Check List of Plant Species of VNP66

Appendix 3. Plant Family Species Richness, VNP 105

Appendix 4. Introduced Species, VNP..... 110

Appendix 5. IPCA Community Outreach Program..... 114

Appendix 6. Species Scheduled With IUCN Red List Conservation Significance 117

Appendix 7. Field Guide Brochure for Common Plants of VNP..... 118

1. INTRODUCTION

The Japan International Cooperation Agency (JICA) in conjunction with Papua New Guinea's Conservation and Environment Protection Authority (CEPA) formally partnered in June 2015 to develop and implement a landmark biodiversity conservation initiative for Protected Areas in PNG's Central Province (JICA, 2018). This initiative is formally referred to by JICA & CEPA as: 'The Project for Biodiversity Conservation through Implementation of the PNG Policy on Protected Areas' (herein referred to as the 'Project').

The Project has been specifically developed to align with the objectives of PNG's existing Policy on Protected Areas (PPA, 2014) and also adopts key principles of the UNESCO's Man and Biosphere Program with a strong focus on improving the livelihood of people and concurrently promoting sustainable resource conservation practices.

The Project comprises multiple stages and is scheduled for roll out over a 5 year period with the primary objective to establish an effective 'Conservation Management Framework' for Protected Areas through a combination of institutional strengthening, capacity building, landholder engagement, sound science and investment in infrastructure (JICA, 2018).

Establishing an effective 'Conservation Management Framework' for PAs requires that the Project be structured to deliver the following four key outcomes (JICA, 2018):

1. Strengthen institutional frameworks including formulation of Policy on Protected Areas (PPA) Action Plan and establish a National Conservation Council;
2. Enhance the terrestrial Protected Area (PA) management model for Varirata National Park (VNP) and the surrounding Koiari area;

3. Develop a model of establishing a new Marine PA; and
4. Raise the awareness of the general public regarding the importance of biodiversity conservation.

1.1. Management Priorities for Varirata National Park

Investment and restoration of Varirata National Park and the surrounding Koiari area comprise key Conservation Management Priorities for the JICA-CEPA Project. The Project aims to re-establish the Park as a major recreational and educational resource for the people in Port Moresby City, National Capital District and Central Province (JICA, 2018).

Capacity building, institutional strengthening and implementation of practical science based resource management strategies for the Park and buffer zone (area surrounding the Park) have been flagged as critical strategies to drive the restoration program for VNP.

1.2. Biodiversity Survey Objectives & Scope

In February 2017, the Indo-pacific Conservation Alliance (IPCA) was commissioned by JICA on behalf of CEPA to undertake Biodiversity Surveys of fauna and flora within VNP to document the Park's key taxa and concurrently provide a thorough appraisal of the Park's current ecological condition and habitat quality. The Biodiversity Surveys comprise a crucial component of the overall Project. Results from these surveys provide the foundations necessary to develop science based resource management strategies crucial to strengthening natural resource management functions within the Park.

Seven key Project objectives established through contract and consultation between JICA and IPCA broadly framed the parameters of the Biodiversity Surveys. They comprise:

- (i) Assess species richness of key taxa that occur within the park and buffer zone through conduct of a detailed literature review and intensive field survey program;
- (ii) Prepare a habitat classification map of key vegetation types within the park using satellite imagery and results from field surveys;
- (iii) Prepare species inventories for key taxa;
- (iv) Produce Field Guide Brochures for key taxa commonly encountered within the park (birds, mammals, invertebrates, plants, amphibians and reptiles);
- (v) Provide opportunity to capacity build with CEPA staff, which was extended to train local Koiari to assist in the conduct of biodiversity field surveys; and
- (vi) Prepare an Invasive Species Management Plan for introduced taxa (primarily Rusa Deer and invasive plants) that occur within and adjacent to VNP.
- (vii) Prepare a Monitoring Plan that identifies and prioritises monitoring programs which will provide Park Managers with information critical to improving the environmental management of VNP.

This standalone document presents key findings associated with the project objectives detailed in items (i) to (iii) for the botanical survey (flora) component of scope (Appendix 1). Reporting requirements for items (iv), the Field Guide Brochures have been prepared as separate standalone documents and are also presented as appendices to this report.

1.3. Overview of Varirata National Park

Varirata National Park is Papua New Guinea's first National Park. It was declared on December 10, 1969 and was officially opened October 8, 1973, two years before Papua New Guinea (PNG) became an independent, sovereign nation. The Park is located approximately 23 km ENE from Port Moresby City (straight-line distance) at the edge of the Sogeri Plateau in the Astrolabe Range, and is accessible by vehicle from Sogeri Road (Figure 1). The Park borders on a prominent escarpment of the Astrolabe Range and occupies a total area of 1,063 hectares (ha) over undulating terrain ranging in elevation from 630 to 833 metres (m) (Figure 2). The Park today contains a mixture of eucalypt savannah, secondary forest in various stages of regeneration, and old-growth primary rain forest. It features picnic and camping areas together with more than 12 km of walking tracks.



Figure 1: Location of VNP, Papua New Guinea

Source: JICA, 2017

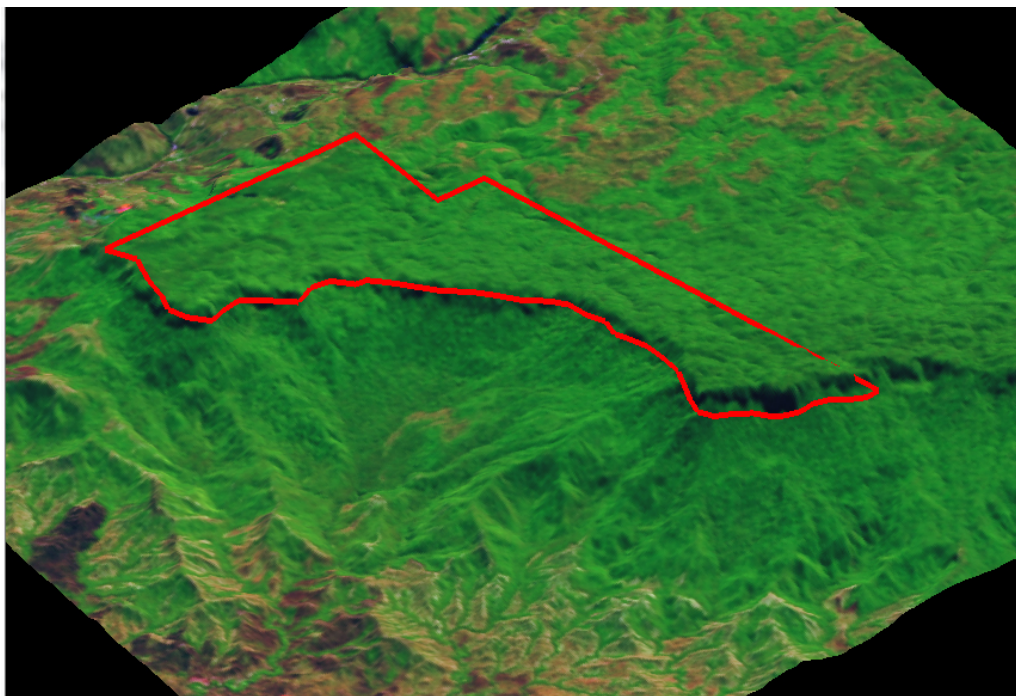


Figure 2: Satellite Image of VNP

Source: Phil Shearman, 2017

Much of the Parkland was purchased by the Crown from the traditional landowners, the Koiari people, who inhabit the Sogeri Plateau. An additional parcel – formerly a pig and poultry farm and now the central picnic and information area of the Park – was later purchased from Burns Philip and added to the Park.

Varirata National Park (VNP), because it is so close to Port Moresby, is the most visited protected area in the country. It offers easy access to a rich array of rain forests and is often the first true rain forest visited by school children growing up in the urban areas of Port Moresby. It is especially important as a model for protection of natural areas in PNG. Historically, a number of important scientific studies have been conducted in the Park, and it comprises an important educational resource for local universities and maintains high recreational values for local tourism and international ecotourism.

1.3.1. Key Vegetation Associations

Three key vegetation associations characterise the park: medium-crowned lowland hill forest (primary rainforest); secondary forest dominated by *Gymnostoma papuana*; and eucalypt savannah. Within these floristically diverse communities are five key habitats. They comprise the three forest types in addition to aquatic habitat (found within and adjacent to streams and lakes) and disturbed habitat (including landscaped gardens, and roadside verges). Both aquatic and disturbed habitats occur in all three forest types.

Approximately 80% of VNP is covered in medium-crowned lowland hill forest, including old re-growth forest rich in diversity but dominated by oaks (Fagaceae), particularly *Castanopsis acuminatissima* and *Lithocarpus celibicus* at higher elevations (Paijmans, 1973; 1975).

The percentage cover of secondary rainforest forest within the Park is truly remarkable given that this vegetation association has

expanded markedly to reclaim more than 200 ha of grassland since 1973 through natural processes of forest succession, largely facilitated by an absence of fire. This is despite the Park's close proximity to Port Moresby and surrounding communities, which have concurrently undergone significant increases in population during the same period. VNP has avoided the ecological and social impacts associated with broad scale deforestation typical in areas adjacent to large metropolitan centres across the country.

1.3.2. Visitor Facilities and Use

There is a network of trails, camping and picnic areas, and staff housing and visitor facilities within the Park (Figure 1). The western boundary of the Park borders on the main escarpment of the Astrolabe Range. There are several lookouts that provide sweeping views of Port Moresby along the Boundary Track and from the Main Lookout, which is accessible by road (Figure 3 to Figure 6). Prior to JICA and CEPA's commitment to re-establishing VNP under the proposed 'Conservation Management Framework', Park facilities were in disrepair with the Park receiving a modest number of visitors, particularly on the weekends. The Park remains a favoured site for avid bird watchers, with 231 species of birds recorded.



Figure 3: Port Moresby from the Main Lookout, VNP
 The Lookout is located at the edge of the main escarpment of the Astrolabe Range. Vegetation on the hills below the Lookout is mainly eucalypt savannah (light green) with gallery forest (dark green) along creeks). Photo credit: Allen Allison



Figure 6: Main Lookout, elevation 833 meters, VNP
 Photo credit: Allen Allison



Figure 4: Lower Laloki Valley & Mt Lawes from the VNP Main Lookout
 Photo credit: Allen Allison



Figure 5: Eucalypt savannah below the VNP Main Lookout
 Photo credit: Allen Allison

2. METHODOLOGY

The IPCA biodiversity surveys comprised a combination of detailed literature reviews and desktop studies in conjunction with field surveys conducted over a twelve month period commencing in mid-April 2017 and concluding in early April 2018. This has enabled the unique opportunity to collect rigorous data sets for key taxa allowing for seasonal (monsoon and dry season) variability. The results of these surveys comprise the first comprehensive assessment of biota in VNP.

CEPA approved IPCA's use of Monomu Lodge, which is located in the northern part of the Park, for use as a field survey base. The facilities included a building, which was converted into a mess and a specimen preparation facility. Several satellite bungalows comprised accommodation for the survey team

2.1. Biodiversity Field Survey Personnel

IPCA employed a field team comprising five land owners, one each from the four Koiari clans with land-owning interests in the Park and a technical officer from another Koiari clan who has been trained by IPCA in survey techniques during previous projects conducted on the Sogeri Plateau and elsewhere in PNG (Figure 7). The survey team included:

- Dabio Moi – Technical Officer (Doe Village)
- Bali Korohi (Omani Clan)
- Gideon Warite (Nadeka Clan)
- Monobe Kisea (Ianari Clan)
- Noel Max (Narime Clan)



Figure 7: IPCA's Koiari Biodiversity Survey Team

Bali Korohi, Monobe Kisea, Gideon Warite, and Noel Max. Photo credit: Angus Fraser

2.2. Botanical Survey Collections

In May 2017, Mr. Kore Maraia a qualified and well regarded botanists was mobilised from the University of Technology in Lae, to supervise construction of plant drying facilities and to train the field survey team on all aspects of plant collecting and specimen preparation. Written protocols were prepared and issued to the team for reference throughout the field survey program. Mr. Maraia has been trained by internationally renowned botanists working in New Guinea, including Ed de Vogel (Naturalis, Leiden) and Michael Sundue (University of Vermont, Burlington) during previous IPCA field survey campaigns.

The field team generally spent Monday to Friday of each week collecting plants and animal specimens and documenting key observations. By deploying the survey team on a nearly continuous basis over a twelve month period, IPCA were able to collect flowering plants as they came into season.

Flowering and fruiting cycles of tree species within VNP is irregular and does not occur in predictable seasonal cycles. Brown and Hopkins (1995) report that only 60% of individual trees flowered during their 26-month study period. This variation in flowering and fruiting cycles among species demonstrates that long-term, sustained monitoring effort is necessary to obtain biological data from PNG's tropical forests. The Hopkins study identified most specimens

collected to genus or morpho-species only. As such, further taxonomic effort is required to resolve the Hopkins collection to species level.

A total of 635 plant specimens were collected from various locations throughout the Park and Park buffer zone (Figure 8) during the course of the program. Specimens were pressed, dried and sorted in the field (Figure 9) and then sent to the UPNG Herbarium for identification by herbarium staff.

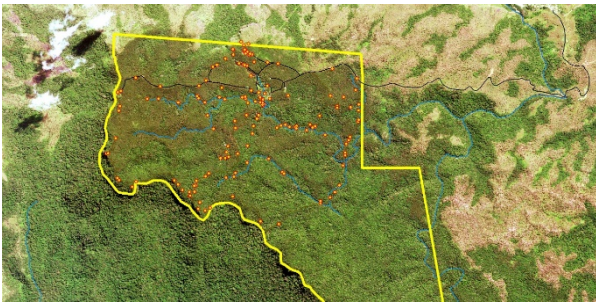


Figure 8: Plant collection sites for the botanical Biodiversity Survey.

Each point represents one or more collection points with multiple plants often collected from the same site.



Figure 9: Bali Korohi and Monobe Kisea sorting pressed botanical specimens

Photo credit: Dabio Moi

2.3. Land Cover

JICA has obtained Worldview satellite coverage of the Park and has used that to classify land cover into nine land use categories (Figure 10). IPCA confirmed this classification by ground truthing areas within the Park and believe that these categories are appropriate for defining the major land use units present in the Park. IPCA have

therefore adopted this land cover classification (vegetation map) as the base map for use in introducing Park visitors to the various ecological associations in the Park and for use in monitoring and management programs.

2.4. Literature Review

IPCA comprehensively searched the leading scientific literature databases, including Zoological Record, Web of Life and Google Scholar, for literature references relating to the biota of VNP. Further, the bibliographies of all major field guides were reviewed regarding the biota of PNG. This effort returned 354 references. These are maintained in Endnote, the leading commercially available product for managing literature references and associated PDF files.

Given the lack of published lists of the vascular flora in VNP, specimen data was obtained from the University of PNG Herbarium and the PNG National Herbarium [Lae]. In addition, records were obtained from Cedric Carr's collections made from the Sogeri Plateau and surrounding area in 1935-36. These collections are housed in various international herbaria including the Singapore Botanical Garden, the Royal Kew Botanic Gardens, the Natural History Museum in London, the Naturalis Biodiversity Centre in Leiden, the Bishop Museum in Honolulu and other institutions. Data from these collections in combination with the UPNG data and data from our surveys comprised the basis of the composite database presented in Appendix 2 to Appendix 4.

IPCA used GIS species distribution shape files and an extensive review of the literature to prepare checklists of species that likely occurred in the Park. Continuous revision of the checklists was undertaken throughout the program based on the results of the field surveys.

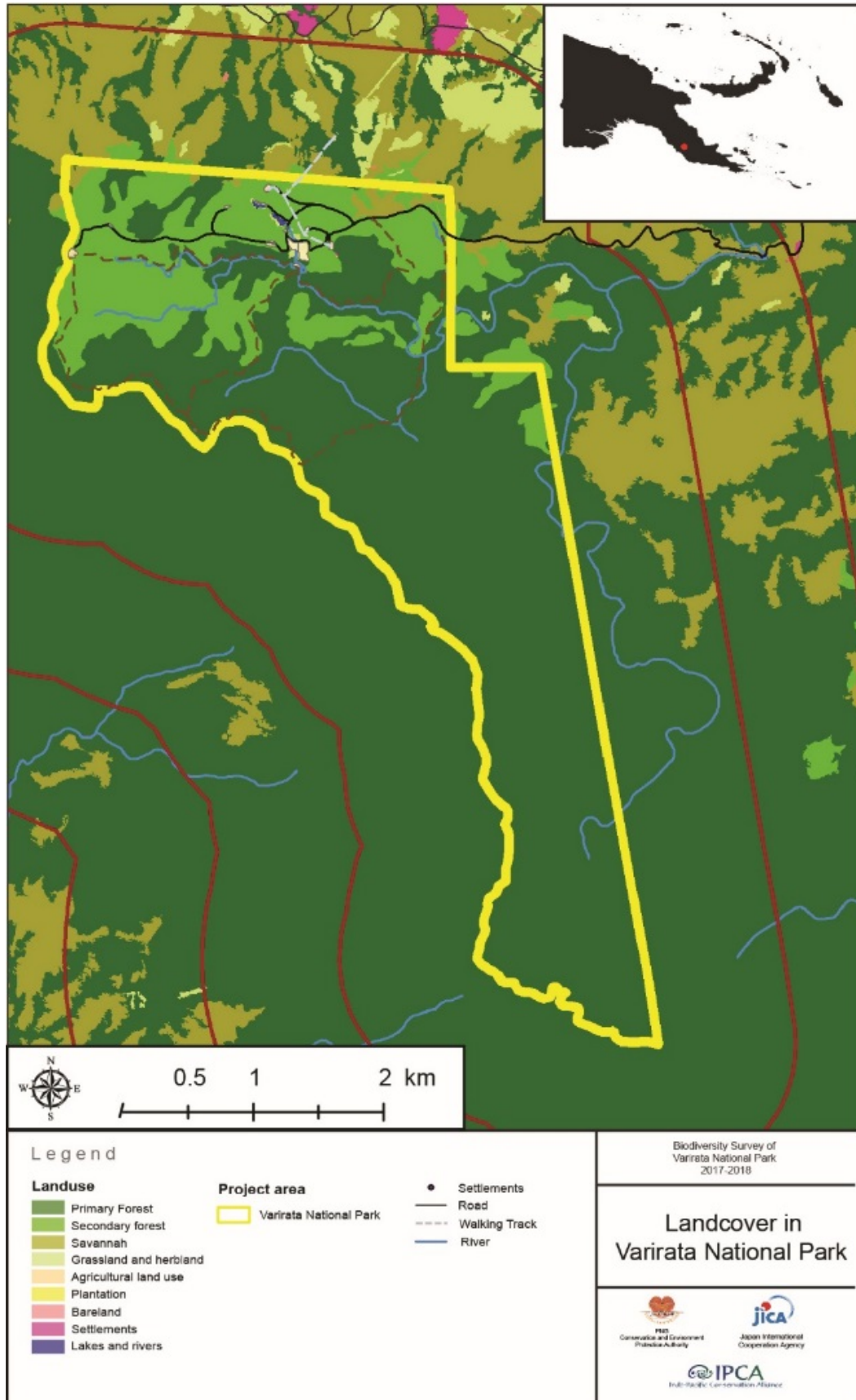


Figure 10: Land use in VNP and surrounding areas.

2.5. Community Outreach Program

Two former U.S. Peace Corps volunteers, Andrew McInnis and Christo Ferguson, joined the IPCA survey team for a three week period between mid-October 2017 to early November 2017. They assisted in determining the feasibility of eradicating *Clidemia* from the Park through the establishment of trial plots in secondary and primary forest habitats as part of IPCA's botanical survey program.

Upon completion of this component of the botanical survey, McInnis and Ferguson assisted in developing and implementing an educational outreach program on behalf of IPCA to surrounding villages, community groups and schools. The program was designed to raise environmental awareness and highlight ecological importance of VNP among neighbouring communities. Live specimens including frogs, lizards and snakes were carefully handled and promoted amongst audiences to emphasize PNG's extraordinary biodiversity and assist in promoting the benefits of community conservation practices (Appendix 5).

3. RESULTS

Sixteen hundred days of fieldwork were amassed by the IPCA Field Team during conduct of the botanical and zoological biodiversity field surveys. At the conclusion of the botanical survey 635 plant specimens were collected with the majority having five replicate specimens when sufficient flower or fruiting material enabled the collection of replicates. Plants collected included ground cover, shrubs, epiphytes, lianas and flowering trees. The survey team also catalogued several hundred photos of plants in flower. Combined with herbaria data the results of the field survey program have contributed to the first comprehensive listing of vascular plant species from VNP (Appendix 2 to Appendix 4).

The vascular plant checklist comprises 157 vascular plant families, 581 genera and 1,126 species. The checklist includes a number of taxa identified only to morpho-species and it is likely that some of these are duplicates. As such, IPCA estimates that the Varirata flora comprises approximately 150 species of ferns, at least eight species of conifers, and between 700 and 900 species of flowering plants.

Although the Park and surrounding area are relatively well collected, much of the material in the UPNG herbarium is sterile and can only be identified to genus. The results from this project have added significant value to the knowledge base of VNP's biota.

4. BOTANICAL BIODIVERSITY IN VNP

VNP's monsoonal climate and its distinctive microclimate are key drivers (in addition to historical land use disturbances and current fire regimes) determining the distribution and composition of vegetation within the Park. Despite the lack of long-term rainfall or temperature data published for the Park Hopkins and Hiaso (1994) monitored rainfall from October 1990 to March 1993 suggesting that the Park receives approximately 1,500 mm of rain per year (Figure 11). This is only slightly greater than Port Moresby, which receives around 1,200 mm annually. The dry season extends from June to September and the wet season typically occurs from October to May. January is the wettest month with rainfall of nearly 300 mm. Temperatures during the day commonly reach 30° C and rarely drop below 16° C at night, with little annual variation.

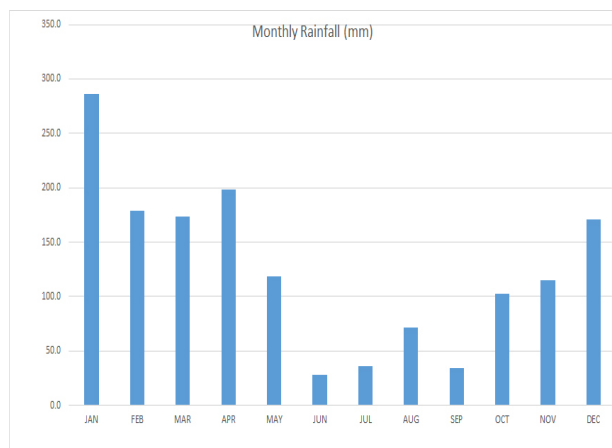


Figure 11: Monthly rainfall in VNP

Source: Hopkins and Hiaso, 1994

It is likely that rainfall totals for the rain forest areas of the Park exceed 2,000 mm annually, with a less pronounced dry season than in the savannah areas.

4.1. Key Vegetation Associations

For the purposes of conducting the botanical survey, IPCA confirmed the presence of three separate vegetation associations. Each is

generally floristically unique (with some convergence at ecotones), however all three associations also contained both aquatic habitat and areas of disturbance. As such, five key habitats were identified and surveyed as follows:

1. Eucalypt Savannah comprising <2% of the Park
2. Secondary Forest dominated by *Casuarina (Gymnostoma papuana)* comprising approximately 18% of the Park ;
3. Medium-crowned Lowland Hill Forest (primary rainforest) comprising approximately 80% of the Park;
4. Aquatic Habitat* (streams & lakes); and
5. Disturbed Habitat* (landscaped areas including picnic grounds and roadside verges and other 'disturbed areas').

* Estimates for the size of these habitats are not calculated given that they typically occur as small patches or areas within each of the three key habitats.

4.2. Eucalypt Savannah

The northern border of the Park is covered in eucalypt savannah (Paijmans, 1973; 1975) (Figure 12 to Figure 14) dominated by four myrtaceous trees, Ghost Gum (*Corymbia papuana*) (Figure 15), Grey Gum (*E. tereticornis*) (Figure 16), White Gum (*E. alba*) (Figure 17) and Weeping Paperbark (*Melaleuca leucadendron*) (Figure 18), with an understory of grasses, particularly Kangaroo Grass (*Themeda triandra*) (Figure 19) and Cogon Grass (*Imperata cylindrica*) (Figure 20), together with scattered shrubs, including Grassland Sheoak (*Grevillea papuana*), Tropical Banksia (*Banksia dentata*) (Figure 21 and Figure 22), and a cycad (*Cycas campestris*) (Figure 23). Other aspect dominants include species of *Pandanus (Pandanus sp.)*.



Figure 12: Eucalypt Savannah, VNP
White Gum (*Eucalyptus alba*), cycad (*Cycas campestris*) in the lower right and a mixture of Kangaroo Grass (*Themeda triandra*) and Congon Grass (*Imperata cylindrica*). Photo credit: Angus Fraser



Figure 13: Eucalypt Savannah and Secondary Forest ecotone, VNP
Ecotone between savannah and secondary forest. The grass species in the foreground is mainly Congon Grass (*Imperata cylindrica*); the plants at the edge of the forest are cycads (*Cycas campestris*). Photo credit: Angus Fraser



Figure 14: Eucalypt Savannah with White Gum and Grey Gum, VNP
White Gum (*Eucalyptus alba*), Grey Gum (*E. tereticornis*) and dominant grass species is Kangaroo Grass (*Themeda australis*). Photo credit: Angus Fraser



Figure 15: *Corymbia papuana*, VNP
Photo credit: Angus Fraser



Figure 16: *Eucalyptus tereticornis* flower buds, VNP
Note the difference in operculum (flower bud) between *C. papuana* and *E. tereticornis*. Photo credit: Angus Fraser



Figure 17: *Eucalyptus alba* woodland, VNP
Foreground grass species is mainly Kangaroo Grass (*Themeda triandra*). Photo credit: Angus Fraser



Figure 18: Weeping Paperbark (*Melaleuca leucadendron*), VNP
 Photo credit: Angus Fraser



Figure 19: Kangaroo Grass (*Themeda triandra*), VNP
 Photo credit: Allen Allison



Figure 20: Cogon Grass (*Imperata cylindrica*), VNP
 Photo credit: Allen Allison



Figure 21: Tropical Banksia (*Banksia dentata*)
 This is the only species of *Banksia* found in New Guinea. The other 170 species occur in Australia. Tropical Banksia is widely distributed in PNG and is found in grasslands at mid-elevations. Photo credit: Allen Allison



Figure 22: *Banksia dentata* in inflorescence, VNP
 Photo credit: Angus Fraser



Figure 23: Cycad (*Cycas campestris*), VNP
 Taken along the roadside leading up to the entrance of the Park in the Park Buffer Zone at the beginning of the monsoon. Note the green grasses shooting after dry season grass fires. Photo credit: Angus Fraser

Hopkins and Hiaso (1994) mention populations of Pitcher Plants (*Nepenthes*) along some of the trails in the Park but these appear to have since disappeared. However, there is a sizable population of *Nepenthes mirabilis* in eucalypt savannah along the Varirata National Park entrance road at approximately a kilometre south of the junction with the Sogeri Road (9.4338S; 147.3969E) (Figure 16). Pitcher plants have modified leaves that form urn-shaped “pitchers” that trap and digest insects and other invertebrates (Figure 24).



Figure 24: Pitcher Plan (*Nepenthes mirabilis*), VNP
Photo credit: Allen Allison

Eucalypt savannah covers < 2% of the overall Park area but is the dominant vegetation around Port Moresby and along the road to Sogeri, reflecting the monsoonal climate of the area. Eucalypts are particularly critical for a variety of mammals and birds, particularly parrots, which rely on hollows produced by these trees for nesting sites.

Eucalypt savannah is highly susceptible to fire and large tracts are burnt each year during the dry season. Savannah plant associations have adapted to a fire ecology with grassland species generally recovering within a year or two if not burned repeatedly (Figure 25 and Figure 26).

Tree density is approximately 150 trees per ha in these habitats, which makes for a very open canopy (Heyligers, 1966). The composition of the Eucalyptus species in the forest clearly depends on slope, aspect and drainage, with specific species becoming dominant and forming nearly pure stands in some areas. The overall plant species richness in these forests is low and comprises less than 1% of the plant species known from the Park.



Figure 25: Large tracts of Eucalypt Savannah burn during the dry season, VNP
Looking east towards the Sogeri Plateau from the VNP escarpment. Photo credit: Angus Fraser



Figure 26: Grass fires along the VNP escarpment
Fires are deliberately lit during the dry season in the Park Buffer Zone. Photo credit: Angus Fraser

4.3. Secondary Forest

Immediately south of the eucalypt savannah lies a band of mainly secondary forest dominated by *Gymnostoma* (*G. papuana*), a nitrogen fixing and pioneering tree species in the family Casuarinaceae (Figure 27 - Figure 28). Other common species include Ghost Gum (*C. papuana*), Grey Gum (*E. tereticornis*), sumac (*Rhus taitensis*) (Figure 29), *Macaranga*

spp., *Ficus* spp (Figure 30) and *Euodia* spp (Figure 31).



Figure 27: Gymnostoma (*Gymnostoma papuana*) foliage and seedpods, VNP

Photo credit: Angus Fraser



Figure 28: Secondary forest dominated by *Gymnostoma papuana*, Lake Lifilikatabu, VNP

Photo credit: Allen Allison



Figure 29: Sumac (*Rhus taitensis*) is prominent in mixed second growth forest, VNP

This tree was photographed in April 2017 near the Lodge. It was in flower throughout the Park and in the upper Laloki Valley. Photo credit: Allen Allison



Figure 30: Fig trees are a common element in secondary forest, VNP

This large fig tree is located in secondary forest along the Koiari Tree House Track near the Main Picnic Ground. Photo credit: Angus Fraser



Figure 31: *Euodia* sp secondary forest, VNP

Photographed in secondary forest along the VNP northern escarpment. Photo credit: Angus Fraser

The central areas of the Park were cleared beginning in 1897 by Burns Philp for an arabica coffee plantation (Lewis, 1996). This area was later expanded to include vegetable gardens. However, a few years later, the coffee became infested with *Hemileia vastatrix*, a fungal disease that causes coffee

rust, and the area was leased to Warirata Estate, which developed it into a piggery. When the Park was officially opened by the Government in 1973, the former plantation areas had reverted to savannah grassland, which covered 220.7 hectares. By 2017 most of this grassland has been replaced by secondary forest through a process called ecological succession. Only 12.8 ha of savannah grassland remains in the Park today (Figure 33).

Gymnostoma forms nearly pure stands in over much of the secondary forest (Figure 61). The boundary between the secondary forest and eucalypt savannah is typically characterised with some mixing of species. In particular Ghost Gum (*C. papuana*) and Grey Gum (*E. tereticornis*) are common elements between the two vegetation types. The presence of the two species of eucalypts together with other typical savannah species, such as Weeping Paperbark (*M. leucadendron*) within the secondary forest likely represents remnants of the former savannah grassland that covered the area in 1973.

Some evidence of forest resource poaching was documented during survey with illegal harvesting of *Gymnostoma* (both green timber and firewood) observed along the Park Boundary (Figure 32). Interestingly, the trees were harvested using a chainsaw and not a bush knife or axe. Paperbark, which occurs in low densities in the Park, was also observed to have been harvested for building materials from trees within the Park Buffer Zone.



Figure 32: Poaching of forest resources, VNP

Gymnostoma (Yar in Tok Pisin) is highly valued timber for firewood given its superior capacity to generate heat compared with other local timbers. This tree was cut with a chainsaw in secondary forest along the Park Boundary just south of the main entrance along an old bush track accessible by vehicle. On other occasions pickup trucks were observed collecting dead yar within the Park for domestic firewood consumption.

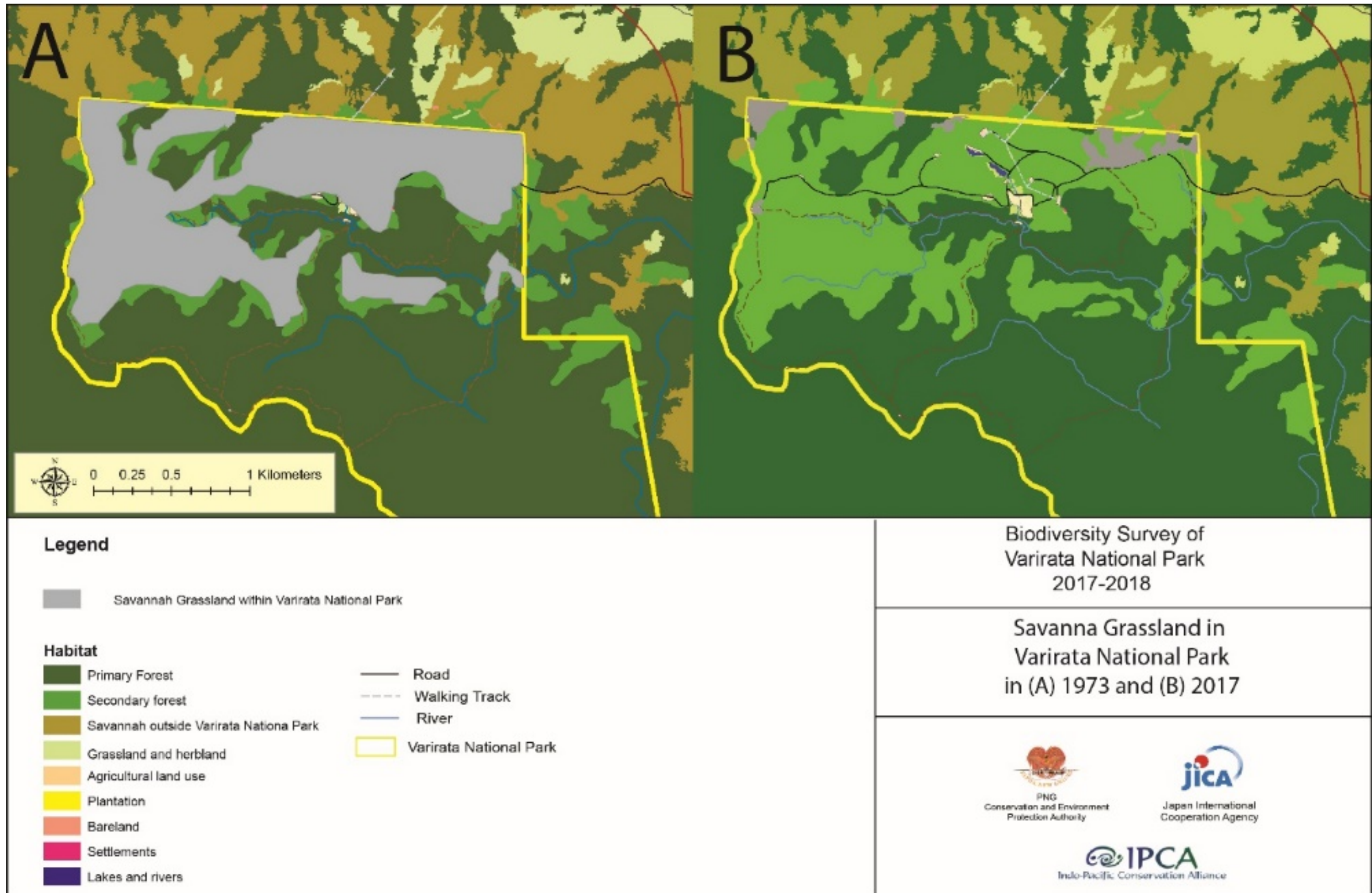


Figure 33: Comparison of savannah grasslands in 1973 and 2017

Sources: 1974 1:100,000 topographic sheet (8379 – Port Moresby) based on 1973 aerial photographs. 2017 WorldView Satellite Imagery (JICA, 2017).

