Chapter 2: MANGROVES OF CHANNEL ISLAND AND DARWIN HARBOUR

DARWIN HARBOUR AND THE NATIONAL ESTATE

The Darwin Harbour Wetlands were given an 'Indicative Place' on the Register ofthe National Estate in 28 February 1995 and its administrative status has not yet been assessed (extract from National Estate Database, 29 May 96)

> *Entire embayment of Darwin Harbour, to East Point in the NE and Mandorah in the NWand most of surrounding catchment. Large embayment. Ria (drowned river valley) coast. Marine waters and several islands, fringing reefs, subtidal coral platforms, seagrass beds, intertidal mucfflats and mangroves. Numerous fish and invertebrate species as well as Turtles, Dugong and Dolphins inhabit the harbour. The reefs are unusually rich in sponges, soft corals and other invertebrates, as well as hard coral. lVfangrove communitiesfringe the whole embayment and are the most extensive and species rich in the NT. These are a major nurselY Gl'eafor fish, crustaceans and other marine fauna and support many species of bird and benthic (bottom dwelling) fauna. Very attractive; an impressive marine natural area adjacent to a major population centre.* (Register of the National Estate Database, No. 019946)

Location of Channel Island mangroves

Mangrove communities on Channel Island are located on the south-eastern, the north-eastern and the north-western shorelines of the island. The bridge to the island passes over the south-eastern mangrove which gradually merges into the north-eastern mangrove with only a small thinning in the seaward line oftrees to mark the boundary. Both areas have rock outcrops in places close to or on the surface. The north-western mangrove community has a greater variety of species and this provides a more diverse group of habitats than is found in the other two communities. Salt pans form an irregular border on the inland side of this area of mangroves.

MANGROVE AS FOREST

Mangroves are forests that are associated with the sea. Located between the high tide levels and the low tide levels, they are capable of growing in soils which are at times covered by salt water. This in itself makes them a unique type of plant community, for plants are usually killed by excess salt levels in the soil. Within the plant world the mangrove forest represents a high degree of adaptation to extreme conditions. The mangrove forests are sometimes called mangals. Mangals may line coastal lagoons and estuaries, grow on the shores of sheltered islands, create a strip of vegetation that runs along the coastline or follow tidal rivers for some distance inland. They may be only metres wide or form dense forests that are almost impenetrable. Although mangals seem unwelcoming to humans they are, however, fascinating places containing a rich variety of animal life.

Mangals can be composed of one species of tree or they can contain many species, depending on their location. In the temperate areas of Australia mangals are made up of the one species, *Avicennia marina*. In tropical areas the mangals have a number of species, grouped into zones which are distinct belts of vegetation growing parallel to the shore.

In the zones there are associations of trees, so that one or two species may be the dominant ones out of a number of others, in the same area. Each zone is named after the dominant species in it, but there can be considerable overlap as when for example numbers of *Ceriops* plants mix in with the *Bruguiera* on the landward side.

The *Sonneratia/Avicennia* zone has large but sparsely distributed trees growing just above the mud flats which appear at low tides. *Avicennia marina* has the lightest green foliage of all the mangroves and grows to 15 m in height. *Sonneratia alba* grows to 8 m. Both have pencil-like pneumatophores (breathing roots). Associated species can be the shrub *Aegialitis annulata* and the small tree *Aegiceras corniculatum*.

The *Rhizophora* zone is occupied by *Rhizophora* species alone. The zone is easy to recognise because of the dense gro\\1h and distinctive prop roots of the trees.

The *Ceriops* zone is distinguished from the others because of the small size of the *Ceriops tagal species*. *Ceriops* thickets are often found lining small tidal channels and in open flat areas. *Avicennia marina* can also be found in the *Ceriops* zone along with *Xylocarpus mekongensis*.

The landward *Bruguiera* zone has the most number of species of all zones. The dominant species are *Bruguiera exaristata* and *B. parviflora*. Both are moderately tall trees of about 5 m and have knobby knee-like pneumatophores. *XyloCGlpuS australasicum* and *Excoecaria ovalis* grow in this zone and *Lumnitzera racemosa* usually occupies the outside landward fringe. There may be salt pans bare of vegetation (samphire flats) inland from the *Bruguiera* zone.

