PART 1



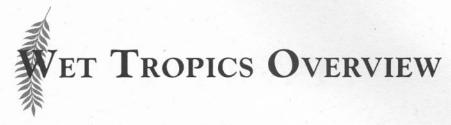
WET TROPICS OVERVIEW

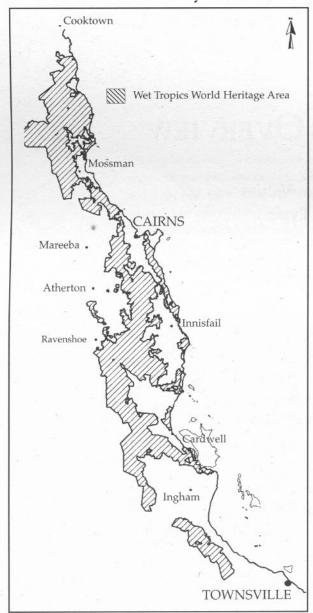
World Heritage Values Rainforest Types

THEORY

Vegetation
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Natural Regeneration
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World Heritage Values of Queensland's Wet Tropics

The Wet Tropics of Queensland is one of the earth's extraordinary treasures. Its importance was globally recognised in 1988 when 900,000 hectares of forest between Townsville and Cooktown was declared a World Heritage Area.

Although the Wet Tropics represents less than seven ten-thousandths of the world's tropical moist forests, it is one of the most significant regional ecosystems in the world.

The Wet Tropics meets all four World Heritage criteria in relation to the earth's history, ecological processes, aesthetics, biological diversity and threatened species:

- The Wet Tropics contains outstanding examples representing major stages of earth's history, including the record of life.
- The Wet Tropics contains outstanding examples representing significant ongoing ecological and biological processes.
- The Wet Tropics contains superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance.
- The Wet Tropics contains some of the most important significant habitats for conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

Earth's History

The plants and animals of the Wet Tropics are associated with eight major stages in the earth's evolutionary history (Dasett 1987):

- Age of Pteridophytes
- Age of Conifers and Cycads (cone bearers)

The predecessor of today's ferns, the archaic 'skeleton-fern' Psilotum sp.



- Age of Angiosperms (flowering plants)
- The final break-up of the ancient super-continent of Gondwana
- The origins of the Australian sclerophyll flora and marsupial fauna
- The origin and radiation of the songbirds
- The mixing of life forms from the Australian and Asian continental plates
- The extreme effects of the Pleistocene glacial period on tropical rainforest vegetation.

The Wet Tropics contains the most complete, complex and diverse living record of the major stages in the evolutionary history of land plants. The animals include some of the most important living members of lineages descended from Gondwanan ancestors.

Of particular importance are the primitive flowering plants. Twelve out of the world's 19 families are found in the area. This is the highest concentration of primitive families on earth. Within these families there are at least 50 species found only in the Wet Tropics.

Rainforest once covered much of Australia and is considered to be the origin of animals and plants which have since adapted to the continent's dry conditions. The Wet Tropics still contains the nearest surviving relatives of the ancestral stock from which they evolved. An outstanding example is the Musky Rat-kangaroo, found only in the Wet Tropics, which appears to represent an early stage in the evolution of kangaroos from tree-dwelling possum-like stock; in fact it is the only living member of the group that has retained the mobile toe on the hind foot characteristic of possums.

Ongoing Ecological Processes

The Wet Tropics provides an unparalleled living record of the ecological and evolutionary processes that shaped the flora and fauna of Australia over the past 415 million years.

In comparison, humid tropical regions in the rest of the world are relatively new and although they are rich in numbers of species, the level of endemism is surprisingly low. (Endemic species are those which are restricted to a certain area.) The long isolated ancient floras of New Caledonia, Madagascar and Queensland's Wet Tropics

> have exceptionally high levels of endemism. The Wet Tropics is second only to



New Caledonia in the number of endemic genera conserved per unit area. Interestingly, 75% are monotypic - that is, there is only one living species of the entire genus.

Whereas New Caledonia is an island, the Wet Tropics is part of an ancient continental landscape. It was uplifted over 100 million years ago and was tectonically stable during much of the evolution of flowering plants.

Another reason for the Wet Tropics' high levels of endemism is its geomorphological diversity. It ranges in altitude from sea level to mountains 1622m high and is dissected by deep valleys. As a result some species have been restricted to upland 'islands' and have formed distinct subspecies.

The Musky Ratkangaroo, found only in the Wet Tropics, appears to represent an early stage in the evolution of kangaroos from tree-dwelling possum-like stock.

Biological Diversity and Threatened Species

Australia is recognised as one of the seven 'megadiverse' countries in the world along with Brazil, Colombia, Mexico, Zaire, Madagascar and Indonesia. Between them they contain 54% of all species on the planet.