In the absence of fire in areas with sufficient rainfall, a shield fern (*Sticherus* sp.) will tend to invade forest clearings. This fern (Figure 34), which forms dense thickets and helps re-establish soil, is eventually followed by other successional species, particularly *Gymnostoma*. This process of ecological succession can result in nearly pure stands of *Gymnostoma* with a ground layer of shield fern (Figure 35). The shade produced by the *Gymnostoma* canopy allows for the establishment of other tree species within the secondary forest, including sumac (*Rhus taitensis*), Albert Palm (*Caryota rumphiana*), Red Cedar (*Toona sureni*) and species of *Macaranga*, *Pandanus*, *Syzygium*, *Ficus*, *Neolitsea*, *Schizomeria*, and *Euodia*.

Forest succession has also been quite evident along the access road near the Park's entrance as indicated by photographs taken in 1992 and 2017. This has resulted in secondary forests having a greater element of primary forest species (Figure 36 and Figure 37).



Figure 34: Early successional native shield fern (*Sticherus* sp), VNP

Sticherus is abundant in Varirata National Park and tends to invade clearings and open areas adjacent to forest and is eventually shaded out by pioneering tree species. Photo credit: Allen Allison



Figure 35: Shield Fern (*Sticherus* sp) comprising a dominant ground cover, VNP

Photo credit: Allen Allison



Figure 36: Entrance to VNP in 1992

This photo was taken in 1992 at approximately the same location as the 2017 photograph below. A comparison between the two images shows that the secondary forest is now much more diverse and dense than it was 25 years ago. Photo credit: Allen Allison



Figure 37: Entrance to VNP, 2017

Photo credit: Angus Fraser

Clidemia (*Miconia crenata*), an aggressive invasive shrub from South America, apparently became established in VNP around 2005-2006 (Figure 38). This species is commonly known as *Clidemia* and was formerly classified as *Clidemia hirta*.

Subsequent taxonomic classification resulted in the plant being reclassified as *Miconia crenata* (Mabberley, 2017), however the plant is still referred to as Clidemia.

Clidemia is now well established in the Park and appears to be replacing *Sticherus* as the dominant ground plant in the secondary forest. Although pure stands of *Sticherus* remain (Figure 35), some patches now contain a mixture of *Sticherus* and Clidemia (Figure 39). In some areas Clidemia forms nearly pure stands (Figure 40). A native species of *Rubus* is often found in association with both species and also appears to be an early successional pioneering species (Figure 41).



Figure 38: Clidemia (*Miconia crenata*) in flower, VNP
Photo credit: Allen Allison



Figure 39: Shield Fern (*Sticherus* sp.) and Clidemia (*Miconia crenata*), VNP
Photo credit: Allen Allison



Figure 40: Clidemia (*Miconia crenata*) dominant in secondary forest, VNP

This image is taken between Lake Lifilikatabu and the Lodge. Photo credit: Allen Allison



Figure 41: Rubus (*Rubus* sp.) VNP

Rubus sp is common in the undergrowth of the secondary forest, occurring within stands of Clidemia and *Sticherus*. Photo credit: Allen Allison

In addition to Clidemia, another serious invasive shrub from Central and South America, Spiked Pepper (*Piper aduncum*) (

Figure 42), occurs throughout the secondary forest and in disturbed areas along roadsides and tracks. It has been in Papua New Guinea for decades and has spread throughout much of the country.



Figure 42: Spiked Pepper (*Piper aduncum*), VNP
Photo credit: Allen Allison.

4.4. Primary Forest (Medium crowned lowland hill forest)

Although there are subtle differences in the occurrence and distribution of tree species within the primary forest, depending primarily on slope, aspect and other factors, these differences are ecologically minor with respect to the overall distribution of plants within the Park. Approximately 80% of the land area of the Park is covered in primary forest, including old re-growth forest, which includes a rich diversity of tree species and a dense understory of shrubs, small trees and lianas (Figure 43). These forests are dominated by ten plant families (Table 1) and are part of an association termed medium-crowned lowland hill forest (Paijmans, 1973; 1975; Figure 45 to Figure 52). In addition, a conifer, Tulip (*Gnetum gnemon*) (Figure 49), is common throughout the forest, which is also rich in epiphytes, particularly ferns and orchids.



Figure 43: Aerial photograph of primary forest along VNP’s Western Escarpment

Image taken near Gare’s lookout. Several dozen tree genera are represented in the photo. Photo credit: JICA, 2017

Table 1: Dominant plant families by biomass in primary forests of Varirata National Park.

FAMILY	COMMON GENERA
Fagaceae	<i>Castanopsis, Lithocarpus</i>
Meliaceae	<i>Aglaia, Chisocheton, Dysoxylum, Toona</i>
Elaeocarpaceae	<i>Elaeocarpus, Sloanea</i>
Myrtaceae	<i>Syzygium</i>
Myristicaceae	<i>Myristica</i>
Annonaceae	<i>Popowia</i>
Lauraceae	<i>Cryptocarya, Litsea</i>
Moraceae	<i>Ficus</i>
Burseraceae	<i>Canarium</i>
Pandanaceae	<i>Pandanus</i>

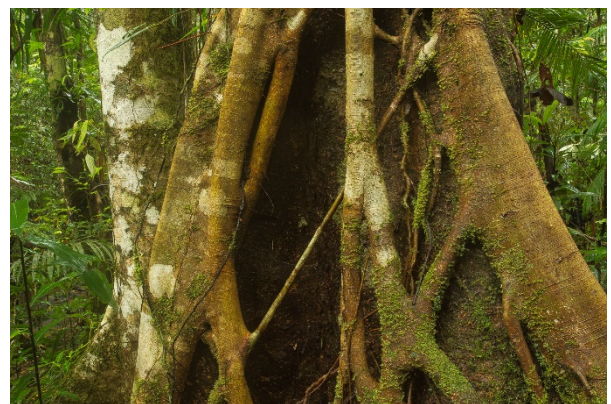


Figure 44: Strangling figs (*Ficus spp*) are a common element in primary forests, VNP

Photo credit: Angus Fraser

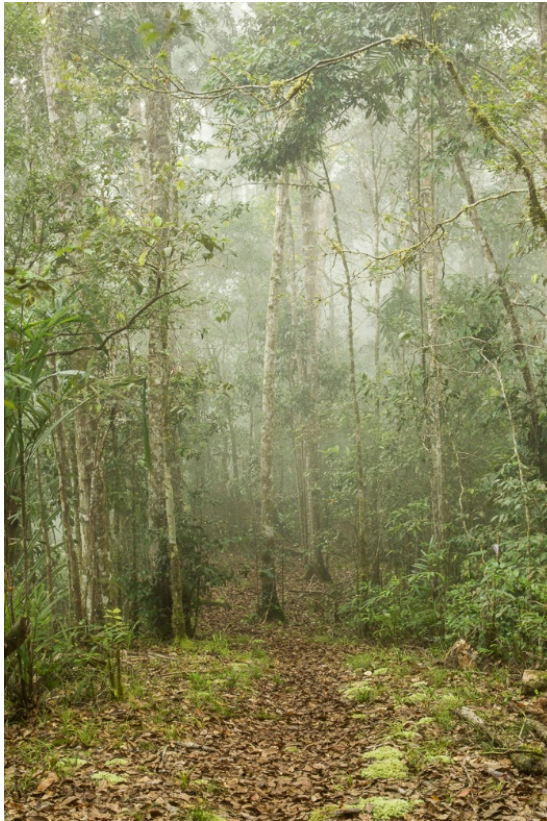


Figure 45: Re-growth primary forest along the Scarp Track, VNP

The dominant tree is PNG Oak (*Castanopsis acuminatissima*). Forest mist is a regular occurrence throughout the year providing moisture and relatively cool conditions that influence the Park’s micro-climate throughout the year compared with the seasonally hot dry conditions experienced in Port Moresby. Photo credit: Angus Fraser



Figure 46: Aerial photograph of primary forest at Gare’s Lookout, VNP

Gare’s Lookout is on the edge of the escarpment of the Astrolabe Range. The dominant trees are PNG Oak (*Castanopsis acuminatissima*) and Lithocarpus (*Lithocarpus celibicus*). Photo credit: JICA, 2017



Figure 47: Aerial photograph of primary and secondary forest ecotone, VNP

This image was taken near the Digicel Tower (9.430232°S, 147.351295°E) showing the sharp separation (ecotone) between secondary forest dominated by *Gymnostoma* (*Gymnostoma papuana*) (left) and primary forest (right). The secondary forest now probably comprises the areas that were cleared for coffee plantations in the late 1800s. Photo credit: JICA, 2017

Oak forest occurs at higher elevations in the Park, particularly around Gare’s Lookout and is dominated by two species: PNG Oak (*Castanopsis acuminatissima*) and *Lithocarpus celibicus*. These forests typically occur along ridgelines and comprise a distinctive element within the medium-crowned lowland hill forest. The understory of these forests is generally less dense than other parts of the primary forest, with fewer lianas and epiphytes. The fruit, a spiny ovoid nut (Figure 52) is harvested by people throughout PNG for food and is also an important food source for many species of parrots. The distribution of *Castanopsis* forests within the Park is presented in Figure 53.



Figure 48: Orchids are abundant and diverse in VNP
Epiphytes such as orchids (*Bulbophyllum* sp.) and fern occur throughout medium crowned lowland hill forest. Photo credit: Angus Fraser



Figure 49: Tulip (*Gnetum gnemon*) a common gymnosperm in VNP
Tulip is a common component of the primary forest within VNP. It is easily recognised by its distinctive ringed trunk (left). Although it is a gymnosperm, closely related to conifers, it has expanded, paired leaves resembling those of flowering plants. The fruit and foliage are edible and the bark is used to make billum twine. The fruit is bright red when ripe and is eaten by people and is also favoured by many species of birds including fruit doves, hornbills, pigeons and birds of paradise. Photo credit: Angus Fraser



Figure 50: PNG Oak (*Castanopsis acuminatissima*), near Gare's Lookout, VNP
Photo credit: Allen Allison



Figure 51: A large PNG Oak (*Castanopsis acuminatissima*), Scarp Track, VNP
PNG Oak can be easily identified by its propensity to coppice (shoot multiple stems) from the base of the tree. Photo credit: Angus Fraser



Figure 52: PNG Oak (*Castanopsis acuminatissima*) in fruit
Photo credit: NSW State Herbarium

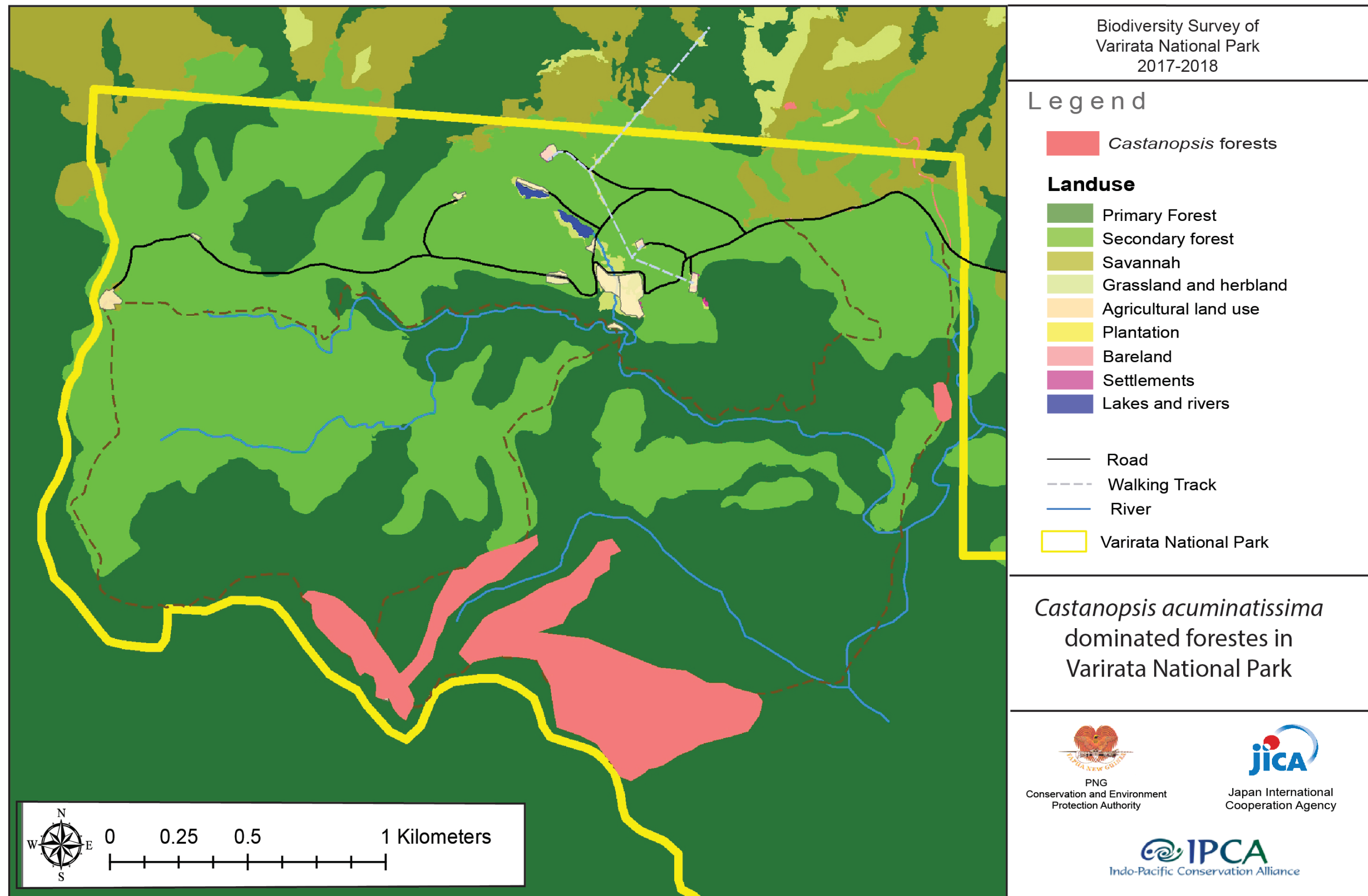


Figure 53: Distribution of *Castanoipsis*-dominated forests in VNP

4.5. Aquatic Habitat

Lotic habitat comprises Nairogo Creek, which is a small stream with several tributaries within the Park's catchment. The lentic habitat in the Park comprises two small lakes referred to as the Lake Lifilikatabu complex situated west of the Main Picnic Area.

4.5.1. Streams

The Park is drained by Nairogo Creek, which originates in the Park's west from two main branches that flow eastwards and join near the Park's eastern boundary after which it joins the Laloki River. Some plants such as *Neonauclea* sp. and *Impatiens* sp. are restricted to the stream channels and others comprise the riparian vegetation along the stream banks (Figure 54 to Figure 60).



Figure 54: Primary re-growth riparian vegetation along Nairogo Creek, VNP

Nairogo Creek along the Circuit Track. Photo credit: Angus Fraser

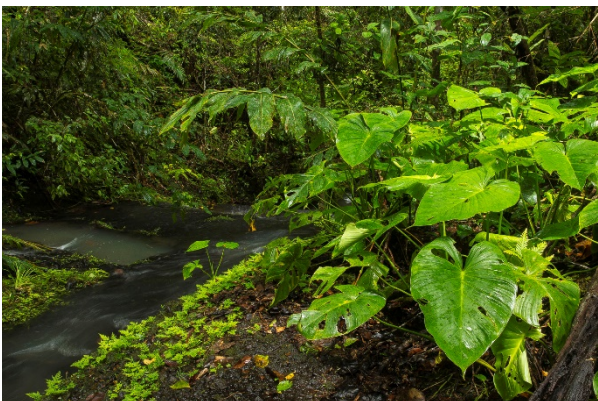


Figure 55: Alocasia sp. and Heliconia sp. adjacent to a tributary of Nairogo Creek, VNP

Primary forest. Photo credit: Angus Fraser



Figure 56: Nairogo Creek in secondary forest, VNP

This image is taken in the Park Buffer Zone Photo after the confluence of the two main branches. Photo credit: Angus Fraser



Figure 57: Neonauclea sp. in inflorescence, VNP

This common riparian shrub (Family Rubiaceae) occurs along the watercourses throughout VNP. Photo credit: Allen Allison



Figure 58: New Guinea Impatiens sp., VNP

New Guinea *Impatiens* sp is common along watercourses in primary and secondary forest. Photo credit: Angus Fraser



Figure 59: Nairogo Creek tributary in Primary Forest, VNP

Photo credit: Angus Fraser



Figure 60: Dense stands of Kanda (*Calamus* sp.) along a tributary of Nairogo Creek, VNP

Primary forest. Photo credit: Angus Fraser

4.5.2. Lakes

The Lake Lifilikatabu complex (Figure 61) is believed to have been built when the area supported a piggery (Hopkins & Hiaso, 1994). However, members of the Koiari Field Survey Team believe that the upper lake is natural and that the lower lake is artificial. Both are shallow and vary in size with rainfall. They are generally less than 0.5 ha in total area and have historically gone dry. The lower lake has a fine stand of Pandanus at the northern end (Figure 62 and Figure 63).



Figure 61: Aerial photo of the Lake Lifilikatabu complex and secondary forest, VNP

Lake Lifilikatabu is surrounded by almost pure stands of *Gymnostoma papuana* approximately 50 years old. Photo credit: JICA, 2017



Figure 62: Upper Lake Lifilikatabu in the dry season, VNP

Photo credit: Angus Fraser



Figure 63: Pandanus (*Pandanus* sp.) bordering upper Lake Lifilikatabu, VNP

Photo credit: Angus Fraser

There are a number of species of plants that in the Park are restricted to the lakes. These include a small aquatic fern, *Azola* (*Azola* sp.) and sedges (*Eleocharis* sp.) that line the water's edge (Figure 64). The lakeside

vegetation is otherwise unremarkable and consists mostly of introduced weeds.



Figure 64: Sedges (*Eleocharis* sp.) in upper Lake Lifilikatabu

This is prime habitat for a frog (*Litoria chloristona*), recorded from the lakes. Photo credit: Angus Fraser

4.6. Disturbed Habitat

Open grassy areas, such as the Main Picnic Area and grounds around Monomu Lodge, tend to be dominated by introduced (non-native) weeds generally restricted to landscaped garden areas and roadside verges (Figure 65 and Figure 66; Table 2). These species are discussed further in the Introduced Plants section of this Chapter (Section 4.10. Introduced Species) with a detailed account also provided in the Invasive Species Management Plan (IPCA, 2018d).



Figure 65: Landscaped gardens around the Main Picnic Area, VNP

Photo credit: Nitty Simard



Figure 66: Roadside verge of entrance road into the Park, VNP

Roadside verges characteristically have a high abundance of weed species. Photo credit: Angus Fraser

Table 2: Common weeds in VNP

FAMILY	COMMON GENERA
ASTERACEAE	<i>Ageratum conyzoides</i>
"	<i>Bidens pilosa</i>
"	<i>Crassophyllum crepidoides</i>
"	<i>Elephantopus mollis</i>
"	<i>Eleutherantra ruderalis</i>
"	<i>Erechtites valerianifolia</i>
"	<i>Mikania micrantha</i>
"	<i>Syndrella nodiflora</i>
CLEOMACEAE	<i>Clemone viscosa</i>
FABACEAE	<i>Mimosa pudica</i>
"	<i>Senna alata</i>
ONOGRACEAE	<i>Ludwigia octovalnis</i>
OXALIDACEAE	<i>Oxalis corniculata</i>
PASSIFLORACEAE	<i>Passiflora foetida</i>
POACEAE	<i>Eleusine indica</i>
"	<i>Paspalum conjugatum</i>
"	<i>Sporobolus sp.</i>
POLYGALACEAE	<i>Polygala paniculata</i>
RUBIACEAE	<i>Spermacoce laevis</i>

4.7. Species with Scheduled Conservation Significance

The IUCN Red List establishes seven categories of ‘extinction risk’, which can only be applied to a species if sufficient ecological data is available to make an informed

decision against established assessment criteria (Figure 67).

Species that have been assigned as Vulnerable (VU), Endangered (EN), or Critically Endangered (CR) are classified as ‘Threatened’. If threatening processes continue unmitigated these species are expected to become extinct.

Species, which have been assigned a Near Threatened (NT) status, have been assessed against established criteria and do not currently meet any of the ‘Threatened’ categories. However, Near Threatened taxa are considered to be of high risk in subsequently being classified as ‘Threatened’ in the absence of mitigating strategies.

4.7.1. Critically Endangered & Endangered

A species of tree *Halfordia papuana*, (Family Rutaceae) known from the Sogeri Plateau is scheduled as Critically Endangered under the IUCN Red List. *Halfordia papuana* is a synonym for *H. kendack*, which is widely distributed throughout PNG occurring in Morobe, Western, Eastern and Southern Highlands, and Western, Central and New Britain Provinces. The IUCN assessment for this species requires revision given that this plant is not considered to be under threat. It could be reasonably expected to occur within the Park, although this was not confirmed during the Biodiversity Survey (Figure 68).

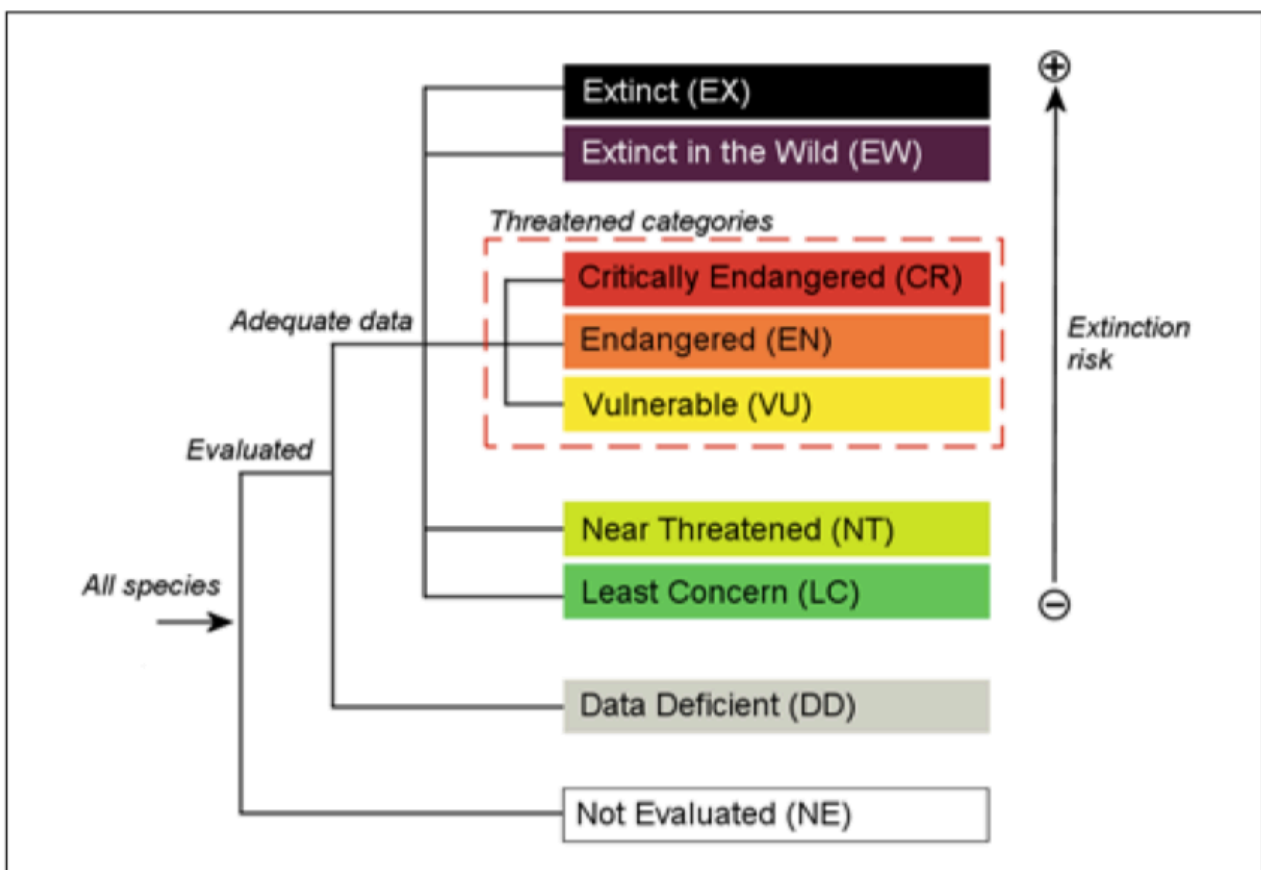


Figure 67: IUCN Red List Conservation Categories

Source: IUCN, 2018



Figure 68: *Halfordia papuana*, Critically Endangered under the IUCN Red List

Source: Botanic Illustrations.org

A widespread tree species *Flindersia pimenteliana* (Rutaceae) recorded from the Park by Hopkins and Hiaso (1994) is listed as ‘Endangered’ on the IUCN Red List (Figure 69). Hopkins and Hiaso provide a drawing of a mature *Flindersia pimenteliana* tree growing near Picnic Area 2 in 1991, however this tree could not be located during the Biodiversity (Flora) Survey. *F. pimenteliana* is widely distributed in hill forests throughout Papua New Guinea, Indonesian New Guinea and Australia.

Both *H. papuana* and *F. pimenteliana* are widely distributed in New Guinea and neither appears to be endangered throughout their range. They have both been scheduled on the IUCN Red List primarily because of over-exploitation in the Wau – Bulolo area of the Morobe Province. There is no compelling reason to treat these species as species of importance within the Park. It is strongly believed that the IUCN accounts for both species require revision.

Appendix 6 presents the IUCN Fact sheet for each species.



Figure 69: *Flindersia pimenteliana*, Endangered under the IUCN Red List

Source: Australian Tropical Rainforest Plants CSIRO, 2018

4.7.2. Near Threatened

Four species from the Park’s checklist (Appendix 2 and Appendix 6) are scheduled as Near Threatened. They comprise the locally common cycad (*Cycas campestris*) (Family Cycadaceae); a Dipterocarp, (*Hopea forbesii*) which is a lowland timber species; *Myristica globosa* (Family Myristicaceae) and *Helicia albiflora* (Family Proteaceae).

Cycas campestris is endemic to PNG with its range largely confined to low altitudes in the Central Province. Habitat loss through clearing and burning of savannah grasslands where it occurs are primary threats to this species.

The Dipterocarps (Family Dipterocarpaceae) are highly sought after by the logging industry throughout PNG and South East Asia given their high value as timber species. *Hopea forbesii* is native to the island of New Guinea (including West Papua) and has a broad distribution from Milne Bay Province to the Sepik and Western Provinces. It has been subjected to an estimated 25% decline in population in the last three generations due to loss of habitat and logging. These impacts have been most severe in Central

and Milne Bay Provinces. The IUCN indicate that this species is borderline 'Vulnerable' (Figure 67).

Myristica globosa is a large mid montane (up to 1,200 m) tree species to 30 m without commercial logging value. Very little data is available regarding its status and key threatening processes.

Helicia albiflora is widespread throughout PNG where it is typically associated with *Castanopsis* and *Nothofagus* dominant forests (PNGTrees, 2018). Little information is available regarding its status in the wild. Appendix 6 presents the IUCN Fact Sheets for each species.

4.8. Endemic Species

There are no species of plants endemic to Varirata National Park, however the locally common cycad *Cycas campestris* is restricted in distribution to the Central Province. Savannah comprises less than 2% of VNP and significant ecological value would be achieved by extending the Park's boundary to include a larger proportion of this habitat.

4.9. Important Species

Several important plant species occur throughout the Park, which comprise critical food sources for a variety of animals within the Park. A selection of these plants is discussed in the following sections.

4.9.1. Sogeri Velvet Bean (*Mucuna macropoda*)

Mucuna macropoda (Figure 70) is a leguminous vine that was collected in 1885 by Henry Forbes from the Sogeri Plateau and named in 1923 (Baker, 1923). It was known only from the holotype until it was re-discovered in 1988 by Helen and Michael Hopkins (Hopkins and Hopkins, 1993).

The genus *Mucuna* includes around 100 species that occur in both the Old World and New World tropics. It includes the familiar Flame of the Forest from New Guinea and

many species are pollinated by bats. Hopkins and Hopkins (1993) reported that *Mucuna macropoda* was pollinated by a small bat (*Syconycteris australis*) that occurs from the Moluccas, throughout New Guinea, including the Bismarck Archipelago, and along the east coast of Australia from Cape York south to the Sydney region. It is abundant throughout much of its range and is one of the most common species of bats found in the Park. *Mucuna macropoda* appears to be restricted, within Varirata National Park, to *Castanopsis* forests (Figure 53).



Figure 70: Common Blossom Bat (*Syconycteris australis*) feeding on *Mucuna macropoda*, VNP

Mucuna macropoda is a vine endemic to the Sogeri Plateau. Photo credit: M.J.G. Hopkins

4.9.1. Birthwort (*Aristolochia momandol*)

Aristolochia momandol is the only known food plant within the Park of the large iconic birdwing butterfly, *Ornithoptera priamus*. This plant is relatively common within primary and late secondary forest within the Park (Figure 71).



Figure 71: *Aristolochia momandol* in secondary forest, VNP

A. momandol is the primary host plant for the Birdwing Butterfly. Photo credit: Angus Fraser

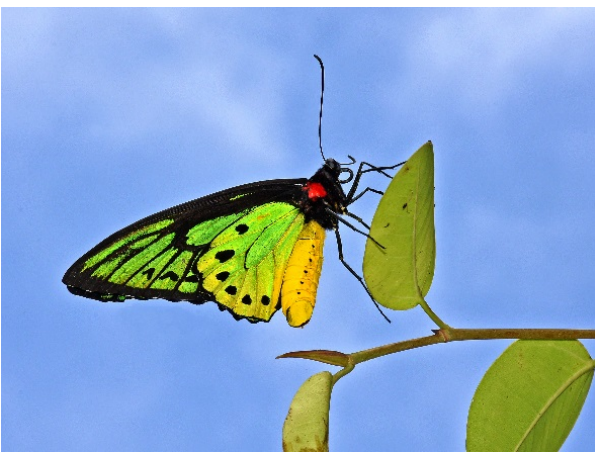


Figure 72: Birdwing Butterfly (*Ornithoptera priamus*)

Photo credit: Dan Polhemus

4.9.2. Tulip (*Gnetum gnemon*)

Gnetum gnemon, a gymnosperm that occurs throughout New Guinea and much of Southeast Asia, is common in the primary forests of Varirata National Park. It is easily recognised by raised rings around the otherwise smooth trunk (Figure 49) and by its paired, expanded leaves, which has given it the Pidgin name of Tulip. The fruits and leaves are edible and the bark is used to produce billum string. Tulip is also an important food plant for many of the frugivorous birds that occur in VNP.

4.9.3. PNG Oak (*Castanopsis acuminatissima*)

The genus *Castanopsis*, a member of the oak family, Fagaceae, includes around 120 species of trees and shrubs concentrated in tropical and subtropical Asia but with a few

species occurring in Japan and close relatives in North America. There is a single species in New Guinea, *Castanopsis acuminatissima*, (Figure 50 - Figure 52) which occurs throughout the island, mostly in lower montane forest from elevations of 800 to 1,800 m, but it can range in some areas down to sea-level and up to around 2,200 m. The fruit, a spiny ovoid nut, is harvested by people in many areas and is an important source of food to many species of parrots. It is common at higher elevations in the Park, particularly in areas around Gare's lookout.

4.9.4. Fruiting Trees

There are at least 26 species of frugivorous birds occurring in Varirata National park (Frith et al., 1998), including, five species of birds of paradise, pigeons, berrypeckers and a diversity of other species. These birds are dependent on fruit produced by various species of primary rain forest trees. Two species of meliaceous trees, *Chisocheton lasiocarpus* and *Dysoxylum pettigrewianum* (Meliaceae) (Figure 73) and a species of *Myristica* (Myristicaceae) are visited almost exclusively by birds of paradise (Beehler and Dumbacher, 1996). Birds of paradise also feed heavily on the fruits from a fig, *Ficus* cf. *obliqua* and from a conifer, *Podocarpus nereifolius* (Podocarpaceae).



© W.T. Cooper

Figure 73: Fruit of *Dysoxylum pettigrewianum* (Family Meliaceae).

Source: Cooper and Cooper (1994)

There are, at least 42 species of *Ficus* found within the Park. One of these species, with small, bright orange fruits, is common at the forest edge. A tree, near the Lodge, was in fruit during November – December 2017 and was commonly visited by Raggiana Birds of Paradise, Brown Orioles, and several species of fruit doves and pigeons (Figure 74). Species of *Syzygium* (Figure 75) produce large, reddish fruit on the lower trunks of the trees; these are eaten by cassowary and other frugivorous birds and mammals.



Figure 74: *Ficus* sp., probably *Ficus rhizophoriphylla*, located near the Lodge, VNP

This species was frequently visited by a number of frugivorous birds, including the Pink-spotted Fruit Dove (*Ptilinopus perlatus*). Photo credit: Allen Allison



Figure 75: *Syzygium* sp., Primary forest, VNP

Photo credit: Angus Fraser

4.10. Introduced Species

IPCA have documented at least 51 species of introduced plants to occur within the Park (Appendix 4).

The introduced flora of VNP includes many of the same species, which occur along the Kokoda Track (Allison et al., 2015). These are mostly restricted to disturbed areas along roads and tracks and include many species of grasses together with a number of common herbaceous weeds such as Tobacco Weed (*Elephantophis mollis*) and *Synedrella* (*Synedrella nodiflora*). These and other weeds are common around the Main Picnic Area, the lakes, Monomu Lodge, roadside verges and other disturbed areas within VNP.

Of the introduced flora, six species have been recorded which warrant Park Management attention. These species comprise: African Tulip Tree (*Spathodea campanulata* Figure 76); lantana (*Lantana camara* Figure 77); Spiderwort (*Tradescantia* sp Figure 78) in addition to Hemp Vine (*Mikania micrantha* Figure 79) and two highly invasive and

problematic species: Spiked Pepper (*Piper aduncum*) and Clidemia (*Miconia crenata*). Both are widely established in secondary forests (Figure 40 and (Figure 42).



Figure 76: African Tulip Tree (*Spathodea campanulata*), VNP

Photo Credit: Allen Allison



Figure 77: Lantana (*Lantana camara*), VNP

Photo Credit: Angus Fraser



Figure 78: Spiderwort (*Tradescantia* sp.) surrounding Clidemia (*Miconia crenata*), VNP

Photo Credit: Angus Fraser



Figure 79: Hemp Vine (*Mikania micrantha*) in flower, VNP

Hemp Vine (*Mikania micrantha*) occurs around the shoreline of the Lake Lifikatabu complex. Photo credit: Angus Fraser

4.11. Potential Invasive Species

There are at least four species of introduced, highly invasive plants growing in the areas surrounding the Park – on the Sogeri Plateau or in the Laloki Valley. These species must be prevented from establishing in the Park, given their significant ecological risk to biodiversity. These species comprise Mexican Sunflower (*Tithonia diversifolia*), Giant Sensitive Plant (*Mimosa pigra*), Sanchezia (*Sanchezia speciosa*), and White Angel’s Trumpet (*Brugmansia candida*).