MANGROVE AS PLANT

Mangroves are vascular plants which are able to grow under saline conditions. Some of the plants are able to withstand being inundated by high tides twice daily whilst others are less resistant and prefer a habitat closer to the very high tide mark. There are many mangrove species of which 36 species are represented in Darwin Harbour.

(Vascular plants have bundles of pipe-like cells used for transporting water and food materials within the plant. They include all flowering plants and ferns. Mosses are non-vascular.)

All mangroves have a number of adaptations to the extreme conditions of the intertidal zone. They include:

- root systems adapted for absorbing air in muddy environments
- salt tolerance through a ' number of strategies
- seeds growing into seedlings while the seed container is still attached to the tree (vivipary).

Some of the mangrove species are widely distributed. The small bushy tree *Scyphiphora hydrophylacea* also occurs in India, Indonesia and New Guinea. *Xylocarpus mekongensis* which has large soft pneumatophores is named after the SE Asian river and is found from East Africa to the Pacific.

TIDES

The zones described above do not occur in a random or haphazard way. They are directly influenced by the rhythm of the tides, and it is the rise and fall of the sea water upon the shore that helps to create the clearly defined zones of mangrove communities. Over the years the mangrove plants have responded to the influence of the tides and each species has evolved so that it fits into a particular place. Some trees may grow in different parts of the intertidal habitat; others are restricted to one particular level of the tidal range.

In Darwin Harbour there are two unequal tides each day, the first high tide occurring about forty minutes later than that of the previous day. The difference between the high tide and the low tide is the range of the tide. In Darwin, a range of six or seven metres is big, and a range of two or three metres is small. Tides with a big range occur twice a month and are called 'spring tides', whilst the tides of smaller range are called 'neap tides'. The height of both spring tides and neap tides vary from month to month.

The measurements in a tide chart are given in metres, and they represent the distance above a datum point which has been chosen as the lowest level that the sea in Darwin Harbour can reach (lowest astronomical level). The datum point has the value~f zero. Although this is more of a mathematical concept than anything, tidal measurements are visibly shown on a painted marker on Fort Hill wharf. A more sophisticated electronic gauge is installed in the harbourmaster's office and the levels of the tides are recorded on a rotating cylinder.

There are five main tide levels which influence life in the intertidal zone. They are:

- MHWS (mean high water springs): the average of spring tides' high waters over a year
- MHWN (mean high water neaps): the average of neap tides' high waters over a year
- MSL (mean sea level): the calculated average level of the sea
- MLWN (mean low water neaps): the average of neap tides' low waters over a year
- MLWS (mean low water springs): the average of spring tides' low waters over a year

There is also a Highest Astronomical Tide (HAT) which is the highest possible tide according to calculations. The word 'astronomical' gives a clue that bodies such as the Sun, Moon and planets enter into the calculations. In practice, strong winds can cause sea levels to be above the HAT and flying salt spray can also affect plants in the vicinity.

ACTIVITIES

Activity 1. Zonation

In small teams, construct a diagram that shows the different zones described above and the species to be found in each zone. Use different symbols for the different species of mangroves. Having constructed a cross-section of a mangrove community and shoreline to your satisfaction (discuss the diagram's clarity, use of symbols, key etc.) make two photocopies of it. Show the following data on the copies.

Copy one: Elevation above datum *SonneratiaiAvicennia* zone 3.0 - 3.6 m *Rhizophora* zone 3.6 - 6.5 m *Ceriops* zone 6.5 - 8.0 m *Bruguiera* zone 8.0 - 9.0 m

Copy two:

Elevation above datum:

HAT 8.0 m, MHWS 6.9 m, MHWN 5.0 m, MSL 4.1m, MLWN 3.2m, MLWS 1.4 m

Compare the two diagrams. Discuss the distribution of the various species and the degree of adaptation shown by individual species and of the mangroves as a whole. What groupings or distribution patterns can you see? How do the two sets of levels match?