Although the Wet Tropics represents less than one-tenth of one percent of the land surface of Australia, it has the highest diversity of species on the continent including:

- 65% of Australia's fern species
- 21% of Australia's cycad species
- 37% of Australia's conifer species
- 30% of Australia's orchid species
- 36% of Australia's mammal species
- 30% of Australia's marsupial species
- 58% of Australia's bat species
- 25% of Australia's rodent species

3b: Mesophyll Fan Palm Vine Forest very wet with seasonally impeded drainage



- 50% of Australia's bird species
- 25% of Australia's frog species
- 23% of Australia's reptile species
- 37% of Australia's freshwater fish species
- 60% of Australia's butterfly species

At least 70 of the area's vertebrate species are found nowhere else in the world.

About 3,000 plant species from 210 families are found in the area, representing about 17% of Australia's vascular plants. More than 700 species, or 23% of the total, are found only in the World Heritage Area.

More than 500 rare or threatened plant species are protected within the World Heritage Area, and 330 of them are found only in this area. More than 80 are considered endangered or vulnerable. Of the 49 monotypic genera found in the area, 19 are listed as rare or vulnerable.

Endangered fauna include two marsupials and seven frog species. A further 12 vertebrate species are classified as vulnerable.

Biological diversity, or biodiversity, refers to the variety of life in all its forms and levels of organisation. It includes genetic diversity of individuals within species, diversity of populations, diversity of communities, and diversity of ecosystems and regional vegetation types. Since all environments are continually changing, this diversity is important for the long-term survival of species.

Our understanding of biological diversity, particularly in the tropics, is often surprisingly superficial; we have hardly begun to appreciate the extraordinary complexity of these systems, much less develop long-term protection strategies. However, our knowledge of natural systems is sufficient to establish and maintain areas that are capable of significantly slowing the erosion of biological diversity.

Fragmentation of habitats is one of the major threats to biological diversity. Fragmentation exerts its effects through both habitat loss and habitat isolation. Edge effects associated with habitat fragmentation can modify the forest for substantial distances from the edge itself.

There is broad scientific agreement that the world's biological resources (biodiversity) are being significantly diminished.

Rainforest Types

Rainforest in the Wet Tropics crosses three major landscape types:

- the uplands/tablelands of the Great Dividing Range
- the intermediate eastern escarpment
- the lowland coastal plain.

The tablelands consist of undulating country at around 800 metres in altitude, with summits rising to more than 1200 metres (Dasett 1987). The highest peak is Mt Bartle Frere which reaches 1622 metres.

To the east of the tablelands lies the rugged topography and great environmental diversity of the eastern escarpment.

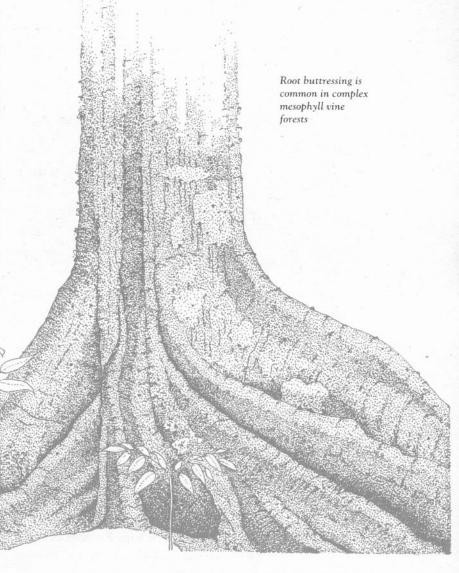
The coastal lowlands consists of an alluvial plain interrupted by ridges of the Great Divide and several large rivers such as the Herbert, North and South Johnstone, Tully, Russell-Mulgrave, Barron, Daintree and Bloomfield.

Many of the distinctive features of the region relate to the high rainfall and terrain diversity. The mean annual rainfall ranges from about 1200 mm to over 8000 mm. However, Mt Bellenden Ker, at an altitude of 1561 metres, has recorded as much as 10 472 mm over an eight-month period (January to August 1979) and has received 1140 mm of rain in a 24-hour period (Tracey 1982). The rainfall is distinctly seasonal with over 60% falling in the summer months of December to March. Compared with other tropical rainforests of the world, the wetter parts of the region lie at the extremely wet end of the hydrological spectrum (Dasett 1987).

Intense tropical cyclones are a feature of the region's climate and are a major factor shaping the structural and floristic differentiation of the vegetation.

particularly the vegetation mosaics of the coastal lowlands.

These different rainfall patterns, soil types, drainage, altitude and a complex evolutionary history have combined to produce a wide variety of identifiable rainforest communities. The region is recognised as being floristically and structurally the most diverse of any in Australia.





