Mangroves in the Northern Territory

Report Number 25/2003D

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Cover photograph shows a *Rhizophora stylosa* surrounded by *Avicennia marina* pneumatophores

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What are Mangroves?

Mangroves consist of a variety of growth forms, from trees, palms, shrubs, vines, epiphytes, samphires, grasses and ferns. Mangroves form valuable ecosystems along sheltered tropical and subtropical coastal environments. Typical mangrove habitats are periodically subjected to tidal influences. Mangroves grow in soil that is frequently waterlogged by saline water. The first explorers described them as 'forests of the sea' (Mastaller 1997).

Plate 1: Mangroves, Channel Island

Mangroves have specialised adaptations enabling them to grow and reproduce in demanding conditions. High levels of salt, tidal inundation and wave action typify these challenging conditions (Mastaller 1997).

Where do Mangrove Communities Occur?

Mangroves are predominantly found in tropical regions between the Tropic of Cancer to the north and the Tropic of Capricorn to the south. The geographical distribution of mangroves can be divided into two main regions, consisting of a Western Group and an Eastern Group. The Eastern Group (Eastern Hemisphere) incorporates East Africa, the Red Sea, India, Southeast Asia, Southern Japan, the Philippines, Australia, New Zealand and the South Pacific archipelago, as far east as Samoa. The Western Group (Western Hemisphere) comprises African-American regions including, the Atlantic coasts of Africa and the Americas, the Pacific coasts of Tropical America and the Galapagos Islands. Approximately 80% of all known mangroves occur in the Indo-Pacific region (Mastaller 1997).

The total area of mangrove communities across the globe can still only be estimated. Current area estimates are in the range of 15.7 million hectares (Mastaller 1997).

Most tropical countries were originally covered with mangrove vegetation. The five basic requirements for extensive mangrove development include (Mastaller 1997):

- tropical temperatures
- fine grained alluvium
- shores free of strong wave and tidal action
- salt water; and
- large tidal range.

These factors can influence the occurrence and size of mangroves, the species composition, species zonation, other structural characteristics and the functions of the ecosystem itself (Mastaller 1997).

Mangroves in Australia

Australia's coastline has vast tracts of mangroves. The highest levels of species diversity can be found on the northern and northeastern coastlines. The greatest concentration is along the tropical northeastern coast from Mackay to Cape York. The tallest, most extensive forests are situated along the north coast of Queensland (Claridge & Burnett 1993).

The western coast has a reduced number of mangrove species, compared to the eastern coast. This is mainly due to seasonal aridity of the western coast and a limited presence of estuaries and embayments to accommodate mangrove communities (Claridge & Burnett 1993).

Mangroves do occur as far south as Victoria and South Australia, although these communities are almost limited to stunted *Avicennia marina* and only in those areas that are predominantly frost-free. No mangroves occur in Tasmania (Claridge & Burnett 1993).

Mangroves in the Northern Territory

Mangroves in the Northern Territory cover approximately 4 120 km^2 of 10,953 kilometres of Northern Territory coastline and river systems, incorporating both mainland mangrove communities and islands off the Northern Territory coastline. This area represents more or less 35% of the 11,600 km^2 of mangroves found throughout Australia (Wightman 1983).

The mangrove stands in the Northern Territory contrast significantly in stand, structure and species diversity. Extensive stands of mangroves are located along the northern coasts of Arnhem Land, in Darwin Harbour and on Bathurst and Melville Islands. Isolated pockets can occur within any number of small embayments or surrounding small coastal estuaries (Wightman 1983).

Mangroves in Darwin Harbour

The mangrove communities of Darwin Harbour are a significant natural resource both locally and globally. The mangroves in the harbour are amongst the most diverse in Australia. Approximately 50 species are regarded as 'mangroves' worldwide, 36 of these occur naturally in Darwin Harbour. The largely undisturbed tracts of mangroves occupy an area of approximately 20,400 hectares (Approx. 5% of the NT's and 0.1% of remaining world mangrove area) (Brocklehurst & Edmeades 1996)

Harsh Conditions

The coastal environment provides challenges which many plants would be unable to cope with. Mangrove plants demonstrate a wide range of adaptations which enable them to thrive in these demanding conditions (Mastaller 1997).

Adaptations to Salt

Salt tolerant plants are called halophytes. Halophytes have adaptations which can counteract high concentrations of salt found in their environment. Salt, or sodium chloride (NaCl), poses a significant threat to non-halophytic plants because it can influence the amount of available fresh water and because salt can be toxic in high concentrations (Knox *et al.* 1994).

Plate 2: *Sonneratia alba* (Mangrove apple)

Salt Exclusion

Don't let the salt in! Many of the major mangrove plants including *Avicennia*, *Bruguiera*, *Ceriops*, *Excoecaria* and *Rhizophora* are able to selectively take in water while filtering most of the salt out. This type of adaptation is called ultra-filtration (Claridge & Burnett 1993).

Salt Excretion

Getting the salt out! Some mangroves are able to actively pump salt out from their leaves. In plants such as *Avicennia* and *Aegialitis* it is possible to see salt which has been excreted in the form of crystals on the outside of leaves (Claridge & Burnett 1993).

Plate 3: Salt crystals on the leaf of *Aegialitis annulata* (Club mangrove)

Storage

Keep the salt for a while, and then get rid of it! Salt which has been taken up by a mangrove plant can be selectively transported by the plant to the most expendable leaves. This salt will be totally lost from the plant when these leaves are dropped. Salt may also be stored in bark (Claridge & Burnett 1993).

Plate 4: Leaf fall in *Bruguiera exaristata* (Orange mangrove)

Adaptations to Inundation and Wave Action

Mechanical adaptations are structural features which enable plants to survive and successfully compete for resources in a particular environment. One of the most obvious mechanical adaptations of mangroves to the marine environment are various root structures. Additionally many mangrove timbers are very heavy which assists in anchoring the plant (Mastaller 1997).

Stabilisation with Roots – Mangrove Balancing Acts

Mangrove root systems are generally not deep, but are widely spread out. Mangroves have several different root types which enable them to remain securely anchored in regions which repeatedly become waterlogged and are subject to tidal influences and wave actions (Claridge & Burnett 1993).

Stilt Roots

Stilt roots or prop roots are elongated aerial roots which originate from the tree trunk and lower branches. *Rhizophora* trees have easily recognisable prop roots (Mastaller 1997).

Plate 5: ***Rhizophora stylosa*** **(Stilt rooted mangrove) roots**

Buttress Roots

Buttress roots radiate from the base of a tree to increase the width of the base. By having a greater width, the chances of the tree being knocked over by wave action or over balancing in the soft mud are reduced (Mastaller 1997).

Plate 6: ***Ceriops tagal*** **(Yellow mangrove) base**

Cable Roots

The *Avicennia marina* (Grey mangrove) cable roots shown in Plate 7 have been exposed through erosive processes. They demonstrate how mangrove roots can spread radially underground to assist with stabilisation in wet and rough conditions.

Plate 7: ***Avicennia marina*** **(Grey mangrove) base**

Aeration through Roots

Plant roots require oxygen for cellular respiration. Normally this gas would be available to plants in the tiny spaces, called interstitial spaces, which occur between soil particles. This space is not available in mangrove mud, due to frequent water logging and inundation. Some mangrove species have adapted to this challenging situation by developing above ground roots, such as pneumatophores and knee roots (Knox *et al* 1994).

Pneumatophores – Mangrove Snorkels

Pneumatophores are specialised roots which grow upwards from a cable root system. By having roots above the surface of the mud these trees are able to ‘breathe’ during low tide. Pneumatophores occur in *Avicennia*, *Sonneratia* and *Xylocarpus* mangroves. Pneumatophores can vary extensively in height, shape and diameter (Claridge & Burnett 1993).

Plate 8: *Sonneratia alba* (Mangrove apple) pneumatophores at low tide (above)

Plate 9: *Sonneratia alba* (Mangrove apple) pneumatophores at high tide (right)

Knee Roots

Knee roots are loops in cable roots, they appear as knee like projections above the surface of the mud. Knee roots are found in *Bruguiera* and *Lumnitzera* (Claridge & Burnett 1993).

Plate 10: *Bruguiera exaristata* (Orange mangrove) knee roots

Seed Dispersal and Establishment

The seeds of mangroves are well adapted to dispersal by water and establishment in tidal areas. Large quantities of buoyant seeds are produced to account for high levels of predation and destruction. Additionally some mangroves are viviparous (Claridge & Burnett 1993).