Be assured that this activity is an important one. It supplies you with a reference base upon which further information about the mangroves can be built. The influence of the tides upon the plants and animals of the mangroves is a beautiful example of nature working in a logical mode. The tides affect the life processes of all organisms in the intertidal zone: their food

gathering, their respiration, their life cycles and their growth. The tides in turn are driven by the movements of the Moon around the Earth and these movements are sequential, predictable and measurable.

Activity 2. Know Your Mangroves

To help you to become familiar with some of the more common mangrove species, small teams of 2 or 3 students can prepare fact sheets for different species and present their sheets to the whole class for discussion and display. Your team will in effect become the experts on one particular type of mangrove so that the rest of the class can become familiar with that species through your team's efforts.

The species which the teams can research are as follows

Sonneratia alba
Avicennia marina (white mangrove)
Ceriops taqa! var. *australis*
Xylocarpus mekonqensis
Lumnitzera Httorea
Osbornia oclodonta
Aeqialitis annulata (club mangrove)
Rhizophora sty/osa (stilt-rooted mangrove)
Bruguiera exaristata (red mangrove)
Lumnitzera racemosa
Bruquiera qymnorrhiza
Aegiceras corniculatum (river mangrove)

Not all mangroves have a common name and often these names (and their use) vary from place to place.

All of the species named above are described and illustrated in Brock (1988). The first edition of Brock's *Top End Native Plants* describes a tree which he calls *Xylocarpus australasica.* The name has been changed and now should be *Xylocarpus mekongensis.*

Students researching the two *Bruguiera* species may find it difficult to distinguish one from the other. Consult the book by Wightman (1989) to find minor differences in the shapes of the fruit, flowers and leaves.

In preparing the fact sheets, teams should include

- identifying features - leaves, flowers, fruit, bark, habit (shape and size)
- habitat. distribution, status (common or not common)
- Aboriginal and overseas use of tree
- special features (e.g. *Aegialitis annulata* excretes salt from salt glands on its leaves).

Illustrations and photographs will aid in identification, and you may need to produce more than one sheet. Consider producing a uniform page layout for the class (see Agnotes produced by Department of Primary Industry and Fisheries).

The sheets produced by the class can be photocopied and, with an appropriate cover, bound to produce a field guide for an excursion to Channel Island.

MANGROVE HABITATS

MANGROVE AS A HABITAT DURING HIGH TIDE

The intertidal zone is an interesting habitat whether it is on beaches, rocky shores or in mangroves. The animals and plants that live there have the problem of coping with an ever-changing environment, and the changes are from one extreme to the other. At one stage the habitat is flooded and marine animals such as fishes can move about freely. Six hours later it is dry and exposed to the sun.

During periods of inundation the mangroves are home to a large range of sea life, particularly the early life stages of fish and crustaceans. Many of these early stages of marine life help to make up the plankton which floats in the water and provides food for small fish like hardyheads and anchovies. The plankton is also taken in by filter feeders such as oysters and barnacles attached to the mangrove roots. A carnivorous shellfish, the thai or mulberry shell, feeds on the oysters and other molluscs of the mangrove. The thai also preys on the lined nerite which is a black snail-like mollusc that scrapes algae off tree roots and rocks.

Strong direct sunlight and warm temperatures help the mangroves to produce an abundance of foliage, and their productivity is almost in the same class as that of rainforests. The leaves and other debris fall into the estuary and are the main source of energy at the beginning of mangrove food chains. The decaying leaves ofthe mangroves break up into very fine particles which along with other organic matter (waste material and dead animals of all sizes) make up the detritus, a fine silt on the sea bed. Detritus provides food for young prawns and other small crustaceans such as isopods. Some polychaete worms live in tubes in the mud and spread out tentacles like spaghetti tubes to catch small particles of food caught up in the detritus. Diamond mullet feed on algae which may be attached to rocks or contained in the detritus. Cuttlefish feed in the mangroves at high tide and large fish - mangrove jacks, threadfin salmon, barramundi, and stingrays - seek out the small fish, crustaceans and worms in the rich waters.

The mud crab, *Scylla serrata,* is active during high tides. \-Vhenthe tide goes out it burrows into the mud with only its eyes protruding. Other crustaceans include the mud lobster which lives in burrows, and the pistol shrimp, so named because of the noise it makes when it snaps its front claw.