Carbine Tableland upland rainforest (1200m)

The region's rainforests have been classified (scale 1:100,000) into 13 major structural types (Tracey 1982) as follows:

Complex Mesophyll Vine Forest (CMVF)

1a Very wet and wet lowlands and foothills; basalts, basic volcanics, mixed colluvium on footslopes, riverine alluvia

1b Very wet and wet cloudy uplands; basalts

1c Moist and dry lowlands; riverine levees

Mesophyll Vine Forest (MVF)

(MFPVF)

2a Very wet and wet lowlands and foothills; granites and schists

2b Very wet and wet lowlands; beach sands Mesophyll Vine Forest with dominant palms

3a Mesophyll Feather Palm Vine Forest - very wet lowland swamps; basalt and alluvial soils

3b Mesophyll Fan Palm Vine Forest - very wet seasonally impeded drainage lowland swamps; schists and granites

Semi-Deciduous Mesophyll Vine Forest (SDMVF)

4 Moist and dry lowlands and foothills; granites and basalts

Complex Notophyll Vine Forest (CNVF)

5a Cloudy wet highlands; very limited areas basalt and basic rocks

5b Moist or dry lowlands, foothills and uplands; basalts

Complex Notophyll Araucarian Vine Forest (CNAVF)

6 Moist foothills and uplands; granites and schists

Notophyll Vine Forest (rarely without Acacia emergents) (NVF)

7a Moist lowlands and coastal foothills; granites and schists

7b Moist and dry lowlands; beach sands

Simple Notophyll Vine Forest (often with Agathis microstachya) (SNVF)

8 Cloudy wet and moist uplands and highlands; granites, schists and acid volcanics

Simple Microphyll Vine-Fern Forest (often with Agathis atropurpurea) (MFF)

9 Cloudy wet highlands; granites

Simple Microphyll Vine-Fern Thicket (MFT)

10 cloudy wet and moist windswept topslopes of uplands and highlands; granites

Deciduous Microphyll Vine Thicket (DVT)

11 dry lowlands and foothills; granite boulders Vine Forest with Acacia

12a Canopy almost exclusively Acacia aulacocarpa

12b Acacia cincinnata, Acacia polystachya and Acacia aulacocarpa canopy

12c Acacia mangium and Acacia aulacocarpa canopy

12d Acacia melanoxylon dominant or codominant with Acacia aulacocarpa

Vine Forest with Eucalyptus, Acacia and sclerophyll emergents codominants

13a Eucalyptus pellita, E. intermedia, E. tessallaris, Acacia crassicarpa, A. cincinnata, A. mangium and A. flavescens dominate canopy

13b Eucalyptus torelliana, E. tereticornis, E. intermedia, E. pellita dominate canopy; Acacia aulacocarpa, A. cincinnata, A. polystachya vine forest understorey

13c Eucalyptus grandis emergents with Acacia melanoxylon and A. aulacocarpa

Eucalyptus tereticornis, major components of canopy; E. tessellaris, E. intermedia in canopy with Acacia crassicarpa and A. flavescens in lower layers

Syncarpia glomulifera, Eucalyptus intermedia, E. pellita, E. tereticornis to 25m in canopy; Acacia aulacocarpa, A. mangium 6-12m with vine forest understorey

Syncarpia glomulifera, Eucalyptus intermedia, Lophostemon confertus, Casuarina torulosa and Banksia compar with vine forest understorey.

Rainforests reach their peak development as complex mesophyll vine forests on the very wet and wet lowlands and foothills on parent materials which include basalts, basic volcanics, mixed colluvia and riverine alluvia. These communities have an uneven canopy ranging from 20 to 40 metres in height. There is a lot of stratification and many of the highest trees ('emergents') have large

spreading crowns. Species composition and the variety of life forms are the most complex of any vegetation type found on the continent. Plank buttressing is common, robust woody lianes, vascular epiphytes and palms are typical, and fleshy herbs with wide leaves (such as gingers and aroids) are prominent (Tracey 1982). Exposed sites such as foothill ridges and seaward slopes often show signs of cyclone-disturbed, broken canopies with 'climber towers' and dense vine tangles. When comparing complex mesophyll vine forest communities, variation between sites brings about obvious structural differences such as an increase in palms on sites with poor drainage, and gingers and aroids in gullies and along creek banks which are permanently saturated with water.

The notophyll vine forest categories include a structurally and floristically diverse group of communities (types 5, 6, 7, 8 of Tracey 1982). They occur on small areas of basic volcanic parent materials on cool wet uplands and highlands (type 5a) and on a range of drier sites at various elevations (type 5b), the western and northern fringes of the main rainforest massif from Cardwell extending to Julatten, the Hann Tableland and to the north of Bloomfield (type 6), on sandy beach ridges in drier coastal zones and exposed



Bellenden Ker upland looking south-west into East Mulgrave Valley

sites backed by foothills north of Cairns (type 7), and as one of the most extensive, an evencanopy mountain forest assemblage (type 8) on granitic ranges rising from 400 to 1000 metres altitude between Ingham and Cooktown. These communities, while extraordinarily variable, are characterised by a canopy range of 12-45 metres in height, rattans or palm lianes, strangler figs, frequently conspicuous epiphytes and variable amounts of ferns, walking stick palms (Linospadix spp.) and fleshy herbs.