A detailed discussion on the ecology, potential environmental impacts and proposed management strategies are provided in the Invasive Species Management Plan (ISMP) prepared by IPCA (IPCA, 2018d).



Figure 80: Mexican Sunflower (*Tithonia diversifolia*)

Source: CABI Data Sheet, 2018



Figure 81: Giant Sensitive Plant (*Mimosa pigra*), lower Laloki Valley

The Giant Sensitive Plant does not currently occur in VNP. Image taken in the lower Laloki Valley. Nittyta Simard in frame. Photo credit: Allen Allison



Figure 82: Sanchezia (*Sanchezia speciosa*), Kokoda Track

Sanchezia is common in parts along the Kokoda Track. Photo credit: Allen Allison



Figure 83: White Angel's Trumpet (*Brugmansia candida*)

Photographed along Nairogo Creek, Sogeri Road outside VNP. Photo credit: Allen Allison.

4.12. Composition and Species Richness of Vascular Plant Flora

PNG's tropical forests sit within the greater 'Papuasias Region' including West Papua, the Bismarck Archipelago, and the Solomon Islands and are widely recognised as a major centre of plant diversity (Takeuchi, 2003b). Estimates of the New Guinea Island's plant diversity are significant and range from 11,000 (Collins et al. 1991) for PNG to 20,000-25,000 species for West Papua (Supriatna 1999).

Dr. Shelley James, formerly of Bishop Museum and now with the Royal Botanic Gardens, Sydney (NSW State Herbarium) is currently compiling a checklist for the flora of PNG. Although this work is still in progress there are approximately 1,800 genera and 13,500 species of vascular plants in PNG. There is no doubt that these figures will rise given there are significant knowledge gaps associated with PNG's flora, which remains poorly collected to date (Takeuchi, 2003b).

The 15 most speciose families occurring within the Park are listed in Table 3. IPCA's checklist of the vascular plants found in the Park includes 157 families, 581 genera and 1,126 species. The species total is considered conservative given previous botanical surveys have identified many taxa only to genus and morpho-species. Many of these likely represent the same taxon.

Based on IPCA's literature reviews and field surveys it is estimated that approximately 150 species of ferns, at least eight species of conifers, and between 700 and 900 species of flowering plants occur within VNP. These totals do not include the two species of Araucaria that were planted near the main lookout.

As such, the Park includes representatives from most PNG plant families, nearly a third of the vascular plant genera, and nearly 10% of PNG's vascular plant species. This is extraordinary diversity for a Park that is only

1,063 ha in total area and has negligible variation in elevation (630 to 833 m).

Table 3: Plant Families ranked according to species richness, VNP

NAME	NO.
Orchidaceae	71
Moraceae	55
Rubiaceae	48
Fabaceae	46
Lauraceae	41
Myrtaceae	30
Elaeocarpaceae	25
Poaceae	25
Apocynaceae	24
Phyllanthaceae	24
Euphorbiaceae	24
Malvaceae	23
Rutaceae	23
Sapindaceae	23
Meliaceae	22

PNG’s orchids have been a topic of great interest from botanists and collectors and have been the

focus of taxonomic interest for decades. PNG’s orchids are relatively well known compared with the majority of the country’s other plant taxa. This is reflected in their representation within literature and databases investigated by IPCA when compiling the check lists of plants for VNP.

Alwin Gentry of the Missouri Botanical Garden examined diversity in 226 temperate and tropical forests around the world. In 1989 he worked with Mike Hopkins of UPNG to examine diversity in VNP. Using a standardised protocol of identifying each species of tree with diameter at breast height (dbh) > 10 cm within ten plots of 100 m each, he determined that there were 209 species of trees and lianas within a hectare of primary forest in VNP. The Park was among the five richest forests surveyed worldwide by Gentry (Figure 84).

**Gentry Tropical Tree Plots (-22° to 22°)
Varirata National Park in Red**

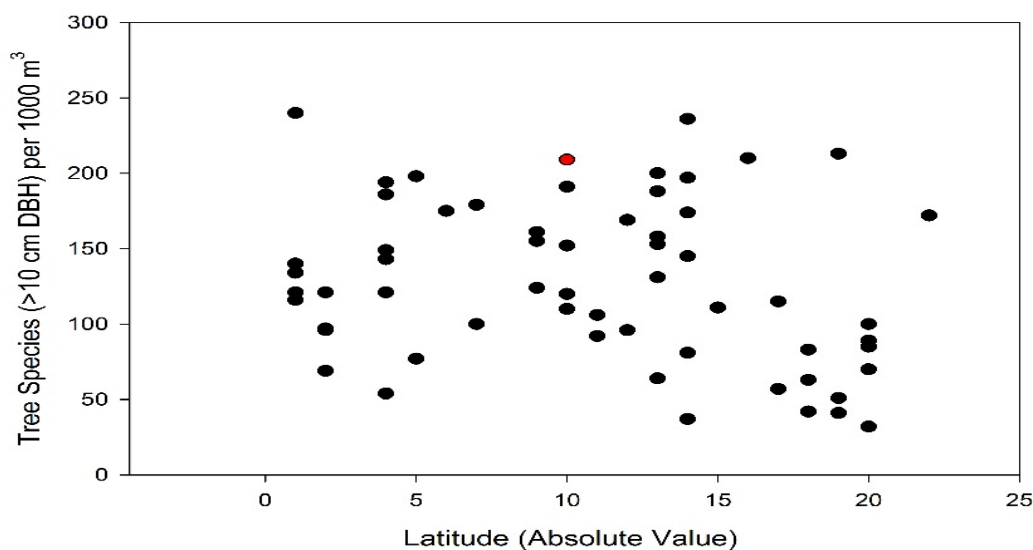


Figure 84: Tropical forest tree species diversity

Tree species diversity in 59 tropical forests of Africa, Indo-Pacific, Australia and the Americas. The result for Varirata National Park is indicated in red in the above figure, it is among the 5th most diverse forest system of those studied by Alwin Gentry (Phillips, O., and J.S. Miller, 2002).

4.12.1. Phenology

Brown and Hopkins (1995; 1996; 2002) established a 3 ha plot in primary forest near Gare’s Lookout in late 1990 and assessed tree flowering and fruiting phenology over 26 months. Their plot included 2,300 individual (permanently tagged) trees with a circumference of 20 cm (roughly a diameter at breast height of 7 cm) represented by 274 species. During their study a few species flowered continuously, some sporadically, some only once during a particularly intense wet season one year and many not at all. Overall, only 60% of the species produced flowers and fruit during the study period.

The proportion of the flora in the primary forest bearing fruit – a general indication of tree phenology – ranged from around 5% to approximately 16% with a peak during the dry season. At least some trees were bearing fruit

at any given time of the year and those with flowers ranged from 10% to 20% with a similar seasonal pattern to the fruiting trees.

These findings in conjunction with the results of IPCA’s field survey suggest that in primary forest flowers and fruit are readily available year-round, as are the nectivorous and frugivorous birds that are dependent on these resources. Although there is clearly a seasonal pattern (Figure 85) it is not particularly pronounced. As Brown and Hopkins (1995; 1996; 2002) demonstrate, unpredictable variation in annual rainfall has a pronounced effect on some plant species and on the nomadic species of birds that depend on them.

The eucalypts (Grey Gum, Ghost Gum and White Gum) that dominate the savannah vegetation generally flower during the dry season.

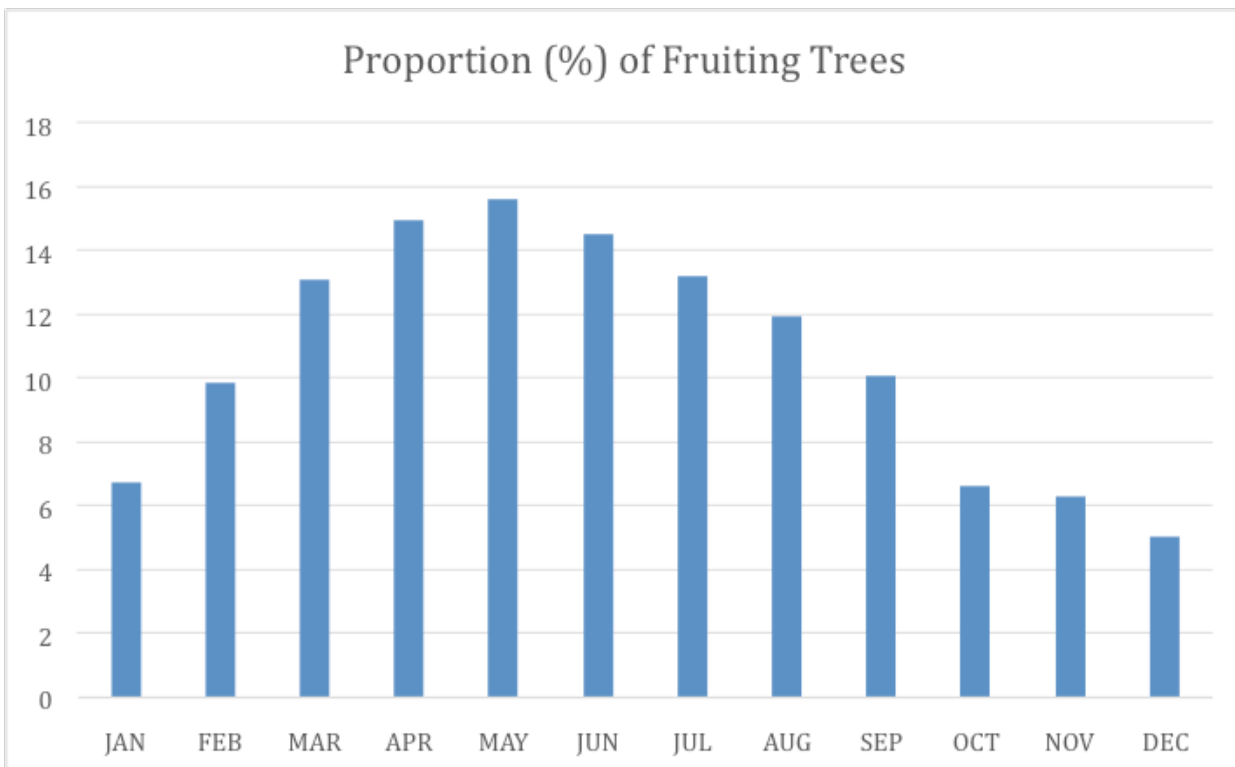


Figure 85: Percentage of trees in primary forest with fruit in VNP

Source: Hopkins & Hiaso, 1994.

4.13. Natural History Field Guide Brochures

In addition to the checklists prepared for each group of taxa, six separate Field Guide Brochures have been prepared for a selection of common and intriguing species likely to be of interest to Park patrons. These brochures briefly describe key characteristics of a number of species to assist Park visitors in their identification of species contained within each brochure. The Field Guide Brochures are as follows:

1. Plants;
2. Invertebrates;
3. Frogs;
4. Reptiles (turtles, lizards and snakes);
5. Birds; and
6. Mammals.

The first Field Guide Brochure issued for Plants of VNP is presented in Appendix 7. The Field Guide Brochures for the fauna species are presented in IPCA's Biodiversity (Fauna) Survey Report (IPCA, 2018c).

5. CONCLUSIONS

PNG's tropical forests sit within the greater 'Papuasia Region' including West Papua, the Bismarck Archipelago, and the Solomon Islands and are widely recognised as a major centre of plant diversity (Takeuchi, 2003b). This places PNG in the centre a 'mega diversity hotspot' (UNEP, 2010). Plant diversity within PNG is significant with estimates ranging from 11,000 (Collins et al. 1991) for PNG to 20,000-25,000 which have been suggested for West Papua alone (Supriatna, 1999). Preparation of a species checklist for the flora of PNG is in progress and currently comprises approximately 1,800 genera and 13,500 species of vascular plants (James, pers.comm). There is no doubt that these figures will rise given there are significant knowledge gaps associated with PNG's flora, which remains poorly collected to date (Takeuchi, 2003b).

The highest diversity of flora is recorded from PNG's lowland forests, which decreases increasing elevation. The medium crowned lowland hill forests that comprise approximately 80% of VNP are species rich and generally poorly known (Takeuchi, 2003b). These forests throughout PNG are subject to a several threatening processes, which are primarily habitat loss and logging.

5.1. Key Vegetation Associations

The botanical survey of the Park confirms three key vegetation associations and five key habitats. Medium crowned lowland hill forest (primary forest), secondary Forest and eucalypt savannah comprise approximately 80%, 18% and <2% of the Park's total area respectively. Aquatic and Disturbed habitats occur in all three associations.

Medium-crowned lowland hill forest includes a rich diversity of tree species with oaks (*Fagaceae*), particularly *Castanopsis acuminatissima* and *Lithocarpus celibicus* often occurring along ridgelines. Forest structure is typically characterised by a closed canopy 25-30 m high, a dense understory of shrubs, small trees and lianas.

Secondary forest communities are dominated by *Casuarina* (*Gymnostoma papuana*) and the extent of these forests within the Park is remarkable. Through natural forest succession this habitat has expanded by more than 200 hectares in less than 50 years. Much of these forests now occupy areas of former grassland from when the Park was officially opened in 1973. Close proximity of a forest seed bank, an absence of fire and limited poaching of forest resources have largely facilitated the successful expansion of secondary forests within VNP. Similarly, since 1992 changes in old secondary forests such as those adjacent to the Main entrance are evident as they now contain a greater composition of primary forest species compared with the almost pure stands of *Gymnostoma* that occur around the Lake Lifikatabu complex in the Main Picnic Area.

At less than 2% of the Park's area, eucalypt savannah is poorly represented despite being a common habitat at low elevations in Central Province. It is however, important ecologically as several species with a restricted range in PNG only occur in these habitats. They include Ghost Gum (*Corymbia papuana*), Grey Gum (*E. tereticornis*) White Gum (*E. alba*), Weeping Paperbark (*Melaleuca leucadendron*) and the cycad (*Cycas campestris*), which is a regional endemic. Furthermore, the eucalypts are particularly critical for a variety of mammals and birds, particularly parrots, which rely on hollows produced by these trees for nesting sites. Increasing the Park's footprint to cover a greater area of eucalypt savannah would comprise a valuable conservation initiative.

The Aquatic habitats within the Park comprise Nairogo Creek and its tributaries, and the Lake Lifikatabu complex. Several species are restricted in their distribution throughout the Park given their dependence on aquatic habitats. These include a species of sedge (*Eleocharis* sp.) from the lake and *Neonauclea* sp a medium sized riparian shrub and native species from the genus *Impatiens*, which are largely confined to watercourses within the park.

Disturbed habitats including landscaped gardens of the Park's picnic areas and roadside verges are dominated by weed species and naturalised grasses.

5.2. Species Richness

IPCA's botanical surveys in conjunction with a detailed analysis of literature including records of past collections undertaken from the Park and the Sogeri Plateau confirm at least 1,126 plant species comprising 581 genera and 157 families. This is considered to be conservative given many of the collection specimens were not identified to species level given an absence of flower or fruit at the time of collection. Brown and Hopkins (1995) demonstrated that flowering and fruiting cycles of tree species within VNP is irregular and does not occur in predictable seasonal cycles reporting only 60% of individual trees flowered during their 26-month study. This variation in flowering and fruiting cycles among species demonstrates that long-term, sustained monitoring effort is necessary to obtain biological data from PNG's tropical forests.

The IPCA 2017-2018 study collected 635 plant specimens, including ground cover, shrubs, epiphytes, lianas and flowering trees. Both studies have contributed greatly to our current understanding of floristics within VNP. There are undoubtedly many new species records to be obtained for the Park with the potential for describing plant species new to science from the Park equally very high.

In broader context, the diversity of flora represented by species accounts from the Park to date is extraordinary. This survey has demonstrated that VNP, which currently only covers 1,063 ha and has negligible range in elevation (630 to 833 m) contains representatives from most of PNG's plant families, nearly a third of the vascular plant genera, and nearly 10% of PNG's vascular plant species. This represents a remarkable proportion of PNG's plant biodiversity. Furthermore, when compared with 59 other tropical forests, VNP ranked within the top 5 for the highest diversity of tree species in

tropical forest ecosystems (Phillips, O., and J.S. Miller. 2002).

It is expected that with further targeted field surveys, additional species records for flora will most certainly be added to the Park's checklists with the potential for describing species new to science considered to be very high.

5.3. Species with Conservation Significance

Six species of plants scheduled with conservation significance under the IUCN Red List are included in the first Checklist of Plants for VNP.

One species is classified as Critically Endangered (*Halfordia papuana*) while a second species, *Flindersia pimenteliana* is scheduled as Endangered. Neither species was collected from the Park during the current surveys, although *F. pimenteliana* was confirmed by Hopkins & Hisao (1994) as occurring within the Park. The distributions of both species co-occur with medium crowned hill forest, which is widely distributed across the country and it is expected that these species are also widely distributed. Their listing under the IUCN Red List is therefore considered questionable and it is believed that these IUCN records require revision.

Of the remaining four species (*Cycas campestris*; *Hopea forbesii*; *Myristica globosa*; and *Helicia albiflora*) all are scheduled as Endangered.

H. albiflora is commonly associated with *Castanopsis* and *Nothofagus* forest communities and has a broad distribution across PNG. Little is known regarding the population status of *Myristica globosa* and both species are considered to be 'low risk' under the 'Near Threatened' category.

The population status of *C. campestris* is comparatively better understood. *Cycas campestris* is endemic to PNG with its range largely confined to low altitudes in the Central Province. Habitat loss through clearing and frequent burning of savannah grasslands where it occurs are the primary threats to this species.

Given that VNP contains less than 2% of eucalypt savannah habitat increasing the Park's footprint to include a greater proportion of savannah would be a tangible measure in affording a greater level of protection to this regionally endemic species.

Hopea forbesii is native to the island of New Guinea (including West Papua) and has a broad distribution from Milne Bay Province to the Sepik and Western Provinces, it has been subjected to an estimated 25% decline in population in the last three generations due to loss of habitat and logging. These impacts have been most severe in Central and Milne Bay Provinces. The IUCN indicate that this species is borderline 'Vulnerable'.

5.4. Introduced Flora & Invasive Species

The introduced fauna of Varirata National Park includes 51 species of exotic plants, the majority (45 species) are common weeds generally associated with roadside verges, and landscaped gardens of the Park's picnic areas. Regular lawn maintenance ensures these species pose little ecological risk to the native plant assemblages in the Park.

The remaining six species are widely recognised as invasives with potential to cause serious ecological impact. Three of these are represented by small populations or individual specimens and can be quickly, and economically eradicated from the Park as strongly recommended. They comprise African Tulip Tree (*Spathodea campanulata*); Spiderwort (*Tradescantia* spp) and Lantana (*Lantana camara*).

The fourth species, Hemp Vine (*Mikania micrantha*) was documented from the foreshore of Lake Lifilikatabu. Further information is required regarding the extent of its distribution throughout the Park.

The remaining two species comprise Clidemia (*Miconia crenata*) and Spiked Pepper (*Piper aduncum*) and both are well established in the Park. Clidemia in particular is a dominant groundcover in secondary forests with

potential to significantly impact floristic diversity and processes of forest succession. The Invasive Species Management Plan (IPCA, 2018d) and Environmental Monitoring Plan (IPCA, 2018a) detail further recommendations regarding the challenges associated with containing and managing these species in the Park.

5.5. Ecological Value of Varirata National Park

The Biodiversity (Flora) Survey has provided critical knowledge required to assist in the development of sound science based resource management strategies crucial to achieving the primary Project Objective of establishing a 'Conservation Management Framework' for Varirata National Park.

The Park's incredible biodiversity, environmental values, cultural significance and educational and ecotourism potential dictates that Varirata National Park represents an outstanding natural asset of high ecological value in PNG's protected area portfolio.

6. REFERENCES

- Alcorn, J.B., B.M. Beehler, J.F. Swartzendruber, Biodiversity Support Program, and Papua New Guinea. Department of Environment and Conservation. 1993. Papua New Guinea Conservation Needs Assessment. Biodiversity Support Program and Govt. of Papua New Guinea, Dept. of Environment and Conservation, Washington, D.C. and Boroko, Papua New Guinea
- Allen, J. 1972. Nebira 4: An early Austronesian site in central Papua. *Archaeology and Physical Anthropology in Oceania* 7(2):92-124.
- Allison, A. 2014. Listing of plant collections made by Henry Ogg Forbes [Visual Foxpro Database Listing].
- Allison, A., and O. Tallwin. 2016. Distribution, diversity and conservation status of the biota along the Kokoda Track with recommendations for its protection. Bishop Museum Technical Report 66:1-281.
- Anonymous. 1880. *Evangelical Magazine and Missionary Chronicle* 1880. Hodder and Stoughton, London. 864 pp.
- Anonymous. 1880. *Geographical Notes. Proceedings of the Royal Geographical Society and Monthly Record of Geography* 2(5):310-318.
- Anonymous. 1883. Later [Letter] from New Guinea [Morrison Expedition to the Owen Stanley Mountains]. *In: Illustrated Sydney News* 29SEP1883 Page 14.
- Anonymous. 1885. NEWSPAPER ARTICLE EX NATIONAL LIBRARY OF AUSTRALIA: *Burrowa News* 16JAN1885 - Moroka.
- Anonymous. 1886. *Geographical notes. Scottish Geographical Magazine* 2(8):499-506.
- Anonymous. 1886. Mr. H.O. Forbes's progress in New Guinea [from Northern Standard, Charters Towers]. *In: South Australian Register*.
- Anonymous. 1886. *Neu Guinea. Deutsche Geographische Blätter* 9:249-253.
- Anonymous. 1898. NEWSPAPER ARTICLE EX NATIONAL LIBRARY OF AUSTRALIA: *Queenslander* 12FEB1898 - Moroka.
- Anonymous. 1898. Sir William Macgregor's late inspection [details on 03 January 1898 Report], p. 312-313. *In: Queensland, Brisbane*.
- Anonymous. 1933. Obituary. Dr. H.O. Forbes. *Nature* 131(3309):460-461.
- Anonymous. 1951. Mount Lamington eruption. Commonwealth of Australia. Territory of Papua Annual Report for the the period 1st July, 1950 to 30th June, 1951:34-36.
- Anonymous. 1982. Problems in the Pacific, with related information. Sogeri National High School, S.I. 19 pp.
- Anonymous. 1990. The Sogeri Village. Expressive Arts Department, Sogeri National High School, Boroko, Papua New Guinea. 46 pp.
- Anonymous. 2012. Preliminary Historic Assessment of Blamey's Garden and Other Selected other WWII Sites in Port Moresby for PNG Department of Environment and Conservation, p. 105. Archaeological & Heritage Management Solutions Pty Ltd, Sydney.
- Aptroot, A. 1998. New lichens and lichen records from Papua New Guinea, with the description of *Crustospathula*, a new genus in the Bacidiaceae. *Tropical Bryology* 14:25-34.
- Aptroot, A., F. Schumm, and M.E.S. Cáceres. 2012. Six new species of *Pyrenula* from the tropics. *Lichenologist* 44(5):611-618.
- Aptroot, A., D. Ertz, J.A. Etayo Salazar, C. Gueidan, J.A. Mercado Diaz, F. Schumm, and G. Weerakoon. 2016. Forty-six new species of Trypetheliaceae from the tropics. *Lichenologist* 48(6):609-638.
- Argus - Australian Newspapers. 1884-1900. Miscellaneous articles dealing with

- Henry Ogg Forbes expedition to Papua New Guinea [downloaded from National Library of Australia].
- Australian National University. Department of Anthropology and Sociology. 1968. An ethnographic bibliography of New Guinea. Australian National University Press, Canberra,
- Australian News and Information Bureau. 1962. Papua and New Guinea 1962.
- Australian Tropical Rainforest Plants: <http://keys.trin.org.au/key-server/data/0e0f0504-0103-430d-8004-060d07080d04/media/Html/index.html>
- Aveskamp, M.M., G.J. Verkley, J. De Gruyter, M.A. Murace, A. Perello, J.H. Woudenberg, J.Z. Groenewald, and P.W. Crous. 2009. DNA phylogeny reveals polyphyly of *Phoma* section *Peyronellaea* and multiple taxonomic novelties. *Mycologia* 101(3):363-82.
- Baas, P., K. Kalkman, and R. Geesink. 1990. The Plant Diversity of Malesia. Proceedings of the Flora Malesiana Symposium Commemorating Professor Dr. C. G. G. I. van Steenis Leiden, August 1989, p. 420. Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Ballantine, D. 1898. Enclosure 6 in Appendix A [Sogeri and Uberi Patrol]. Annual Report of British New Guinea from 1st July, 1897 to 30th June, 1898; with Appendices:16-18.
- Ballantine, D. 1900. Appendix R. Report on inland journey. Annual Report of British New Guinea from 1st July, 1898 to 30th June, 1899; with Appendices: 77-80.
- Basedow, T., and S. Krull. 2005. The occurrence of weeds and the composition and abundance of predatory arthropods in newly sown maize fields in the Central Province of Papua New Guinea. *Zeitschrift fuer Pflanzenkrankheiten und Pflanzenschutz* 112(3):304-311.
- Bean, A.R. 2014. C.T. White's botanical survey and collections from Papua in 1918. *Australbaileya* 9(2):244-262.
- Beaver, W.N. 1920. Unexplored New Guinea: A Record of the Travels, Adventures, and Experiences of a Resident Magistrate amongst the Head Hunting Savages and Cannibals of the Unexplored Interior of New Guinea. Seeley, Service & Co. limited, London. 320 pp.
- Frith, C.B., B.M. Beehler, and W.T. Cooper. 1998. The Birds of Paradise: Paradisaeidae. Oxford University Press, Oxford & New York. xxx+613 pp.
- Bermejo, A., M.J. Lora, M.A. Blázquez, K.S. Rao, D. Cortes, and M.C. Zafra-Polo. 1995. (+)-Goniotharvensin, a novel styryl-lactone from the stem bark of *Goniothalamus arvensis*. *Natural Product Letters* 7(2):117-122.
- Bermejo, A., S. Léonce, N. Cabedo, I. Andreu, D.H. Caignard, G. Atassi, and D. Cortes. 1999. Semisynthesis and Cytotoxicity of Styryl-Lactone Derivatives. *Journal of Natural Products* 62(8):1106-1109.
- Bethell, L.S. 1954. Descriptive list of Papuan papers: accession CP 1, series I, Commonwealth Archives. Department of History, Research School of Social Sciences, Australian National University, Canberra. 156 pp.
- Blake, D.H., J.C. Saunders, J.R. Mcalpine, and K. Pajmans. 1973. No. 32 Land-form Types and Vegetation of Eastern Papua. CSIRO Land Research Surveys 2010(1):1-164.
- Botanic Illustrations.org <http://botanicalillustrations.org/index.php?mobile=0&SID=0>
- British Mycological Society. Symposium (1992 : University of Liverpool), and S. Isaac. 1993. Aspects of tropical mycology: symposium of the British Mycological Society held at the University of Liverpool, April 1992. Published for the British Mycological Society by

- Cambridge University Press, Cambridge, England ; New York, NY, USA. ix+325 pp.
- British New Guinea - Administrator. 1890. British New Guinea: annual report by Her Majesty's Administrator of the Government from 1st July 1889 to 30th June 1890 : with appendices and maps. James C. Beal, Government Printer, Brisbane
- British New Guinea - Administrator. 1893. Annual report on British New Guinea from 1st July 1891 to 30th June 1892 with appendices. James C. Beal, Government Printer, Brisbane
- British New Guinea - Administrator. 1897. Annual report on British New Guinea, from 1st July, 1895, to 30th June, 1896: with appendices. Edmund Gregory, Government Printer, Brisbane
- British New Guinea - Administrator. 1898. Annual report on British New Guinea from 1st July, 1896, to 30th June, 1897: with appendices. Edmund Gregory, Government Printer, Brisbane
- British New Guinea - Administrator. 1899. Annual report on British New Guinea from 1st July, 1897, to 30th June, 1898: with appendices. Edmund Gregory, Government Printer, Brisbane
- British New Guinea - Administrator. 1901. Annual report on British New Guinea from 1st July, 1899, to 30th June, 1900: with appendices. Edmund Gregory, Government Printer, Brisbane
- Brough, E.J. 1983. Seasonal changes in the damage caused by the citrus leaf miner, *Phyllocnistis citrella* (Lepidoptera: Phyllocnistidae) in a lowland orchard in Papua New Guinea. *Science in New Guinea* 10(3):166-171.
- Brown, M.J.F., and University of Papua and New Guinea. Department of Geography. 1970. The Sogeri Plateau. Dept. of Geography, University of Papua and New Guinea, Port Moresby,. 30 pp.
- Brown, W.C. 1991. Lizards of the genus *Emoia* (Scincidae) with observations on their ecology and biogeography. *Memoirs of the California Academy of Sciences* 15:1-94.
- Brune, P. 2003. A Bastard of a Place: The Australians in Papua : Kokoda, Milne Bay, Gona, Buna, Sanananda. Allen & Unwin, Crows Nest, NSW. ix+691 pp.
- Bryan, J.E., and P.L. Shearman. 2015. The State of the Forests of Papua New Guinea 2014: Measuring Change Over the Period 2002-2014, p. 209. University of Papua New Guinea, Port Moresby.
- Burton, J. 2010. Hydro Tasmanis. Naoro-Brown Hydropower Project: Draft Feasibility - Social Baseline Study. ANU Enterprise, Canberra.
- Burton, J. 2015. The Kokoda Initiative – Subcatchment Mapping of Koiari Rural LLG Ward 18, p. 143. ANU edge, Canberra.
- CABI, 2018. Invasive Species Compendium 'Mexican Sunflower *Tithonia diversifolia*'. Wallingford, UK: CAB International. www.cabi.org/isc.
- Carmen González, M., M.A. Sentandreu, K. Sundar Rao, M. Carmen Zafra-Polo, and D. Cortes. 1996. Prenylated benzopyran derivatives from two *Polyalthia* species. *Phytochemistry* 43(6):1361-1364.
- Chalmers, J. 1880. Geographical Notes. *Proceedings of the Royal Geographical Journal* 2(5):310-318.
- Chalmers, J. 1885. *Adventures in New Guinea*. The Religious Tract Society, London
- Chalmers, J., and W.W. Gill. 1885. *Work and adventure in New Guinea, 1877 to 1885*. Religious Tract Society, London. 288 pp.
- Chalmers, J. 1887. *Explorations in South-Eastern New Guinea*. *Proceedings of the Royal Geographical Society and Monthly Record of Geography* 9(2):71-86.