Vivipary means giving birth to live young, as opposed to producing eggs. For example mammals are considered to be viviparous, while birds are not. When referring to a plant, vivipary means that a fertilised seed actually begins to grow while still attached to the parent plant (Claridge & Burnett 1993).

The seeds produced by the mangroves germinate while still attached to the parent tree to form seedlings, called propagules. When the seedling falls to the ground it has already started to develop a root system which will assist it to anchor to the muddy substrate despite constant wave actions and tidal inundation (Claridge & Burnett 1993). *Rhizophora stylosa* propagules can often be spotted along the high tide mark (See Plate 11). Like all mangrove seeds, *Rhizophora* propagules are able to float, allowing them to be dispersed with the tide far away from the parent plant. This is one way that mangroves are capable of colonising new areas.

Plate 11: Developing propagule of *Rhizophora stylosa* (Stilt rooted mangrove)

Mangrove Plants (Flora)

Many plant growth forms are associated with mangrove ecosystems including vines, grasses, shrubs, chenopods, sedges, forbs, palms, ferns and parasitic plants (Mastaller 1997).

Plate 12: *Acrostichum speciosum* (Mangrove fern)

For the purpose of this resource nine tree species have been chosen as representatives of the mangrove communities present in the Top End of the Northern Territory. These species vary considerably in their appearance, adaptations to the coastal habitats, position in relation to the coast and their cultural uses. The chosen species are:

- *Aegialitis annulata* (Club mangrove)
- *Avicennia marina* (White or grey mangrove)
- *Bruguiera exaristata* (Orange mangrove)
- *Ceriops tagal* (Yellow mangrove)
- *Excoecaria ovalis* (Blind your eye)
- *Hibiscus tiliaceus* (Beach hibiscus)
- *Lumnitzera racemosa* (Black mangrove)
- *Rhizophora stylosa* (Stilt rooted mangrove)
- *Sonneratia alba* (Mangrove apple)

* Common names have been included to assist student learning. It should be noted that discrepancies can exist with common names, so where possible scientific names should be preferentially learned and used.

Plate 13: Base of *Ceriops tagal* (Yellow mangrove-left) *Avicennia marina* (Grey mangrove-right)

Aegialitis annulata (Club mangrove)

This mangrove is a small shrub, which generally does not exceed 1.5 metres but can reach up to 3 metres in height (Brock 1988).

Plate 14: *Aegialitis annulata* (Club mangrove) at Dundee beach

The trunk is thick at the base, but quickly narrows to give the appearance of a club. *Aegialitis annulata* is found in a variety of habitats, including rocky beach environments in the seaward zone (Brock 1988).

Plate 15: Club shaped base of *Aegialitis annulata* (Club mangrove)

Plate 16: Salt crystals on the leaf of *Aegialitis annulata* (Club mangrove)

The leathery leaves have specialised glands which excrete salt from their upper surface. The leaves differ from many other mangroves in that they are stem-sheathing. This means that the leaf stem actually flattens out and curls around the stem to which it is attached (Brock 1988).

Aegialitis flowers between September and December. The flowers are small, tubular and white. The fruiting period is between January and March. The fruit are smooth, narrow and banana shaped (Brock 1988).

Plate 17: Developing propagules of *Aegialitis annulata* (Club mangrove)

Avicennia marina (Grey mangrove)

This is the most widespread mangrove in Australia. *Avicennia marina* generally takes the form of a multi-stemmed tree between 4 and 10 metres high, however in some areas these trees can reach 25 metres. *Avicennia* is found in varied environments, including the upper tidal limit of estuaries, salt flats and along the seaward margin (Brock 1988).

Plate 18: *Avicennia marina* (Grey mangrove) at Nightcliff Beach

Another distinguishable feature of this tree is the pencil like pneumatophores which protrude upwards through the mud from lateral roots below. These assist with the aeration of the plant (Brock 1988).

Plate 19: Pencil like pneumatophores

The bark of the *Avicennia* is generally a pale white to grey/green. The flowers of *Avicennia* are small and orange generally occurring between October and January. The fruiting period is between January and February. The fruit are small, green, dish-like capsules (Brock 1988).

Plate 20: *Avicennia marina* (Grey mangrove) base

Plate 21: *Avicennia marina* (Grey mangrove) leaf (pale underside showing salt excretion)

The leaves are elongated (up to 12cm), with a shiny upper surface and pale grey coloured underside (it is this colour which accounts for the common name). This species has salt secreting glands on the leaves. *Avicennia* fruit can be eaten after extensive preparation, including soaking and cooking. Leaves and shoots are used for medicinal purposes. Correct preparation enables the treatment of cuts and marine stings (Brock 1988).

Bruguiera exaristata (Orange mangrove)

Plate 22: *Bruguiera exaristata* (Orange mangrove) flowers

Plate 23: *Bruguiera exaristata* (Orange mangrove) knee roots

These spreading trees are generally between 3 and 10 metres high. The trunks of *Bruguiera* are often buttressed and surrounded by many knee like pneumatophores. The bark of these trees is generally dark and fissured along the trunk and at the roots. *Bruguiera exaristata* is generally found in the landward zone of mangrove communities (Brock 1988).

The thick leathery leaves of *Bruguiera* are found clustered towards the ends of branches. The flowers, which give this mangrove its common name, are bright orange and surrounded by a green calyx. These are found between May and November. The fruit, occurring between June and December, are cone shaped and about 1.5 cm long (Brock 1988).

Plate 24: *Bruguiera exaristata* (Orange mangrove) base

The timber of *Bruguiera* is used to make valuable instruments including oars and tools. The fruit may be eaten after considerable preparation (Brock 1988).

Plate 25: *Bruguiera exaristata* (Orange mangrove) calyx

Ceriops tagal (Yellow mangrove)

Ceriops can form as small trees or shrubs, generally between 2 and 6 metres high. The base of *Ceriops* is often buttressed. Bark is generally pale brown, which can be flaky within the buttresses. *Ceriops* generally cannot tolerate high levels of water inundation and as a consequence are mainly found on the landward fringe of mangrove communities and in salt pan areas (Brock 1988).

Plate 26: Buttress roots of *Ceriops tagal* (Yellow mangrove) showing close up of bark

Plate 27: *Ceriops tagal* (Yellow mangrove) fruit

The leaves of *Ceriops* trees are yellowish green in colour (hence the common name yellow mangrove). The flowers, which occur between June and November are small, white and appear in clusters. Fruit is present on the plant between June and December. The fruits are smooth, cone shaped and approximately 1.3 cm long. Some *Ceriops* varieties can be used to create medicines for the treatment of burns (Brock 1988).

Plate 28: *Ceriops tagal* (Yellow mangrove) form

Excoecaria ovalis (Blind your eye)

This is generally a small tree or shrub which can reach up to 4 metres in height. The roots of this species occasionally knot above the soil surface. *Excoecaria* can be found in and around mudflats and in coastal mangrove communities (Wightman 1983).

Plate 29: Oval shaped leaves and white latex of *Excoecaria ovalis* (Blind your eye)

The species name 'ovalis' refers to the oval shape of the leaves. The leaves generally range between 3 and 7 cm in length. If plucked from the stem *Excoecaria* leave stems will release a small amount of milky white fluid called latex. The flowers of *Excoecaria* occur between October and December. The individual flowers of this species are tiny, the inflorescence produced are in the form of spikes up to 3 cm long. Small mottled brown seeds occur between December and February (Wightman 1983).

While the latex of *Excoecaria* is considered to be toxic and is thought to cause irritation to eyes (hence the common name), it can be used medicinally in the treatment of some diseases including leprosy and for marine stings. The timber may also be used for firewood (Wightman 1983).

Plate 30: *Excoecaria ovalis* (Blind your eye) tree

Plate 31: *Excoecaria ovalis* (Blind your eye) leaves

Hibiscus tiliaceus (Beach hibiscus)

The Beach hibiscus is a small spreading tree which can reach 8 meters in height. The tree is frequently found in sandy beach areas, but can also be found below the high tide mark (Wightman 1983).

The large flowers have yellow petals and a deep maroon centre. These trees flower all year round in the tropics. Fruiting is restricted to between January and April. The fruit are brown, woody capsules which split when they are ripe (Brock 1988).