On the summits and upper slopes of the higher peaks which are frequently covered by cloud and often exposed to strong winds, **simple microphyll fern forests** or thickets dominate. Aerially suspended mosses are often found here (these forests are also referred to as 'cloud' or 'wet montane forests').

Many sites which experience significant water stress during the dry season have closed forest/thicket communities which include semi-deciduous to deciduous vegetation. Semi-deciduous mesophyll vine forest (type 4) is largely restricted to the foothills between the Bloomfield River and Cooktown. The canopy is comparatively even to a height of 25-32 metres with deciduous emergents as high as 36 metres. Figs, including both cluster (cauliflorous) and strangler types, and lianes (rather than rattans) are relatively conspicuous, and epiphytes much less common.

Deciduous microphyll vine thickets (type 11) occur sporadically on rocky, fire-protected sites and exposed headlands between Ingham and Cooktown. Species are often multi-stemmed and fully deciduous. The canopy is generally uneven and around 3-5 metres with emergents rising to 10 metres. Thorny scramblers and shrubs are common and epiphytic and lithophytic ferns and xerophytic orchids occur low in the canopy.

Vine forest with sclerophyll emergents (types 12, 13) represent different stages of post-disturbance succession (such as fire, logging or cyclones). Their composition varies greatly, with each sub-type characterised by the dominance/co-dominance of certain sclerophyll species such as eucalypts and wattles.

- management activities modify the rate and direction of succession rather than the state of the vegetation;
- the initial or early pool of plants on a site is critical to the succession of that site;
- the 'vital attributes' of particular species will determine the course of succession.

Most critical reviews of ecological succession have designated environmental stresses and competition for resources between plants as the main mechanisms determining the course of succession. Egler (1954) proposed two successional models:

(i) relay floristics

(ii) initial floristics

models.

Relay floristics assumes that only pioneer species are able to colonize a site in the conditions that occur immediately

following a large disturbance.

Therefore most - if not all - the mature stage species were not present when succession began.

The initial floristics model assumes that any arriving species, including those which usually appear late in succession, may be able to colonize a site. In the relay floristics model the early secondary species modify the environment so that it is more suitable for later successional species to invade and grow to maturity. In the initial floristics model the modifications wrought on the environment by earlier colonists neither increases nor reduces the rates of recruitment and growth to maturity of later colonists - species which appear later are simply those that arrived later or else arrived at the beginning but grew slowly.

Rainforest Fruit

The production of fleshy fruits by flowering plants and their consumption by a variety of animal species is a distinctive phenomenon of rainforests. Fruit is easier to obtain and digest than faunal prey; however fruit tends to be very patchily distributed in space and time.

The availability of fruit varies seasonally (Crome 1975) with peaks in fruit production tending to coincide with rainfall peaks; the more seasonal the rainfall, the larger the difference be-

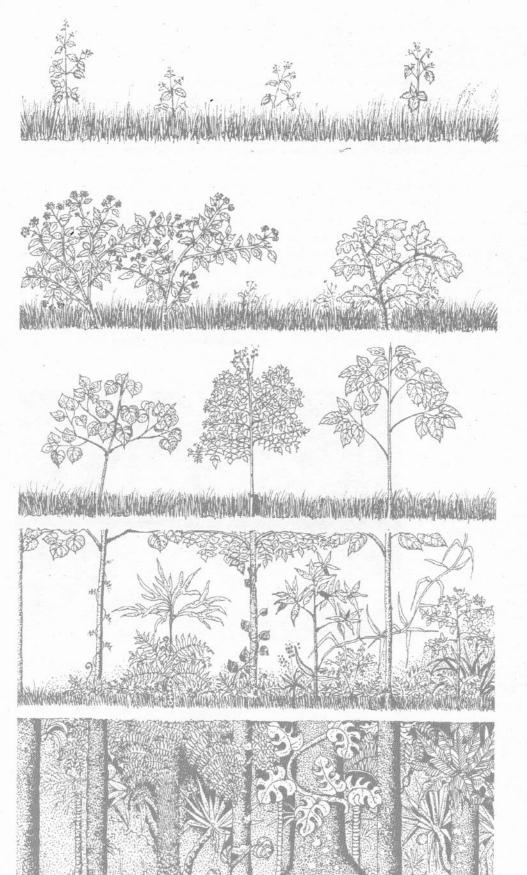
tween the peaks

and troughs of annual fruit production. Lean times for fruit eaters tend to occur at the end of the wet season and the beginning of the dry season.