- Chalmers, J. 1887. Pioneering in New Guinea. Religious Tract Society, London,. x+343 pp.
- Chalmers, J. 1895. Pioneer life and work in New Guinea, 1877-1894. The Religious Tract Society, London,. xiv+19+255 pp.
- Chapman, A.G. 2003. Breaking new ground-Part 6: Efogi Mission: Entering New Guinea. *Journal of Pacific Adventist History* 3(2):6-9.
- Chapman, A.G. 2003. Breaking new ground — Part 5: the Koiari School, Bisiatabu, Papua New Guinea. *Journal of Pacific Adventist History* 3(1):12-14.
- Chester, H.N. 1898. Extracts from diary [Enclosure 1 in Appendix A. Annual Report of British New Guinea from 1st July, 1897 to 30th June, 1898; with Appendices:7-9.
- Cleland, D.M. 1964. Address by His Honor the Administrator to the House of Assembly Seminar, Sogeri, on 12th May, 1964, Port Moresby,. 5 . pp.
- Collins, N. M., Sayer, J. A. & Whitmore, T. C. (eds.) (1991): *The Conservation Atlas of Tropical Forests, Asia and the Pacific*. Macmillan Press, London.
- Commonwealth of Australia. 1902. Annual Report on British New Guinea from 1st July, 1900, to 30th June, 1901 with Appendices. Government Printer for the Commonwealth of Australia, Brisbane
- Coode, M.J.E. 1978. A conspectus of Elaeocarpaceae in Papuasias. *Brunonia* 1(2):131-297.
- Coode, M.J.E. 2010. *Elaeocarpus* for Flora Malesiana: new taxa and understanding in the *Ganitrus* group. *Kew Bulletin* 65:355-399.
- Couthard-Clark, C.D. 2000. *Australia's Military Map-Makers: The Royal Australian Survey Corps 1915-96*. Oxford University Press, South Melbourne, Australia. 246 pp.
- Cumming, I.S. 1969. Preliminary investigation of the geology of the proposed Rouna No. 3 Hydro - Electric Power Station, Port Moresby, Papua. Commonwealth of Australia, Department of National Development, Bureau of mineral Resources, Geology and Geophysics Record 69(106):1-8.
- Danser, B.H. 1938. Miscellaneous notes on Loranthaceae 16—18. *Blumea* 3(1):34-59.
- Darwin, S.P. 1994. Systematics of *Timonius* Subgenus *Abbottia* (Rubiaceae-Guettardeae). *Systematic Botany Monographs* 42:1-86.
- Dasmann, R.F. 1988. Biosphere reserves, buffers and boundaries. *BioScience* 38(7):487-489.
- Davies, S.M. 2012. Catalogue of Papuan artefacts associated with Andrew Goldie in the Queensland Museum and the Museum of the Cumbraes, Millport, Scotland. *Memoirs of the Queensland Museum. Culture* 6:163-208.
- Di Gennaro, F., Museo Nazionale Preistorico Ethnografico, and A. Allison. 2013. CORRESPONDENCE: Letters and E-mail correspondence between Allen Allison and Francesco di Gennaro regarding Lamero Loria's 1893 expedition to Moroka, Papua New Guinea.
- Diamond, J.M. 1989. This fellow frog, name belong him Dawko. *Natural History* 98:16,18-20,23.
- Dissanayake, A.J., A.J.L. Phillips, X.H. Li, and K.D. Hyde. 2016. Botryosphaeriaceae: Current status of genera and species. *Mycosphere* 7(7):1001–1073.
- Douglas, J. 1889. Annual report of British New Guinea from 4th September, 1888 to 30th June, 1889 with appendices.
- Drummond, R.M. 1908. Appendix F. Report on lands and surveys *in* Murray, J.H.P. Annual Report. Parliament of the Commonwealth of Australia. Papua

- Annual Report for the year ending 30th June, 1907:67-71.
- Dutton, T.E. 1969. The peopling of central Papua. Pacific Linguistics series B 9:i-vii+1-182.
- Dutton, T.E. 2010. The dialects of Koiari revisited, p. 111-137. *In: A mosaic of language and culture: Studies celebrating the career of Karl J. Franklin.* K. A. McElhanon and G. Reesink (eds.). SIL International, Dallas.
- Eaton, P. 2005. Land tenure, conservation and development in Southeast Asia. RoutledgeCurzon, London; New York, NY. xii+178 pp.
- Eden, M.J. 1974. The origin and status of savannah and grassland in southern Papua. Transactions of the Institute of British Geographers (63):97-110.
- Ferraro, L.I., R. Lücking, and E. Sérusiaux. 2001. A world monograph of the lichen genus *Gyalectidium* (Gomphillaceae). Botanical Journal of the Linnean Society 137(3):311-345.
- Fisher, N.H. 1941. Geological Report on the Sapphire-Moresby King, Laloki, and other Mines, Astrolabe Mineral Field, Papua. Department of National Development, Bureau of Mineral Resources, Geology and Geophysics: Records 1941/9.
- Fisher, N.H. 1941. Geological Report on the Sapphire-Moresby King, Laloki, and other Mines, Astrolabe Mineral Field, Papua. Commonwealth of Australia, Department of National Development, Bureau of Mineral Resources, Geology and Geophysics Records 1941/9:1-13.
- Fitter, R. 1973. Varirata, the first national park in Papua New Guinea, was officially opened in October 1973. Oryx.
- Forbes, H.O. 1885. MAP - 1888 [Included with Annual Report of British New Guinea for 1887 published in 1888] Held in the State library of New South Wales.
- Forbes, H.O. 1887. The Geographical Society and Mr. H.O. Forbes. *In: Argus*, Melbourne.
- Forbes, H.O. 1888. On attempts to reach Owen Stanley Peak. Scottish Geographical Magazine 4(8):401-415.
- Forbes, H.O. 1890. The Owen Stanley Range, New Guinea. Proceedings of the Royal Geographical Society and Monthly Record of Geography 12(9):558-563.
- Freeman, J. 2014. [Details on map holdings in the State Library of Queensland relating to Henry Ogg Forbes and his expeditions to the Owen Stanley Range, New Guinea].
- Frodin, D.G., and J.L. Gressitt. 1982. Biological exploration in New Guinea, p. 87-130. *In: Biogeography and Ecology of Papua New Guinea.* Vol. 1. J. L. Gressitt (ed.). Dr W. Junk Publishers, The Hague.
- Frodin, D.F. 2007. Biological Exploration of New Guinea, p. 14-107. *In: The Ecology of Papua.* Part Two. A. J. Marshall and B. M. Beehler (eds.). Periplus, Singapore.
- Gare, N. 1986. The marking of a national park. Parks 11(4):13-18.
- Geographic, A. 2011. MAP: The Kokoda Trail, Papua New Guinea. Walker's map and poster. Adventure Kokoda Pty Ltd, P.O. Box Camden, NSW, Australia.
- Gerard, J.M.V., and H.A. Van Der Aa. 1997. *Endomelanconium microsporum*, a New Coelomycete Isolated from Soil in Papua New Guinea. Mycologia 89(6):967-970.
- Gibson, G.H., J. Gibson, and G.H. Gibson. 1935. Papers of Graham Gibson, 1935-1987, p. 4.76 m. (34 boxes).
- Goldman, L. 2009. Papua New Guinea Liquefied Natural Gas Project. Social Impact Assessment 2008.
- González, M.C., C. Zafra-Polo, M.A. Blázquez, A. Serrano, and D. Cortes. 1997. Cerasodine and Cerasonine: New Oxoprotoberberine Alkaloids from

- Polyalthia cerasoides*. *Journal of Natural Products* 60(2):108-110.
- Gonzalez-Orozco, C.E., M.C. Ebach, S. Laffan, A.H. Thornhill, N.J. Knerr, A.N. Schmidt-Lebuhn, C.C. Cargill, M. Clements, N.S. Nagalingum, B.D. Mishler, and J.T. Miller. 2014. Quantifying phytogeographical regions of Australia using geospatial turnover in species composition. *PLoS ONE* 9(3):e92558.
- Goodger, D.R. 1954. Papua New Guinea patrol reports and related correspondence, 1954-1988. Pacific Manuscripts Bureau, Canberra. 1 microfilm reel pp.
- Goodger, D.R. 1955. Patrol reports and correspondence of D.R. Goodger, Papua New Guinea.
- Grafe, T.U., and R.J. Kohout. 2013. A new case of ants nesting in *Nepenthes* pitcher plants. *Biotropica* 19:77-80.
- Grimshaw, B. 1911. *The New New Guinea*. Hutchinson, London. viii +322 pp.
- Haddon, A.C. 1894. *The ethnography of British New Guinea*. II. Guide to the literature. *Science Progress* 2:226-248.
- Haddon, A.C. 1900. Studies in the Anthropogeography of British New Guinea (Continued). *The Geographical Journal* 16(4):414-440.
- Haddon, A.C. 1900. Studies in the Anthropogeography of British New Guinea. *Geographical Journal* 16(4):414-440.
- Hahn, F. 1891. *Geographische Ergebnisse der Wissenschaftlichen Reisen, Forschungsexpeditionen oder Landesaufnahmen. Australien und Polynesien 1885—89*. *Geographisches Jahrbuch* 14:31-61.
- Harrington, G.N., M.G. Bradford, and K. Sanderson. 2005. *The Wet Sclerophyll and Adjacent Forests of North Queensland. A Directory to Vegetation and Physical Survey Data*. 69 pp.
- Hartley, T.G. 1986. Floristic relationships of the rainforest flora of New Guinea. *Telopea* 2(6):619-630.
- Hartley, T.G. 2000. On the taxonomy and biogeography of *Euodia* and *Melicope* (Rutaceae). *Allertonia* 8(1):1-319.
- Hawthorne, S. 2003. *The Kokoda Trail: A History*. Central Queensland University Press, Queensland. xiv +269 pp.
- Hawthorne, S. 2011. *Port Moresby: Taim Bipo*. Boolarong Press, Moorooka, Qld. x+310 pp.
- Hays, T.E. 2014. [New Guinea Anthropology Bibliography].
- Hays, T.E. 2015. FIND DATA FILES: Central Province, Papua New Guinea.
- Heads, M. 2006. Panbiogeography of *Nothofagus* (Nothofagaceae): analysis of the main species massings. *Journal of Biogeography* 33(6):1066-1075.
- Healey, C. 1932. Patrol Report - Owen Stanley Range - Port Moresby District - extracted from National Archives & Public Records Services of Papua New Guinea 1928-1932 Patrol Reports. District: Central. Station: Port Moresby. Volume 1. Accession No. 498 1928-1932.
- Hedger, J., P. Lewis, and H. Gitay. 1993. Litter-trapping by fungi in moist tropical forest, p. 15-36. *In: Aspects of Tropical Mycology: Symposium of the British Mycological Society held at the University of Liverpool, April 1992*. Published for the British Mycological Society by Cambridge University Press, Cambridge, UK.
- Hennessy, J.M. 1896. A few months' experience in New Guinea. *Proceedings of the Queensland Branch of the Geographical Society of Australasia* 1:106-116.
- Henty, E.E. 1969. *A Manual of the Grasses of New Guinea* Division of Botany, Lae. 214 pp.

- Henty, E.E., and G.H. Pritchard. 1998. Weeds of New Guinea and their Control [4th edition, reprinted]. Division of Botany, Department of Forests, Lae, Papua New Guinea. 186 pp.
- Heyligers, P.C. 1965. Vegetation and ecology of the Port Moresby - Kairuku area in No. 14 Lands of the Port Moresby-Kairuku Area, Territory of Papua New Guinea. CSIRO Land Research Surveys 14:146-173.
- Heyligers, P.C. 1965. Lands of the Port Moresby - Kairuku area, Papua - New Guinea. Part VIII. Vegetation and ecology of the Port Moresby - Kairuku area. CSIRO Aust. Land Res. Ser. No. 14:146-173.
- Heyligers, P.C. 1966. Observations on *Themeda australis-Eucalyptus* Savannah in Papua. Pacific Science 20(4):477-489.
- Heyligers, P.C. 1972. Reference List for Distribution Data of Taxa Occurring in the Port Moresby Area. CSIRO Division of Land Research, Canberra.
- Heyligers, P.C. 1972. Analysis of the Plant Geography of the Semideciduous Scrub and Forest and the Eucalypt Savannah near Port Moresby. Pacific Science 26(2):229-241.
- Hitchcock, P., and A.J. Gabriel. 2015. World Heritage tentative listed sites In Papua New Guinea, p. 224. OCConsulting, Cairns, Australia.
- Höft, R. 1992. Plants of New Guinea and the Solomon Islands. Dictionary of the Genera and Families of Flowering Plants and Ferns. Wau Ecology Institute. Handbook No. 13, Wau, Papua New Guinea
- Hook, M. 2013 [downloaded]. Lotu bilong Sevenday: Early Adventism in Papua New Guinea. Booklet 27. Adventist Education. South Pacific Department of Education, Wahroonga, NSW, Australia. 22 pp.
- Hopkins, H.C.F., and M.J.G. Hopkins. 1993. Rediscovery of *Mucuna macropoda* (Leguminosae: Papilionoideae), and its pollination by bats in Papua New Guinea. Kew Bulletin 48(2):297-305.
- Hopkins, M., and J. Hiaso. 1994. Varirata: National Park, Trail Guide. Christensen Research Institute. Publication 11, Madang. 80 pp.
- Hoskin, C.J., and P.J. Couper. 2012. Description of two new *Carlia* species (Reptilia: Scincidae) from north-east Australia, elevation of *Carlia pectoralis inconnexa* Ingram & Covacevich 1989 to full species status, and redescription of *Carlia pectoralis* (de Vis 1884). Zootaxa 3546:1-28.
- Huxley, C.R. 1978. The Ant-Plants *Myrmecodia* and *Hydnophytum* (Rubiaceae), and the Relationships between their Morphology, Ant Occupants, Physiology and Ecology. New Phytologist 80(1):231-268.
- Huxley, C.R., and M.H.P. Jebb. 1993. The tuberous epiphytes of the Rubiaceae 5: A revision of *Myrmecodia*. Blumea 37:271-334.
- Huynh, K.-L. 2000. The genus *Freycinetia* (Pandanaeae) in New Guinea (part 3). Candollea 55:283-306.
- Huynh, K.-L. 2002. The Genus *Freycinetia* (Pandanaeae) in New Guinea (part 6). Candollea 57(1):55-65.
- Independent State of Papua New Guinea - Ministry of Agriculture and Livestock. 2007. National Agriculture Development Plan 2007-2016.
- Indo-Pacific Conservation Alliance. 2018a Environmental Monitoring Plan, Biodiversity Survey of Varirata National Park: Project for Biodiversity Conservation Through Implementation of the Papua New Guinea Policy on Protected Areas. IPCA Doc No. 023
- Indo-Pacific Conservation Alliance. 2018c Biodiversity Survey (Fauna) of Varirata National Park: Project for Biodiversity Conservation Through Implementation

- of the Papua New Guinea Policy on Protected Areas. IPCA Doc No. 025
- Indo-Pacific Conservation Alliance. 2018d Invasive Species Management Plan, Biodiversity Survey of Varirata National Park: Project for Biodiversity Conservation Through Implementation of the Papua New Guinea Policy on Protected Areas. IPCA Doc No. 022
- Irwin, P.F. 1913. Report on the affairs and working of the Central Division for the year ended 30th June, 1913. Parliament of the Commonwealth of Australia. Papua Annual Report for the year 1912-1913:90-93.
- Ison, B. 1974. Report of the cultural visit by students of Sogeri Senior High School to Irian Jaya during the national independence day celebrations. Publisher not identified, Port Moresby. 32 pp.
- Ison, B., and Sogeri Senior High School. 1975. Asimba : a collection of designs by young artists from Sogeri Senior High School. Expressive Arts Department, Sogeri Senior High School, Sogeri, Papua New Guinea. 40 pp.
- Ison, B., and Sogeri Senior High School. Expressive Arts Department. 1975. Tairu : commemorating the independence of Papua New Guinea. Sogeri Senior High School, Sogeri, P.N.G. 124 pp.
- Ito, C., Y. Miyamoto, K.S. Rao, and H. Furukawa. 1996. A novel dibenzofuran and two new xanthenes from *Calophyllum paniciflorum*. Chemical and Pharmaceutical Bulletin (Tokyo) 44(2):441-443.
- Ito, C., Y. Miyamoto, M. Nakayama, Y. Kawai, K.S. Rao, and H. Furukawa. 1997. A novel depsidone and some new xanthenes from *Garcinia* species. Chemical and Pharmaceutical Bulletin (Tokyo) 45(9):1403-1413.
- James, K. 2009. "The track" A historical desktop study of the Kokoda Track, p. 73. Department of Environment, Water, Heritage, and the Arts, Canberra.
- James, S 2018. Pers.comm. Royal Botanic Gardens, Sydney (New South Wales State Herbarium)
- JICA , 2018 <https://www.jica.go.jp/png/english/activities/activity18.html#a01>
- Johns, R. 2007. An introduction to the New Guinea database, with notes on the Zingiberaceae, specifically *Riedelia* Oliv. Gardens' Bulletin Singapore 59(1&2):89-104.
- Johns, R., O. Gideon, J. Simaga, T. Kuria, and G. Bagoera. 2009. An introduction to the flora of the Milne Bay Archipelago. Blumea - Biodiversity, Evolution and Biogeography of Plants 54:251-254.
- Johnston, F. 1934. Papers, 1934-1990. 1 microfilm reel pp.
- Johnston, A.L., and E.L. Johnston. 1944. Papers, 1944-1983. 1 microfilm reel pp.
- Johnston, A.L., E.L. Johnston, E.M. Johnston, and J. Bridge. 1993. Johnston family papers : correspondence, miscellaneous papers, certificates, maps, photographs, 1934-1990. *In*: Pmb 1054. Pacific Manuscripts Bureau,, Canberra, ACT.
- Jorim, R.Y., S. Korape, W. Legu, M. Koch, L.R. Barrows, T.K. Matainaho, and P.P. Rai. 2012. An ethnobotanical survey of medicinal plants used in the eastern highlands of Papua New Guinea. Journal of Ethnobiology and Ethnomedicine 8(1/47):1-17.
- Kemung, H., T.K. Matainaho, L.R. Barrows, and P.P. Rai. 2014. Exploring the antimicrobial properties of fungal endophytic metabolites from tropical rainforest lianas of Papua New Guinea. *In*: Proceedings of RST UPNG Sci. Conf. Nov 2014.
- King, B., and P.J. Hughes. 1998. Protected Areas in Papua New Guinea, p. 383-405. *In*: Modern Papua New Guinea. L. Zimmer-

- Tamakoshi (ed.). Thomas Jefferson University Press, Kirksville, Mo.
- Klein, W.C., A.J. Beversluis, and A.F. Kuysten. 1953. Nieuw Guinea: De Ontwikkeling op Economisch, Sociaal en Cultureel Gebied, en Nederlands en Australisch Nieuw Guinea. Met Tijdelijke Redactionele Medewerking [Volume 03]. Staatsdrukkerij- en Uitgeverijbedrijf, 's-Gravenhage,. 3 volumes. pp.
- Knight, W.J. 2010. Leafhoppers (Cicadellidae) of the Pacific. An annotated systematic checklist of the leafhoppers recorded in the Pacific region during the period 1758 – 2000.
<http://www.tymbal.org/publicat/KnightCatalogue.pdf>.
- Kokoda Initiative. 2013. Joint Planning Meeting - 4-6 March 2013 - PNG National Museum.
- Kokoda Initiative. 2014. Annual Report 2012-2013.
- Kokoda Initiative. 2016. Annual Report 2014-2015.
- Krieger, M. 1899. Neu-Guinea [excerpt on exploration]. A. Schall, Berlin,. xii+535 pp.
- Krieger, M. 1899. Neu-Guinea. A. Schall, Berlin,. xii+535 pp.
- Kruseman, M.J.V.S., and Nationaal Herbarium Nederland. 2013. Cyclopaedia of Collectors: James Chalmers.
- Kruseman, M.J.V.S., and Nationaal Herbarium Nederland. 2013. Cyclopaedia of Collectors: William George Lawes.
- Kruseman, M.J.V.S., and Nationaal Herbarium Nederland. 2013. Cyclopaedia of Collectors: Henry Ogg Forbes.
- Kruseman, M.J.V.S., and Nationaal Herbarium Nederland. 2014. Cyclopaedia of Collectors: Carl Hunstein.
- Lal, B.V., and V. Luker. 2008. Telling Pacific Lives: Prisms of Process
- Laloo, D., A. Trevett, J. Black, J. Mapao, S. Naraqi, D. Owens, R. Hutton, R.D.G. Theakston, and D.A. Warrell. 1994. Neurotoxicity and haemostatic disturbances in patients envenomed by the Papuan black snake (*Pseudechis papuanus*). *Toxicon* 32(8):927-936.
- Lampert, R.J. 1968. Some Archaeological Sites of the Motu and Koiari Areas. Research School of Pacific Studies, Australian National University, Canberra. 28 pp.
- Lane-Poole, C.E. 1925. The forest resources of the territories of Papua and New Guinea:. Government Printer for the government of the Commonwealth of Australia, 1925
- Lawes, W.G. 1884. Recent Explorations in South-Eastern New Guinea. Proceedings of the Royal Geographical Society and Monthly Record of Geography 6(4):216-218.
- Lawes, P., and Sogeri National High School. Expressive Arts Department. 1978. Wati kui : drawings. Sogeri National High School, Expressive Arts Dept., Sogeri. 45 leaves pp.
- Lea, D.a.M., N. Clark, and R.G. Ward. 1975. Geographers in Papua New Guinea: a preliminary bibliography. *Australian Geographer* 13(2):104-145.
- Legra, L., X. Li, and A. Townsend Peterson. Biodiversity consequences of sea level rise in New Guinea. *Pacific Conservation Biology* 14(3):191-199.
- Lennox, C. 1902. James Chalmers of New Guinea, missionary, pioneer, martyr. A. Melrose, London. xv+208 pp.
- Lewis, D.C. 1996. The Plantation Dream [details on Alearce Savery Anthony]. *Journal of Pacific History*, Australian National University, Canberra
- Lewis, D.C. 1996. The Plantation Dream [details on Alearce Savery Anthony]. *Journal of Pacific History*, Australian National University, Canberra

- Light Railways Society of Australia. 2017. Index - Contents. Light Railways of Australia,.
- Lindt, J.W. 1887. Picturesque New Guinea. Longmans, Green and Co., London. xviii + 194 pp.
- Lombard, L., J. Houbraken, C. Decock, R.A. Samson, M. Meijer, M. Réblová, J.Z. Groenewald, and P.W. Crous. 2016. Generic hyper-diversity in Stachybotriaceae. *Persoonia : Molecular Phylogeny and Evolution of Fungi* 36:156-246.
- Lücking, R., and E. Sérusiaux. 1992. *Gyalideopsis Cochlearifer*, a New Pantropical, Commensalistic Species on Foliicolous Gomphillaceae. *Lichenologist* 30(6):543-549.
- Lücking, R., and E. Sérusiaux. 1996. *Musaespora kalbii* (lichenized Ascomycetes: Melanommatales), a new foliicolous lichen with a pantropical distribution. *Nordic Journal of Botany* 16(6):661-668.
- Lücking, R., and A. Vězda. 1998. Taxonomic studies in foliicolous species of the genus *Porina* (lichenized Ascomycotina: Trichotheliaceae) — II. The *Porina* epiphylla group. *Willdenowia* 28(1-2):181-225.
- Lücking, R., E. Sérusiaux, and A. Vězda. 2005. Phylogeny and systematics of the lichen family Gomphillaceae (Ostropales) inferred from cladistic analysis of phenotype data. *Lichenologist* 37(2):123-170.
- Lumbsch, H.T., and J.A. Elix. 1993. Notes on the circumscription of the lichens *Lecanora leprosa* and *L. sulphurescens* (Lecanoraceae, lichenised Ascomycotina). *Tropical Bryology* 7:71-75.
- Lumbsch, H.T., G.B. Feige, and J.A. Elix. 1994. Chemical variation in two species of the *Lecanora subfusca* group (Lecanoraceae, lichenized Ascomycotina). *Plant Systematics and Evolution* 191(3):227-236.
- Mabberley, D.J., C.M. Pannell, and A.M. Sing. 1995. Meliaceae. *Flora Malesiana* 12(1):1-407.
- Mabbutt, J.A., P.C. Heyligers, R. Pullen, R.M. Scott, and J.G. Speight. 1965. Lands of the Port Moresby - Kairuku area, Papua - New Guinea. Part III. Land systems of the Port Moresby - Kairuku area. *CSIRO Aust. Land Res. Ser. No. 14*:19-82.
- Mabbutt, J.A., P.C. Heyligers, R.M. Scott, R. Pullen, E.A. Fitzpatrick, J.R. Mcalpine, and J.G. Speight. 1965. No. 14 Lands of the Port Moresby—Kairuku Area, Territory of Papua New Guinea. *CSIRO Land Research Surveys* 2010(1):1-192.
- Macgregor, W. 1885. British New Guinea. *Scottish Geographical Magazine* 11(4):161-180.
- Macgregor, W. 1897. British New Guinea country and people. John Murray, London. 100 pp.
- Macgregor, W. 1898. Annual Report. Annual Report of British New Guinea from 1st July, 1897 to 30th June, 1898; with Appendices: V-XLVI+1-18.
- Macgregor, W. 1898. Appendix A. Despatch reporting visit of inspection to district lying between Port Moresby and the headwaters of the Goldie and Brown rivers. Annual Report of British New Guinea from 1st July, 1897 to 30th June, 1898; with Appendices:1-18.
- Mack, A.L. 1998. A Biological Assessment of the Lakekamu Basin, Papua New Guinea, p. 187. *In: RAP Working Papers. Vol. 9. Conservation International, Washington, D.C.*
- Mack, A.L., and D.D. Wright. 2005. The frugivore community and the fruiting plant flora in a New Guinea rainforest: identifying keystone frugivores, p. 185-203. *In: Tropical Fruits and Frugivores: The Search for Strong Interactors. J. L. Dew and J. P. Boubli (eds.). Springer, Netherlands.*

- Mack, A.L., and D.D. Wright. 2011. Training Manual for Field Biologists in Papua New Guinea. Green Capacity. 173 pp.
- Mackay, K. 1909. Across Papua. Witherby & co., London,. xvi+192 pp.
- Maitland, A.G. 1893. Geological observations in British New Guinea in 1891. Annual Report of British New Guinea from 1st July 1891, to 30th June, 1892; with Appendices:53-84.
- Manser, W. 1974. Earth science abstracts, Papua New Guinea, to 1971. Bulletin, Department of Minerals and Energy, Bureau of Mineral Resources, Geology and Geophysics 143:i-iv+1-444.
- Martini, A.M.Z., P. Fiaschi, A.M. Amorim, and J.L. Da Paixão. 2007. A hot-point within a hot-spot: a high diversity site in Brazil's Atlantic Forest. *Biodiversity Conservation* 16:3111-3128.
- May, R.J. 1984. Kaikai Aniani: A Guide to Bush Foods, Markets, and Culinary Arts of Papua New Guinea. Robert Brown & Associates, Bathurst, N.S.W., Australia. 192 pp.
- Mayo, J. 1969. The Protectorate of British New Guinea 1884-1888: an oddity of empire, p. 77-99. *In: The history of Melanesia : papers delivered at a seminar sponsored jointly by the University of Papua and New Guinea, the Australian National University, the Administrative College of Papua and New Guinea, and the Council of New Guinea Affairs held at Port Moresby from 30 May to 5 June 1968.* K. S. Inglis (ed.). University of Papua and New Guinea and Research School of Pacific Studies, Australian National University, Port Moresby and Canberra.
- Mayo, J. 1969. The German Empire in Melanesia 1884-1914: a German self-analysis, p. 45-76. *In: The history of Melanesia : papers delivered at a seminar sponsored jointly by the University of Papua and New Guinea, the Australian National University, the Administrative College of Papua and New Guinea, and the Council of New Guinea Affairs held at Port Moresby from 30 May to 5 June 1968.* K. S. Inglis (ed.). University of Papua and New Guinea and Research School of Pacific Studies, Australian National University, Port Moresby and Canberra.
- Mccarthy, D., and Australian War Memorial. 1959. South-west Pacific Area - First Year : Kokoda to Wau. Australian War Memorial, Canberra. xiv+656 pp.
- Mcneely, J.A., D.C. Pitt, and International Union for Conservation of Nature and Natural Resources. 1985. Culture and conservation : the human dimension in environmental planning. Croom Helm, London ; Dover, N.H. xi+308 pp.
- Menzies, J.I. 1999. A study of *Albericus* (Anura: Microhylidae) of New Guinea. *Australian Journal of Zoology* 47(4):327-360.
- Miller S. (Ed). 1994. Status of biodiversity in Papua New Guinea: Papua New Guinea Country Report on Biological Diversity. Waigani: The Department of Environment and Conservation, Conservation Resource Centre and the Africa Centre for Resources and Environment (ACRE); 67-95.
- Moore, C. 2003. New Guinea: Crossing Boundaries and History. University of Hawai'i Press, Honolulu. xiv+274 pp.
- Morden, C.W., D.E. Gardner, and D.A. Weniger. 2003. Phylogeny and biogeography of Pacific *Rubus* subgenus *Idaeobatus* (Rosaceae) species: investigating the origin of the endemic Hawaiian raspberry *R. macraei*. *Pacific Science* 57(2):181-197.
- Mueller, F.V., R.W. Home, A.M. Lucas, S. Maroske, D.M. Sinkora, J.H. Voigt, and M. Wells. 1998. *Regardsfully Yours: Selected Correspondence of Ferdinand von Mueller* [material relating to Henry Ogg Forbes]. Peter Lang, Bern; New York

- Murray, J.H.P. 1912. Papua: or, British New Guinea. T. Fisher Unwin, London. 388 pp.
- Murray, J.H.P., and Australia. Department of Territories. Territory of Papua. 1922. Index to British New Guinea annual reports, 1886 to 1906. E.G. Baker, Port Moresby. 44 pp.
- Murray, J.H.P. 1925. Papua of To-day or an Australian Colony in the Making [excerpts on exploration]. P. S. King, London,. xvi+308 pp.
- Murray, N. 2010. Education officer, T.P.N.G. : a story of my first five years teaching in the territory of Papua and New Guinea, 1958-1962. Neil Murray, Cairns, Qld. 247 pp.
- Nairne, W.P. 1913. Greatheart of Papua (James Chalmers). H. Milford, London; New York. 229 pp.
- National Library of Australia. [Biographical cuttings on Don McColm, former manager of the Tiaba Estates, on Sogeri Road, PNG, containing one or more cuttings from newspapers or journals]
- Neldner, V.J., R.E. Niehus, B.A. Wilson, W.J.F. Mcdonald, and A.J. Ford. 2014. The Vegetation of Queensland. Descriptions of Broad Vegetation Groups. Version 1.1. Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts, Brisbane. 238 pp.
- Nelson, H. 2003. Kokoda: The Track from History to Politics. *Journal of Pacific History* 38(1):109-127.
- Nelson, H. 2007. Kokoda: and two national histories. *Journal of Pacific History* 42(1):63-88.
- Nelson, H., C. Ballard, J. Burton, N. Haley, D. Temu, E. Maidment, and K. Moloney. 2009. Kokoda Track-Brown River Catchment Region Preliminary Social Mapping Study. ANU Enterprise, Canberra.
- Newsome, D. 2015. Conflict between cultural attitudes, development and ecotourism: the case of bird watching tours in Papua New Guinea, p. 194-210. *In: Animals and Tourism: Understanding Diverse Relationships*. K. Markwell (ed.).
- Noku, S.K., J.O. Espi, and H. Matsueda. 2012. Magmatic contributions to the mineralization of the Laloki and Federal Flag strata-bound massive sulfide deposits, Papua New Guinea: Sulfur isotope evidence. *In: PNG Research, Science and Technology Conference (Pacific Adventist Univ., Port Moresby, June 25–29, 2012)*, At Pacific Adventist University, Port Moresby, Papua New Guinea.
- Noku, S.K., H. Matsueda, J.O. Espi, and M. Akasaka. 2012. Petrology, Geochemistry, and Fluid Inclusion Microthermometry of Sphalerite from the Laloki and Federal Flag Strata-Bound Massive Sulfide Deposits, Papua New Guinea: Implications for Gold Mineralization. *Resource Geology* 62(2):187-207.
- Noku, S.K., J.O. Esp, and H. Matsueda. 2015. Involvement of magmatic fluids at the Laloki and Federal Flag massive sulfide Cu–Zn–Au–Ag deposits, Astrolabe mineral district, Papua New Guinea: sulfur isotope evidence. *Mineralium Deposita* 50:55-64.
- NSW State Herbarium, *Castanopsis* image.
- Nye, P.B., and N.H. Fisher. 1954. The mineral deposits and mining industry of Papua-New Guinea. Commonwealth of Australia, Department of National Development, Bureau of Mineral Resources, Geology and Geophysics. Report No. 9.
- Nye, P.B., and N.H. Fisher. 1954. The mineral deposits and the mining industry of Papua - New Guinea. Commonwealth of Australia, Department of National Development, Bureau of Mineral

- Resources, Geology and Geophysics Records 1954/9:1-34.
- Oatham, M., and B.M. Beehler. 1998. Richness, taxonomic composition, and species patchiness in three lowland forest treeplots in Papua New Guinea, p. 613-631. *In*: Forest Biodiversity Research, Monitoring and Modeling. Conceptual Background and Old World Case Studies. F. Dallmeier and J. A. Comiskey (eds.). UNESCO, Paris.
- Ohff, H.-J.R. 2008. Empires of enterprise: German and English commercial interests in East New Guinea 1884 to 1914, p. 449. *In*: School of History and Politics. Vol. PhD. University of Adelaide, Adelaide.
- O'malley, J.T., and T. Miller. 1914. Magisterial reports: Central Division [Rigo Patrols - includes map of Sogeri - Moroka area]. Parliament of the Commonwealth of Australia. Papua Annual Report for the year ending 30th June, 1914:26-30.
- O'shea, M. 1991. The reptiles of Papua New Guinea. British Herpetological Society Bulletin 37:15-32.
- Paijmans, K. 1973. Landform-form types and vegetation of eastern Papua. Part VI. Vegetation of eastern Papua. Land Research Series, Commonwealth Scientific and Industrial Research Organization 32:89-125.
- Pain, C.F. 1983. Volcanic rocks and surfaces as indicators of landform age: the astrolabe agglomerate, Papua New Guinea. Australian Geographer 15(6):376-381.
- Paine, J.R., International Union for Conservation of Nature and Natural Resources, South Pacific Regional Environment Programme, and IUCN Commission on National Parks and Protected Areas. 1991. IUCN directory of protected areas in Oceania. IUCN, Gland, Switzerland. xxiv+447 pp.
- Papua New Guinea Electoral Commission. 2012. [Details on village polling stations for the 23 June 2012 polling scheduled for the Kairuku-Hire Electorate - includes details on villages in the Moroka District].
- Papua New Guinea Forest Stewardship Council National Initiative, and WWF Papua New Guinea. 2006. High conservation value forest toolkit for Papua New Guinea Papua New Guinea Forest Stewardship Council National initiative, WWF Papua New Guinea, Boroko
- Papua New Guinea Sustainable Development Program. 2011. Annual Report Summary 2010.
- Papua New Guinea. Department of Works and Supply., K.B. Saville, and M.B. Oubuku. 1982. Longitudal section of the Kokoda Trail : as in May 1982. DWS, Department of Works and Supply ;, Boroko, Papua New Guinea.
- Papua New Guinea. National Mapping Bureau., and Papua New Guinea. Department of Natural Resources. 1977. "Varirata" National Park. National Mapping Bureau,, Port Moresby?
- Papua New Guinea. National Mapping Bureau. 1978. Port Moresby street directory. The Bureau,, Port Moresby, Papua New Guinea?
- Perembo, R. 1983. Stratigraphy of Delena Headland, Central Province, Papua New Guinea. Science in New Guinea 10(3):137-165.
- Pernetta, J.C., and D. Black. 1983. Species of gecko (*Lepidodactylus*) in the Port Moresby area, with the description of a new species. Journal of Herpetology 17(2):121-128.
- Pernetta, J.C., and D. Black. 1983. Species of gecko (*Lepidodactylus*) in the Port Moresby area, with the description of a new species. Journal of Herpetology 17(2):121-128.