Plate 32: *Hibiscus tiliaceus* (Beach hibiscus) flower

The large leaves of the hibiscus are heart shaped. The top side of the leaves are smooth and dark green, while the underside is covered with many fine hairs which form a pale grey colour (Brock 1988).

The wood and bark of these trees can be used by Aboriginal people to make objects including weapons and rope. The sap can be used in the treatment of boils and wounds (Brock 1988).

Plate 33: *Hibiscus tiliaceus* (Beach hibiscus) heart shaped leaf

Plate 34: *Hibiscus tiliaceus* (Beach hibiscus) form

Lumnitzera racemosa (Black mangrove)

This shrub or tree can reach 5 metres in height, however in substandard conditions, such as those found in salt pans, *Lumnitzera* may remain under 1 metre (Plate 35) (Wightman 1983). The bark of the black mangrove is often very dark - hence its name. These trees are generally found towards the landward edge of mangrove areas (Brock 1988).

Plate 35: Stunted growth form of *Lumnitzera racemosa* (Black mangrove) and close up of bark

The leaves of *Lumnitzera* are one of the best ways to identify this species. Each leaf has an indentation at its tip which forms a heart shape. If you look carefully a small gland can be seen at the base of the indentation (Brock 1988).

Lumnitzera racemosa flowers between October and May. The flowers are small, white and usually occur in groups. The fruit of the *Lumnitzera* are small, smooth lobes (Brock 1988).

Aboriginal people choose to use *Lumnitzera* timber for fire wood because it is slow burning and maintains hot coals (Brock 1988).

Plate 36: Heart shaped leaves of *Lumnitzera racemosa* (Black mangrove)

Rhizophora stylosa (Stilt rooted mangrove)

Rhizophora is perhaps one of the best known of all mangroves as a result of the intertwined, arching prop roots which originate from the base and lower branches of these trees. These roots have proved highly successful in enabling *Rhizophora* to colonise the seaward edge of mangrove communities, despite constant tidal inundation and wave action. The trees can vary in height between 5 and 12 metres (Brock 1988).

Plate 37: *Rhizophora stylosa* (Stilt rooted mangrove) roots

Plate 38: *Rhizophora stylosa* (Stilt rooted mangrove) leaves, showing dark upper and pale underside

Rhizophora leaves are thick, leathery and have a small point projecting at the apex. The flowers of this species, which occur between April and November, are small, white and feathery. The fruit, which can be observed between April and November, is smooth, brown and pear shaped (Brock 1988).

Rhizophora is used by Aboriginal people in the treatment of several medical conditions, including chicken pox (Brock 1988).

Plate 39: Developing *Rhizophora* (Stilt rooted mangrove) at Nightcliff

Sonneratia alba (Mangrove apple)

This spreading tree is generally between 4 and 5 metres high, however it can reach 8 metres in height. *Sonneratia* trees have large, cone shaped pneumatophores. *Sonneratia* are found in the seaward zone (Brock 1988).

Plate 40: *Sonneratia alba* (Mangrove apple) fruit

Plate 41: *Sonneratia alba* (Mangrove apple) cone shaped pneumatophores

The leaves of *Sonneratia* are bright green, thick and fleshy. The flowers, which occur between March and October, are red or white. The flowers do not have visible petals, but instead are made of many coloured stamen. The fruit, which also occurs between March and October, appear as flattened, globular berries, which give *Sonneratia* its common name. The edible fruit remains attached to the green calyx which surrounds the flowers. As the fruit forms the calyx is forced into a star shape (Brock 1988).

Plate 42: *Sonneratia alba* (Mangrove apple) flowers (above)

Plate 43: *Sonneratia alba* (Mangrove apple) at high tide, East Arm Inlet (left)

Mangrove Zonation

Mangrove communities are often made up of obvious zones which run parallel to the shore. Each zone is likely to be dominated by one particular tree species which has adapted to specific environmental characteristics (Claridge & Burnett 1993). The aerial photograph (Plate 44) shows distinct zones formed by mangrove species which run parallel to the coast or riverine system.

Plate 44: Leaders Creek

Why does Zonation Occur?

The amazing way that mangroves sort themselves into zones has been the subject of a great deal of scientific research. Many ideas have been put forward to explain why this happens. Some ideas are summarised below.

Environmental Variables

It has previously been explained that mangroves have different ways of adapting to the challenging conditions of coastal life. Conditions such as salt concentration, wave action, inundation levels and even levels of predation (mainly by crabs)vary considerably between the coastal edge and the landward extremes of a mangrove community (Mastaller 1997).

Different plant species have different adaptations which enable them to successfully compete against other mangrove species for positions at varying distances from the water's edge. *Rhizophora, Avicennia* and *Sonneratia* all have complex root systems, which enable them to live in, the areas most affected by tidal inundation and wave action. This accounts for the consistent presence of these tree species at the seaward edge of mangrove communities (Claridge & Burnett 1993).

Propagule characteristics

Propagule size, shape and density have also been implicated in mangrove zonation. The larger and more irregularly shaped propagules, are less likely to be transported by wave action through complex root structures and mud to the landward side of a mangrove community. For example the large propagules produced by *Rhizophora stylos*a (see Plate 11) are rarely transported to the landward edge of a community and it is only large propagules that are capable of withstanding the wave action which can prevent smaller lighter propagules from establishing in tidal areas. Smaller propagules such as those of *Bruguiera* are more likely to be landward, where the reduced levels of inundation allow root establishment (Tomlinson 1986).

What zones occur ?

Generally a minimum of three zones are recognised, these being the landward zone, the seaward zone and an intertidal zone (Claridge & Burnett 1993). These simplified zones will be outlined. Figure 1 depicts a more complicated zonation pattern which has been mapped in Darwin Harbour.