Several predictable trends occur regarding fruit

and its seasonal availability. Canopy fruits tend to be produced in larger crops, are larger in size and more seasonal than fruits in the rainforest understorey. Small seeded, early successional trees tend to have more extended fruiting periods but smaller daily fruit crops than primary forest trees (Goosem & Young 1989). In addition to this community or habitat level of variation, there are annual variations within species in the size of fruit crops and the timing of fruit production. Trees whose fruiting patterns have been observed over several years usually do not produce similar-sized crops every year, and individual plants often skip years between fruit crops (Crome 1975).

The interdependence of fruit-eating animals and dispersal of seeds is of profound importance in many habitats. This interdependence is particularly well developed in the tropics, where a majority of trees and shrubs depend on animals for their seed dispersal (Janzen 1975).



Plant succession: Ecological communities go through a dynamic process of change as they become established.

Pasture grasses, broad-leaf weeds

Lantana, Tobacco Bush

Sarsparilla, Wattle, Bleeding Heart

Butterfly trees, Quandong, Queensland Maple, Silver Ash, Miva Mahogany, Supple Jack

Mature rainforest with many species and many life forms.

Seed dispersal mechanisms of plants producing fleshy fruits are based upon plant-animal mutualism. In these associations, plants provide nutritious tissue closely associated with the seed, and fruit-eating animals eat these fruits, then regurgitate, defaecate or drop viable seeds at variable distances. The larger the fruit, the fewer animal species are capable of handling or ingesting them.

Dispersal moves offspring away from the parent and spreads them in lower densities over a greater area. Seedling recruitment may be enhanced by this dispersal pattern. Also, dispersing seeds over a greater area increases the number of habitats the seeds sample and therefore increases the species' chances of successful establishment (Connell 1975).

A significant proportion of rainforest birds either depend on fruit for food or eat fruit when it is available. The most important group for seed

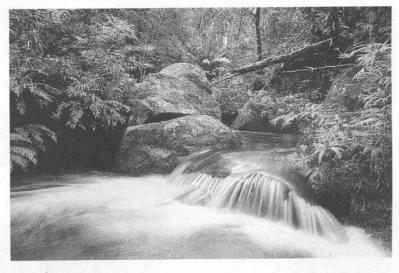
dispersal are probably the pigeons, for which Australia is a major centre of diversity. The fruiteating rainforest species tend to be nomadic, moving both latitudinally and altitudinally to take advantage of locally available fruit. Fruit bats are also important long-distance dispersal agents. Cassowaries are considered the

main animal dispersal agent for many largefruited trees (Crome & Moore 1988). Native rodents may disperse seeds of smaller fruit but are also probably major consumers of both fallen fruit and seeds.

Dispersal of Seed

Even when animals are involved in seed dispersal, a heavy seed generally falls closer to the parent tree than a light one. Yet the larger the seed, the more potentially vigorous the seedling. In such a trade-off between dispersal ability and seed provisioning, it is doubtful whether there is such a thing as the 'perfect rainforest seed' from the vantage of both seed dispersal and seedling vigour, simply because a seed cannot be both large and small at the same time.

There are four seed dispersal agents operating to varying degrees within rainforests: wind, animals, water and gravity. Each agent is associated with a group of character traits.



Dispersal of seed by water is mostly confined to trees fringing watercourses.

(i) Wind Dispersal

Seeds which glide in a still environment are well represented amongst trees and lianes of tropical rainforests (Harper 1977). Although wind dispersed seeds are common among canopy and emergent trees where both wind and height enhance the potential dispersal distance, it is also found in some tree species of the sub-canopy. In the sub-canopy, the absence of wind and stature generally results in a relatively dense seed rain close to the parent plant.

(ii) Animal Dispersal

Only animals which do not digest seed can act as dispersal agents. They either:

- eat fruit and seed but pass the seeds undamaged in faeces
- eat the fruit but discard the seed
- disperse seeds which get caught or stick to the body of the animal.

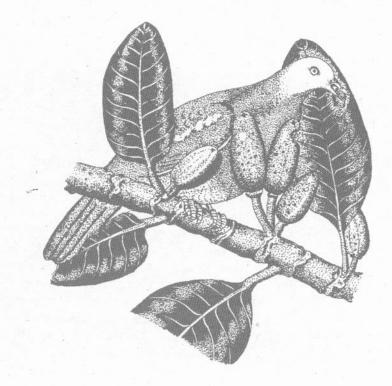
Most common is dispersal of seed by passage through the gut of a bird or mammal, or transportation by mammals. Rainforest trees with seeds adapted to dispersal by fruit eaters display a number of traits which encourage certain dispersal agents and discourage others. Fruits with bird-dispersal traits are generally vibrantly coloured black, blue, red, orange or white, such as members of the families Lauraceae, Sapindaceae, Elaeocarpaceae and Myrtaceae (Howe & Westley 1986).

Bat-dispersed fruits are usually duller colours such as browns, greens or yellows. In stark contrast, wind dispersed seeds are usually grey or brown, mimicking the colour of dead plant tissue (Howe & Westley 1986).