- Phillips, O., and J.S. Miller. 2002. Global Patterns of Plant Diversity: Alwyn H. Gentry's Forest Transect Data Set. Missouri Botanical Press, St. Louis, Missouri. xvi+319 pp.
- Pieters, P.E. 1978. 1:250,000 Geological Series - Explanatory Notes. Port Moresby - Kalo-Aroa, Papua New Guinea Sheets SC/55-6, 7, 11 International index. Australian Government Publishing Service, Canberra. 55 pp.
- Piskaut, P 2018. University of Papua New Guinea, Personal communication.
- Pounder, G.M. 1973. Summary of groundwater data for the Laloki Valley and Sogeri Plateau. Geological Survey of Papua New Guinea, Dept. of Lands, Surveys and Mines, Port Moresby. 19 leaves in various foliations pp.
- Prance, G.T. 1979. New Genera and Species of Chrysobalanaceae from Malesia and Oceania. *Brittonia* 31(1):79-95.
- Province, P.R.-C. 1928. Sogeri Plateau [Moroka] - August 1928.
- Province, P.R.-C. 1929. Sogeri Plateau [Moroka] - September 1929.
- Province, P.R.-C. 1932. Sogeri Plateau [Moroka] - May 1932.
- Province, P.R.-C. 1943. Sogeri Plateau [Moroka] - January 1943.
- Province, P.R.-C. 1944. Sogeri Plateau [Moroka] - June 1944.
- Pu Yu, A. 1974. Letters to Mrs E.M. Johnston, 1974 Mar. - 1992 Sept. 1 microfilm reel pp.
- Quanchi, M., and Proquest (Firm). 2007. Photographing Papua representation, colonial encounters and imaging in the public domain, p. xx+369. Cambridge Scholars Pub., Newcastle.
- Queensland. 1893. Annual report of British New Guinea from 1st July, 1891 to 30th June, 1892 with appendices.
- Queensland. 1898. Annual report of British New Guinea from 4th September, 1888 to 30th June, 1889 with appendices.
- Queensland. 1898. Annual Report of British New Guinea from 1st July, 1896 to 30th June, 1897; with Appendices [ex Google via Hathi]
- Queensland. 1902. Annual report of British New Guinea from 1st July, 1900 to 30th June, 1901 with appendices.
- Queensland Department of Agriculture and Fisheries, *Mikania micrantha* Fact Sheet: https://www.daf.qld.gov.au/__data/assets/pdf_file/0011/75539/IPA-Mikania-Vine-PP143.pdf
- Quinnell, M. 2015. Sir William Macgregor's Itinerary in British New Guinea 1888-1898.
- Ray, S.H. 1895. A comparative vocabulary of the dialects of British New Guinea. Society for Promoting Christian Knowledge, London. 40 pp.
- Ray, S.H. 1929. The Languages of the Central Division of Papua. *The Journal of the Royal Anthropological Institute of Great Britain and Ireland* 59:65-96.
- Ridley, H.N., E.G. Baker, S. Moore, li, F. Wernham, C.H. Wright, and C.B. Kloss. 1916. Report on the Botany of the Wollaston Expedition to Dutch New Guinea, 1912-13. *Transactions of the Linnean Society of London*, ser 2 9(1):1-260.
- Ritako, T.B. 2011. *Arise Sir Thomas : an autobiography from Papua New Guinea*. University of Papua New Guinea Press and Bookshop, Port Moresby. xxi+255 pp.
- Ritchie, J. 2012. *Ebia Olewale: A Life of Service*. x+292 pp.
- Rochfort. 1898. Enclosure 4 in Appendix A. Annual Report of British New Guinea

- from 1st July, 1897 to 30th June, 1898; with Appendices:11-13.
- Rochfort. 1898. Visit to the main range, September and October, 1897 [Enclosure 5 in Appendix A]. Annual Report of British New Guinea from 1st July, 1897 to 30th June, 1898; with Appendices:13-16.
- Rogerson, R., D.W. Haig, and S.T.S. Nion. 1981. Geology of Port Moresby. Report 1981/16. University of Papua New Guinea, Waigani.
- Romilly, H.H. 1889. From My Verandah in New Guinea. D. Nutt, London. xxvi+277 pp.
- Romilly, H.H., and S.H. Romilly. 1893. Letters from the western Pacific and Mashonaland 1878-1891. D. Nutt, London,. xii+384 pp.
- Ross, K., and A. Webb. 1974. Port Moresby and Sogeri climbing guide. K. Ross, Sogeri, P.N.G. 27 pp.
- Sabi, J., A. Taplin, and Papua New Guinea Department of Environment and Conservation (Dec). 2010. Kokoda Initiative/Terrestrial Ecosystems Management - 2010 (Jul-Dec) Budget. Papua New Guinea Department of Environment and Conservation (DEC), Waigani, Papua New Guinea.
- Sands, D.P.A. 1986. A revision of the genus *Hypochrysops* C. & R. Felder (Lepidoptera: Lycaenidae). Entomograph 7:1-116.
- Sekhran, N., and S.E. Miller. 1994. Papua New Guinea Country Study on Biological Diversity. Papua New Guinea Department of Environment and Conservation, [Waigani, Papua New Guinea]
- Seligman, C.G., F.R. Barton, and E.L. Giblin. 1910. The Melanesians of British New Guinea. The University Press, Cambridge. xxiii+766 pp.
- Seligmann, C.G. 1909. A Classification of the Natives of British New Guinea. Journal of the Royal Anthropological Institute of Great Britain and Ireland 39:314-333.
- Serussiaux, E. 1992. Reinstatement of the lichenized genus *Eremothecella* Sydow. Systema Ascomycetum 11:39-47.
- Serussiaux, E., and R. Lücking. 2003. The lichen genus *Caprettia* Bat. & H. Maia (Monoblastiaceae), p. 161-176. In: Lichenological Contributions in Honour of G.B. Feige (ed.): Bibliotheca Lichenologica Vol. 86. M. Jensen (ed.). J. Cramer in der Gebriider Borntraeger Verlagsbuchhandlung, Berlin ·Stuttgart.
- Shaverdo, H., K. Sagata, and M. Balke. 2016. Taxonomic revision of New Guinea diving beetles of the *Exocelina danae* group, with the description of ten new species (Coleoptera, Dytiscidae, Copelatinae). ZooKeys (619):45-102.
- Sheppard, S., and L. Cranfield. 2012. Geological Framework and Mineralization of Papua New Guinea – An Update. Mineral Resources Authority, Port Moresby, Papua New Guinea. iv+62 pp.
- Sherley, G. 2000. Invasive species in the Pacific: A technical review and draft regional strategy. South Pacific Regional Environment Programme, Apia, Samoa.
- Shivas, R.G. 1997. First record of *Melanotaenium euphorbiae* in Papua New Guinea. Australasian Plant Pathology 26(2):132.
- Shivas, R.G., K. Vánky, C. Vánky, G.R. Kula, and V. Gavali. 2001. An annotated check list of Ustilaginomycetes in Papua New Guinea. Australasian Plant Pathology 30(3):231-237.
- Simpson, C.C. 1907. Across the Owen Stanley Range, British New Guinea. Victorian Naturalist 23(9):156-167.
- Sipman, H.J.M. 2004. Survey of *Lepraria*-like lichens with lobed thallus margins in the tropics. Herzogia 17:23-35.

- Slater, K.R. 1956. On the New Guinea taipan. *Memoirs of the National Museum of Victoria* 20:201-205.
- Sleumer, H.O. 1986. A revision of the genus *Rapanea* Aubl. (Myrsinaceae) In New Guinea. *Blumea* 31(2):245-269.
- Sogeri National High School. Sogerinumu, p. v. Sogeri National High School., Sogeri.
- Sogeri National High School. Papua New Guinea culture today and yesterday at Sogeri National High School. Publisher not identified, Place of publication not identified. 8 pp.
- Sogeri National High School. Emai. Sogeri Senior High School, Sogeri, Papua New Guinea. v. pp.
- Sogeri National High School. Sogeri : the magazine of the territory's senior high school. Sogeri National High School, Sogeri, Papua New Guinea. v pp.
- Sogeri National High School. 1979. Traditional dancing, p. volumes. Sogeri National High School, Boroko, Papua New Guinea.
- Sogeri National High School. 1980. Death, mourning and funeral feasts. Sogeri National High School, Sogeri. 11 leaves pp.
- Sogeri National High School. 1980. Sogeri traditional dancing, p. volumes. Sogeri National High School, Boroko, Papua New Guinea.
- Sogeri National High School. Expressive Arts Department., and B. Ison. 1976. Pukari : voices of Papua New Guinea. Tofua Press, San Diego. ix+95 pp.
- Sogeri Rubber Plantations Ltd. Annual report, balance sheet and accounts. The Firm., Port Moresby. v. pp.
- Sogeri Rubber Plantations Ltd., A.L. Johnston, E.L. Johnston, and J. Bridge. 1993. Minutes, reports, balance sheets, correspondence : 1944-1993. *In*: Pmb 1052. Pacific Manuscripts Bureau,, Canberra, ACT.
- Sogeri Senior High School. Papua New Guinea-Australia cultural exchange : newsletter, Sogeri.
- Sogeri Senior High School. 1973. Sogeri '73 : the magazine of Sogeri Senior High School. Sogeri Senior High School, Sogeri. 70 pp.
- Sogeri Senior High School. 1974. Taim Bipo, Taim Nau: A Selection of Oral Histories, Creative Writing and Designs. Sogeri Senior High School, Sogeri. 54 pp.
- Sogeri Senior High School. 1974. Toemwasala. Expressive Arts Dept., Sogeri Senior High School, Sogeri. 48 pp.
- Sogeri Senior High School., and B. Ison. 1975. Emai. The School, Sogeri. 40 pp.
- Souter, G. 1963. New Guinea: The Last Unknown. Angus and Robertson, Sydney
- Sowei, J.W.-A. 2001. Demonstrating the value of biodiversity conservation at Ogotana Village, Sogeri Plateau, Central Province. United Nations University Project on People, Papua New Guinea. 18 pp.
- Stenroos, S. 1988. The family Cladoniaceae in Melanesia. 3. Cladonia sections *Helopodium*, *Perviae* and *Cladonia*. *Annales Botanici Fennici* 25(2):117-148.
- Stuart, I. 1973. Port Moresby: Yesterday and Today. Pacific Publications, Sydney. 368 pp.
- Suarez, V., C.C. Carmarán, and B.C. Sutton. 2000. *Melanconiopsis microspora* sp. nov. from bamboo in Argentina. *Mycological Research* 104(12):1530-1534.
- Supriatna, J. (ed.) (1999): The Irian Jaya Biodiversity Conservation Priority-Setting Workshop. Final Report. Conservation International, Washington, DC.
- Suzuki, T., and Z. Iwatsuki. 2011. *Fissidens* (Fissidentaceae, Bryopsida) from Papua New Guinea located in the herbarium of the Australian National Botanical Gardens (CBG). *Hattoria* 2:1-33.

- Symon, D.E. 1985. The Solanaceae of New Guinea. *Journal of the Adelaide Botanical Garden* 8(1-171).
- Takeuchi, W., and M. Golman. 2001. Floristic documentation imperatives: some conclusions from contemporary surveys in Papua New Guinea. *SIDA* 19(3):445-468.
- Takeuchi, W. 2003a. Botanical summary of lowland ultrabasic flora in Papua New Guinea. *Sida* 20(4):1491-1559.
- Takeuchi, W 2003b. Plant discoveries from PABITRA-related exploration in Papua New Guinea. *Organisms, Diversity & Evolution*, vol. 3, 77–84 (2003)
- Tan, B.C., T. Koponen, and D.H. Norris. 2007. Bryophyte flora of the Huon Peninsula, Papua New Guinea. LXX. *Sematophyllaceae (Musci) 1. Acanthorrhynchium, Acroporium, Clastobryophilum, Pseudopiloecium, Radulina and Trichosteleum. Annales Botanici Fennici* 44:35-78.
- Taylor, L. 1988. *Taim Bipo: The Disappearing Traditions and Practices of Papua New Guinea as Seen through the Eyes of Young Sogeri Artists*. Expressive Arts Department, Sogeri National High School, Sogeri
- Taylor, L., and Sogeri National High School. Expressive Arts Department. 1988. *Kalamimi : poetry from Sogeri. s.n., s.l.* 67 pp.
- Taylor, L. 1990. *Snake Road : a guide to the history, people and places of the Sogeri district : a Sogeri publication*. Expressive Arts Department, Sogeri National High School, Boroko, Papua New Guinea. xviii+350 pp.
- Taylor, L. 1990. *Sogeri During the War: A Brief History and Guide*. Expressive Arts Department, Sogeri National High School, Boroko, Papua New Guinea. 69 pp.
- Taylor, L. 1991. *Pasin Bilong Mipela (Our Way). Traditional Life in The Provinces of Papua New Guinea Depicted In Art and in Essay*. Expressive Arts Department, Sogeri National High School, Sogeri, Papua New Guinea. 158 pp.
- Taylor, L. 1992. *Snake road : a guide to the history, people and places of the Sogeri district*. Sogeri National High School, Boroko, Papua New Guinea. xviii+350 pp.
- Taylor, L. 1992. *Snake Road*. Expressive Arts Department, Sogeri High School, Sogeri, Central Province, Papua New Guinea. 350 pp.
- Taylor, L. 2002. *Sogeri : the school that helped to shape a nation : a history 1944 - 1994*. Research Publications, Vermont, Vic. xv+342 pp.
- Thompson, C., N. Stronach, E. Verheij, T. Mamu, S. Schmitt, and M. Wright. 2011. *Final Frontier: Newly Discovered Species in New Guinea (1998-2008)*. WWF Western Melanesia Programme Office, Port Moresby, Papua New Guinea. 55 pp.
- Thomson, J.P. 1892. *British New Guinea*. George Philip & Son, London. 336 pp.
- Thomson, J.P. 1896. On Sir W. Macgregors journey in New Guinea. *Journal of the Manchester Geographical Society* 7(4-6):201-203.
- Tolhurst, L.P. 1990. Three lesser golden plovers spend winter near Port Moresby. *Muruk* 4(3):108-109.
- Tomlinson, P.B. 1992. Deforestation Provides a Renewable Resource. *Conservation Biology* 6(2):306-307.
- Trotter, C. 1884. New Guinea: a summary of our present knowledge with regard to the island. *Proceedings of the Royal Geographical Society and Monthly Record of Geography* 6(4):196-216.
- UNEP, 2010 *Papua New Guinea's Fourth National Report to the Convention on Biological Diversity*

- University of California, S.D., Library,. 2013. Papua New Guinea: Central Province Patrol Reports.
- UNSECO, 2018
<http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/>
- Van Der Sande, G.a.J. 1910. Ethnography and anthropology *in* Résultats de l'Expédition Scientifique Néerlandaise à la Nouvelle-Guinée en 1903 sous les auspices de Arthur Wichmann. Nova Guinea 3:1-384.
- Van Gorsel, J.T. 2013. Bibliography of the Geology of Indonesia and Surrounding Areas
- Verdcourt, B. 1978. New taxa of Leguminosae from Papua New Guinea. Kew Bulletin 32(2):455-473.
- Verkley, G.J.M., M.D. Silva, D.T. Wicklow, and P.W. Crous. 2004. *Paraconiothyrium*, a new genus to accommodate the mycoparasite *Coniothyrium minitans*, anamorphs of *Paraphaeosphaeria*, and four new species. Studies in Mycology 50:323-335.
- Verkley, G.J.M., K. Dukik, R. Renfurm, M. Göker, and J.B. Stielow. 2014. Novel genera and species of coniothyrium-like fungi in Montagnulaceae (Ascomycota). Persoonia - Molecular Phylogeny and Evolution of Fungi 32(1):25-51.
- Visagie, C.M., J. Houbraken, J. Dijksterhuis, K.A. Seifert, K. Jacobs, and R.A. Samson. 2016. A taxonomic review of *Penicillium* species producing conidiophores with solitary phialides, classified in section *Torulomyces*. Persoonia : Molecular Phylogeny and Evolution of Fungi 36:134-155.
- Von Mueller, F. 1884. Record of a New Papuan *Rhododendron*. Victorian naturalist 1(10):101-102.
- Von Mueller, F. 1885. [Letter to Edward Strickland ML MSS.2134/1, Royal Geographical Society of Australasia (NSW Branch) papers, Mitchell Library, State Library of New South Wales, Sydney][Letter mentioning Henry Ogg Forbes].
- Wa-Ai Soweï, J. 2001. Demonstrating the Value of Biodiversity Conservation at Ogotana Village, Sogeri Plateau, Central Province. United Nations University Project on People, Land Management, and Environmental Change, Papua New Guinea Cluster.
- Walker, A.S. 1957. The Island Campaigns. Australian War Memorial, Canberra. xvi+426 pp.
- Walker, M. 1978. Transition, a developing style of the arts in Papua New Guinea. Publisher not identified, Sogeri, Papua New Guinea. 4 leaves pp.
- Wallach, V. 1996. Two new blind snakes of the *Typhlops ater* species group from Papua New Guinea (Serpentes: Typhlopidae). Russian Journal of Herpetology 3(2):107-118.
- Warner, J.N., and C.O. Gassl. 1958. The 1957 sugar cane expedition to Melanesia. Hawaiian Planters' Record 55(3):209-236.
- Wearn, J.A., and I. Darbyshire. 2013. Hulemacanthus species (Acanthaceae: Barlerieae) in New Guinea. Blumea 57:215-216.
- Weaver, D.B. Strategies for the development of deliberate ecotourism in the South Pacific. Source: Pacific Tourism Review 2(1):53-66.
- West, F.J. 1968. Hubert Murray; the Australian pro-consul. Oxford University Press, Melbourne, New York etc. vii+296 pp.
- Wetherell, D. 1974. Christian missionaries in eastern New Guinea: A study of European, South Sea island and Papuan influences, p. 462. Vol. PhD. Australian National University.
- White, C.T. 1923. A contribution to our knowledge of the flora of Papua (British

- New Guinea). Proceedings of the Royal Society of Queensland 34:5-65.
- White, C.T. 1929. Ligneous plants collected in the territory of Papua (British New Guinea) in 1925-26 by L.J. Brass. Journal of the Arnold Arboretum 10(4):197-274.
- Whitmore, T.C., and C.N. Page. 1980. Evolutionary Implications of the Distribution and Ecology of the Tropical Conifer *Agathis*. New Phytologist 84(2):407-416.
- Wiat, C. 2007. *Goniothalamus* species: a source of drugs for the treatment of cancers and bacterial infections? Evidence-Based Complementary and Alternative Medicine 4(3).
- Wichmann, A. 1910. Entdeckungsgeschichte von Neu-Guinea, 1828-1902. E.J. Brill, Leiden. 1026 pp.
- Wichmann, A. 1910. Entdeckungsgeschichte von Neu-Guinea 1828 bis 1885 in Résultats de l'Expédition Scientifique Néerlandaise à la Nouvelle-Guinée en 1903 sous les auspices de Arthur Wichmann. Nova Guinea 2 (1re. partie):i-xiv + 369.
- Wichmann, A. 1912. [EXTRACTS - Forbes 1887 pp 444-446] Entdeckungsgeschichte von Neu-Guinea 1885 bis 1902 in Résultats de l'Expédition Scientifique Néerlandaise à la Nouvelle-Guinée en 1903 sous les auspices de Arthur Wichmann. Nova Guinea.
- Wichmann, A. 1912. [EXTRACTS - MacFarlane 1885 p 391] Entdeckungsgeschichte von Neu-Guinea 1885 bis 1902 in Résultats de l'Expédition Scientifique Néerlandaise à la Nouvelle-Guinée en 1903 sous les auspices de Arthur Wichmann. Nova Guinea.
- Wichmann, A. 1912. [EXTRACTS - Forbes 1886 pp 401-403] Entdeckungsgeschichte von Neu-Guinea 1885 bis 1902 in Résultats de l'Expédition Scientifique Néerlandaise à la Nouvelle-Guinée en 1903 sous les auspices de Arthur Wichmann. Nova Guinea.
- Wichmann, A. 1912. Entdeckungsgeschichte von Neu-Guinea 1885 bis 1902 in Résultats de l'Expédition Scientifique Néerlandaise à la Nouvelle-Guinée en 1903 sous les auspices de Arthur Wichmann. Nova Guinea.
- Wichmann, A. 1912. [EXTRACTS - Forbes 1885 pp 389-391] Entdeckungsgeschichte von Neu-Guinea 1885 bis 1902 in Résultats de l'Expédition Scientifique Néerlandaise à la Nouvelle-Guinée en 1903 sous les auspices de Arthur Wichmann. Nova Guinea.
- Wichmann, A. 1912. [EXTRACTS - Douglas 1885 p 391] Entdeckungsgeschichte von Neu-Guinea 1885 bis 1902 in Résultats de l'Expédition Scientifique Néerlandaise à la Nouvelle-Guinée en 1903 sous les auspices de Arthur Wichmann. Nova Guinea.
- Williams, F.E. 1932. Sex affiliation and its implications. The Journal of the Royal Anthropological Institute of Great Britain and Ireland 62:51-81.
- Williams, F.E. 1960. The Bush Koiari people of the Sogeri Plateau, Central Division, Territory of Papua 1932 : sex affiliation and it's implications. s.n., Port Moresby? 38 pp.
- Williams, B. 1993. The Knowledge: A Guide to Living in Port Moresby. IMPS Research, Port Moresby, Papua New Guinea. 320 pp.
- Williamson, R.W. 1912. The Mafulu mountain people of British New Guinea. Macmillan and Co., London. xxiii+361 pp.
- Winn, J.R.D., and P. Pousai. 2010. Synorogenic alluvial-fan - fan-delta deposition in the Papuan foreland basin: Plio-Pleistocene Era Formation, Papua New Guinea. Australian Journal of Earth Sciences 57(5):507-523.

Worldwide Fund for Nature. 2010. Final Frontier - Newly Discovered Species of New Guinea [Draft - February 2010].

Yates, K.R., and R.Z. De Ferranti. 1967. Geology and Mineral Deposits Port Moresby/Kemp Welch Area, Papua. Commonwealth of Australia. Department of National Development, Bureau of Mineral Resources, Geology and Geophysics. Report 105:1-117.

Yates, K.R., and R.Z. De Ferranti. 1967. Geology and Mineral Deposits Port Moresby/Kemp Welch Area, Papua. Commonwealth of Australia. Department of National Development, Bureau of Mineral Resources, Geology and Geophysics. Report 105:1-117.

7. GLOSSARY OF TERMS

Biomass: The total mass of organisms in a given area.

Disturbed Areas: Areas that extensively altered by human activity.

Endemic: refers to whether an organism is native to and restricted to a specific geographic area. For example, a species endemic to Varirata National would be found only there; similarly a species endemic to Papua New Guinea would be found only within the political borders of PNG; a species endemic to New Guinea would be restricted to the island of New Guinea.

Ecosystem: The complete assemblage of plants and animals in an area.

Ecotone: A region of transition between two biological communities.

Introduced: A species of plant or animal that is not native to an area and has been introduced by human activity.

Invasive: An introduced species of plant or animal that is able to spread into and adversely impact native ecosystems.

Native: A species of plant or animal that occurs naturally in a given area.

8. ACKNOWLEDGEMENTS

IPCA would like to formally thank the staff from the JICA office in Port Moresby, particularly, Hitoshi Watanabe, Koji Asano, Hiroshi Imae, Ted Mamu, Ayako Ochi, John Dege, Biatus Bito and Nancy Bobora. JICA have provided outstanding support and logistical assistance throughout the conduct of the Biodiversity Surveys and IPCA are profoundly grateful. Mr Ted Mamu, Mr John Dege, Mr Biatus Bito were extremely helpful in facilitating the fieldwork program and without their active support IPCA's delivery of the contract would have been inordinately more difficult. John Dege's assistance in transporting staff, supplies and equipment to and from the Park has also been highly appreciated. His driving skills and knowledge of the Sogeri Road are unmatched. In particular, IPCA acknowledges Mr Ted Mamu who is deserving of special mention given his crucial role in assisting our field team through field logistics, technical support, local knowledge and Project Management skills. Mr Mamu was professional at all times and instrumental in our success. We sincerely acknowledge his efforts as they have been greatly appreciated. Ms. Ayako Ochi (JICA) has an impressive command of Geographic Information Systems and has been very helpful in developing a grid system to guide the Clidemia study. She has also provided essential maps and IPCA very much appreciate the support that she has provided. As the Japanese Project Focal Point, Hiroshi Imae has been collaborative, insightful and demonstrated thorough professionalism throughout his tenure in this role. It has been a pleasure delivering this commission together. Working collaboratively with the JICA team on the Varirata National Park Biodiversity Surveys has been a thoroughly rewarding professional experience.

IPCA would also like to acknowledge the assistance received from colleagues from the Conservation and Environmental Protection Authority (CEPA), in particular Bense Thomas, Kay Kalim and James Sabi. The faculty and staff of the University of Papua New Guinea have

been generous in their support. This includes Prof. Simon Saulei, Pius Piskaut and Dan Kundun.

The care, attention and rigour that Dr. Shelley James put into the development of her checklist of vascular plants of Papua New Guinea is extraordinary and has been critical to this commission.

IPCA have also received considerable assistance from scientific colleagues, including Dr. Gerald Allen from the Western Australian Museum (fishes), Dr. Kristopher Helgen from the University of South Australia and Dr. Tanya Leary from the New South Wales National Park Service (mammals), Dr. Bruce Beehler from the Smithsonian Institution and Dr. Thane Pratt from Bishop Museum (birds).

Several colleagues have helped identify insects, including Dr. Dan Polhemus and Dr. G. Allan Samuelson from Bishop Museum and Dr. Scott Miller of the Smithsonian Institution.

Nitty Simard demonstrated her skill as an outstanding field scientist and contributed a very high standard of professionalism in all stages of project delivery. We also thank Andrew McInnis and Christo Ferguson for their work in assisting to document the distribution of Clidemia within the Park and initiating community outreach programs promoting biodiversity conservation to surrounding villages on behalf of IPCA.

Maya Trevidy, who spent a month at Bishop Museum in July 2017 on an internship, did a superb job of compiling a composite database of Cedric Carr's 1935-36 plant collections from PNG. This important material – now well studied and identified – was crucial to the development of our plant checklist.

Dr. Phil Shearman of the PNG Remote Sensing Centre provide crucial GIS mapping and analysis assistance.

Our informal driver, Koipa Dei, has provided essential transportation around Port Moresby.

We are extremely grateful to Koiari landowners from the surrounding area. It is a privilege to work with them and to learn from them.

Our colleagues from Bishop Museum, particularly Tracie Mackenzie has assisted our efforts in many ways, as has the collections manager for vertebrates, Molly Hagemann.

The chairman of the Indo-Pacific Conservation Alliance, Burke Burnett, has helped with financial and administrative matters, as has the book keeper, Grace Jiho. Molly Hagemann did a superb job of editing and formatting the document.

Finally, Allen Allison would like to thank his spouse, Isabella Forster, for her continuing support of field work in Papua New Guinea – thirty years and counting!

Appendix 1. Scope of Work

Section	Fauna	Flora
4.1 (a)	Conduct a literature review of relevant scientific publications, reports, GIS shape files, specimen database records, on the fauna diversity of VNP and prepare a check list of species	Conduct a literature review of relevant scientific publications, reports, GIS shape files, specimen database records, on the fauna diversity of VNP and prepare a check list of species
4.2 (a)	Preparation of a habitat classification map: Prepare a habitat classification map based on satellite imagery and ground truthing techniques. A high resolution satellite image (World View 2) will be provided by the consultant	Preparation of a vegetation map and habitat classification map: Prepare a vegetation map based on satellite imagery and ground truthing techniques. A high resolution satellite image (World View 2) will be provided by the consultant
4.3	Conduct field surveys targeting the following: a) Vertebrate taxa; (i) Freshwater fishes (ii) Amphibians; (iii) Reptiles; (iv) Birds; (v) Mammals b) Invertebrate taxa; Insects (visually appealing, iconic, or scientifically interesting species) Other invertebrates of interest	Conduct field surveys targeting the following: (a) Vascular plant taxa;
4.4 (a)	Not Stated	Development of a monitoring program Prepare a comprehensive monitoring program targeting indicator species of fauna and flora for the National Park and surrounding area. Assess specific ecological requirements of selected groups of fauna and flora which may require specific management measures and are potential targets for ecotourism Propose a management actions for conservation and protection of selected groups of flora and fauna
4.5	Not Stated	Production of Field Guide Brochures a) Produce field guides / Biodiversity Information Brochures for selected groups of fauna and flora below, with a brief description of their natural history will be printed for visitors to learn about the biodiversity of VNP for VNP: b) The field guide will be used for the general public, tourists and students, hence the descriptions must be simplified without too much scientific jargon. <ul style="list-style-type: none"> ▪ Common Vascular Plants ▪ Vertebrate <ul style="list-style-type: none"> ○ Amphibians ○ Common reptiles ○ Common birds ○ Common mammals ▪ Common invertebrates

Section	Fauna	Flora
4.6	NA	<p>Biodiversity Seminar</p> <ul style="list-style-type: none"> a) A biodiversity (fauna & flora) seminar aiming to disseminate information obtained through the project will be conducted in POM at the end of the project. The target audience will be 80 people and stakeholders will include researchers, students, residents of the Koairi LLG etc. Details to be confirmed with the CEPA – JICA team. b) A seminar report will be prepared

Appendix 2. Check List of Plant Species of VNP

Notes:

1. All non-native plants are indicated with an * in the checklist of vascular plants from the Park;
2. Species shaded in grey are native species listed under the IUCN Red List. Refer to Appendix 6 for further information on each species.

VASCULAR PLANT SPECIES OF VARIRATA NATIONAL PARK

THIS RUN ON 31/07/2018 04:14:16 PM

TOTAL NUMBER OF GENERA =	581
TOTAL NUMBER OF FAMILIES =	157
TOTAL NUMBER OF SPECIES =	1126
TOTAL NUMBER OF WEEDS =	51

FERNS**ASPLENIACEAE**

Asplenium bipinnatifidum
Asplenium kelelense
Asplenium lobatum
Asplenium ludens
Asplenium nidus
Asplenium pellucidum
Asplenium phyllitidis
Asplenium polyodon
Asplenium sancti-christofori
Asplenium spathulinum
Asplenium tenerum
Asplenium sp.
Diplora durvillaei

ATHYRIACEAE

Diplazium cordifolium
Diplazium crenato-serratum
Diplazium sorzogonense

BLECHNACEAE

Blechnum orientale

CYATHEACEAE

Cyathea contaminans

Cyathea fusca

Cyathea macrophylla

Cyathea rumphiana

Cyathea sp.

CYSTODIACEAE

Cystodium sorbifolium

DAVALLIACEAE

Davallia denticulata

Davallia parvula

Davallia pectinata

Davallia solida

DENNSTAEDTIACEAE

Dennstaedtia ampla

Dennstaedtia novoguineensis

Dennstaedtia scandens

DICKSONIACEAE

Calochlaena straminea

DRYOPTERIDACEAE

Dryopteris concolor

GLEICHENIACEAE

Dicranopteris linearis

Gleichenia sp.

Stichurus milnei

HYMENOPHYLLACEAE

Abrodictyum obscurum

Cephalomanes acrosorum

Cephalomanes atrovirens

Cephalomanes javanicum
Crepidomanes bilabiatum
Crepidomanes bipunctatum
Crepidomanes kurzii
Crepidomanes venulosum
Trichomanes bimarginatum
Trichomanes diffusum
Trichomanes saxifragoides
Vandenboschia maxima

LINDSAEACEAE

Bierhorstia chinensis
Lindsaea lucida
Lindsaea obtusa
Lindsaea repens
Sphenomeris sp.

LYCOPODIACEAE

Huperzia phlegmaria
Lycopodiella cernua
Lycopodium nummularifolium
Lycopodium squarrosum

LYGODIACEAE

Lygodium circinatum
Lygodium dimorphum
Lygodium microphyllum

MARATTIACEAE

Angiopteris evecta

NEPHROLEPIDACEAE

Nephrolepis biserrata
Nephrolepis hirsutula
Nephrolepis obliterated

OPHIOGLOSSACEAE

Ophioderma pendula

POLYPODIACEAE

Aglaomorpha parkinsonii
Calymmodon mnioides
Drynaria quercifolia
Goniophlebium verrucosum
Lemmaphyllum accedens
Loxogramme scolopendrioides
Microsorium membranifolium
Microsorium papuanum
Microsorium pteropus
Microsorium punctatum
Microsorium rampans
Microsorium sp.
Phymatosorus scolopendria
Pyrrosia lanceolata
Pyrrosia longifolia
Pyrrosia princeps
Schizaea dichotoma
Schizaea digitata

PSILOTACEAE

Psilotum nudum

PTERIDACEAE

Antrophyum callifolium
Cheilanthes distans
Monogramma dareicarpa
Pneumatopteris sogerensis
Pteris papuana
Syngamma quinata
Taenitis blechnoides
Taenitis mediosora
Vaginularia junghuhnii
Vittaria ledermannii

SELAGINELLACEAE

Selaginella hieronymi
Selaginella kaernbachii
Selaginella muelleri

Selaginella purpuripes

Selaginella velutina

Selaginella sp.

TECTARIACEAE

Arthropteris articulata

Tectaria bamleriana

Tectaria barclayi

Tectaria ferruginea

Tectaria pubescens

THELYPTERIDACEAE

Adiantum caudatum

Adiantum diaphanum

Adiantum neoguineense

Adiantum philippense

Ampelopteris prolifera

Macrothelypteris polypodioides

Plesioneuron tuberculatum

Pronephrium triphyllum

Sphaerostephanos arfakianus

Sphaerostephanos heterocarpus

CONIFERS

CYCADACEAE

Cycas campestris (EN)

GNETACEAE

Gnetum costatum

Gnetum gnemon

Gnetum latifolium

Gnetum sp.

PODOCARPACEAE

Decussocarpus sp.

Podocarpus neriifolius

Podocarpus sp.

FLOWERING PLANTS

ACANTHACEAE

Calophanoides sp.
Calycacanthus magnusianus
Dicliptera sp.
Graptophyllum pictum
Graptophyllum sp.
Hemigraphis sp.
Hygrophila sp.
Jadunia sp.
Justicia sp.
Lepidagathis sp.
Leptosiphonium versicolor
Phlogacanthus novoguineensis
Pseuderanthemum sp.
Ptyssiglottis pubisepala
Rungia diversiformis
Rungia sp.

ACHARIACEAE

Erythrospermum sp.
Pangium edule

ACTINIDIACEAE

Saurauia conferta
Saurauia dufaurii
Saurauia sp.

AMARANTHACEAE

Achyranthes bidentata
*Alternanthera sessilis**

ANACARDIACEAE

Buchanania amboinensis
Buchanania macrocarpa
Camptosperma montana
Dracontomelon brinco
Dracontomelon sp.

Euroschinus papuanus

Euroschinus sp.

*Mangifera minor**

Mangifera sp.

Rhus taitensis

Semecarpus cassuvium

Semecarpus magnificus

Semecarpus schlechteri

Semecarpus sp.

Spondias sp.

ANNONACEAE

Artabotrys sp.

Cyathocalyx petiolatus

Goniothalamus aruensis

Goniothalamus species 1

Goniothalamus sp.

Haplostichanthus longirostris

Maasia glauca

Meiogyne sp.

Mitrella sp.

Polyalthia forbesii

Polyalthia sclerophylla

Polyalthia species 1

Polyalthia sp.

Popowia sp

Popowia species 1

Popowia sp.

Pseuduvaria sp.

Uvaria rosenbergiana

Uvaria sp.

Xylopiia sp.

APIACEAE

*Centella asiatica**

Oenanthe javanica

APOCYNACEAE

Alstonia scholaris
Alstonia sp.
*Asclepias curassavica**
Dischidia major
Dischidia nummularia
Dischidia cf. papuana
Dischidia sp.
Ervatamia coronaria
Ervatamia sp.
Gymnanthera sp.
Gymnema sp.
Hoya nicholsoniae
Hoya sp.
Ichnocarpus frutescens
Melodinus australis
Melodinus forbesii
Ochrosia ficifolia
Ochrosia sp.
Papuechites aambe
Parsonsia buruensis
Parsonsia oligantha
Tabernaemontana aurantiaca
Tabernaemontana pandacaqui
Urceola javanica

APONOGETONACEAE

Aponogeton loriae

AQUIFOLIACEAE

Ilex sp.

ARACEAE

Amydrium magnificum
Cyrtosperma carrii
Epipremnum papuanum
Homalomena davidiana
Homalomena schlechteri
Lasia spinosa

Pothos hellwigii

Schismatoglottis potamophila

ARALIACEAE

Arthrophyllum macranthum

Boerlagiodendron novoguineense

Mackinlaya celebica

Osmoxylon species 1

Osmoxylon sp.

Polyscias ledermanii

Schefflera actinophylla

Schefflera bractescens

Schefflera elliptica

Schefflera stahlia

Schefflera thaumasiantha

Schefflera versteegii

Schefflera species 1

Schefflera sp.

ARECACEAE

Calamus aruensis

Calamus sp.

Calyptrocalyx forbesii

Calyptrocalyx sp.

Caryota rumphiana

Caryota sp.

Cyrtostachys loriae

Heterospathe sp.

Hydriastele cf. beccariana

Hydriastele sp.

Korthalsia brassii

Orania sp.

Paralinospadix sp.

Ptychosperma sp.

ARISTOLOCHIACEAE

Aristolochia momandul

ASPARAGACEAE

Cordyline fruticosa
Cordyline sp.
Dracaena angustifolia
Dracaena sp.

ASPHODELACEAE

Geitonoplesium cymosum

ASTERACEAE

Acmella grandiflora
*Ageratum conyzoides**
*Bidens pilosa**
Blumea riparia
Blumea saxatilis
*Crassocephalum crepidioides**
*Elephantopus mollis**
*Eleutheranthera ruderalis**
*Erechtites valerianifolia**
Gynura procumbens
Microglossa pyrifolia
Mikania cordata
*Mikania micrantha**
*Synedrella nodiflora**
*Tithonia diversifolia**
Vernonia lanceolata
*Wedelia spilanthoides**

BALSAMINACEAE

Impatiens hawkeri

BEGONIACEAE

Begonia sp.

BIGNONIACEAE

Deplanchea tetraphylla
Deplanchea sp.
Neosepicaea sp
Neosepicaea sp.

Pandorea sp.

*Spathodea campanulata**

Tecomanthe dendrophila

BIXACEAE

*Bixa orellana**

BURSERACEAE

Canarium acutifolium

Canarium asperum

Canarium cestracion

Canarium hirsutum

Canarium indicum

Canarium kaniense

Canarium maluense

Canarium cf. moluense

Canarium species 1

Canarium sp.