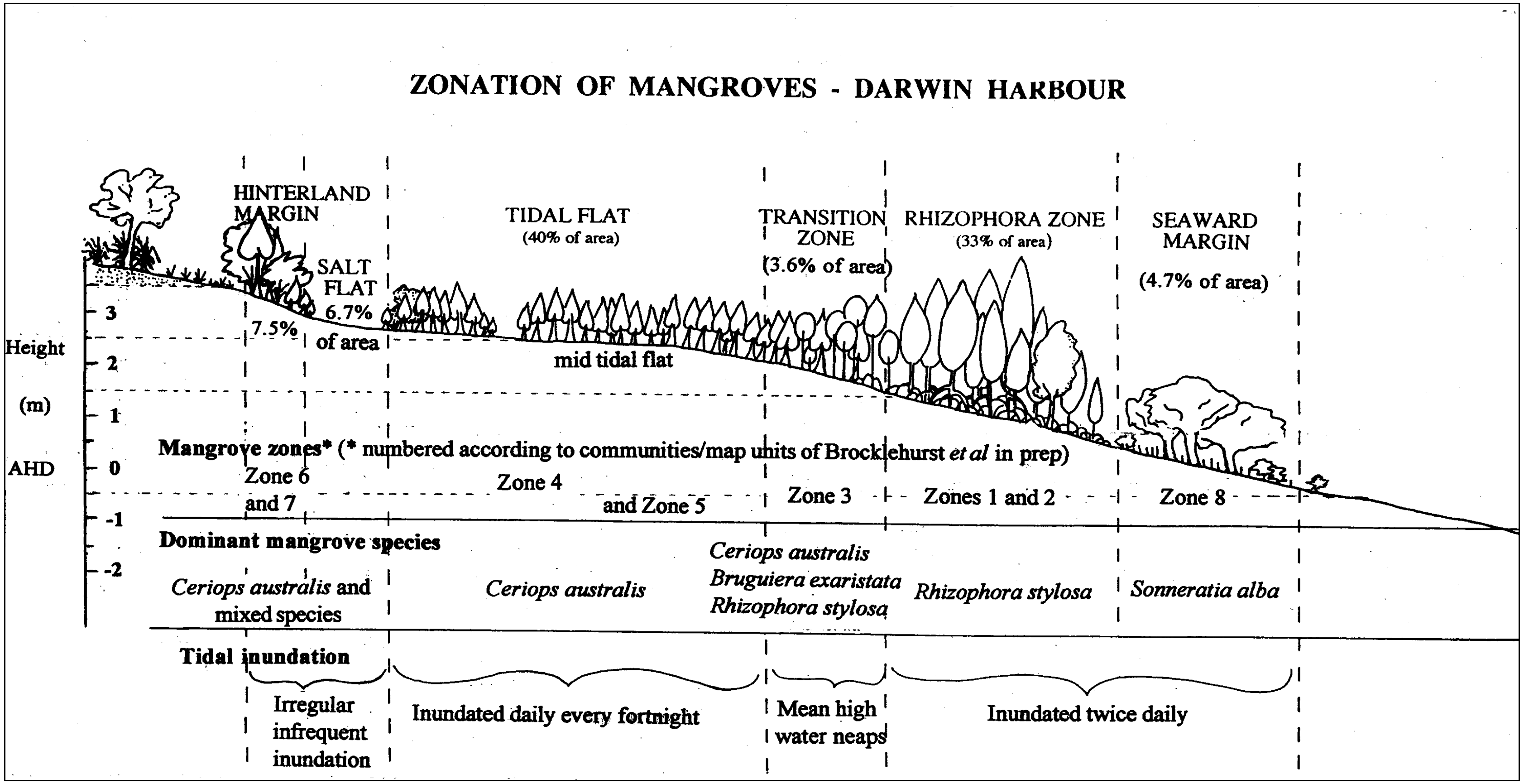


Figure 1: Schematic profile of mangrove zonation, topography and elevation in Darwin Harbour (Metcalfe 1999).

The Seaward Zone

The Seaward zone runs parallel to the sea. Because of the close proximity to the water this zone is the most susceptible to wave action and inundation. The mangrove species which are found in this zone are highly adapted to the associated challenging conditions. The species most likely to occur within the tidal zone include *Rhizophora*, *Avicennia* and *Sonneratia* (Claridge & Burnett 1993).

Plate 45: *Sonneratia alba* and *Rhizophora stylosa* in the seaward zone

The Middle Zone

This zone is generally at a higher elevation than the seaward zone and as a result is inundated far less frequently. The species which are likely to occur within the middle zone include *Ceriops tagal, Bruguiera exaristata* and *Excoecaria ovalis* (Claridge & Burnett 1993).

Plate 46: *Ceriops tagal* (Yellow mangrove) in the middle zone

The Landward Zone

The landward zone is inundated less frequently than both other zones, depending on tides. The landward zone occurs between the middle zone and the terrestrial environment (hinterland). In these areas other species may occur including *Eucalyptus*, *Melaleuca*, *Pandanus* and *Acacia*. Mangrove species found in this zone include *Lumnitzera racemosa, Hibiscus tiliaceus* and *Ceriops tagal* (Claridge & Burnett 1993).

Plate 47: *Melaleuca* (Paperbark) and *Pandanus* in Landward zone

Mangrove Animals (Fauna)

Vertebrates

Vertebrates are animals that have backbones, or more specifically an internal skeleton. Mammals, reptiles, amphibians, fish and birds are all vertebrates (Knox et al. 1994).

Mammals

Bats are the most prevalent mammals within mangrove communities. In particular the little red flying fox (*Pteropus scapulatus*) feeds on the pollen of mangroves. These and other bats retreat to the mangroves to roost often in groups of thousands. Wallabies, dingoes, possums and small rodents can be found within and near the landward fringe (Strahan 1995).

Plate 48: *Pteropus scapulatus* (Little red flying fox)
Photo courtesy of Denise Batten

Birds

Many birds are dependent on the rich levels of productivity and sheltered habitats which mangroves provide. Mudflats and intertidal areas provide important feeding grounds for wading birds. Numerous flowers and fruits of mangrove comminutes provide rich food sources for nectarivores (nector eaters) and frugivores (fruit eaters). Many migratory bird species are dependent on north Australian mangroves (Donato *et al.* 1997). These visitors highlight the importance of mangrove conservation on a global scale.

Plate 49: *Merops ornatus* (Rainbow bee-eater)

Reptiles

Various reptiles are found in mangrove forests including the dangerous saltwater crocodile (*Crocodylus porosus*), mangrove monitors and other lizards and snakes.

Plate 50: Mangrove snake

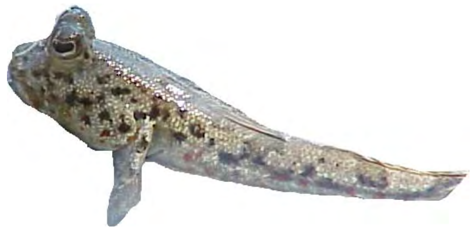
Fish

Many fish, including commercially viable species, are dependent on mangrove assemblages for food and for breeding (Mastaller 1997). An influx of various fish species can be observed entering the mangroves with the rising high tide.

Mudskippers

Mudskippers are a type of fish which continue to live in mangrove environments even when the tide is out. Strong pectoral fins assist movements on land. When out of water mudskippers can breathe air from moisture trapped in their gill chambers. Mudskippers prey on crustaceans and other small animals (Mastaller 1997).

Plate 51: *Periophthalmus sp.* (Mudskippers)



Invertebrates

Invertebrates are animals which do not have backbones. Major groups include arthropods and molluscs (Knox *et al*. 1994).

Arthropods

Arthropods are a group of invertebrates which includes spiders, crustaceans and insects. Arthropods do not have internal skeletons like humans and other vertebrates, instead they have a hard external skeleton called an exoskeleton. The exoskeleton is jointed which allows movement of limbs (Knox *et al*. 1994).

Spiders

Most spiders have three types of sensory organs which enable them to decipher what is happening in their immediate environment. Hairs on the body and legs of spiders actually assist the spider to detect vibrations in the air. Slit sense organs, rather than ears, are used to detect sound vibrations. While most spiders have simple eyes, only hunting spiders, such as the huntsman pictured, can actually see detailed images (Knox *et al*. 1994).

Plate 52: Camouflaged spider on the bark of an *Avicennia marina* (Grey mangrove)

Crustaceans

Crustaceans, a group of animals which includes prawns and crabs, can be differentiated from other animals by having appendages (legs) which split into two. The most obvious example being the claw of crabs (see Plate 52) (Knox *et al*. 1994).

Crabs play an important role in mangrove nutrient recycling and soil aeration (Moritz- Zimmerman *et al* 2002).

Plate 53: Fiddler crab (*Uca* sp.)

Fiddler crabs can be easily identified, as male fiddler crabs have one massively disproportionate, brightly coloured claw which is used when courting female crabs, in territorial defence and as a warning system (Mastaller 1997).

Insects

Many different types of insects can be found in mangrove environments. However their significance to tropical mangrove systems, specifically in regards to pollination and herbivory is poorly understood. The links between mangroves and insects is a current focus of study in Darwin Harbour (Moritz-Zimmerman *et al* 2002).

Plate 54: Katydid

The most infamous of mangrove insects are those which parasitise humans. Biting insects found in the mangroves include mosquitos and sand flies. Visitors to mangroves should be careful by wearing protective clothing and insect repellent.

Molluscs

Molluscs are animals which have soft bodies which are supported and protected by unusually hard shells. Examples of molluscs include snails, oysters and mussels. Many different types of molluscs can be found in the mangroves. Indigenous people harvest various mollusc types for food. Bush tucker can include long bums, periwinkles, scallops, mud whelks and mussels (Puruntatameri *et al* 2001).

Plate 55: *Telescopium telescopium* (Long bum)

Mangrove Soils

Mangrove communities are often associated with thick glutenous mud. This mud has been formed by the continuous deposition of fine soil particles which may have been transported by watercourses such as creeks or rivers for many kilometres (Mastaller 1997).

Plate 56: Mangrove mud

What's that smell?

The muddy substrate commonly associated with mangroves is actually made up of many tiny grains of soil, which in combination with tidal water sources form semi fluid mud. The lack of spaces between soil particles mean that no oxygen can infiltrate past the uppermost soil layers. This lack of oxygen means that bacteria can live happily in these lower levels. The bacteria produce a gas called hydrogen sulphide. When this gas reaches the surface it is easily recognisable by its characteristic rotten egg smell (Mastaller 1997)!

Acid sulphate soils

Acid sulphate soils are a major concern of both environmental scientists and developers of mangrove areas. Acid sulphate soils are formed when naturally occurring regions of waterlogged iron sulphides are exposed to oxygen in the air. When these sulphides come into contact with air, for example through clearing or excavation, they oxidise to form sulphuric acid (Sammut & Lines-Kelly 1997).