Size, colour and flavour tend to be similar in fruits which are dispersed by animals, and consequently they generally attract a whole range of consumers. Plants have also evolved character traits which protect immature fruits from predation, including camouflage (e.g. unripe fruits are often green), mechanical methods such as spines and an array of chemical defences which make the unripe fruits unpalatable, poisonous or uninviting to potential consumers.

(iii) Water Dispersal

Dispersal of seed by water is basically confined to rainforest trees fringing watercourses. The woody material enclosing the seed of Elaeocarpus angustifolius, the large seed of Castanospermum australe and the fleshy, irregularly shaped globular mass containing numerous seeds of Nauclea orientalis can float and remain viable for considerable periods. This is a necessary requirement for species often found in riparian rainforests.



(iv) Gravity Dispersal

While rolling down slopes may seem trivial, it is possibly the only means of dispersal for some species with large seeds. Generally only a select few animals can disperse large seeded species which highlights the importance of the cassowary as a dispersal agent in north Queensland's rainforests (Crome & Moore 1988).

Birds are one of the most important seed dispersal agents

Natural Regeneration

The labour and costs associated with tree planting can be reduced by protecting existing continuous and remnant vegetation patches. Even fragmented or remnant vegetation cover helps conserve wildlife, provides shade and shelter, lessens soil erosion and protects water catchments. It is easy to overlook the potential contribution vegetation patches and fragments may have. Without wider recognition of their importance they will inevitably be whittled away, patch after patch. Each forested fragment, though appearing insignificant, can be extremely valuable, and their value can be significantly increased if they are linked. Such linkages can give fragmented or remnant vegetation a new and larger ecological dimension.

Recruitment of Seedlings

Seeds of many species of the primary forest canopy have no dormancy period and lose viability quickly, remaining fertile for only a few weeks. The active seed bank in the soil of a primary forest consists largely of species which have recently fruited. Even seeds of the wider ranging late secondary phase such as *Flindersia* spp. remain viable for only a few months, while seeds which are enclosed by a fleshy fruit generally can not tolerate prolonged desiccation.

Ecological Restoration

Well developed ecological communities are expressions of the land and its history, and have achieved a balance with the natural forces that shape the landscape. They are relatively stable and self-perpetuating. Such communities are ideal models for plantings, as well as indicators of local site conditions.

Restoration as a general term means returning some degraded portion of the landscape to an improved and more natural condition including both the function and structure which allow a community to evolve and natural succession to occur.

Ecological restoration is the art and science of recreating viable ecological communities. It goes beyond just doing plantings for the purpose of stabilising areas that are eroding. It goes beyond the idea of landscaping with native plants. It is an attempt to recreate, direct and accelerate natural processes.

To restore a truly natural system is beyond our capacity. We can, however, assist nature by bringing together the basic components and characteristic plants and animals of an area. Natural processes will take over and other components of the natural system will naturally invade the rehabilitated system. We do not seek to preserve a static entity but to protect and nurture its natural capacity for change.

Landscape restoration is based on an understanding of how ecosystems work. Studies of species' requirements, biological diversity, landscape ecology, and ecosystems have led to the recognition of specific principles that can be applied to maintain and restore natural diversity.

Ecological restoration affects the landscape in a variety of ways:

- it can act as a bandage for a wounded landscape
- it can help maintain a diversity of plants and animals
- it can help in the protection of ecosystems and ecological communities
- it can create a healthier, sustainable mosaic of land uses on the landscape
- it can help maintain the gene pool of particular plant and animal species, promoting hardiness, disease resistance, and adaptability
- it can create lower maintenance landscapes
- it can improve water quality
- it can help minimise erosion
- it can create positive, progressive, and constructive attitudes about our natural heritage.

A variety of goals and objectives can be developed for a potential restoration site. They include improving wildlife habitat, creating more aesthetically pleasing surroundings, restoring natural communities, protecting local rare plants or animals, or preserving the local gene pool of a particular species or natural community.

Ecological rehabilitation serves as an excellent example of how to create less intensively managed landscapes which help reduce maintenance costs, conserve natural resources, increase biological diversity and benefit wildlife.

Many disturbances that change ecosystems today are different from natural disturbances because of their size, duration and intensity. Frequently these degraded lands are taken over by aggressive weeds and grasses and succession can not take place. These depauperate associations are a sad contrast to the diverse and stately rainforests that previously occupied the land.

It takes hundreds of years for an ecological community to develop. We however, begin the process, and promote changes that result in

the succession of these plants into a more natural ecological community. 'Naturalness' is the degree to which the present community of plants and animals resembles the community that existed before human intervention.

The aim is not necessarily to plant as many different kinds of trees as possible on a particular site, but to create the conditions suitable for a natural community to develop with as full a complement of native species as possible. The aim is to provide a variety of habitats valuable to a variety of animals.