Garuga floribunda

Haplolobus furfuraceus

Haplolobus sp.

Protium macgregorii

Protium species 1

Protium sp.

Santiria sp.

CALOPHYLLACEAE

Calophyllum soulattri

Calophyllum trachycaule

Calophyllum sp.

CANNABACEAE

Aphananthe philippinensis

Trema orientalis

CARDIOPTERIDACEAE

Gonocaryum sp.

Pseudobotrys doraе

Pseudobotrys sp.

CARYOPHYLLACEAE

*Drymaria cordata**

CASUARINACEAE

Gymnostoma papuana

CELASTRACEAE

Bhesa archboldiana

Celastrus novoguineensis

Celastrus sp.

Salacia erythrocarpa

Salacia sp.

CHLORANTHACEAE

Chloranthus erectus

Chloranthus officinalis

CHRYSOBALANACEAE

Hunga papuana

CLEOMACEAE

*Cleome viscosa**

CLUSIACEAE

Garcinia assugu

Garcinia dulcis

Garcinia hollrungii

Garcinia sp

Garcinia subtilinervis

Garcinia sp.

COMBRETACEAE

Terminalia archboldiana

Terminalia kaernbachii

Terminalia species 1

Terminalia sp.

COMMELINACEAE

Commelina sp.

Dictyospermum sp.
Floscopa scandens
Polia secundiflora
*Tradescantia sp.**

CONNARACEAE

Rourea minor
Rourea cf. simnlans

CONVOLVULACEAE

Ipomoea eriocarpa
Ipomoea sp.
Lepistemon urceolatus
Merremia gemella
Merremia peltata
Merremia umbellata

CRYPTERONIACEAE

Crypteronia cumingii

CUCURBITACEAE

Nealsomitra pilosa
Papuasicyos papuana

CUNONIACEAE

Caldcluvia nymanii
Caldcluvia papuana
Caldcluvia sp.
Schizomeria floribunda
Schizomeria serrata
Schizomeria sp.

CYPERACEAE

Carex cryptostachys
Cyperus cf. brevifoli
Cyperus compressus
Cyperus digitatus
Cyperus halpan
Cyperus laxus

Cyperus meistostylus
Cyperus tenuiculmis
Eleocharis dulcis
*Fimbristylis dichotoma**
Fuirena umbellata
Hypolytrum nemorum
*Kyllinga brevifolia**
Mapania anomala
Mapania cuspidata
Paramapania parvibractea
Rhynchospora corymbosa
Rhynchospora rubra
Scleria lithosperma
Scleria polycarpa
Scleria scrobiculata

DICHAPETALACEAE

Dichapetalum papuanum
Dichapetalum sp.

DILLENiaceae

Tetracera nordtiana

DIOSCOREACEAE

Dioscorea nummularia
Dioscorea pentaphylla

DIPENTODONTACEAE

Perrottetia alpestris
Perrottetia species 1
Perrottetia sp.

DIPTEROCARPACEAE

Hopea forbesii (NT)
Hopea similis
Hopea sp.

EBENACEAE

Diospyros cordato-oblonga

Diospyros humilis

Diospyros novoguineensis

Diospyros sp.

ELAEAGNACEAE

Elaeagnus triflora

ELAEOCARPACEAE

Aceratium archboldianum

Aceratium muellerianum

Aceratium oppositifolium

Aceratium species 1

Aceratium species 2

Aceratium sp.

Elaecarpus sp

Elaeocarpus angustifolius

Elaeocarpus culminicola

Elaeocarpus dolichostylus

Elaeocarpus hartleyi

Elaeocarpus ledermannii

Elaeocarpus stenodactylus

Elaeocarpus womersleyi

Elaeocarpus species 1

Elaeocarpus species 2

Elaeocarpus species 4

Elaeocarpus sp.

Sloanea forbesii

Sloanea paradisearum

Sloanea sogerensis

Sloanea species 3

Sloanea species 4

Sloanea species 5

Sloanea sp.

ERYTHROXYLACEAE

Erythroxylum ecarinatum

Erythroxylum sp.

ESCALLONIACEAE

Polyosma forbesii

Polyosma sp.

EUPHORBIACEAE

Acalypha hellwigii

Alchornea rugosa

Aleurites moluccana

Claoxylon ledermannii

Claoxylon tenerifolium

Codiaeum variegatum

Croton choristadenius

*Croton hirtus**

Croton prunifolius

Endospermum medullosum

Endospermum myrmecophilum

Endospermum sp.

Euphorbia sp.

Homalanthus novoguineensis

Macaranga aleuritoides

Macaranga densiflora

Macaranga glaberrima

Macaranga punctata

Macaranga quadriglandulosa

Macaranga sp.

Mallotus floribundus

Mallotus sp.

Pimelodendron amboinicum

EUPOMATIACEAE

Eupomatia laurina

Eupomatia sp.

FABACEAE

Albizia papuensis

Archidendron lucyi

Archidendron sp.

Cajanus reticulatus

*Calopogonium mucunoides**

Canavalia papuana
*Cassia grandis**
Cassia javanica
*Castanospermum australe**
Castanospermum sp.
*Centrosema pubescens**
Crotalaria albida
Crotalaria chinensis
Crotalaria sessiliflora
Cynometra minutiflora
Derris rubrocalyx
Desmodium gyroides
Desmodium microphyllum
Desmodium pulchellum
Desmodium pullenii
Desmodium sequax
Desmodium velutinum
Dioclea hexandra
Erythrina merrilliana
Falcataria moluccana
*Flemingia macrophylla**
Indigofera linifolia
Macropsychanthus lauterbachii
Maniltoa cynometroides
Maniltoa psilogyne
Maniltoa sp.
*Mimosa pudica**
Mucuna stanleyi
Mucuna sp.
*Phaseolus lunatus**
Phylacium bracteosum
Phyllodium pulchellum
Pterocarpus sp.
Pueraria montana
Rhynchosia acuminatissima
*Senna alata**
Strongylodon lucidus
*Stylosanthes humilis**
Stylosanthes sp.

Tephrosia vestita

Zornia gibbosa

FAGACEAE

Castanopsis acuminatissima

Lithocarpus celebicus

Lithocarpus sp.

FLAGELLARIACEAE

Flagellaria indica

GENTIANACEAE

Fagraea berteriana

Fagraea ceilanica

Fagraea gracilipes

Fagraea racemosa

Fagraea sp.

Lisianthus sp.

GESNERIACEAE

Aeschynanthus hartleyi

Boea lawesii

Cyrtandra sp.

Rhynchotechum discolor

GOODENIACEAE

Scaevola oppositifolia

Searda sp

HIMANTANDRACEAE

Galbulimima belgraveana

Galbulimima sp.

HYDROCHARITACEAE

Blyxa aubertii

HYPOXIDACEAE

Curculigo capitulata

Curculigo orchioides

ICACINACEAE

Gomphandra papuana
Phytocrene interrupta
Platea excelsa
Platea latifolia
Platea sp.
Polyporandra scandens
Rhyticaryum longifolium

JUGLANDACEAE

Engelhardia rigida

LAMIACEAE

Callicarpa longifolia
Callicarpa pentandra
Clerodendrum buruanum
Clerodendrum costatum
Clerodendrum cf. tracyanum
Clerodendrum sp.
Faradaya splendida
Faradaya sp.
Gmelina sp.
Leucas flaccida
*Mesosphaerum suaveolens**
Plectranthus congestus
Plectranthus scutellarioides
Plectranthus sp.
Pogostemon stellatus
Premna regularis
Premna serratifolia
Premna sp.

LAURACEAE

Beilschmiedia sp
Beilschmiedia sp.
Cinnamomum grandiflorum
Cinnamomum massoia
Cinnamomum sp.

Cryptocarya alleniana
Cryptocarya apamifolia
Cryptocarya cf. apamifolia
Cryptocarya cagayanensis
Cryptocarya forbesii
Cryptocarya ledmannii
Cryptocarya masseyi
Cryptocarya cf. multinerva
Cryptocarya novo-guineensis
Cryptocarya papuana
Cryptocarya splendens
Cryptocarya sulcata
Cryptocarya species 1
Cryptocarya species 2
Cryptocarya species 3
Cryptocarya species 4
Cryptocarya species 5
Cryptocarya species 7
Cryptocarya species A
Cryptocarya sp.
Endiandra faceta
Endiandra ledermannii
Endiandra species 1
Endiandra sp.
Litsea communis
Litsea densiflora
Litsea elliptica
Litsea engleriana
Litsea firma
Litsea galorei
Litsea guppyi
Litsea timoriana
Litsea species 1
Litsea sp.
Neolitsea australiensis
Neolitsea sp.

LECYTHIDACEAE

Barringtonia calyptrocalyx

Barringtonia sp.
Planchonia papuana

LENTIBULARIACEAE

Utricularia striatula

LINACEAE

Hugonia jenkinsii

LOGANIACEAE

Fragraea ceilanica
Geniostoma rupestre
Neuburgia corynocarpa
Neuburgia sp.

LORANTHACEAE

Amyema cf. friesiana
Amyema rigidiflora
Amyema sp.
Decaisnina hollrungii
Decaisnina pedicellata
Dendrophthoe gjellerupii
Sogerianthe sogerensis

LYTHRACEAE

Lagerstroemia piriformis

MAGNOLIACEAE

Magnolia tsiampacca
Magnolia sp.

MALPIGHIACEAE

Stigmaphyllon timoriense

MALVACEAE

Abelmoschus manihot
Brachychiton carruthersii
Commersonia bartramia
Grewia sp.
*Melochia corchorifolia**

Melochia odorata
Melochia umbellata
Microcos sp.
Scaphium sp.
*Sida acuta**
*Sida cordifolia**
*Sida rhombifolia**
Sterculia schumanniana
Sterculia shillinglawii
Sterculia species 1
Sterculia species 2
Sterculia species 3
Sterculia sp.
Trichospermum burretii
Trichospermum pleiostigma
Trichospermum sp.
Triumfetta sp.
*Urena lobata**

MARANTACEAE

Donax canniformis
Phrynium sp.

MELASTOMATACEAE

Astronia brunneoaenea
Astronia sp.
Astronidium sp.
Creochiton novoguineensis
Medinilla forbesii
Medinilla sp.
Melastoma malabathricum
Melastoma polyanthum
*Miconia crenata**
Osbeckia chinensis

MELIACEAE

Aglaiia flavescens
Aglaiia leucoclada
Aglaiia mariannensis

Aglaiia sp.
Aphanamixis lauterbachii
Aphanamixis sp.
Chisocheton novoguineensis
Chisocheton species 1
Chisocheton sp.
Dysoxylum alliaceum
Dysoxylum excelsum
Dysoxylum gaudichaudianum
Dysoxylum kaniense
Dysoxylum parasiticum
Dysoxylum pettigrewianum
Dysoxylum species 1
Dysoxylum species 2
Dysoxylum species 3
Dysoxylum sp.
Toona sureni
Toona sp.
Vavaea sp.

MENISPERMACEAE

Arcangelisia tympanopoda
Macrococculus sp.

MONIMIACEAE

Kairoa suberosa
Kibara katikii
Kibara species 1
Kibara species 2
Kibara sp.
Levieria sp.
Palmeria gracilis
Palmeria sp.
Stegathera cf. salomonensis
Stegathera sp.

MORACEAE

*Artocarpus vriesianus**
Artocarpus sp.

Ficus adenosperma
Ficus albipila
Ficus archboldiana
Ficus baeuerlenii
Ficus benjamina
Ficus bernaysii
Ficus botryocarpa
Ficus caulocarpa
Ficus congesta
Ficus copiosa
Ficus crassiramea
Ficus disticha
Ficus distichoidea
Ficus drupacea
Ficus erythrosperma
Ficus glandulifera
Ficus gul
Ficus hesperidiiformis
Ficus hispidioides
Ficus itoana
Ficus mafuluensis
Ficus microcarpa
Ficus odoardii
Ficus opposita
Ficus pachyrrhachis
Ficus pantoniana
Ficus patellata
Ficus prasinicarpa
Ficus pungens
Ficus rhizophoriphylla
Ficus ribes
Ficus scratchleyana
Ficus semilanata
Ficus septica
Ficus subcordata
Ficus subtrinervia
Ficus subulata
Ficus tinctoria
Ficus trachypison

Ficus variegata
Ficus virens
Ficus virgata
Ficus xylosyca
Ficus species 1
Ficus species 2
Ficus species 3
Ficus species 4
Ficus sp.
Parartocarpus venenosus
Parartocarpus sp.
Prainea limpato
Streblus glaber
Trophis scandens

MYRISTICACEAE

Endocomia macrocoma
Gymnacranthera farquhariana
Horsfieldia hellwigii
Horsfieldia sinclairii
Horsfieldia spicata
Horsfieldia subtilis
Horsfieldia sp.
Myristica globosa (NT)
Myristica longipes
Myristica subalulata
Myristica undulatifolia
Myristica species 1
Myristica species 2
Myristica species 3
Myristica species 4
Myristica sp.

MYRTACEAE

Corymbia confertiflora
Corymbia papuana
Decaspermum bracteatum
Decaspermum parviflorum
Decaspermum sp.

Eucalyptus alba
Eucalyptus tereticornis
Eugenia sp.
Melaleuca dealbata
Melaleuca sp.
Octamyrtus sp.
Rhodamnia glauca
Rhodamnia latifolia
Rhodomyrtus elegans
Rhodomyrtus trineura
Rhodomyrtus sp.
Syzygium acuminatissimum
Syzygium furfuraceum
Syzygium gonatanthum
Syzygium jambos
Syzygium lagerstemioides
Syzygium longipes
Syzygium porphyrocarpum
Syzygium pyrocarpum
Syzygium roemeri
Syzygium species 1
Syzygium species 2
Syzygium species 3
Syzygium species 4
Syzygium sp.

NEPENTHACEAE

Nepenthes mirabilis
Nepenthes sp.

NYCTAGINACEAE

Pisonia longirostris
Pisonia umbellifera

NYSSACEAE

Mastixia kaniensis
Mastixia sp.

OCHNACEAE

Schuermansia henningsii

Schuermansia sp.

OLEACEAE

Chionanthus sp.

Jasminum elongatum

Jasminum papuasicum

Ligustrum glomeratum

ONAGRACEAE

*Ludwigia octovalvis**

ORCHIDACEAE

Acriopsis liliifolia

Agrostophyllum elongatum

Appendicula sp.

Bulbophyllum cimicinum

Bulbophyllum clandestinum

Bulbophyllum desmotrichoides

Bulbophyllum ebulbe

Bulbophyllum fractiflexum

Bulbophyllum gerlandianum

Bulbophyllum globiceps

Bulbophyllum hirudiniferum

Bulbophyllum infundibuliforme

Bulbophyllum manobulbum

Bulbophyllum sp.

Cadetia sp.

Calanthe sp.

Ceratostylis sp.

Cleisostoma firmulum

Coelogyne asperata

Coelogyne carinata

Crepidium brachycaulos

Dendrobium axillare

Dendrobium bracteosum

Dendrobium calceolum

Dendrobium capituliflorum

Dendrobium discolor
Dendrobium mirbelianum
Dendrobium smillieae
Dendrobium sp.
Dendrochilum longifolium
Didymoplexis sp.
Diplocaulobium sp.
Dipodium squamatum
Eria sp.
Eulophia bicallosa
Flickingeria comata
Flickingeria convexa
Geodorum sp.
Glossorhyncha sp.
Grammatophyllum sp.
Habenaria sp.
Hetaeria sp.
Hippeophyllum micranthum
Hippeophyllum sp.
Lecanorchis sp.
Liparis barbata
Luisia sp.
Malaxis zippelii
Micropera fasciculata
Oberonia sp.
Peristylus sp.
Pholidota imbricata
Phreatia micrantha
Phreatia paleata
Phreatia sp.
Plocoglottis moluccana
Podochilus scalpelliformis
Rhinerrhizopsis moorei
Sarcanthopsis nagarensis
Schoenorchis micrantha
Spathoglottis papuana
Spathoglottis parviflora
Taeniophyllum sp.
Thelasis sphaerocarpa

Thrixspermum sp.

Trichoglottis sp.

Trichotosia flexuosa

Trichotosia iodantha

Tropidia disticha

Tuberolabium sp.

Vanda hindsii

OROBANCHACEAE

Striga parviflora

OXALIDACEAE

*Oxalis barrelieri**

*Oxalis corniculata**

PANDACEAE

Galearia sp.

PANDANACEAE

Benstonea stenocarpa

Freycinetia lalokiensis

Freycinetia pseudoinsignis

Pandanus tectorius

Pandanus sp.

PASSIFLORACEAE

Hollrungia aurantioides

Passiflora aurantia

*Passiflora foetida**

PENTAPHYLACACEAE

Adinandra sp.

Eurya sp.

Ternstroemia merrilliana

Ternstroemia sp.

PHYLLANTHACEAE

Antidesma excavatum

Antidesma ghaesembilla

Antidesma polyanthum

Antidesma species 1

Antidesma species 2

Antidesma sp.

Aporosa brassii

Aporosa species 1

Aporosa sp.

Breynia cernua

Breynia sp.

Bridelia insulana

Bridelia tomentosa

Bridelia sp.

Cleistanthus inglorius

Glochidion benthamianum

Glochidion eucleoides

Glochidion cf. eucleoides

Glochidion fulvirameum

Glochidion ramiflorum

Glochidion sp.

Phyllanthus ciccooides

Phyllanthus reticulatus

Phyllanthus sp.

PINACEAE

Pinus kesiya

PIPERACEAE

Peperomia blanda

Peperomia gemella

Peperomia parvibacca

Peperomia sp

*Piper aduncum**

Piper caninum

Piper macropiper

Piper sp.

PITTOSPORACEAE

Pittosporum ferrugineum

Pittosporum ramiflorum

Pittosporum sinuatum

Pittosporum sp.

POACEAE

Bambusa sp.

Centotheca lappacea

Coix lacryma-jobi

Cyrtococcum accrescens

Cyrtococcum trigonum

*Eleusine indica**

Eriachne squarrosa

Eulalia irritans

Garnotia stricta

Isachne myosotis

Microstegium spectabile

Oplismenus compositus

Panicum sarmentosum

Panicum sp

*Paspalum conjugatum**

Paspalum sp.

Pogonatherum crinitum

Polytoca macrophylla

Pseudechinolaena polystachya

Sacciolepis myosuroides

Scrotochloa urceolata

Setaria palmifolia

*Sporobolus sp.**

Themeda triandra

Themeda villosa

PODOSTEMACEAE

Torrenticola queenslandica

POLYGALACEAE

Epirixanthes papuana

*Polygala paniculata**

Polygala persicariifolia

Polygala triflora

Securidaca sp.

Xanthophyllum papuanum

Xanthophyllum suberosum

PRIMULACEAE

Ardisia cf. tristanoides

Ardisia venusta

Ardisia sp.

Conandrium polyanthum

Embelia cotinoides

Maesa edulis

Myrsine acrosticta

Myrsine leucantha

Myrsine sp.

PROTEACEAE

Banksia dentata

Finschia carrii

Grevillea papuana

Grevillea pinnatifida

Helicia albiflora (NT)

Helicia sp.

PUTRANJIVACEAE

Drypetes longifolia

Drypetes neglecta

Drypetes sp.

RANUNCULACEAE

Clematis papuasica

RHAMNACEAE

Alphitonia excelsa

Alphitonia incana

Alphitonia macrocarpa

Alphitonia sp.

Gouania exilis

Gouania sp.

RHIZOPHORACEAE

Carallia brachiata

Carallia sp.

Gynotroches axillaris

ROSACEAE

Prunus dolichobotrys

Prunus turneriana

Prunus sp.

Rubus ledermannii

Rubus moluccanus

Rubus rosifolius

ROUSSEACEAE

Carpodetus sp.

RUBIACEAE

Amaracarpus attenuatus

Atractocarpus albituba

Canthium caudatum

Canthium megistocarpum

Canthium sp.

Coptosapelta carrii

Cyclophyllum barbatum

Gardenia species 1

Gardenia sp.

Geophila repens

Geophila zollingeriana

Hedyotis auricularia

Hydnophytum radicans

Ixora sp.

Lasianthus chlorocarpus

Lasianthus clementis

Morinda jasminoides

Morinda sp.

Mussaenda ferruginea

Mussaenda whitei

Mussaenda sp.

Mycetia javanica

Myrmecodia platytyrea
Myrmecodia tuberosa
Neonauclea acuminata
Neonauclea chalmersii
Oxyceros bispinosus
Porterandia macroptera
Psychotria micrococca
Psychotria papuana
Psychotria sp.
Randia ixoriflora
Randia pseudoixoraeflora
Randia sp
Randia sp.
Saprosma subrepandum
*Spermacoce laevis**
Tarenna buruensis
Tarenna sp.
Timonius pubistipulus
Timonius timon
Timonius sp.
Uncaria lanosa
Uncaria orientalis
Uncaria sp.
Wendlandia paniculata
Wendlandia sp.
Wrightia sp.

RUTACEAE

Clausena sp.
Euodia alata
Euodia elleryana
Euodia species 1
Euodia species 2
Euodia species 3
Euodia sp.
Evodiella muelleri
Flindersia pimenteliana (EN)
Flindersia species 1
Flindersia sp.

Glycosmis sp.

Halfordia papuana (CE)

Halfordia sp.

Lunasia amara

Melicope denhamii

Melicope cf. *muelleri*

Melicope xanthoxyloides

Melicope sp.

Murraya paniculata

Murraya sp.

Zanthoxylum ovalifolium

Zanthoxylum sp.

SABIACEAE

Meliosma sp.

Sabia pauciflora

SALICACEAE

Casearia carrii

Casearia sp.

Flacourtia zippelii

Flacourtia sp.

Xylosma papuanum

SANTALACEAE

Dendromyza ledermannii

Dendromyza reinwardtiana

Viscum ovalifolium

SAPINDACEAE

Alectryon ferrugineum

Alectryon species 1

Alectryon sp.

Allophylus sp.

Cupaniopsis curvidens

Cupaniopsis sp.

Dictyoneura obtusa

Elattostachys sp.

Ganophyllum sp.

Guioa comesperma

Guioa sp.

Harpullia carrii

Harpullia ramiflora

Harpullia species 1

Harpullia species 2

Harpullia sp.

Lepidopetalum species 1

Mischocarpus lachnocarpus

Mischocarpus sp.

Pometia pinnata

Pometia sp.

Toechima erythrocarpum

Toechima sp

SAPOTACEAE

Palaquium sp.

Planchonella obovoidea

Planchonella cf. sarcospermoides

Planchonella sp

Planchonella species 1

Planchonella species 2

Planchonella species 3

Planchonella sp.

Pouteria anteridifera

Pouteria suboppositifolia

SCROPHULARIACEAE

Vandellia anagallis

SIMAROUBACEAE

Picrasma sp.

SMILACACEAE

Smilax calophylla

Smilax sp.

SOLANACEAE

Solanum cf. anfractum

Solanum erianthum

Solanum lasiocarpum

Solanum torvoideum

*Solanum torvum**

STAPHYLEACEAE

Turpinia sp.

SYMPLOCACEAE

Symplocos pulvinata

Symplocos sp.

THEACEAE

Gordonia papuana

Gordonia sp.

THYMELAEACEAE

Phaleria macrocarpa

Phaleria sp.

Pimelea cornucopiae

URTICACEAE

Elatostema integrifolium

Elatostema rigidum

Elatostema sesquifolium

Leucosyke capitellata

Oreocnide sp.

Pipturus sp.

Poikilospermum inaequale

Poikilospermum sp.

Pouzolzia hirta

Procris frutescens

Procris sp.

VERBENACEAE

*Lantana camara**

Stachytarpheta mutabilis

VIOLACEAE

Rinorea horneri

VITACEAE

Cayratia japonica

Cissus conchigera

Cissus discolor

Cissus sp.

Leea indica

Leea sp

Leea sp.

Tetrastigma maluense

Tetrastigma pisicarpum

Tetrastigma schraderi-montis

Tetrastigma sp.

XANTHORRHOEACEAE

Dianella ensifolia

ZINGIBERACEAE

Alpinia sp.

Etlingera sp.

Hornstedtia sp.

Riedelia sp.

Appendix 3. Plant Family Species Richness, VNP

PLANT FAMILY SPECIES RICHNESS IN VARIRATA NATIONAL PARK

Plant Families of Varirata National Park with number of species per family. Listed in descending order by number of species per family.

FAMILY	No of Species
Orchidaceae	71
Moraceae	55
Rubiaceae	48
Fabaceae	46
Lauraceae	41
Myrtaceae	30
Elaeocarpaceae	25
Poaceae	25
Apocynaceae	24
Phyllanthaceae	24
Euphorbiaceae	23
Malvaceae	23
Rutaceae	23
Sapindaceae	23
Meliaceae	22
Cyperaceae	21
Annonaceae	20
Lamiaceae	18
Polypodiaceae	18
Asteraceae	17
Burseraceae	17
Acanthaceae	16
Myristicaceae	16
Anacardiaceae	15
Araliaceae	14
Arecaceae	14
Aspleniaceae	13
Hymenophyllaceae	12
Urticaceae	11
Vitaceae	11
Melastomataceae	10
Monimiaceae	10
Pteridaceae	10
Sapotaceae	10
Thelypteridaceae	10
Primulaceae	9
Araceae	8
Piperaceae	8

FAMILY	No of Species
Bignoniaceae	7
Icacinaceae	7
Loranthaceae	7
Polygalaceae	7
Clusiaceae	6
Convolvulaceae	6
Cunoniaceae	6
Gentianaceae	6
Proteaceae	6
Rhamnaceae	6
Rosaceae	6
Selaginellaceae	6
Celastraceae	5
Commelinaceae	5
Cyatheaceae	5
Lindsaeaceae	5
Pandanaceae	5
Salicaceae	5
Solanaceae	5
Tectariaceae	5
Asparagaceae	4
Combretaceae	4
Davalliaceae	4
Ebenaceae	4
Gesneriaceae	4
Gnetaceae	4
Loganiaceae	4
Lycopodiaceae	4
Oleaceae	4
Pentaphragmaceae	4
Pittosporaceae	4
Zingiberaceae	4
Actinidiaceae	3
Athyriaceae	3
Calophyllaceae	3
Cardiopteridaceae	3
Dennstaedtiaceae	3
Dipentodontaceae	3
Dipterocarpaceae	3
Fagaceae	3
Gleicheniaceae	3
Lecythidaceae	3

FAMILY	No of Species
Lygodiaceae	3
Nephrolepidacea	3
Passifloraceae	3
Podocarpaceae	3
Putranjivaceae	3
Rhizophoraceae	3
Santalaceae	3
Thymelaeaceae	3
Achariaceae	2
Amaranthaceae	2
Apiaceae	2
Cannabaceae	2
Chloranthaceae	2
Connaraceae	2
Cucurbitaceae	2
Dichapetalaceae	2
Dioscoreaceae	2
Erythroxylaceae	2
Escalloniaceae	2
Eupomatiaceae	2
Goodeniaceae	2
Himantandraceae	2
Hypoxidaceae	2
Magnoliaceae	2
Marantaceae	2
Menispermaceae	2
Nepenthaceae	2
Nyctaginaceae	2
Nyssaceae	2
Ochnaceae	2
Oxalidaceae	2
Sabiaceae	2
Smilacaceae	2
Symplocaceae	2
Theaceae	2
Verbenaceae	2
Aponogetonaceae	1
Aquifoliaceae	1
Aristolochiaceae	1
Asphodelaceae	1
Balsaminaceae	1
Begoniaceae	1

FAMILY	No of Species
Bixaceae	1
Blechnaceae	1
Caryophyllaceae	1
Casuarinaceae	1
Chrysobalanaceae	1
Cleomaceae	1
Crypteroniaceae	1
Cycadaceae	1
Cystodiaceae	1
Dicksoniaceae	1
Dilleniaceae	1
Dryopteridaceae	1
Elaeagnaceae	1
Flagellariaceae	1
Hydrocharitaceae	1
Juglandaceae	1
Lentibulariaceae	1
Linaceae	1
Lythraceae	1
Malpighiaceae	1
Marattiaceae	1
Onagraceae	1
Ophioglossaceae	1
Orobanchaceae	1
Pandaceae	1
Pinaceae	1
Podostemaceae	1
Psilotaceae	1
Ranunculaceae	1
Rousseaceae	1
Scrophulariaceae	1
Simaroubaceae	1
Staphyleaceae	1
Violaceae	1
Xanthorrhoeaceae	1

Appendix 4. Introduced Species, VNP

LIST OF INTRODUCED PLANTS RECORDED FROM VARIRATA NATIONAL PARK

AMARANTHACEAE

Alternanthera sessilis

ANACARDIACEAE

Mangifera minor

APIACEAE

Centella asiatica

APOCYNACEAE

Asclepias curassavica

ASTERACEAE

Ageratum conyzoides

Bidens pilosa

Crassophyllum crepidoides

Elephantopus mollis

Eleutheranthera ruderalis

Erechtites valerianifolia

Mikania micrantha

Syndrella nodiflora

Tithonia diversifolia

Wedelia spilanthoides

Spathodea campanulata

Bixa orellana

Drymaria cordata

Clemone viscosa

Tradescantia spp.

CYPERACEAE

Fimbristylis dichotoma

Kyllinga brevifolia

EUPHORBIACEAE

Croton hirtus

FABACEAE

Calopogonium mucunoides

Cassia grandis

Castanospermum australe

Centrosema pubescens

Flemingia macrophylla

Mimosa pudica

Phaseolus lunatus

Senna alata

Stylosanthes humilis

LAMIACEAE

Mesosphaerum suaveolens

MALVACEAE

Melochia corchorifolia

Sida acuta

Sida cordifolia

Sida rhombifolia

Urena lobata

MELASTOMATACEAE

Miconia crenata

MORACEAE

Artocarpus vriesianus

ONOGRACEAE

Ludwigia octovalnis

OXALIDACEAE

Oxalis barrelieri

Oxalis corniculata

PASSIFLORICACEAE

Passiflora foetida

PIPERACEAE

Piper aduncum

POACEAE

Eleusine indica

Paspalum conjugatum

Sporobolus sp.

POLYGALACEAE

Polygala paniculata

RUBIACEAE

Spermacoce laevis

SOLANACEAE

Solanum torvum

VERBENACEAE

Lantana camara

Appendix 5. IPCA Community Outreach Program

Outreach Program to Local Schools

Andrew McInnis and Christo Ferguson conducted an outreach program to local schools and villages from 1-8 November.

Given that local people and villages play an integral part in the Park's future success IPCA felt it important to engage with the community to share some key findings and images from the project. A presentation was created to share the scope and importance of the Park's biodiversity, the benefits of the Park's ecosystem goods and services, threats to the Park, future opportunities for Park collaboration, and potential livelihood activities from the Park's unique biodiversity. The program was implemented to achieve three main goals:

1. Community Engagement
2. Youth Environmental Education
3. Field Team Growth and Experience

Community Engagement

At the community level, a presentation was given to a local women's group affiliated with the United Church. A short introductory talk was also provided to a woman's group in Bisiatabu, affiliated with the Seventh Day Adventist Church. Both meetings were held in collaboration with SERACS.

Youth Environmental Education

A total of four schools participated in our youth outreach effort: Depo Elementary School, Sogeri Elementary School, Sogeri Primary School, and Iarowari Secondary School.

November 2nd, 2017

Presenters: Andrew McInnis, Christopher Ferguson and Noel Max.

At Depo Elementary IPCA completed an interactive presentation with a total of 40 students, grades included: Prep, Grade 1 and Grade 2.

At Iarowari Secondary IPCA completed two interactive presentations. One session included Grade 9 with a total of 50 students in attendance and the second session included Grade 11 with a total of 35 students in attendance.

November 3rd, 2017

Presenters: Andrew McInnis, Christopher Ferguson and Noel Max.

At Sogeri Elementary IPCA completed two interactive presentations. One session included Grade 1 with a total of 30 students in attendance; Second session included Prep and Grade 2 with a total of 50 students in attendance.

At Iarowari Secondary IPCA completed one interactive presentation with a total of 70 students, grades included: Grade 9 and Grade 11.

November 7th, 2017

Presenters: Andrew McInnis, Christopher Ferguson, and Monobe Kisea.

At Sogeri Primary School IPCA completed three interactive presentations. One session included Grade 7 with a total of 45 students in attendance the second session included

Grade 6 with a total of 60 students in attendance and the third session included Grade 5 with a total of 65 students in attendance.

November 8th, 2017

Presenters: Andrew McInnis, Christopher Ferguson and Bali Korohi.

At Sogeri Primary School IPCA completed two interactive presentations. One session included Grade 4 with a total of 40 students in attendance and the second session included Grade 3 with a total of 50 students in attendance.

All schools noted that they would be interested in participating in future events with the Park and CEPA, including school field trips to the Park, student projects, volunteering projects, and further environmental education presentations in the schools.

A total of **535** students received environmental education through IPCA's Community Outreach Program from the following schools:

Depo Elementary: 40 students

Sogeri Elementary: 80 students

Sogeri Primary: 260 students

Iarowari Secondary: 155 students

Two additional schools also expressed interest in receiving presentations and attending field trips to VNP, these comprised: Sogeri National High School and Seven Adventist School Bisiatabu. These schools should be included in future programs.

Field Team Growth & Experience

Five local Koiari field assistants were trained in Environmental Education concepts, activities and techniques. In addition, three local team members assisted and facilitated presentations with local youths at community schools. The presentation was created so team members and park rangers can continue to use the provided information for school and tourist groups in the future.

Contacts

School Contacts

1. Depo Elementary: Head Master Mr. Arue Uwea. No cell # at this time.
2. Sogeri Elementary: Head Teacher Mr. Womae Degini. Cell: 7212-3978
3. Sogeri Primary: Head Master Mr. Maima Iamuia. Cell: 7659-7714; 7908-4850
4. Iarowari Secondary: Head Master Mr. Andrew Moava. Cell: 7113-9016

Future Contacts

1. Sogeri National High School: Deputy Master Ms. Ellen Toti. Cell: 7255-3173; Direct: 325-1095; General: 325-1526
2. Seven Adventist School Bisiatabu: awaiting contact information, see Dr. Rodney Kameata.

Varirata National Park Biodiversity Project

Led by: Dr. Allen Allison and IndoPacific Conservation Alliance

Presentation by: Andrew McInnis and Christo Ferguson

Field team: Bali, Monobe, Dabio, Gilliam, Noel

Support from JICA, CEPA

Photography: Angus Fraser

What is a Park?



Why are Parks Important?