Regions most susceptible to acid sulphate soil formation are low lying areas near the coast including mangrove forests, salt marshes, estuaries and tidal lakes. The sulphuric acid produced can acidify the soil, soil water, groundwater and surface water, including tidal creeks. Acid affects the health of fish, plants and other organisms by reducing the ability to breed and increasing susceptibility to disease (Sammut & Lines-Kelly 1997).

The sulphuric acid produced can also be strong enough to dissolve many man made materials including concrete, steel and some aluminium alloys. Acid has already been observed to weaken and corrode concrete slabs, building foundations and underground water and sewage pipes (Sammut & Lines-Kelly 1997).

The effects of acid sulphate soil disturbance can have tragic short and long term effects. Rectifying and rehabilitating problems which have arisen from the disturbance of potential acid sulphate soils can be very difficult and expensive. It is very important that people learn about acid sulphate soils so that their disturbance can be avoided in the future and those areas which are currently affected can be properly managed to minimise the impacts (Sammut & Lines-Kelly 1997). Information on acid sulphate soils can be found at http://www.agric.nsw.gov.au/reader/8632

Why are Mangroves so Important?

Ecological importance

Coastal Stabilisation

Coastlines and beaches are dynamic. This means that they are constantly changing as a result of both natural and anthropogenic (man made) influences (Mastaller 1997).

Plate 57: *Rhizophora stylosa* (Stilt rooted mangrove - left) and *Bruguiera exaristata* (Orange mangrove - right) on Lee Point Beach

Mastaller (1997) states that natural processes which can influence coastal and estuarine dynamics include

- longshore currents;
- wave action;
- wind action; and
- storm surges, including tropical cyclones.

Anthropogenic processes which can influence coastal and estuarine dynamics include:

- coastal development; and
- removal and destruction of coastal vegetation including mangroves.

In many cases natural processes are accelerated by human development and populations. The rate at which coastal change takes place can be quite slow and may only become evident over a number of years. However even gradual changes can cause serious environmental and economic problems (Mastaller 1997).

The dense structure of mangrove communities results in a firmly anchored physical wall of trees linked together through complex interlaced root systems. As a result mangrove communities provide protection against coastal erosion by creating a buffer against currents, waves, wind and storm events (Mastaller 1997).

In many regions of the world, including Australia, the removal of mangroves has resulted in severe erosion and subsequent economic cost. The construction of artificial barriers is structurally challenging due to the unstable nature of coastal substrates and as a consequence is very expensive (Mastaller 1997).

Sediment Traps

Mangrove comminutes and their complex root systems trap large quantities of silt which is carried downstream from rivers and other estuarine systems. By trapping these tiny particles of silt and soil, mangroves act as a filter and consequently contribute to the quality of coastal waters (Mastaller 1997).

This function is important particularly for the sustainability of coral reefs. The tiny coral polyps which form reef communities are sensitive to sediment loadings. If these polyps become smothered the coral communities die back and are no longer able to support the rich and diverse ecological communities associated with reef environments. Darwin has several coral reefs which provide interesting snorkelling and diving. Figure 2 depicts the surprisingly high number of coral reefs which can be found around Darwin Harbour, many of which correlate to mangrove communities. More information on the attributes of Darwin Harbour can be found at: http://www.ntlis.nt.gov.au/ by selecting Australian Coastal Atlas NT Node and following the prompts. This site provides interactive access to a geographic information system (GIS) which allows the user to access various layers of information which can be overlaid onto a map of the Northern Territory.

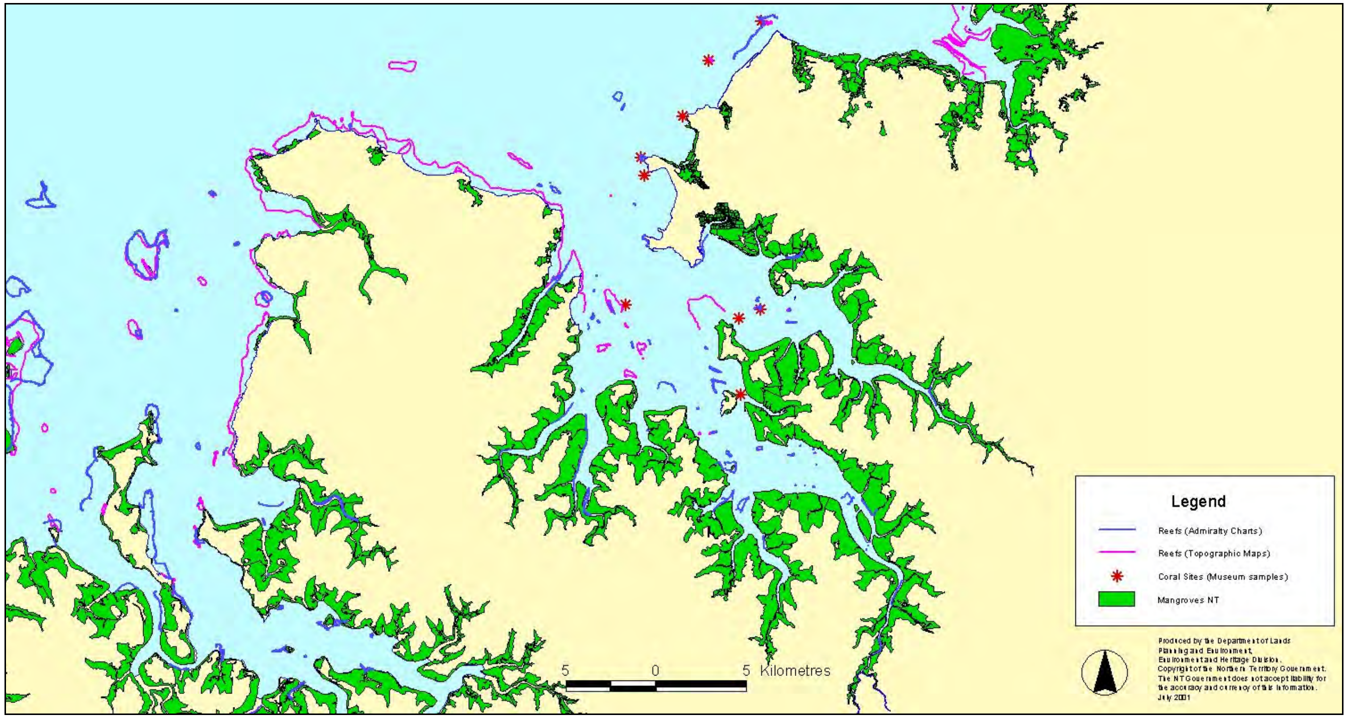


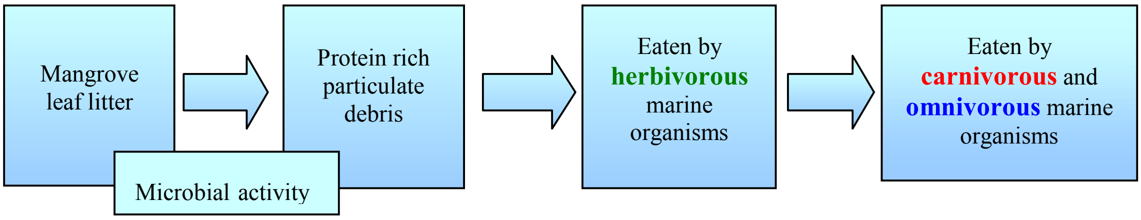
Figure 2: Coral Reefs in Darwin Harbour

High Productivity

Productivity is a term used by scientists to describe the ecological value of a vegetation community. The productivity of mangrove communities is high in comparison with many other vegetation communities. The high productivity of mangroves form an integral part of the marine food web (Mastaller 1997).

A food web is now widely recognised as a more accurate and complicated version of a food chain. The complexity and extensiveness of the food web stems from the high nutrient availability, which has come from extensive mangrove leaf litter decomposition over time (Mastaller 1997).

When mangrove leaves and branches fall to the ground they provide many terrestrial and marine species with a 'primary' food source. These primary level consumers are then consumed by secondary level consumers such as small fish, who are in turn eaten by third level consumers such as crocodiles (Mastaller 1997).



High Biodiversity

The word biodiversity is made up of the two words ‘biological’ and ‘diversity’. Biodiversity refers to the all species in an ecosystem and therefore can be used as a measure of the variety of life (Knox *et al.* 1994).