The most important component for success is understanding that rehabilitation takes time. Fortunately, once the canopy closes the maintenance required is relatively low so in the longterm, maintaining a rehabilitated ecosystem requires negligible labour.

Native forest fragments, regardless of how small the area, play an important role in the overall network of conservation areas. It is not possible or practical to adequately conserve all species in national parks and reserves alone.

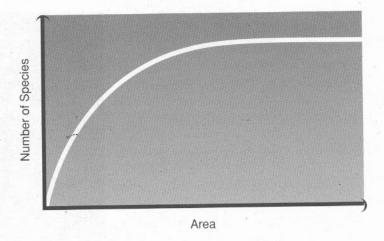
If native vegetation is provided, native animals will also be present. The number of species a forest fragment can maintain depends on its extent and the diversity of habitats it contains.

Ecological restoration goes beyond the idea of landscaping with native plants. It is an attempt to recreate, direct and accelerate natural processes.

Another important factor is whether the fragment is close to other patches of forest or is linked to them by corridors so that wildlife can move between them.

The wildlife found in remnant forest fragments on rural lands can also be of direct benefit to the landowners as predators and parasites of agricultural pests. It is possible to retain wildlife habitat on a farm and manage it so that it is selfsustaining, and at the same time provide habitat for useful species which may be involved in pest control.

Species-Area Curve



Landscape Restoration

Landscape restoration is based on understanding how ecosystems work. In design and planning stages you should take into account, wherever possible, the natural landscape and how your restoration efforts fit within the local and regional landscape.

Ecological studies have shown that specific principles can be applied to maintain and restore natural diversity. Although every site is different, and every site has its own unique array of constraints, considering the following landscape configuration principles will not only increase the diversity of an area but also preserve its ecological functions.

Size

Although bigger is not always better, larger areas of rainforest generally sustain more species than smaller areas. Very large areas ensure the preservation of rare species, large predators and forest interior species. A larger area has a greater chance of having a higher diversity of habitat types and in general tends to be more stable and self-buffered. The natural recovery processes also tend to be greater as size increases. The speciesarea curve is different for different vegetation types, but in general the number of species in any ecosystem will increase rapidly as the area increases up to a certain point and then increase less rapidly. The best way to maintain maximum diversity is to preserve many large areas.

Shape

The shape of a rainforest patch is often as important as its size. The ideal shape depends on the surrounding landscape, however, in general the shape of forest patches should be designed to create more interior habitat and minimise edge. Long thin corridors are good at catching immigrants and directing them to larger habitat blocks but they do not allow distinct interior habitats to develop. The shape with the least edge per unit area is preferred wherever feasible, but often the overriding aim is to reconnect isolated patches by any means possible.

Quantity

Even though it is desirable to preserve large areas, fragmentation of natural forests and expanding human populations preclude this in many areas. The next best option is to preserve many smaller areas. Because of subtle habitat differences, each small area will contain different species. By maintaining several patches the likelihood of a species becoming extinct is reduced. Many small patches of rainforest in an area will help sustain regional diversity.

Focal Areas

The existing remnant patches in the landscape are an ideal framework in which to strategically design landscape restoration projects. These areas provide a blueprint of what it is that should be created, an ideal source of propagating material, and help in the selection of species adapted to the site.



Corridors of forest along waterways connect habitat patches.

Linkage

Forested corridors increase the chances of colonisation by providing a path to re-establish populations that have been exterminated in an area. They also have benefits for the rainforest patches they link. Species diversity in rainforest patches connected by corridors tends to be greater than in disconnected patches. 'Stepping stones', or closely spaced patches, may have a similar effect for some species. Corridors may also act as conduits for genetic exchange among small populations, helping to maintain their viability and adaptability. Corridors increase the movement of adults among patches and dispersal of young.

The more isolated the forest patch the less the chance for recolonisation of the patch from outside. Isolated patches of rainforest also generally sustain fewer species than closely associated patches.

The regional landscape approach to conservation and land management recognises the importance of broad corridors connecting habitat patches. Stream corridors can be avenues of dis-

> persal for terrestrial as well as aquatic organisms, particularly if they are wide and contain a range of habitat types and should be protected wherever possible. Corridors and an increased number of 'stepping stone' patches in the landscape can reduce or prevent isolation particularly in rainforests where animal dispersal of seed is critical.

Riparian vegetation is ideally suited as the basis for a corridor system for several reasons:

- Gullies, drainage lines, streams and rivers form a hierarchy of natural corridors
- through the landscape.
- Riparian habitats support rich biological communities and usually have a high level of structural habitat diversity.

- Most forest-dependent species use riparian vegetation and most animals require water to drink on a regular basis.
- Vegetated strips are presently retained along streams to protect water quality and for erosion control. Using the same area as a wildlife corridor minimises the loss of productive rural land.