- ▶ Biodiversity
- ▶ Ecosystem goods and services
 - ▶ Watersheds
 - ▶ Clean Air and Water
- ▶ Science
- ▶ Recreation
- ▶ Culture

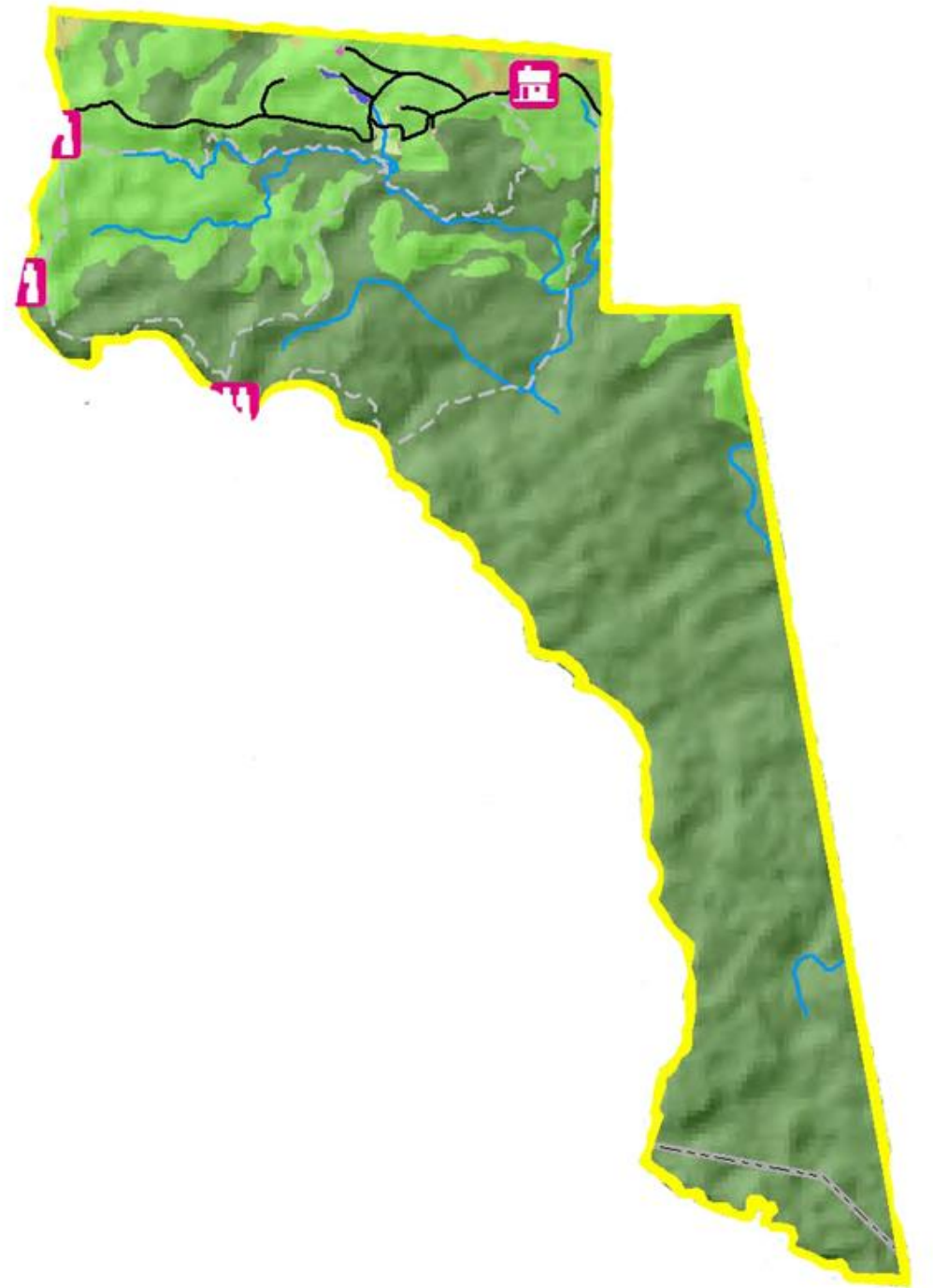


christo ferguson



Map

- ▶ Covers an area of 1,063 ha
- ▶ 600-800m in elevation



History

- ▶ Land was locally called Wodobonomu
- ▶ In 1950's sections had coffee nursery, piggery and poultry farm
- ▶ 8th of October 1973
 - ▶ First official National Park in PNG

Ecosystems



christo ferguson

Ecosystems



christo ferguson

Ecosystems



christo ferguson

Ecosystems



Ecosystems



christo ferguson

Threats to the Park: Invasive Species *add clidemia



Threats to Park



Our Project

- ▶ PNG Policy on the Protected Areas in 2014
- ▶ Ridge to Reef w/ Bootless Bay
- ▶ Biodiversity Survey
 - ▶ Plants
 - ▶ Animals
- ▶ CEPA/ JICA
- ▶ Indo-Pacific Conservation Alliance

Our Team: PNG Local Field Team



Our methods

- ▶ Plant
 - ▶ Press and dry specimens
 - ▶ Museums
 - ▶ Studies
 - ▶ All parts of plant (flower, leaf, fruits, ect)
 - ▶ season
- ▶ Animals
 - ▶ Catch, Bag
 - ▶ Genetics
 - ▶ Gps
 - ▶ Handling
 - ▶ Documentation





christo ferguson

Animals

- ▶ Endangered
- ▶ Endemic
- ▶ Vertebrates 355

Frogs







AJKMcInnis

Birds









AJKMcInnis

Reptiles





AJKMcInnis





AJKMcInnis





Insects









Mammals









How can you get involved

- ▶ Student Projects
- ▶ Practicums
- ▶ Volunteering

Future opportunities

- ▶ Park ranger
- ▶ Scientist
- ▶ CEPA

Thank You

▶ Questions?

Appendix 6. Species Scheduled With IUCN Red List Conservation Significance

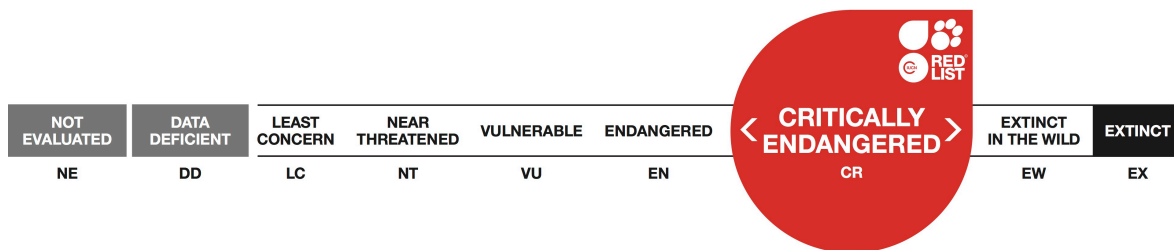
SUMMARY OF THE FIVE CRITERIA (A-E) USED TO EVALUATE IF A TAXON BELONGS IN AN IUCN RED LIST THREATENED CATEGORY (CRITICALLY ENDANGERED, ENDANGERED OR VULNERABLE).¹

A. Population size reduction. Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered	Endangered	Vulnerable
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3 & A4	≥ 80%	≥ 50%	≥ 30%
<p>A1 Population reduction observed, estimated, inferred, or suspected in the past where the causes of the reduction are clearly reversible AND understood AND have ceased.</p> <p>A2 Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.</p> <p>A3 Population reduction projected, inferred or suspected to be met in the future (up to a maximum of 100 years) [(a) cannot be used for A3].</p> <p>A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.</p>		<p>(a) direct observation [except A3]</p> <p>(b) an index of abundance appropriate to the taxon</p> <p>(c) a decline in area of occupancy (AOO), extent of occurrence (EOO) and/or habitat quality</p> <p>(d) actual or potential levels of exploitation</p> <p>(e) effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.</p>	
<i>based on any of the following:</i>			
B. Geographic range in the form of either B1 (extent of occurrence) AND/OR B2 (area of occupancy)			
	Critically Endangered	Endangered	Vulnerable
B1. Extent of occurrence (EOO)	< 100 km ²	< 5,000 km ²	< 20,000 km ²
B2. Area of occupancy (AOO)	< 10 km ²	< 500 km ²	< 2,000 km ²
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented OR Number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			
C. Small population size and decline			
	Critically Endangered	Endangered	Vulnerable
Number of mature individuals	< 250	< 2,500	< 10,000
AND at least one of C1 or C2			
C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future):	25% in 3 years or 1 generation (whichever is longer)	20% in 5 years or 2 generations (whichever is longer)	10% in 10 years or 3 generations (whichever is longer)
C2. An observed, estimated, projected or inferred continuing decline AND at least 1 of the following 3 conditions:			
(a) (i) Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
(ii) % of mature individuals in one subpopulation =	90–100%	95–100%	100%
(b) Extreme fluctuations in the number of mature individuals			
D. Very small or restricted population			
	Critically Endangered	Endangered	Vulnerable
D. Number of mature individuals	< 50	< 250	D1. < 1,000
D2. Only applies to the VU category Restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to CR or EX in a very short time.	-	-	D2. typically: AOO < 20 km ² or number of locations ≤ 5
E. Quantitative Analysis			
	Critically Endangered	Endangered	Vulnerable
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)	≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)	≥ 10% in 100 years

¹ Use of this summary sheet requires full understanding of the *IUCN Red List Categories and Criteria* and *Guidelines for Using the IUCN Red List Categories and Criteria*. Please refer to both documents for explanations of terms and concepts used here.

Halfordia papuana

Assessment by: Eddowes, P.J.



View on www.iucnredlist.org

Citation: Eddowes, P.J. 1998. *Halfordia papuana*. *The IUCN Red List of Threatened Species 1998*: e.T38151A10103085. <http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T38151A10103085.en>

Copyright: © 2015 International Union for Conservation of Nature and Natural Resources

Reproduction of this publication for educational or other non-commercial purposes is authorized without prior written permission from the copyright holder provided the source is fully acknowledged.

Reproduction of this publication for resale, reposting or other commercial purposes is prohibited without prior written permission from the copyright holder. For further details see [Terms of Use](#).

The IUCN Red List of Threatened Species™ is produced and managed by the [IUCN Global Species Programme](#), the [IUCN Species Survival Commission \(SSC\)](#) and [The IUCN Red List Partnership](#). The IUCN Red List Partners are: [BirdLife International](#); [Botanic Gardens Conservation International](#); [Conservation International](#); [Microsoft](#); [NatureServe](#); [Royal Botanic Gardens, Kew](#); [Sapienza University of Rome](#); [Texas A&M University](#); [Wildscreen](#); and [Zoological Society of London](#).

If you see any errors or have any questions or suggestions on what is shown in this document, please provide us with [feedback](#) so that we can correct or extend the information provided.

Taxonomy

Kingdom	Phylum	Class	Order	Family
Plantae	Tracheophyta	Magnoliopsida	Sapindales	Rutaceae

Taxon Name: *Halfordia papuana* Laut.

Assessment Information

Red List Category & Criteria: Critically Endangered C2a [ver 2.3](#)

Year Published: 1998

Date Assessed: January 1, 1998

Annotations: Needs Updating

Geographic Range

Range Description:

Mostly confined to the Bulolo/Wau region in Morobe Province. It is not certain how many mature specimens remain but it is certainly less than 250.

Country Occurrence:

Native: Papua New Guinea

Habitat and Ecology

This tree is scattered in submontane and montane rainforest between 1,200 and 2,700 m.

Systems: Terrestrial

Threats (see Appendix for additional information)

The region has been heavily exploited, logged and converted into *Araucaria* plantations.

Credits

Assessor(s): Eddowes, P.J.

Bibliography

Eddowes, P.J. 1997. Completed data collection forms for New Guinea.

Oldfield, S., Lusty, C. and MacKinven, A. (compilers). 1998. *The World List of Threatened Trees*. World Conservation Press, Cambridge, UK.

Citation

Eddowes, P.J. 1998. *Halfordia papuana*. *The IUCN Red List of Threatened Species 1998*: e.T38151A10103085. <http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T38151A10103085.en>

Disclaimer

To make use of this information, please check the [Terms of Use](#).

External Resources

For [Images and External Links to Additional Information](#), please see the Red List website.

Threats

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Threat	Timing	Scope	Severity	Impact Score
5. Biological resource use -> 5.3. Logging & wood harvesting -> 5.3.5. Motivation Unknown/Unrecorded	Ongoing	-	-	-
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation		

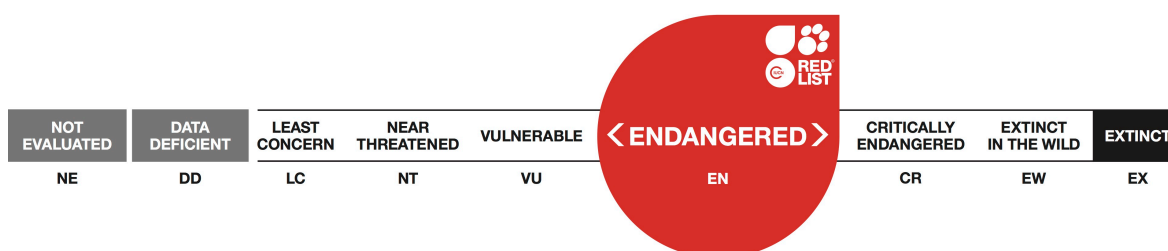
The IUCN Red List Partnership



The IUCN Red List of Threatened Species™ is produced and managed by the [IUCN Global Species Programme](#), the [IUCN Species Survival Commission \(SSC\)](#) and [The IUCN Red List Partnership](#). The IUCN Red List Partners are: [BirdLife International](#); [Botanic Gardens Conservation International](#); [Conservation International](#); [Microsoft](#); [NatureServe](#); [Royal Botanic Gardens, Kew](#); [Sapienza University of Rome](#); [Texas A&M University](#); [Wildscreen](#); and [Zoological Society of London](#).

Flindersia pimenteliana

Assessment by: Eddowes, P.J.



View on www.iucnredlist.org

Citation: Eddowes, P.J. 1998. *Flindersia pimenteliana*. *The IUCN Red List of Threatened Species 1998*: e.T38149A10102702. <http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T38149A10102702.en>

Copyright: © 2015 International Union for Conservation of Nature and Natural Resources

Reproduction of this publication for educational or other non-commercial purposes is authorized without prior written permission from the copyright holder provided the source is fully acknowledged.

Reproduction of this publication for resale, reposting or other commercial purposes is prohibited without prior written permission from the copyright holder. For further details see [Terms of Use](#).

The IUCN Red List of Threatened Species™ is produced and managed by the [IUCN Global Species Programme](#), the [IUCN Species Survival Commission \(SSC\)](#) and [The IUCN Red List Partnership](#). The IUCN Red List Partners are: [BirdLife International](#); [Botanic Gardens Conservation International](#); [Conservation International](#); [Microsoft](#); [NatureServe](#); [Royal Botanic Gardens, Kew](#); [Sapienza University of Rome](#); [Texas A&M University](#); [Wildscreen](#); and [Zoological Society of London](#).

If you see any errors or have any questions or suggestions on what is shown in this document, please provide us with [feedback](#) so that we can correct or extend the information provided.

Taxonomy

Kingdom	Phylum	Class	Order	Family
Plantae	Tracheophyta	Magnoliopsida	Sapindales	Rutaceae

Taxon Name: *Flindersia pimenteliana* F. Muell

Assessment Information

Red List Category & Criteria: Endangered C2a [ver 2.3](#)

Year Published: 1998

Date Assessed: January 1, 1998

Annotations: Needs Updating

Geographic Range

Range Description:

In Papua New Guinea, the species is widespread but uncommon and sporadic. The population status in Australia is not taken into consideration in this evaluation.

Country Occurrence:

Native: Australia (Queensland); Indonesia (Papua); Papua New Guinea

Habitat and Ecology

A large tree found mainly in lower montane rainforest or in foothill rainforest.

Systems: Terrestrial

Threats (see Appendix for additional information)

It has been heavily exploited in the Bulolo/Wau region of Morobe Province. Populations on spurs and ridges of mountain ranges may be spared from future exploitation.

Credits

Assessor(s): Eddowes, P.J.

Bibliography

Eddowes, P.J. 1997. Completed data collection forms for New Guinea.

Oldfield, S., Lusty, C. and MacKinven, A. (compilers). 1998. *The World List of Threatened Trees*. World Conservation Press, Cambridge, UK.

Citation

Eddowes, P.J. 1998. *Flindersia pimenteliana*. *The IUCN Red List of Threatened Species 1998*: e.T38149A10102702. <http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T38149A10102702.en>

Disclaimer

To make use of this information, please check the [Terms of Use](#).

External Resources

For [Images and External Links to Additional Information](#), please see the Red List website.

Threats

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Threat	Timing	Scope	Severity	Impact Score
5. Biological resource use -> 5.3. Logging & wood harvesting -> 5.3.5. Motivation Unknown/Unrecorded	Ongoing	-	-	-
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation		

The IUCN Red List Partnership



The IUCN Red List of Threatened Species™ is produced and managed by the [IUCN Global Species Programme](#), the [IUCN Species Survival Commission \(SSC\)](#) and [The IUCN Red List Partnership](#). The IUCN Red List Partners are: [BirdLife International](#); [Botanic Gardens Conservation International](#); [Conservation International](#); [Microsoft](#); [NatureServe](#); [Royal Botanic Gardens, Kew](#); [Sapienza University of Rome](#); [Texas A&M University](#); [Wildscreen](#); and [Zoological Society of London](#).

PNGTreesKey Flindersia pimenteliana F.Muell.

Barry Conn (NSW) & Kipiro Damas (LAE).

Guide to trees of Papua New Guinea

Copyright held by the authors, National Herbarium of New South Wales, and Papua New Guinea National Herbarium

Flindersia pimenteliana F.Muell.

Fragmenta Phytographiae Australiae Vol. 9: 132 (1875)

Other Literature: D.J. Boland *et al.*, *Forest Trees of Australia* 620-621 (1984) Fig. 621 (page).

Family: Rutaceae

Dicotyledon

Timber Group: Minor hardwood

Field Characters: Large canopy tree (up to 40 m high) or Small sub-canopy tree; Bole cylindrical (up to c. 100 cm diam.); straight (mostly bole up to 20 m long); buttresses absent; spines absent; aerial roots absent; stilt roots absent; Bark grey or brown, slightly rough, pustular or slightly cracked, lenticels elongated vertically; Subrhytidome (under-bark) sometimes green or dark red; less than 25 mm thick, (6.0-) 8.0-14.0; bark blaze consisting of one layer; strongly aromatic or faintly to non-aromatic; pleasant (fruity); outer blaze white, yellow (pale (straw-coloured), red, or pink, with stripes (white), fibrous; inner blaze pink, red, white, or yellow (pale (straw-coloured), with stripes (white), fibrous; bark exudate (sap) present, colourless, not readily flowing (spotty), colour not changing on exposure to air, not sticky; terminal buds not enclosed by leaves.

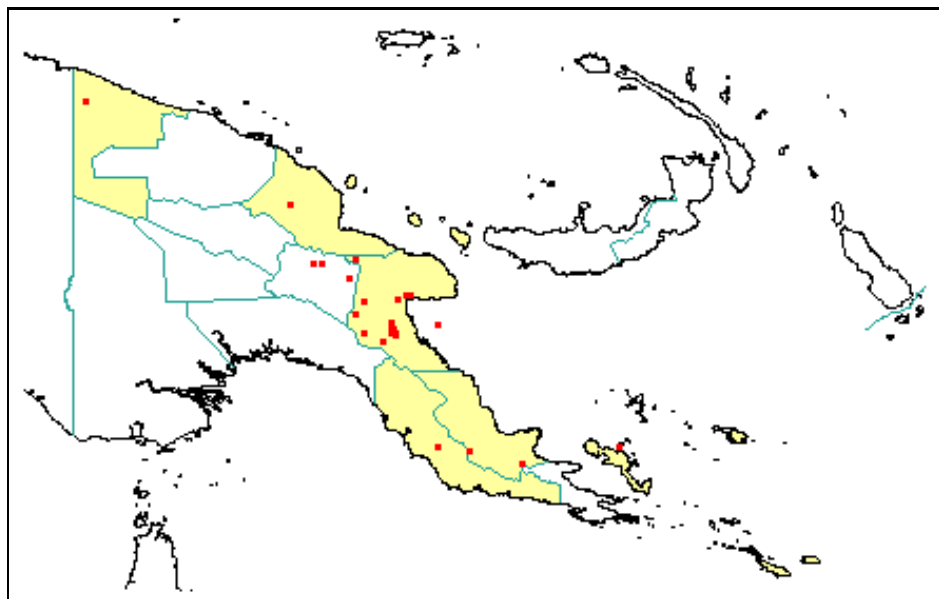
Indumentum: Complex hairs absent; stinging hairs absent; mature twig indumentum (hairs) absent.

Leaves: Leaves spaced along branches, opposite (in pairs, opposite one another on the branchlet) (to subopposite), compound (a leaf made up from two or more leaflets); petiole present, not winged, attached to base of leaf blade, not swollen; leaves pinnate (unbranched with more than three leaflets); petiolule not swollen; rachis present, absent; leaves with a terminal leaflet (the number of leaflets odd - imparipinnate), broadest below middle, 8.0-34.0 cm, 2.0-5.0 cm, leaflets opposite, symmetric (to slightly asymmetric), terminal developing leaflet buds straight; venation pinnate, secondary veins open, not prominent, but visible, intramarginal veins absent; leaves lower surface pale green or yellowish green, upper surface dark green, indumentum (hairs) absent; absent or present; domatia absent; stipules absent.

Flowers: Inflorescence terminal, flowers on a branched axis, cones absent; flowers bisexual, stalked, flowers with many planes of symmetry, 2.5-4.0 mm long, diameter small (up to 10 mm diam.) (c. 3 mm diam.); perianth present, with distinct sepals and petals whorls, inner perianth red (dark towards base) or white (on inner surface); 5, some or partly joined (shortly at base) or free; stamens 5, present, free of each other, free of the perianth; ovary superior, carpels joined (when more than one), locules 10 (2 per carpel); styles solitary, 1.

Fruits: Infructescence arranged on branched axis, fruit 50.0-120.0 mm long, 40.0-60.0 mm diam., brown, spiny (with blunt spines), non-fleshy, simple, dehiscent, capsule; seeds 30 (c.), much more than 10 mm long (40-60 mm long), winged (at both ends), narrow (longer than wide), seed 1-10 mm diam. (c. 10 mm diam.).

Distribution: West Sepik, Madang, Morobe, Central, Northern & Papuan Islands.



[Botanical records
in PNGplants database](#)

[Map details](#)

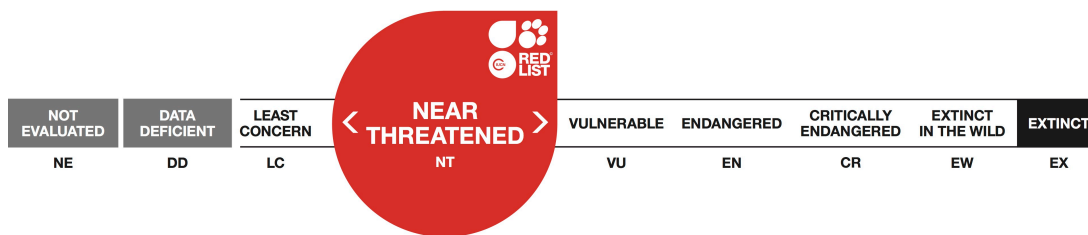




The IUCN Red List of Threatened Species™
ISSN 2307-8235 (online)
IUCN 2008: T42072A10618293

Cycas campestris

Assessment by: Hill, K.D.



View on www.iucnredlist.org

Citation: Hill, K.D. 2010. *Cycas campestris*. *The IUCN Red List of Threatened Species 2010*: e.T42072A10618293. <http://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T42072A10618293.en>

Copyright: © 2015 International Union for Conservation of Nature and Natural Resources

Reproduction of this publication for educational or other non-commercial purposes is authorized without prior written permission from the copyright holder provided the source is fully acknowledged.

Reproduction of this publication for resale, reposting or other commercial purposes is prohibited without prior written permission from the copyright holder. For further details see [Terms of Use](#).

The IUCN Red List of Threatened Species™ is produced and managed by the [IUCN Global Species Programme](#), the [IUCN Species Survival Commission \(SSC\)](#) and [The IUCN Red List Partnership](#). The IUCN Red List Partners are: [BirdLife International](#); [Botanic Gardens Conservation International](#); [Conservation International](#); [Microsoft](#); [NatureServe](#); [Royal Botanic Gardens, Kew](#); [Sapienza University of Rome](#); [Texas A&M University](#); [Wildscreen](#); and [Zoological Society of London](#).

If you see any errors or have any questions or suggestions on what is shown in this document, please provide us with [feedback](#) so that we can correct or extend the information provided.

Taxonomy

Kingdom	Phylum	Class	Order	Family
Plantae	Tracheophyta	Cycadopsida	Cycadales	Cycadaceae

Taxon Name: *Cycas campestris* K.D.Hill

Assessment Information

Red List Category & Criteria: Near Threatened [ver 3.1](#)

Year Published: 2010

Date Assessed: October 31, 2009

Justification:

Assessed as Near Threatened because of ongoing decline and the extent of occurrence being less than 20,000 km², but the population is not severely fragmented and is found at more than ten locations. Almost qualifies as threatened under criterion B1ab(iii,v).

Previously Published Red List Assessments

2003 – Near Threatened (NT)

Geographic Range

Range Description:

This species is endemic to Papua New Guinea, where it occurs in the Central Province, particularly around Port Moresby, extending from Kairuku to Abau.

Country Occurrence:

Native: Papua New Guinea (Papua New Guinea (main island group))

Population

The population size is not well known but is estimated to exceed 10,000 plants in the wild.

Current Population Trend: Decreasing

Habitat and Ecology (see Appendix for additional information)

This species is locally abundant but sporadic and it occurs in savanna woodland country. Plants are often in more open and grassy areas prone to frequent fire. Occurs only at low altitudes on the coastal plain.

Systems: Terrestrial

Threats (see Appendix for additional information)

This species may be subject to over-collecting for ornamental purposes. Fire may also be a problem as in other *Cycas* species, frequent fires have led to decline.

Conservation Actions (see Appendix for additional information)

This species is listed on Appendix II of the CITES Appendices.

Credits

Assessor(s): Hill, K.D.

Reviewer(s): Donaldson, J.S. & Bösenberg, J.D.

Bibliography

Donaldson, J.S. (ed.). 2003. *Cycads. Status Survey and Conservation Action Plan*. IUCN/SSC Cycad Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.

Hill, K.D. and Stevenson, D.W. 1998-2006. The Cycad Pages. Available at: <http://plantnet.rbgsyd.gov.au/PlantNet/cycad/>.

IUCN. 2010. IUCN Red List of Threatened Species (ver. 2010.3). Available at: <http://www.iucnredlist.org>. (Accessed: 2 September 2010).

Jones, D.L. 2002. *Cycads of the World (2nd edition)*. Smithsonian Institute Press, Washington, DC.

Whitelock, L.M. 2002. *The Cycads*. Timber Press, Portland, Oregon.

Citation

Hill, K.D. 2010. *Cycas campestris*. *The IUCN Red List of Threatened Species 2010*: e.T42072A10618293. <http://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T42072A10618293.en>

Disclaimer

To make use of this information, please check the [Terms of Use](#).

External Resources

For [Images and External Links to Additional Information](#), please see the Red List website.

Appendix

Habitats

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Habitat	Season	Suitability	Major Importance?
1. Forest -> 1.5. Forest - Subtropical/Tropical Dry	-	Suitable	-
2. Savanna -> 2.1. Savanna - Dry	-	Suitable	-
4. Grassland -> 4.5. Grassland - Subtropical/Tropical Dry	-	Suitable	-

Use and Trade

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

End Use	Local	National	International
Pets/display animals, horticulture	No	Yes	Yes

Threats

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Threat	Timing	Scope	Severity	Impact Score
5. Biological resource use -> 5.2. Gathering terrestrial plants -> 5.2.1. Intentional use (species is the target)	Ongoing	-	-	-
	Stresses:	2. Species Stresses -> 2.1. Species mortality		
7. Natural system modifications -> 7.1. Fire & fire suppression -> 7.1.1. Increase in fire frequency/intensity	Future	-	-	-
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation		

Conservation Actions in Place

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Conservation Actions in Place
In-Place Education
Included in international legislation: Yes
Subject to any international management/trade controls: Yes

Conservation Actions Needed

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Conservation Actions Needed

1. Land/water protection -> 1.1. Site/area protection

4. Education & awareness -> 4.3. Awareness & communications

Research Needed

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Research Needed

1. Research -> 1.3. Life history & ecology
--

1. Research -> 1.6. Actions

Additional Data Fields

Distribution

Estimated extent of occurrence (EOO) (km ²): 9250

Population

Number of mature individuals: 10000-12000

Population severely fragmented: No

Habitats and Ecology

Generation Length (years): 40

The IUCN Red List Partnership

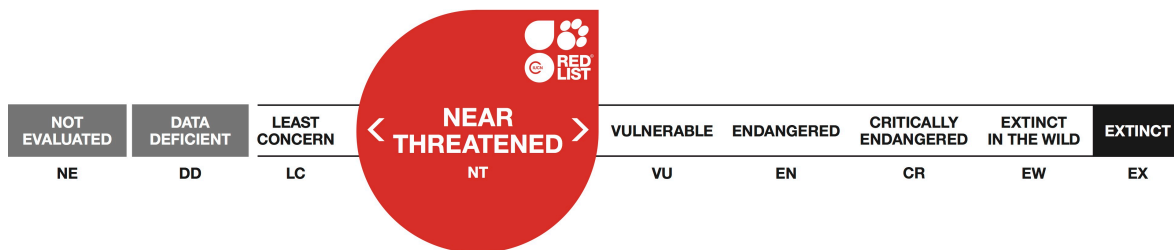


The IUCN Red List of Threatened Species™ is produced and managed by the [IUCN Global Species Programme](#), the [IUCN Species Survival Commission \(SSC\)](#) and [The IUCN Red List Partnership](#). The IUCN Red List Partners are: [BirdLife International](#); [Botanic Gardens Conservation International](#); [Conservation International](#); [Microsoft](#); [NatureServe](#); [Royal Botanic Gardens, Kew](#); [Sapienza University of Rome](#); [Texas A&M University](#); [Wildscreen](#); and [Zoological Society of London](#).



Hopea forbesii, Giam

Assessment by: Barstow, M.



View on www.iucnredlist.org

Citation: Barstow, M. 2018. *Hopea forbesii*. The IUCN Red List of Threatened Species 2018: e.T36291A68070385. <http://dx.doi.org/10.2305/IUCN.UK.2018-1.RLTS.T36291A68070385.en>

Copyright: © 2018 International Union for Conservation of Nature and Natural Resources

Reproduction of this publication for educational or other non-commercial purposes is authorized without prior written permission from the copyright holder provided the source is fully acknowledged.

Reproduction of this publication for resale, reposting or other commercial purposes is prohibited without prior written permission from the copyright holder. For further details see [Terms of Use](#).

The IUCN Red List of Threatened Species™ is produced and managed by the [IUCN Global Species Programme](#), the [IUCN Species Survival Commission \(SSC\)](#) and [The IUCN Red List Partnership](#). The IUCN Red List Partners are: [Arizona State University](#); [BirdLife International](#); [Botanic Gardens Conservation International](#); [Conservation International](#); [NatureServe](#); [Royal Botanic Gardens, Kew](#); [Sapienza University of Rome](#); [Texas A&M University](#); and [Zoological Society of London](#).

If you see any errors or have any questions or suggestions on what is shown in this document, please provide us with [feedback](#) so that we can correct or extend the information provided.

Taxonomy

Kingdom	Phylum	Class	Order	Family
Plantae	Tracheophyta	Magnoliopsida	Malvales	Dipterocarpaceae

Taxon Name: *Hopea forbesii* (Brandis) Slooten

Synonym(s):

- *Shorea forbesii* Brandis

Common Name(s):

- English: Giam

Assessment Information

Red List Category & Criteria: Near Threatened [ver 3.1](#)

Year Published: 2018

Date Assessed: May 23, 2017

Justification:

This species is a large tree native to the lowland evergreen forests of Papua New Guinea and east Irian Jaya. It has an estimated extent of occurrence (EOO) of 85,000 km². As well as confirmation of the species range, population size and volume of species harvested for timber also requires investigation. The species is suspected to be in decline due to the loss of lowland forest within its native range which is estimated to be at least 25% over the last three generations. The species is also exploited for its timber which is a growing threat particularly within Central and Milne bay provinces where harvest is greatest. Due to this, it is estimated that the species has experienced at least 25% population decline over the last three generations. The species is therefore globally assessed as Near Threatened as it almost meets the criteria for Vulnerable under criterion A2.

Geographic Range

Range Description:

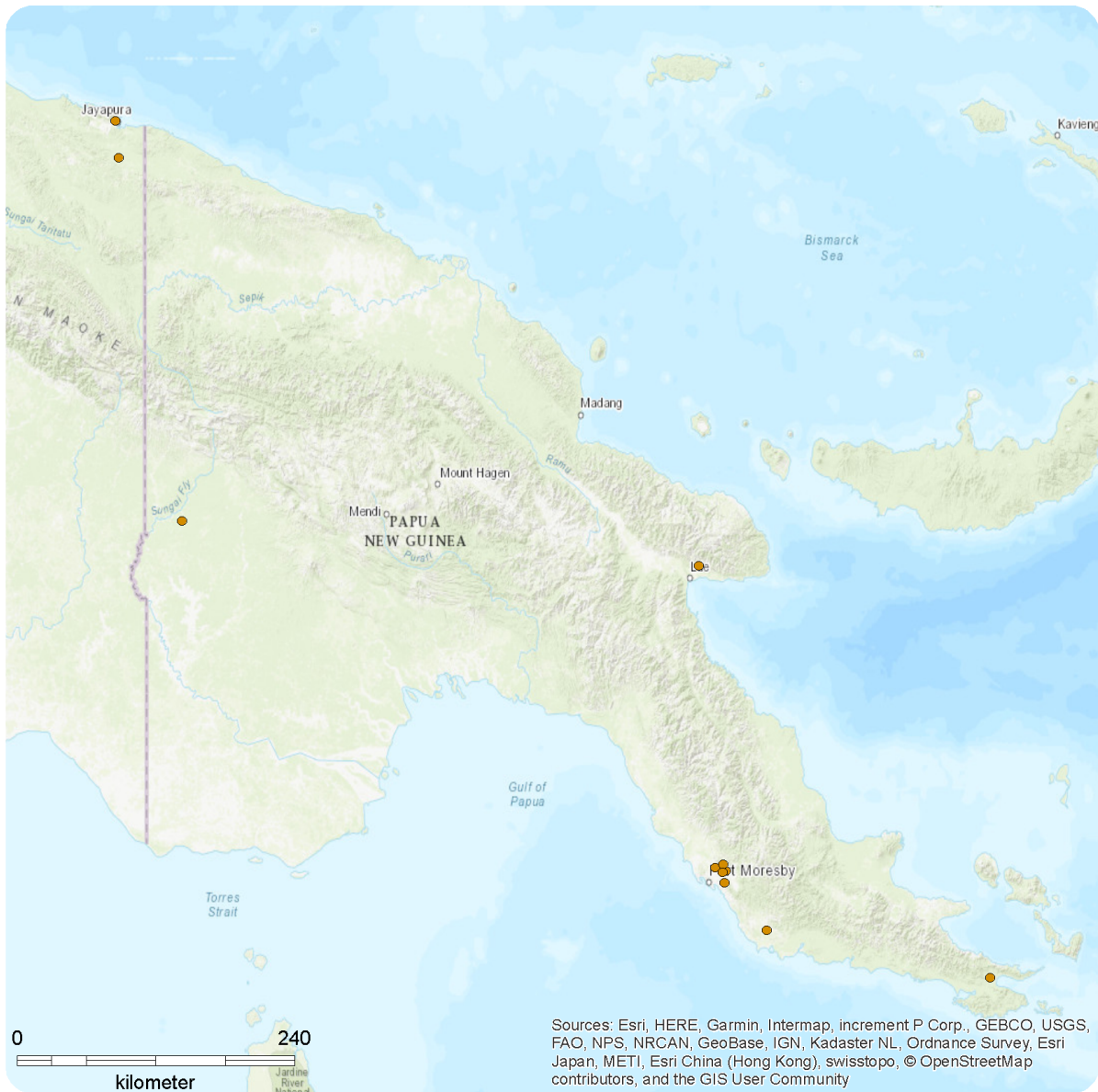
This species is native to Papua New Guinea (PNG) along the coast of the Papuan Islands, Milne Bay Province, and the inland and coastal forest of Central Province, Morobe Province and Western Province (T. Jimbo pers. comm. 2018). The species is also present within Irian Jaya. More sampling across New Guinea is required to confirm the species range. The species has an estimated extent of occurrence (EOO) of around 285,000 km².