The high level of productivity associated with mangrove ecosystems support complex plant communities, these in turn become the unique habitats that sustain extensive and varied populations of animals. The high level of biodiversity associated with mangroves is an important indicator in the need for conservation of these ecosystems (Mastaller 1997).

Plate 58: Mangrove snake

Economic Importance

Tourism

Mangroves provide a habitat for many animals and birds which are very important to the tourism industry. Tourists can now readily access mangroves through the use of boats or via board walks. Tourism provides an excellent opportunity for people to learn about the ecological and economic importance of mangroves.

Faunal Harvesting

Mangroves are now recognised as being extremely important for recreation and commercial fisheries. The harvesting of animals from mangroves may be either direct or indirect. As the tides flush in they bring with them a wealth of animals including stingrays, fish and prawns. Low tide exposes alternate harvests including invertebrate species such as long bums and mud crabs.

Indirectly many industries are dependent on mangroves as breeding grounds. The young of many species are not harvested until well after they mature and leave the mangrove environment. Such species include prawns and barramundi, both of which are economically important in the Northern Territory.

Wood Harvesting

Wood harvesting of mangroves is not as common in Australia as it is in many overseas countries. Countries such as Thailand are dependent on the timber of mangrove species for fuel, charcoal, pulp and for the construction of rural dwellings. Other smaller pieces of wood may be used for wooden carvings and in the creation of small household objects (Mastaller 1997).

Recreational and Cultural Uses

Indigenous Harvest

Cultural uses of mangroves include various uses of flora and fauna for food, medicine and for the construction of weapons and artworks. Traditional Aboriginal hunting and gathering practices reap bountiful and varied harvests. Food sources include fish, stingrays, mammals, reptiles, invertebrates and honey (Puruntatameri *et al* 2001).

Fishing

Fishing in the Northern Territory is seen to be important from both cultural and recreational perspectives. Mangroves provide important breeding and feeding grounds for many species of fish including the highly sought after barramundi. Mud crabs (*Scylla serrata*) are also a prized food source that can be caught in shallow tidal waters using a crab pot or in the mangroves themselves.

Plate 59: Fishing off Channel Island

Other Recreational Pursuits

Plate 60: Recreational mangrove use - Photograph courtesy of Libby Benson

Mangroves are also used by many people for their aesthetic value. Wildlife observers, field naturalists, bird watchers and photographers frequently use mangrove areas.

Impacts on Mangroves

Coastal Development

The development of population centres, such as Darwin, have the potential to alter the ecological balance of mangrove communities. Some areas of mangroves have been reclaimed (cleared and filled) to make way for coastal developments including residential and industrial estates, marinas and wharf precincts (Moritz-Zimmerman *et al.* 2002).

Pollution

Many types of pollution can affect mangrove communities. Landward pollution sources include stormwater runoff, sewage discharges, thermal discharges, pesticide runoff and rubbish. Mangroves are also vulnerable to pollution from the seaward side. Pollution from the sea most often results from vessels including boats and ships. These pollution types may include rubbish, discarded fishing equipment and oil (Mastaller 1997).

Plate 61: Rubbish is serious form of pollution

Several legislative mechanisms are in place to monitor and control the amount of pollution entering the environment. Information on mechanisms to reduce and combat pollution can be found at the following Internet site: http://www.lpe.nt.gov.au/enviro/poldoc/waste.htm. It does however remain important for members of the public to consciously reduce the amount of waste they are producing and responsibly dispose of or recycle waste which is generated.

Sedimentation

The accumulation of sediments in mangroves can be greatly increased by upstream disturbances including clearing of vegetation and construction. Increased levels of silt and soil in mangroves can lead to decreases in water quality and lowered dissolved oxygen levels. These impacts can destroy plant and animal life and subsequently impact on food webs (Mastaller 1997).

Plate 62: *Rhizophora stylosa* (Stilt rooted mangrove) and sedimentation.

The amount of sedimentation can be reduced by controlling the amount of erosion. Information on how this can be achieved may be found at the following Internet site: http://www.lpe.nt.gov.au/advis/land/soils.htm

Weed and Feral Animal Invasion

Weeds

A weed is a plant which has established in an environment outside its natural range. Often when plants enter a foreign ecosystem there are no population control mechanisms. Noxious weeds have the capacity to out-compete native plants for space, light and nutrients. The establishment of weeds can further affect natural ecosystems by impacting on the food resources and habitats of native species. Weeds can be spread in many ways. Transport mechanisms for seeds and runners include wind and water (including stormwater drains), native and feral animals, vehicles, and people! We can easily transport seeds on our clothing and shoes (Smith 1995).

Plate 63: Coffee Bush *(Leucaena leucocephala*)

Weeds were either accidentally or intentionally introduced. Accidental introductions can occur when plants or seeds 'hitchhike' with people or cargo. Intentional introductions include plants that were brought in for a specific purpose, for example to provide cattle with nutrient rich pasture or for their attractive qualities (Smith 1995).

Information on weeds, including ways to identify and help reduce them can be found at http://www.nt.gov.au/dbird/dpif/plants/weeds/weed_buster_logos.shtml

Feral Animals

Many feral animals have established stable and often destructive populations in Australia. Feral animals which can impact on mangrove ecology include buffalos and feral pigs. As an example, feral pigs are omnivorous, they compete with native and pastoral animals for feed and have been observed to hunt small animals and birds. Feral pigs can also significantly alter their chosen habitat by destroying vegetation, spreading weeds and by compacting and eroding soils. In addition feral pigs are pose a significant threat to our agriculture industry through to their capacity to spread disease to livestock (Strahan 1995).

Marine Pests

Aquatic pest species can threaten aquaculture, commercial and recreational fisheries, port industries, tourism, defence and coastal biodiversity. An example of an aquatic pest which recently had to be eradicated from Darwin Harbour is the black stripped mussel. If you believe you have identified an aquatic pest, please link to the Department of Business, Industry and Resource Development website at (http://www.nt.gov.au/dbird/dpif/fisheries/environment/pestman/index.shtml) to report the incident.

Mangrove Monitoring and Protection

The Northern Territory Government recognises the importance of mangroves and is committed to their conservation and effective management. Sustainable coastal development is dependent on maintaining key ecological habitats. To give effect to this the Northern Territory Government has initiated measures to under the *Planning Act* to provide conservation status to over 90% of all mangroves in Darwin Harbour.

Plate 64: Overlooking the protected mangroves of Charles Darwin National Park towards the Darwin CBD

The Mangrove Management in the Northern Territory Report, completed by the Department of Infrastructure, Planning and Environment in 2002, summarises the current status of our knowledge of this resource, and the management practices in place to ensure the values of our harbour are not endangered. This report can be down-loaded from http://www.lpe.nt.gov.au/advis/land/mangrove/mangrovemgt/default.htm

The current Northern Territory Coastal Management Policy Implementation Strategy can also be accessed via the Internet at: http://www.lpe.nt.gov.au/advis/land/coastal/dwnload.htm. This Policy is currently under review, with a representative stakeholder committee developing a revised policy which will address coastal and marine matters.

Scientific monitoring of mangrove communities is necessary to increase our knowledge and understanding of mangrove ecology, particularly in relation to potential development impacts. The Department of Infrastructure, Planning and Environment has recently published the Darwin Harbour mangrove monitoring methodology report. The report outlines the methodologies implemented in the Mangrove Monitoring Program.

Plate 65: Leaf litter collection provides an indication of mangrove productivity.

The main objectives of the Mangrove Monitoring Program are:

1. To help determine the natural status and condition of the mangroves in Darwin Harbour.
2. To monitor seasonal and annual changes in productivity of mangrove communities in Darwin Harbour.
3. To determine the impact of coastal development on Darwin Harbour mangroves.
4. To establish and monitoring framework and standard methodology for present and future research.

The monitoring attributes assessed as a part of the plan include vegetation stand structure, soil, phenology, site information and descriptions, crab holes, primary productivity and regeneration.

Community Mangrove Monitoring Program

2002 saw the completion of the joint Commonwealth and NT Government Community Mangrove Monitoring Program. The objectives of this program were to determine the impacts of coastal development on mangrove communities in the Darwin region. Over 880 community members were directly involved in the mangrove survey work, as a consequence education and awareness was considered to be a major achievement of the project (Lewis 2002).