MANGROVE AS A HABITAT DURING LOW TIDE

When the tide is out, the mangroves become a hunting ground for a different set of animals. Some, like the egrets stalking the water's edge on the mud flats are visitors. Other animals, permanent residents, emerge from their shelters where they hid at high tide. The most noticeable are the fiddler crabs, *Uca* spp., that live in burrows in the mud. The male fiddler crab has one brightly coloured claw enormously enlarged which the crab waves in courtship displays. Fiddler crabs extract algae and other organic matter from the detritus. Less conspicuous are the dull sentinel crabs which may occur in large numbers on the mud flats beyond the mangroves. The larger mangrove crab, *Sesamia* spp., lives at the landward side of the mangrove forest and is responsible for the crab burrows so characteristic ofthis habitat. They are about 40 mm in width (i.e. across the carapace or shell) and are scavengers and predators.

Mudskippers are commonly seen around the mangroves at the time of low tide. These unusual fish vary in size from 50 mm. to 250 mm. The smallest mudskippers, *Periphthalmus* spp., eat insects, spiders, small crabs, amphipods (beach-hoppers) and marine worms. They measure about 50-100 mm in length and live in short bunows which they dig with their teeth.

Slightly larger species, *Boleophthalmus* spp., are found where the mud is semi-liquid over a firm base. They eat by straining through the soupy mud, moving their heads from side to side as they filter out fme algae, tiny worms, diatoms and small crustaceans. These mudskippers have the largest and most colourful dorsal fins and have an extensive underground system of tunnels.

The giant mudskipper, *Periphthalmus* spp: is up to 250 mm in length, lives near the top of the steep mangrove banks and catches crabs and other mudskippers as food. It is a wary animal and not easily approached.

Reptiles are represented amongst the permanent residents of the mangrove habitat. The bockadam snake is a water lover and does not like to crawl onto open spaces of mud, preferring to swim across shallow pools close to the bottom when disturbed. It is about 120-cm long and may be coloured light grey, reddish brown or olive with irregular cross bars. The bockadam eats mudskippers, fish stranded at low tide and crabs. It has poisonous upper rear fangs but is not thought to be dangerous to humans. Another reptile is the mangrove monitor. It has a black colouration with yellow markings on its back and side. The throat and belly are a bright yellow. The mangrove monitor hunts fishes, crabs, eels, small mammals, insects, reptiles and birds. It is equally at home in the water or in the dense foliage of the mangroves.

The little file snake, *Arochordus granulatus),and* the white-bellied mangrove snake, *Fordonia leucobalia,* are two other common reptiles of the tropical mangroves. Another reptile, the salnvater crocodile, is the largest predator in the mangroves and is the final link in many tropical estuary food chains.

Mang~ove islands in the estuaries of the tropical north are favourite places for large colonies of black flying foxes. These animals like roosting in high trees with dense foliage, and the mangrove is an ideal place of refuge. At dusk thousands of flying foxes stream out of the camps, and individuals may travel to as far as 50 knl in search of food. The flying foxes have another link with the mangroves, for they are known to assist in the pollination of the mangrove species *Sonneratia alba*.

Three species of kingfisher are often seen in the mangrove forests. The forest kingfisher has a rich blue colour for its wings and black and white underparts. The azure kingfisher is smaller and has tan to rufous underparts. The smallest is the little kingfisher which has a white spot in front of its eye and on the side of its neck. It has a white throat and belly.

Other birds of the mangrove habitat include the red-headed honeyeater and the mangrove golden whistler. The migrant waders are represented by the eastern curlew, the terek sandpiper, common sandpiper and the broad-billed sandpiper, all well adapted to the wet muddy conditions of the mangroves.

The eastern reef egret and the intermediate egret both find the mangrove habitat suited to their needs and they are conspicuous members of the bird populations. Not so conspicuous are the black bittern and striated heron, both of them experts at freezing in a head-up position to escape notice. These birds have unobtrusive coloration and are camouflaged with patterns of broken stripes and streaks.