Country Occurrence:

Native: Indonesia (Papua); Papua New Guinea (Papua New Guinea (main island group))

Distribution Map

Hopea forbesii

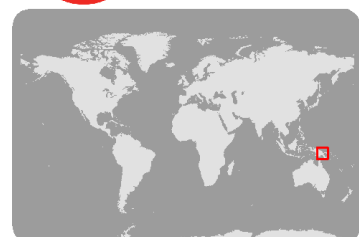


Range

- Extant (resident)

Compiled by:

BGCI



The boundaries and names shown and the designations used on this map do not imply any official endorsement, acceptance or opinion by IUCN.



Population

The species is considered locally common in lowland rain forests (ITTO 2017). Shearman *et al.* (2009) estimated that between 1972 and 2002 the Milne Bay region experienced forest decline of 27.28% and in Central Province deforestation was slightly lower at 25.15%. Overall in Papua New Guinea, there was 15% forest decline from 1972 to 2002. The greatest amount of decline occurred in lowland areas and the greatest cause of forest loss was logging (Shearman *et al.* 2009). The highest rates of timber extraction in PNG are in Central and Milne provinces where this species is found (T. Jimbo pers. comm. 2018). As *Hopea forbesii* is used as a timber and is found in lowland forest it is likely that its population has been adversely affected by this decline. It is also predicted that 49% of remaining unlogged forests will be logged and subject to degradation in the future (Shearman *et al.* 2009). We therefore infer that population is currently in decline and may have declined by at least 25% in the last 300 years based on this information. Population decline may continue into the future due to commercial logging and due to growth of urban and agricultural areas.

Current Population Trend: Decreasing

Habitat and Ecology (see Appendix for additional information)

Hopea forbesii is a large tree species, growing up to 32 m in height and up to 100 cm in diameter (ITTO 2017). This species is found in lowland seasonal semi-evergreen forest. It is sometimes the dominant tree on ridges (ITTO 2017) and is an under canopy species (Ashton 1988). The species does not have a persistent seed bank instead many seedling of the species persist in the undergrowth as they are shade tolerant. These then rapidly grow upon an opening in the canopy (Sist *et al.* 2003). Pollination is by insects and flowering most often occurs in a mast year. Seedling recruitment is greatest this year and is often local to the mother tree due to poor wind dispersal of winged fruits (Sist *et al.* 2003). The species habitat is declining in area due to the expansion of subsistence agriculture in the area as a consequence of a growing population (Shearman *et al.* 2009). Lowland forests are also subject to degradation due to the loss of canopy cover caused by logging and also destruction of the under-story vegetation due to the heavy machinery used for timber extraction.

Systems: Terrestrial

Use and Trade

Hopea forbesii is a commercially important timber species (Mark *et al.* 2014). The wood is used for making window frames, doors and marine constructions (ITTO 2017). In PNG, the species is traded under the name 'Light Hopea' alongside other species of *Hopea*, it may also be called 'Heavy Hopea'. From 1995 to 2017 SGS (PNG) shipment records found Milne Bay recorded a volume of 7,284 log pieces of 'Heavy Hopea' were logged and 15,348 log pieces of 'Light Hopea'. In Central Province 49,777 pieces of log were recorded as being felled (T. Jimbo pers. comm. 2018). If this rate of extraction continues population will continue to decline in the future.

Threats (see Appendix for additional information)

This species is threatened by habitat loss and degradation within the lowland forests of PNG. Deforestation is occurring as a consequence of the need to expand agricultural areas to cope with a growing population. This is a particular threat in Milne Bay and Central province for both large and small

scale agricultural expansion (T. Jimbo pers. comm. 2018). It is also caused by the increase in commercial logging within the country which began to grow in the nineties (Shearman *et al.* 2009). Logging may be a particular threat to the species as it is a desirable timber, but this has yet to be confirmed and the effect of the extraction on the population is not known. Also due to logging practice the regeneration of the species may be adversely affected as the machinery can destroy seedlings persisting in the under growth (Bryan *et al.* 2013). Forests are becoming more susceptible to forest fires due to the decline in canopy cover and due to the growing occurrence of extreme El Niño years which causes forests to become dry (Shearman *et al.* 2009).

Conservation Actions (see Appendix for additional information)

This species is not reported from any *ex situ* collections (BGCI 2017). Seed collections of this species should be made to ensure the genetic conservation of this species and to contribute to *ex situ* conservation efforts. More information on the population size and trend of this species is needed as well as the localities of individuals. The species should be identified within current protected areas and habitat protection should also be expanded. The harvest and trade of the species requires monitoring and sustainable management plans should be established to insure the current and future use of the species.

Credits

Assessor(s): Barstow, M.

Reviewer(s): Jimbo, T.

Bibliography

- Ashton, P.S. 1988. Dipterocarp Biology as a Window to the Understanding of Tropical Forest Structure. *Annual Review of Ecology, Evolution and Systematics* 19: 347-70.
- Ashton, P.S. 2003. Floristic zonation of tree communities on wet tropical mountains revisited. *Perspectives in Plant Ecology, Evolution and Systematics* 6(1): 87-104.
- BGCI. 2017. PlantSearch. Botanic Gardens Conservation International, London. Available at: https://www.bgci.org/plant_search.php.
- Bryan, J.E., Hearman, P.L., Asner, G.P., Knapp, D.E., Aoro, G and Lokes, B. 2016. Extreme Differences in Forest Degradation in Borneo: Comparing Practices in Sarawak, Sabah, and Brunei. *Plos One* 8(7).
- ITTO (International Tropical Timber Organization). 2017. ITTO: Lesser Used Species Database. Available at: <http://www.tropicaltimber.info/>. (Accessed: February 2017).
- IUCN. 2018. The IUCN Red List of Threatened Species. Version 2018-1. Available at: www.iucnredlist.org. (Accessed: 28 June 2018).
- Mark, J., Newton, A.C., Oldfield, S. and Rivers, M. 2014. The international timber trade: a working list of commercial timber tree species. Botanic Gardens Conservation International, Richmond.
- PNGPlants. 2017. PNGplants Database: Plant Collections from Papua New Guinea. Available at: <http://www.pngplants.org/search.htm>. (Accessed: May 2017).
- Shearman, P.L., Ash, J., Mackey, B., Bryan, J.E and Lokes, B. 2009. Forest Conversion and Degradation in Papua New Guinea 1972-2002. *Biotropica* 41(3): 379-390.
- Sist, P., Fimbel, R., Sheil, D., Nasi, R. and Chevallier, M-H. 2003. Towards sustainable management of mixed dipterocarp forests of Southeast Asia: moving beyond minimum diameter cutting limits. *Environmental Conservation* 30(4): 364-374.
- Soerianegara, I. and Lemmens, R.H.M.J. (eds) 1993. *Plant Resources of South-East Asia* 5(1). Timber trees: major commercial timbers. Pudoc Scientific Publishers, Wageningen.

Citation

Barstow, M. 2018. *Hopea forbesii*. The IUCN Red List of Threatened Species 2018: e.T36291A68070385. <http://dx.doi.org/10.2305/IUCN.UK.2018-1.RLTS.T36291A68070385.en>

Disclaimer

To make use of this information, please check the [Terms of Use](#).

External Resources

For [Images and External Links to Additional Information](#), please see the [Red List website](#).

Appendix

Habitats

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Habitat	Season	Suitability	Major Importance?
1. Forest -> 1.6. Forest - Subtropical/Tropical Moist Lowland	-	Suitable	-

Threats

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Threat	Timing	Scope	Severity	Impact Score
2. Agriculture & aquaculture -> 2.1. Annual & perennial non-timber crops -> 2.1.2. Small-holder farming	Ongoing	Unknown	Slow, significant declines	Unknown
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.1. Species mortality 2. Species Stresses -> 2.2. Species disturbance		
5. Biological resource use -> 5.3. Logging & wood harvesting -> 5.3.5. Motivation Unknown/Unrecorded	Ongoing	Unknown	Unknown	Unknown
	Stresses:	2. Species Stresses -> 2.1. Species mortality		
7. Natural system modifications -> 7.1. Fire & fire suppression -> 7.1.1. Increase in fire frequency/intensity	Ongoing	Unknown	Very rapid declines	Unknown
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.1. Species mortality		

Conservation Actions in Place

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Conservation Actions in Place
In-Place Species Management
Subject to ex-situ conservation: No

Conservation Actions Needed

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Conservation Actions Needed
1. Land/water protection -> 1.1. Site/area protection
3. Species management -> 3.4. Ex-situ conservation -> 3.4.2. Genome resource bank

Research Needed

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Research Needed
1. Research -> 1.2. Population size, distribution & trends
3. Monitoring -> 3.1. Population trends
3. Monitoring -> 3.2. Harvest level trends
3. Monitoring -> 3.3. Trade trends
3. Monitoring -> 3.4. Habitat trends

Additional Data Fields

Distribution
Estimated extent of occurrence (EOO) (km ²): 285000
Upper elevation limit (m): 1000
Habitats and Ecology
Continuing decline in area, extent and/or quality of habitat: Yes
Generation Length (years): 100

The IUCN Red List Partnership

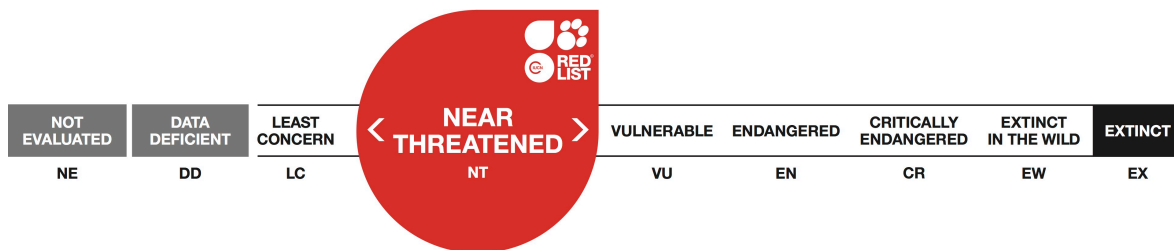


The IUCN Red List of Threatened Species™ is produced and managed by the [IUCN Global Species Programme](#), the [IUCN Species Survival Commission \(SSC\)](#) and [The IUCN Red List Partnership](#).

The IUCN Red List Partners are: [Arizona State University](#); [BirdLife International](#); [Botanic Gardens Conservation International](#); [Conservation International](#); [NatureServe](#); [Royal Botanic Gardens, Kew](#); [Sapienza University of Rome](#); [Texas A&M University](#); and [Zoological Society of London](#).

Myristica globosa

Assessment by: World Conservation Monitoring Centre



View on www.iucnredlist.org

Citation: World Conservation Monitoring Centre. 1998. *Myristica globosa*. *The IUCN Red List of Threatened Species 1998*: e.T37876A10077890.

<http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T37876A10077890.en>

Copyright: © 2015 International Union for Conservation of Nature and Natural Resources

Reproduction of this publication for educational or other non-commercial purposes is authorized without prior written permission from the copyright holder provided the source is fully acknowledged.

Reproduction of this publication for resale, reposting or other commercial purposes is prohibited without prior written permission from the copyright holder. For further details see [Terms of Use](#).

The IUCN Red List of Threatened Species™ is produced and managed by the [IUCN Global Species Programme](#), the [IUCN Species Survival Commission \(SSC\)](#) and [The IUCN Red List Partnership](#). The IUCN Red List Partners are: [BirdLife International](#); [Botanic Gardens Conservation International](#); [Conservation International](#); [Microsoft](#); [NatureServe](#); [Royal Botanic Gardens, Kew](#); [Sapienza University of Rome](#); [Texas A&M University](#); [Wildscreen](#); and [Zoological Society of London](#).

If you see any errors or have any questions or suggestions on what is shown in this document, please provide us with [feedback](#) so that we can correct or extend the information provided.

Taxonomy

Kingdom	Phylum	Class	Order	Family
Plantae	Tracheophyta	Magnoliopsida	Magnoliales	Myristicaceae

Taxon Name: *Myristica globosa* Warb.

Assessment Information

Red List Category & Criteria: Lower Risk/near threatened [ver 2.3](#)

Year Published: 1998

Date Assessed: January 1, 1998

Annotations: Needs Updating

Geographic Range

Country Occurrence:

Native: Papua New Guinea (North Solomons); Solomon Islands

Habitat and Ecology

Confined to evergreen rainforest up to 1,200 m.

Systems: Terrestrial

Credits

Assessor(s): World Conservation Monitoring Centre

Bibliography

Lemmens, R.H.M.J., Soerianegara, I. and Wong, W.C. (eds) 1995. *Timber Trees: Major Commercial Timbers (Plant Resources in South-East Asia, No. 5[2])*. Backhuys Publishers, Leiden.

Oldfield, S., Lusty, C. and MacKinven, A. (compilers). 1998. *The World List of Threatened Trees*. World Conservation Press, Cambridge, UK.

Citation

World Conservation Monitoring Centre. 1998. *Myristica globosa*. *The IUCN Red List of Threatened Species 1998*: e.T37876A10077890.

<http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T37876A10077890.en>

Disclaimer

To make use of this information, please check the [Terms of Use](#).

External Resources

For [Images and External Links to Additional Information](#), please see the Red List website.

The IUCN Red List Partnership



The IUCN Red List of Threatened Species™ is produced and managed by the [IUCN Global Species Programme](#), the [IUCN Species Survival Commission \(SSC\)](#) and [The IUCN Red List Partnership](#). The IUCN Red List Partners are: [BirdLife International](#); [Botanic Gardens Conservation International](#); [Conservation International](#); [Microsoft](#); [NatureServe](#); [Royal Botanic Gardens, Kew](#); [Sapienza University of Rome](#); [Texas A&M University](#); [Wildscreen](#); and [Zoological Society of London](#).

PNGTreesKey Myristica globosa Warb.

Barry Conn (NSW) & Kipiro Damas (LAE).

Guide to trees of Papua New Guinea

Copyright held by the authors, National Herbarium of New South Wales, and Papua New Guinea National Herbarium

Myristica globosa Warb.

Nova Acta Academiae Caesareae Leopoldino-Carolinae Germanicae Naturae Curiosorum. Abhandlungen der Kaiserlichen Leopoldinisch-Carolinischen Deutschen Akademie der Naturforscher Vol. 68: 540

Other Literature: W.J.J.O. De Wilde, *Flora Malesiana, Series 1* 480-483 (2000)

Family: Myristicaceae

Dicotyledon

Timber Group: Non-timber species

Field Characters: Large canopy tree (up to 30 m high) or Small sub-canopy tree; Bole cylindrical (mostly 40-70 cm diam.); straight (bole up to c. 5 m long); buttresses absent (sometimes slightly spurred near base); spines absent; aerial roots absent; stilt roots sometimes present or absent; Bark brownish grey or brown, rough or almost smooth, slightly scaly or flaky or fissured; Subrhytidome (under-bark) red or brown; less than 25 mm thick, 5.0-8.0; bark blaze consisting of one layer; faintly to non-aromatic; pleasant; outer blaze pale pink, red, or brown, markings absent, fibrous; inner blaze pale pink, red, or brown, markings absent, fibrous; bark exudate (sap) present, colourless (watery), flowing or not readily flowing (spotty), colour changing on exposure to air, to red, not sticky or sticky; terminal buds not enclosed by leaves.

Indumentum: Complex hairs absent; stinging hairs absent; mature twig indumentum (hairs) present when young or absent, hairs sparse.

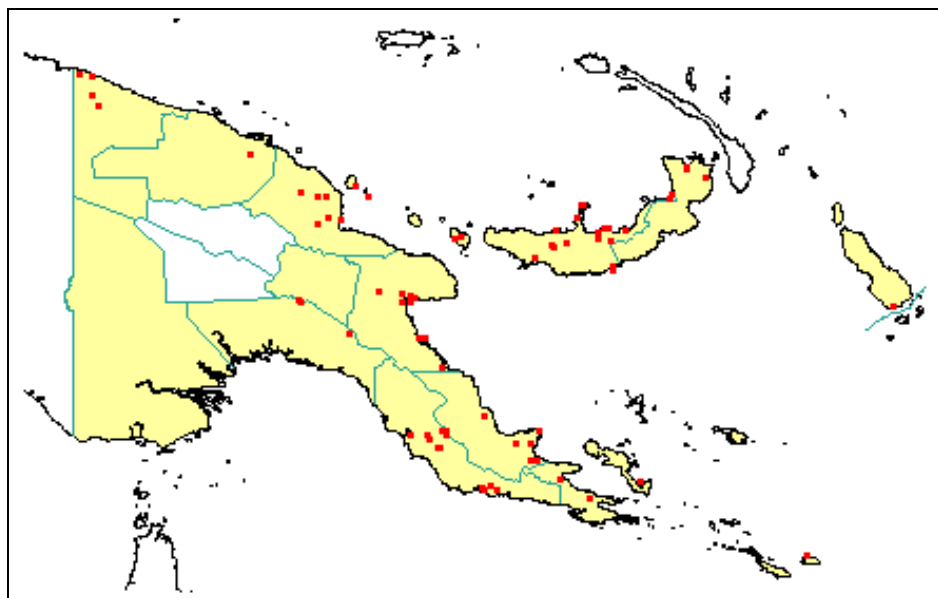
Leaves: Leaves spaced along branches, spiral (leaves occurring singly at a node and arranged spirally up the branchlet), simple (a leaf composed of a single blade); petiole present, not winged, attached to base of leaf blade, not swollen; leaves sometimes broadest below middle or equally broad throughout much of length, (6.0-) 7.0-16.0 (-21.0) cm, 2.0-7.0 (-8.0) cm; symmetric, entire, not dissected or lobed, acute or acuminate, venation pinnate, secondary veins open, prominent, intramarginal veins absent; leaves lower surface blue-green, pale green, or slightly grey, upper surface dark green (glossy) or slightly grey, indumentum (hairs) absent or present when young, indumentum (hairs) sparse; absent; domatia absent; stipules absent.

Flowers: Inflorescence axillary (and below leaves), flowers on a branched axis, cones absent; flowers unisexual, unisexual with male and female flowers on different plants, stalked, flowers with many planes of symmetry, 4.0-6.5 mm long, diameter small (up to 10 mm diam.) (c. 3 mm diam.); perianth present, with all sepals and/or petals (hence tepals) similar, inner perianth cream-coloured, pale yellow, or green; 2-3, some

or partly joined; stamens 10-?-16 (-20), absent, joined (to form a central staminal column), free of the perianth; ovary superior, carpels joined (when more than one), locules 1; styles absent.

Fruits: Infructescence arising from single point (usually (usually 1-3 fruits per infructescence), fruit 15.0-32.0 (-40.0) mm long, 20.0 (c.) mm diam., yellow, red, or brown (with nut meg aroma), not spiny, fleshy, simple, dehiscent, capsule; seeds 1, much more than 10 mm long (10-22 mm long), not winged, narrow (longer than wide), seed more than 10 mm diam. (10-20 mm diam.).

Distribution: West Sepik, East Sepik, Madang, Morobe, Eastern Highlands, Western, Gulf, Central, Northern, Milne Bay, Papuan Islands, New Britain & Bougainville.



[Botanical records
in PNGplants database](#)

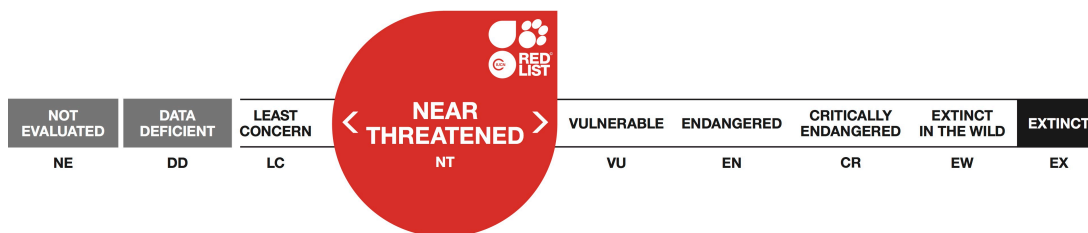
[Map details](#)

Notes: Notes WJ.J.O de Wilde, 2000 (*Flora Malesiana*, Series 1, volume 14, pp. 482-483) recognises two subspecies, namely, subsp. *globosa* and subsp. *chalmersii*. The differences between these two subspecies appears to be slight with subsp. *globosa* having slightly larger fruit (at least 2.5 cm long), with pericarp 3-5 mm thick, whereas subsp. *chalmersii* has fruits up to 2.4 cm long and pericarp up to 3 mm thick.



Helicia albiflora

Assessment by: Eddowes, P.J.



View on www.iucnredlist.org

Citation: Eddowes, P.J. 1998. *Helicia albiflora*. *The IUCN Red List of Threatened Species 1998*: e.T32940A9743886. <http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T32940A9743886.en>

Copyright: © 2015 International Union for Conservation of Nature and Natural Resources

Reproduction of this publication for educational or other non-commercial purposes is authorized without prior written permission from the copyright holder provided the source is fully acknowledged.

Reproduction of this publication for resale, reposting or other commercial purposes is prohibited without prior written permission from the copyright holder. For further details see [Terms of Use](#).

The IUCN Red List of Threatened Species™ is produced and managed by the [IUCN Global Species Programme](#), the [IUCN Species Survival Commission \(SSC\)](#) and [The IUCN Red List Partnership](#). The IUCN Red List Partners are: [BirdLife International](#); [Botanic Gardens Conservation International](#); [Conservation International](#); [Microsoft](#); [NatureServe](#); [Royal Botanic Gardens, Kew](#); [Sapienza University of Rome](#); [Texas A&M University](#); [Wildscreen](#); and [Zoological Society of London](#).

If you see any errors or have any questions or suggestions on what is shown in this document, please provide us with [feedback](#) so that we can correct or extend the information provided.

Taxonomy

Kingdom	Phylum	Class	Order	Family
Plantae	Tracheophyta	Magnoliopsida	Proteales	Proteaceae

Taxon Name: *Helicia albiflora* Sleumer

Assessment Information

Red List Category & Criteria: Lower Risk/near threatened [ver 2.3](#)

Year Published: 1998

Date Assessed: January 1, 1998

Annotations: Needs Updating

Geographic Range

Range Description:

Known from the East and Western Highlands, Morobe, Northern and Central provinces of Papua New Guinea.

Country Occurrence:

Native: Papua New Guinea

Habitat and Ecology

A tree often found in *Castanopsis-Nothofagus* rainforest from 900 to 2,000 m.

Systems: Terrestrial

Threats (see Appendix for additional information)

Its conservation is dependent upon the conservation of its montane habitat.

Credits

Assessor(s): Eddowes, P.J.

Bibliography

Conn, B.J. (ed.) 1995. *Handbooks of the Flora of Papua New Guinea*. Melbourne University Press.

Eddowes, P.J. 1997. Completed data collection forms for New Guinea.

Oldfield, S., Lusty, C. and MacKinven, A. (compilers). 1998. *The World List of Threatened Trees*. World Conservation Press, Cambridge, UK.

Van Steenis, C.G.G.J. 1948. *Flora Malesiana*. Flora Malesiana Foundation, Leiden.

Citation

Eddowes, P.J. 1998. *Helicia albiflora*. *The IUCN Red List of Threatened Species 1998*: e.T32940A9743886. <http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T32940A9743886.en>

Disclaimer

To make use of this information, please check the [Terms of Use](#).

External Resources

For [Images and External Links to Additional Information](#), please see the Red List website.

Threats

(<http://www.iucnredlist.org/technical-documents/classification-schemes>)

Threat	Timing	Scope	Severity	Impact Score
1. Residential & commercial development -> 1.1. Housing & urban areas	Ongoing	-	-	-
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation		
2. Agriculture & aquaculture -> 2.1. Annual & perennial non-timber crops -> 2.1.4. Scale Unknown/Unrecorded	Ongoing	-	-	-
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation		
2. Agriculture & aquaculture -> 2.3. Livestock farming & ranching -> 2.3.4. Scale Unknown/Unrecorded	Ongoing	-	-	-
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation		
5. Biological resource use -> 5.3. Logging & wood harvesting -> 5.3.5. Motivation Unknown/Unrecorded	Ongoing	-	-	-
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation		

The IUCN Red List Partnership



The IUCN Red List of Threatened Species™ is produced and managed by the [IUCN Global Species Programme](#), the [IUCN Species Survival Commission \(SSC\)](#) and [The IUCN Red List Partnership](#). The IUCN Red List Partners are: [BirdLife International](#); [Botanic Gardens Conservation International](#); [Conservation International](#); [Microsoft](#); [NatureServe](#); [Royal Botanic Gardens, Kew](#); [Sapienza University of Rome](#); [Texas A&M University](#); [Wildscreen](#); and [Zoological Society of London](#).

Appendix 7. Field Guide Brochure for Common Plants of VNP

When learning about the plants of Varirata National Park it is useful to know a little plant classification. Plants that can internally transport nutrients and water are vascular plants. This group includes ferns, which reproduce from spores, and also plants that produce seeds. This latter group includes gymnosperms, which produce seeds in unprotected structures such as cones, and plants with flowers that produce seeds within a fleshy ovary or fruit

Ferns are generally easy to recognise by their feathery or leafy fronds and often by the appearance of yellow or golden spores on their undersides. They are mostly found in the forest interior, particularly in damp areas, but some species have adapted to seasonally dry habitats and are common in the savannah grasslands in the northern parts of the Park. One species, a shield fern (*Stichurus*) covers large areas of the floor of secondary forest. Most fern species grow in soil but many species are epiphytes which means that they grow on another plant, usually a tree, which provides support.

There are only a few species of gymnosperms occurring the Park. These include cycads, fern-like plants restricted in the Park to the savannah grasslands, and well known rainforest trees such as tulip - a species that has leaf-like foliage and is often mistaken for a flowering plant. The Klinki and Hoop Pines planted around the main lookout are also gymnosperms.

The flowering plants in VNP include at least 300 different kinds of trees, a large number of shrubs, a profusion of vines and at least 70 species of orchids, most of which are epiphytic. Many of the trees produce large, fleshy fruits that are eaten by mammals and birds including honeyeaters, birds of paradise and cassowaries.

A list of all the different plants from a geographic area is termed a **Flora**. The world flora, for example, includes around 300,000 different vascular plants. Around 5% of

these (about 14,000) are found in Papua New Guinea. The flora of VNP includes about 150 species of ferns, at least five species of gymnosperms, and around 850 to 900 species of flowering plants. This is an extraordinarily diverse assemblage that represents around 7% of all the different kinds of plants found in Papua New Guinea.

The physical or structural appearance of a plant community is generally referred to as **Vegetation**. The type of vegetation found in an area is strongly influenced by climate, mainly temperature and rainfall. There are three main types of vegetation found in the Park. These include **Eucalypt Savannah** which is the dominant plant community found around Port Moresby and characterized by scattered gum trees with an understory of grasses. **Secondary forests**, readily recognized in the Park by the presence of the dominant species, *Gymnostoma* (*Gymnostoma papuana*), which is recolonizing areas that were formerly cleared for a coffee plantation. **Primary forest or Rainforest** is the largest and most diverse assemblage of plants in the Park, and covers most of the areas along the walking tracks and the entire area south of the main picnic ground.

There are also more than 50 different kinds of introduced plants found in the Park. Introduced plants are those that do not occur naturally in an area but have become established, deliberately or accidentally, by people. These plants are found mostly around public use areas such as the main lookout and picnic grounds but two of them, *Clidemia* and *Spiked Pepper*, are invading the forests and displacing native species. These are considered serious pests in Papua New Guinea. Please be careful not to spread them to other areas.

The following letter keys are used in the photo captions:
I: introduced, PF: primary forest, SF: secondary forest, ES: eucalypt savannah



PLANTS

Varirata National Park (VNP) is PNG's first national park, declared on 10th December 1969 and officially opened on 18th October 1973. It is on state land on the Sogeri Plateau at an elevation of 600–900 m and covers an area of 1,063 ha. It is 48 km east of Port Moresby City and accessible by road. The land was locally called *Wodobonomu* and was the traditional hunting ground of the Koiari people.

VNP has scenic views and beautiful rainforests, savannah grasslands and secondary regrowth. The average annual rainfall is 1400–2000 mm. The Park is inhabited by some unique plants and animals such as forest wallabies, possums, bandicoots, cassowaries, the raggiana bird of paradise, as well as many extraordinary reptile and frog species, and a rich variety of remarkable insects.

The Park is one of the best places in the country to learn about biodiversity. It is visited by dozens of nature tours each year and attracts researchers from throughout the world. It is also an important training site for students from surrounding universities.

Conservation & Environment Protection Authority
Level 5 Dynasty Tower A Savannah Heights Waigani Drive
P.O Box 6601 BOROKE NCD Papua New Guinea
Tel: (+675) 301 4500 email: kkalim@dec.gov.pg
www.jica.go.jp/png/english/activities/activity18.html
www.facebook.com/pngbiodiv/

Photography Angus Fraser, Allen Allison, Text Allen Allison, Design Mike McCoy
Publication funded by JICA



Oakleaf Fern *Drynaria quercifolia* (Polypodiaceae) PF, SF, ES
Common on boulders in eucalypt woodland; basket-forming epiphyte or climber, also found on trees throughout the Park.



Ghost Gum *Corymbia papuana* ES
Tree to 40 m; distinctive white trunk; whitish flowers an important source of nectar for honeyeaters and lorikeets.



Tulip Gnetum *Gnetum* (Gnetaceae) (trunk and foliage) PF
Gymnosperm; tree up to 20 m; distinctive raised rings around trunk; broad leaves; red fruit; bark used for bilum twine.



Sumac *Rhus taeniata* (Anacardiaceae) SF
Tree to 30 m, common in secondary forest and forest edge; large clusters of white flowers in early dry season; fruit black.



Gymnostoma *Gymnostoma papuana* (Casuarinaceae) SF
Pioneering tree to 30 m; dominant tree in secondary forest; fruit cone-like, this is a flowering plant, not a gymnosperm.



Umbrella Tree *Schefflera thauassantha* (Araliaceae) PF, SF
Tree to 10 m; common at forest edges; palm-shaped leaves; small reddish flowers produced on spikes; fruit a black berry.



Shield Fern *Stichurus milnei* (Gleicheniaceae) PF, SF
Branching fern; pioneering species that forms dense thickets up to 3 m in forest gaps and open areas.



Butterfly Tree *Evodella muelleri* (Rutaceae) SF
Tree to 10 m; flowers in conspicuous bunches; pink; leaves with three leaflets; source of nectar for butterflies & birds.



Kangaroo Grass *Themeda triandra* (Poaceae) ES
Grass up to 1.5 m; reddish spikelets produced on branched stems. It has deep roots, grows back quickly following fires.



Birthwort *Aristolochia momandul* (Aristolochiaceae) PF
Vine with heart-shaped leaves. Flowers prominent, purplish. This is the primary food plant of the Birdwing Butterfly.



Clidemia *Miconia crenata* (Melastomataceae) I, PF, SF
Shrub up to 5 m; flowers small, white; fruit a small purple berry. An invasive species originally from South America.



Ant Plant *Myrmecodia platyrea* (Rubiaceae) PF, SF, ES
An epiphyte with small white flowers and a swollen base that is inhabited by ants, a relationship known as mutualism.





Papuan Oak *Castanopsis acuminatissima* (Fagaceae) PF
Tree to 35 m; easily recognized by ring of root suckers around the trunk; fruit a spiny nut that is eaten by people as well as parrots.



Bottlebrush Orchid *Dendrobium smillieae* (Orchidaceae) PF
Epiphytic, with grass-like leaves. Flowers grow in clusters with distinctive green, hooded lip; pollinated by birds.



Cycad *Cycas campestris* (Cycadaceae) ES
Plants up to 2.5 m, with a single shaggy trunk topped with a crown of fern-like leaves; fruit an ovoid nut, toxic; fire resistant.



Tropical Mistletoe *Amyema cf. friesiana* (Loranthaceae) PF, SF
Parasite; leaves thick and brittle; flowers in triads up to 30 mm long; fruit small, with special features to attach to host plants.



Spiked Pepper *Piper adnucum* (Piperaceae) I; PF; SF; ES
Tree or shrub to 7 m; native to Central and South America; serious invasive pest that has spread throughout the Old World tropics.



Hyacinth Orchid *Dipodium squamatum* (Orchidaceae) ES
Ground orchid, with showy spikes of pink flowers; leafless, regarded as mycoheterotrophic (parasitic on soil fungi).



Planchonia *Planchonia papuana* (Lecythidaceae) PF
Rainforest canopy tree to 35 m; leaves toothed, flowers to 10 mm diameter with numerous stamens, probably pollinated by bats.



East New Guinea Fig *Ficus rhizophoriphylla* (Moraceae) PF, ES
Trees to 15 m, primarily at forest edge; fruit bright orange; eaten by a variety of pigeons, doves and birds of paradise.



Brown Pine *Podocarpus neriifolius* (Podocarpaceae) PF
Gymnosperm; trees to 25 m tall; leaves spirally arranged; Female cone solitary, reddish; important food tree for birds of paradise.



Tropical Banksia *Banksia dentata* (Proteaceae) ES
Shrub up to 6 m; large cone-like head of showy, yellow flowers; a source of nectar for insects, birds and nectar-feeding mammals.



Chalmers' Neonauclea *Neonauclea chalmersii* (Rubiaceae) PF
Aquatic shrub growing to 4 m; restricted to streams; flowers in heads, 15-20 mm in diameter; leaves narrow, tapering to a point.



Melastome *Melastoma polyanthum* (Melastomitaceae) PF
Shrub 2.5 m tall; common along the walking tracks; leaves large, hairy with three parallel veins; mauve flowers; fruit a black berry.



Pandanus *Benstonea stenocarpa* (Pandanaeae)
Understory tree to 5 m; leaves slender, to 2.7 m long; fruit large, scarlet, oblong, head-like cluster; eaten by birds and mammals.



Common Pitcher Plant *Nepenthes mirabilis* (Nepenthaceae) ES
Terrestrial climber; carnivorous plant with spikes of red flowers and leaves modified into fluid-filled pitchers that trap insects.



Semecarpus *Semecarpus cassuvium* (Anacardiaceae) PF
Tree to 10 m; flowers white; fruit fleshy with a central stone and borne on a yellowish receptacle; sap black; can cause skin rash.



Water Chestnut *Eleocharis dulcis* (Cyperaceae) SF, Aquatic
Grass-like sedge up to 2 m, common in shallow water at edges of lakes; occasionally cultivated in PNG to make grass skirts.