As part of the above program, a rubbish survey was developed through the National *Revive our Wetlands Program.* The survey involved volunteers collecting and assessing rubbish accumulated in mangroves at six sites in three different catchments. The most dominant form of rubbish was aluminium cans, followed by plastic bottles and bags (Lewis 2002).

Plate 66: Litter collection

Northern Territory University / Government Projects

The Department of Infrastructure, Planning and Environment; and the Department of Business Industry and Resource Development, in conjunction with the Northern Territory University support post-graduate studies involving mangroves. Past and present projects include:

- analysis of links between mangrove communities and fish population and ecology;
- establishing the role of Sesarmid crabs in mangrove leaf litter breakdown;
- establishing links between insects and mangroves;
- description of the biological diversity of mangroves;
- studies pertaining to the recovery of mangroves from disturbance;
- studies pertaining to mangrove rehabilitation; and
- mud crab habitat analysis.

Plate 67: DIPE workers monitoring mangrove health

Remote Sensing – A Management Tool

All natural ecosystems are dynamic, meaning they can change over time. It is important that we understand how mangrove communities can change as a result of natural occurrences such as cyclones or in response to development. This information is very important for future conservation strategies (Mastaller 1997).

Plate 68: Satellite image of Darwin Harbour (mangroves are bright green regions parallel to the coast)

Remote sensing refers to the process of obtaining information about the Earth's surface from remote locations, such as satellites, aeroplanes or shuttles. Remote sensing technologies can provide vast amounts of digital information, which is being increasingly used in environmental management. The large-scale spatial information provided by satellites is particularly useful in areas like the Northern Territory because it can provide information about areas which are vast and often inaccessible. Remotely sensed images can be compared over time to enable temporal comparison (Gratz *et a.l* 1992).

Landsat Satellites

Landsat is the name given to a series of satellites which were first launched in 1972. These satellites continuously orbit the Earth at an altitude of approximately 705 km. Each orbit crosses the equator twice and travels past both poles. A full orbit of the Earth only takes 99 minutes! As the satellite orbits the Earth it records digital images based on the spectral reflectance of the Earth's surface at particular points. Each image represents an area on the Earth's surface 185km long by 185km wide (Gratz *et a.l* 1992). The picture is made up of millions of square pixels which are 30m long by 30m wide. It is possible to zoom in on a satellite image and see the individual pixels (see below).

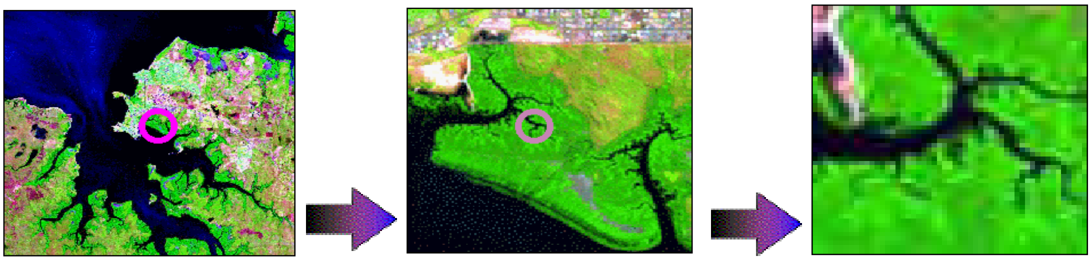


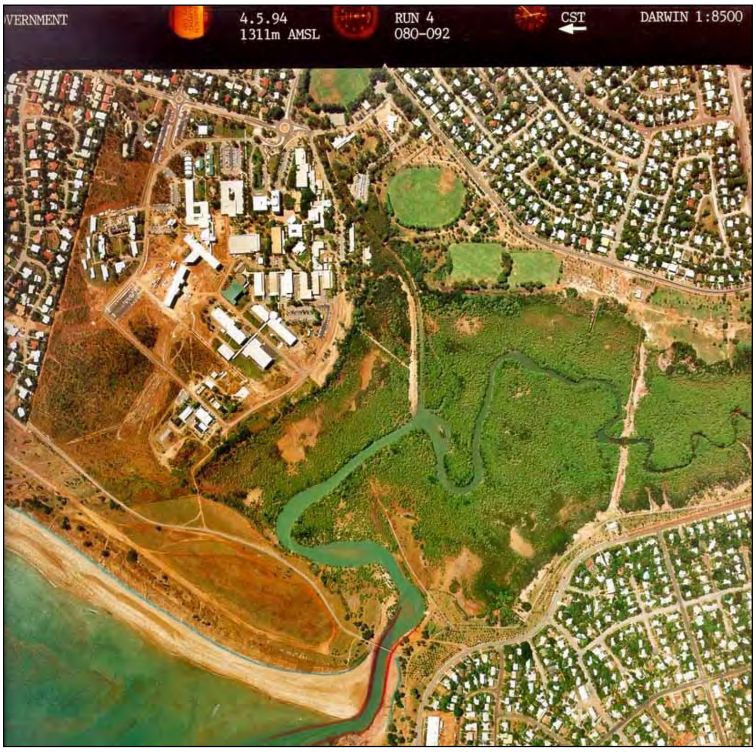
Plate 69: Demonstration of pixellation in Landsat satellite images

Various reflective values of a target landscape result in different colour pixels. The reflectance changes with different structures (Gratz *et a.l* 1992), for example it is easy to see the pink-white areas on the map which correlate to the high reflectance characteristics of buildings and roads in the Darwin and Palmerston district centres. Pixel colours also vary between different types of vegetation. Mangrove communities stand out on the image as deep green regions parallel to the coastline. This means that satellite images can be used to delineate mangrove habitat. Over time dieback or recolonisation will become evident on this large scale (Hosking *et al*. 2001).

Mangrove Monitoring using Landsat

Landsat images taken of the Mary River, NT between 1987 and 2000 were used by the NT Government to detect mangrove colonisation (increases) as salt water intruded into previously freshwater floodplains. It has been estimated that over 100km of mangroves have been established on tidal creek extensions during this period (Hosking *et al*. 2001).

Aerial Photography



Aerial photographs also provide good information on mangroves. Aerial photographs show a high level of detail.

Information about an aerial photograph is displayed at the top edge of the photograph. The photo in Plate 70 shows the photograph was taken on 4 May 1994, the target location was Darwin and the scale of the photograph was originally 1:8500. The direction of the photograph in relation to north is indicated by the arrow. The average height of the flight above sea level (1311 metres). The small dials give the time the photograph was taken and the plane's altitude above ground level.

Plate 70: Aerial photograph of the mangrove communities at Rapid Creek (1994).

Aerial photography has been used consistently in the Darwin Harbour region since 1944. This kind of visual information has proved very important in enabling comparisons of mangrove growth and regeneration over time.

Plate 71 demonstrates the vast tracts of Rapid Creek mangroves which were cleared in 1978 for development which never eventuated. The 1994 photograph on the right shows the extent of mangrove regeneration that has occurred.

Plate 71: Comparisons over time. Rapid Creek in 1978 (left) and 1994 (right)

Mangrove Mapping

In 1994 and 1995 the then Conservation Commission of the Northern Territory, undertook a survey of the mangrove communities in Darwin Harbour. One of the aims of this project, funded by the National Forestry Inventory, was to create a map and detailed list of mangrove community types. A more detailed map and report on this project can be found at http://www.lpe.nt.gov.au/advis/LAND/mangrove/default.htm.

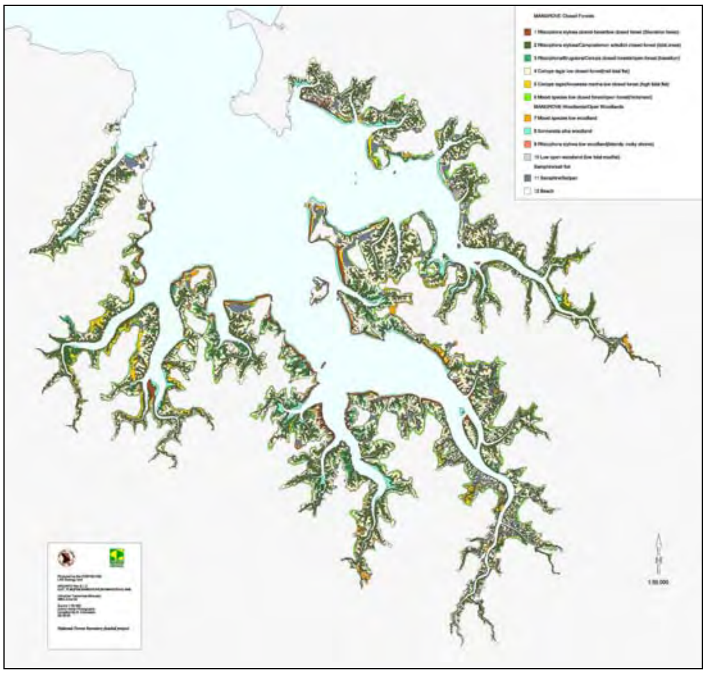


Figure 3: Darwin Harbour mangrove communities (Brocklehurst and Edmeades 1996)

Further reports and maps, which outline mapping techniques reliant on aerial photography can be found on the Department of Infrastructure, Planning and Environment website at http://www.lpe.nt.gov.au/advis/LAND/mangrove/bynoe/default.htm.