Establishing a corridor could incorporate any method which is designed to link areas of natural habitat or direct fauna away from areas of potential hazard. A corridor can be continuous vegetated strips such as along watercourses, or a series of clumped vegetation patches. Corridor plantings can be made attractive to native wildlife by having a high proportion of food species which fruit outside the period of general fruit abundance - which is likely to correlate to the main periods of wildlife movement.

Ecological/Habitat Principles

Diversity

Preserving a diversity of ecological communities means preserving many different habitat types on many different tracts of land. Each tract will contain slightly different environmental factors and therefore slightly different communities of plants and animals which increases the opportunity for continued evolutionary processes to occur. A heterogeneous mosaic of forest types sustain more species and are more likely to support rare species than a single homogene-

ous community. When we rehabilitate natural communities and create new habitats it is with the ultimate aim of developing these mosaics on a regional scale.

Deep Forest

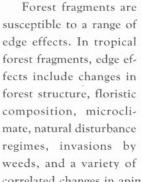
Many species of wildlife are forest interior species which avoid forest edges. The size and shape of forest patches is vitally important if these species are to survive and breed in fragmented landscapes. To maintain these species, patches need to be both large and have a high area:edge ratio.

Fragmentation

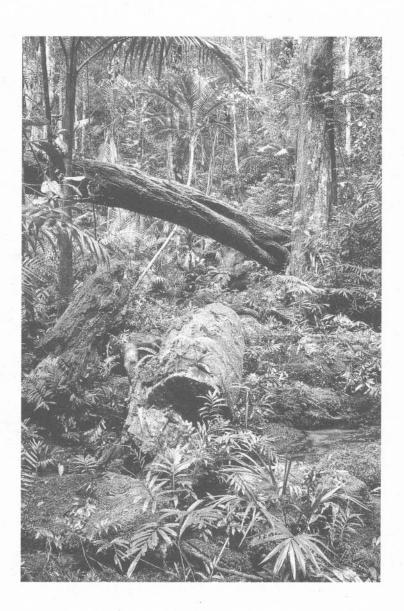
Fragmentation is the increase in isolation and decrease in size of resource patches, eventually leading to the creation of isolated remnants of natural forest. Rare species and species with patchy distributions are more susceptible to extinction as a result of fragmentation than are common species with a more even distribution.

The diversity of habitat in the Wet Tropics means that a larger proportion of the fauna and flora have naturally sparse or patchy distributions. This can influence the initial composition of species in the rainforest fragments. Therefore, forest fragments are not just smaller than the original forest, they are also ecologically different.

Leave old dead trees, fallen limbs, other organic litter and rocks on site to be used by different animals and plants.



correlated changes in animal populations. Forest fragments tend to be more susceptible to canopy damage and colonisation by disturbanceadapted plants - especially near the edges of the fragment. Species that respond positively to forest edges and tree-fall gaps are often successful in fragmented rainforest. Edge effects are therefore a powerful structuring force in fragmented rainforest.



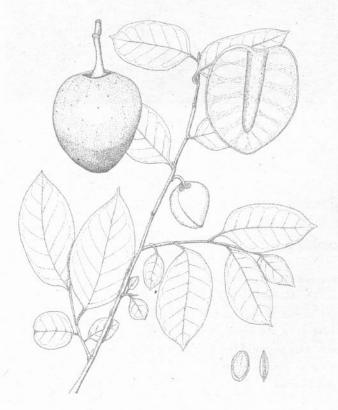
Microhabitat

A forest is more than the sum of the component trees. The biodiversity of a forest is also a function of 'niches' of various types and sizes at various heights in the forest. Old dead trees, fallen limbs, other organic litter and rocks should be left on site to be used by an array of different animals and plants.

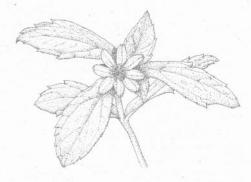
Weeds

Approximately 10% of Australia's plant species are introduced and this number is increasing steadily. Many of these plants are better adapted to living in disturbed environments than native plants and in the absence of pests and diseases some are better at coping with our soils and climate than native species. Several general points about weeds are:

- weeds can grow in all plant communities
- invasion by weeds is most likely after disturbance
- the greater the degree of disturbance the greater the degree of invasion



Pond apple (Annona glabra) courtesy Dr J.T. Swarbrick Weed Science Consultancy



Singapore daisy (Wedelia tricornuta)

- the greater the diversity of the natural community the less likely weeds are to invade
- most weeds do not germinate, survive or thrive under a closed canopy
- by reverting to natural systems, the conditions which allow weeds to proliferate are reduced or eliminated.

The success of any tree planting is largely dependent upon controlling weeds. Site preparation is a crucial stage in the control process. Mulching around newly planted trees helps and a regular ongoing maintenance regime is vital for successful rainforest re-establishment.