MANGROVES AS A RESOURCE

The mangrove habitat is a refuge for many types of marine life during various stages of their development. The tangled gro\\1h of the *Rhizophora* roots offer a haven from predators and the warm nutrient laden waters provide an ideal environment for young organisms. As an abstract example of the efficiency of natural ecosystems, mangroves are worthy of our interest and attention. However, there is a much more convincing argument for regarding the mangroves as being of some value. They are a habitat for four species of banana prawns in the early stages of growth and in export earnings banana prawns are a valuable natural resource.

The annual catches for banana prawns in the Northern Pra\\TI Fishery have been as follows:

1987	1988	1989	1990	1991	1992
4312t	3433t	5472t	2250t	6626t	5132t

Wholesale prices per kg for banana prawns in1992 ranged from A$6.50 to A$8.00. Some simple arithmetic shows us that the banana prawn fishery on an average earns about A$47 million per year and yet, without the mangroves there would be no pra'"TIS,no industry and no export dollars. (Young brown tiger prawns and grooved tiger prawns develop in seagrass beds and these species have not been entered in the above data.)

Besides the banana prawns, the mangrove habitats are home to other forms of marine life of economic importance. The mangroves play an essential role in the life cycle of the commercial barramundi and threadfin salmon fishery. Mud crabs, giant tiger prawns and endeavour prawns also use the mangroves at some stage or other of their growth.

It would therefore seem essential that the social and financial benefits of any development projects, involving the loss of even the smallest area of mangroves should be weighed against the continued monetary value of the mangroves as a natural resource.

ACTIVITIES

Activity 3. Conservation - Team Research and Evaluation

By now your team will have gathered as much information as you need for the completion of this activity. Your final tasks are to produce a report on the three aspects of conservation that you were asked to investigate i.e. potential environmental threats to the estuarine environment, preventative measures in place to minimise the threats (particularly as they apply to Channel Island), and steps being taken to ensure future conservation of foreshore ecosystems e.g. mangroves.

Having written part one (the report on the three conservation issues) your team can now discuss the effectiveness of the overall management plans for Darwin Harbour, with a focus on the conservation prospects for Channel Island in particular. Your discussions should be analytical and balanced. When examining the information you have gathered, distinguish between statements of intention (often using the word 'action' without any indication of what real 'action' is to be taken) and actual measures in place. Look for legislation, acts of parliament and subsequent departmental regulations that are in operation rather than 'policies' and 'plans'. Once enacted, how are the laws enforced? At the same time, beware of making emotionally loaded statements without evidence to back up your statements.

Prepare a summary of your discussions and make an evaluation of the conservation measures and management strategies that exist for the protection of Darwin Harbour's marine environment.

Your evaluation should be an analysis of the effectiveness of the various aspects of environmental protection and conservation that you have researched. Make comments and suggestions about any improvements your team think are necessary. Conclude with a general statement about how your team feels regarding the future integrity of Channel Island and Darwin Harbour wetlands as heritage sites.

Discuss with your teacher the culmination of this activity e.g. sending some of your reports to the local Member of Parliament.

Activity 4. Animal Roles in Ecosystems

Read through the above description of the way in which different animals are affected by tidal movements in the mangrove. Pay particular attention to how the organisms interact with each other and their environment. What plants, animals or other organic materials does each use as a food resource? What are their predators? How do the organisms affect the mangrove ecosystem by their presence? In what ways do animals adapt to the conditions of the mangrove habitat?

Write a magazine article about one particular animal of the mangroves using the above questions as a guide to the life processes that you will describe. In your article include a diagram of a food web which is built around the animal of your choice. You may need to consult other reference sources to gather more data about your subject and to discover more about the nature of ecology. Illustrate the article if possible.

Activity 5. Adaptation

Describe thejays in which different species of mudskippers are adapted to life in the mangroves. /Consider body structure, behaviour, choice of habitat, and food gathering techniques in relation to the physical conditions of their surroundings.

Activity 6. Conservation Poster

Working in teams, design and paint a poster that has the conservation of mangroves as its message. Think of an eye-catching slogan that presents mangroves as valuable economic resources and include it in the design.