Mangrove Visits

There are many areas around Darwin which are well suited to learning more about mangroves. Board walks with helpful interpretive signs, suitable for use by tourists, scientists and students, can be found at East Point Nature Reserve, Mindil Beach and Casuarina Coastal Reserve.

If you choose to go and spend some time in mangrove areas be sure to observe basic safety precautions including the following:

- Wear **protective clothing**. Long sleeves and pants will protect you from sharp objects and biting insects.
- Wear **sturdy footwear**. Mud, mud and more mud! Be aware that the mud may hide sharp objects.
- **Insect repellent** should be worn on any exposed areas including your hands and neck.
- Wear **sun cream**, especially if you are observing mangroves in open areas such as beach foreshore.
- Drink lots of **water**. Walking in hot, humid mangroves can be hard work!

Always stay on the board walk where possible

and

take care not to unnecessarily damage any plant or animal species.

Plate 72: Stuart Park Primary students visiting East Point board walk

Contact Details

This educational resource is available from the Conservation and Natural Resources Group of the Department of Infrastructure, Planning and Environment in hard copy or digital format. We encourage any suggestions which can improve the quality of this resource package. The Conservation and Natural Resources Group may be contacted on 8999 4455.

Northern Territory Government
Department of Infrastructure, Planning and Environment

Why are Mangroves Important?

Activity 1

Focus Question:

- **Why are mangroves important?**

Aim:

1) To gain an understanding of mangrove types and how they vary between different environments.

Main Ideas:

- The NT coastline has many varied and beautiful mangrove ecosystems. The mangrove species present depend on the level of tidal inundation, severity of wave action and on the concentration of salt.
- Simplistic zones can be identified as the seaward zone, the middle zone and the landward zone.

Need:

Art materials, large pieces of paper or a white board for group drawing.

Consider:

Read the section on zonation and tree types in this resource. Look at the various photos in this kit.

Analysis:

- Identify and then draw (using their distinctive shaped roots and forms) the mangrove trees which exist in different zones.
- Then include the different factors, such as wave action and salt which affect the position of the tree types.

Reflection:

Trees like *Rhizophora* and *Sonneratia* are often found in the seaward zone. When might this type of tree be of value to humans? Consider extreme weather events and coastal development.

Plate 73: Mangrove zonation, Leaders Creek

Mangrove Snorkels

Activity 2

Focus Question:

- **Why are pneumatophores important?**

Aim:

1) To increase understanding of mangrove adaptations to coastal environments.

Main Idea:

- Pneumatophores are specialised roots which grow upwards through the soil from underground roots.
- They enable mangrove roots to continue to take up oxygen despite waterlogged soils and high level of inundation.

Need:

A clear container and a straw. Rocks of various sizes, sand and water.

Consider:

This experiment will demonstrate the concept of water logged soils.

Most plants are able to 'breathe' in gases which exist in the tiny gaps between soil particles, called interstitial spaces. The uptake of oxygen is necessary for root growth and for water and nutrient uptake.

Mangroves often live in soils which are regularly inundated or are completely water logged. In these instances gas is not available to mangrove roots under the soil surface. Some mangroves have adapted to these challenging conditions by developing pneumatophores and knee roots.

Analysis:

Place the clear container in a central location.

Ask a volunteer to come and fill the jar with rocks. Ask the class is the container full.

Ask a second volunteer to come and add as much sand as possible to the container, avoiding the straw. Again ask the class if the container is full.

Finally add the water to the brim of the container. Finally the container is full!

Reflection:

Discuss why pneumatophores are an important adaptation of mangrove species. Discuss how the concept is similar to people using snorkels in a pool or the ocean.

Extension:

Research different mangrove species which have pneumatophores. Explore how these pneumatophores look different.

Plate 74: Mangrove snorkels of *Avicennia marina* (Grey mangrove)

***Did you know a three metre tall *Avicennia marina* can have over 10,00 pneumatophores!**

Remote Sensing

Activity 3

Focus Question:

- **Why are remote-sensing technologies important when monitoring mangroves?**

Aim:

1) To increase understanding of satellite remote sensing and how its use can help to address many of the challenges which face environmental scientists in the NT.

Main Idea:

- Remote sensing refers to the process of obtaining information about the Earth's surface from remote locations, such as satellites, aeroplanes or shuttles.
- The large-scale spatial information provided by satellites is particularly useful in areas like the Northern Territory because it can provide information about areas which are vast and often inaccessible.
- Remotely sensed images can be used to compare spatial and temporal information.

Need / Consider:

Read and discuss the Section on remote sensing which starts on page 33. Student then complete the Student Sheet 1 on the following page.

Analysis / Answers to Student Sheet 1:

Question 1. Difficulties may arise in scientists accessing remote regions due a number of factors including vehicle access restrictions, time constraints and crocodiles.

Accessibility would be made far more difficult as a result of the wet season. Vast regions of the NT become submerged for extended periods of time, limiting vehicle access to boat or airboat. The Mary River Wetlands are an example.

Question 2.

a) A 24 hour day – approximately 14.5 revolutions

b) A week – approximately 101.8 revolutions

Question 3. Spatial refers to space and consequently distances and areas. Temporal refers to time. Temporal environmental changes may occur relatively rapidly over days or may only become noticeable over a period of years or decades.

Question 4. Significant amounts of mangroves have been cleared as a result of developments including housing estates and marinas. Mangrove dieback has also been observed in close proximity to such developments.

Some human impacts can actually enhance the density and health of mangrove ecosystems by increasing the amount of nutrients available to these communities through sewage and aquaculture outfalls.

Reflection:

Aerial photographs and remotely sensed imagery is available for purchase from Maps NT. Your class may like to purchase and image and interpret it to the best of your ability.

Student Sheet: Remote Sensing

Questions

1. Why might it be difficult for scientists to access regions of the Territory's coastline? Would accessibility vary between seasons?

2. If a Landsat satellite takes 99 minutes to complete a full orbit of the Earth, how many times would the satellite circle the Earth in:
   a) A 24 hour day? ____________________
   b) A week? ____________________

3. Define spatial and temporal.

4. What temporal changes may be visible using remote sensing technologies with respect to mangroves in Darwin Harbour?

Extension

There are many different uses for satellite technology. Research the various uses and capabilities of satellites on the Internet. Examples include military applications, weather tracking and fire monitoring. The following sites provide useful information.

- http://www.ssec.wisc.edu/data/
- http://ourworld.compuserve.com/homepages/mjff/sources.htm
- http://ask.usgs.gov/satimage.html

List as many different Satellite names as you can find. Where possible list their potential scientific applications.

Want more activities?????

Greening Australia NT has produced an educational kit designed for primary and junior secondary teachers entitled *East Point Mangrove Boardwalk.*

The education kit was designed in parallel to the 1994 construction of the mangrove boardwalk at East Point (opposite the Lake Alexander carpark). The 1.5 KM walk winds its way through several plant communities. The 200 metre boardwalk through the mangroves is best viewed at low to mid tides.

The activities in the kit are cross-curriculum and relate to a class visit to the mangrove boardwalk. The kit was designed to be flexible, allowing teachers the choice of what they use. For those who want to study the mangrove community in depth there is a detailed 10 week teacher/learning sequence written by teachers and mangrove experts with the classroom teacher in mind. Alternatively, for the class who want to simply visit the East Point Mangrove Boardwalk, all the necessary information is provided.

This publication is available from Greening Australia NT for $25 by phoning (08) 8981 1344.

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