MARVELLOUS**MANGROVES**

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A new study by the Department of Environment and Conservation's Marine Science Program and Western Australian Herbarium seeks to uncover some of the hidden secrets of mangroves, the seaside trees that line nearly a fifth of Western Australia's shoreline and play a vital role in coastal protection and ecology. This article looks at the mangroves found in one of our wilderness wonderlands, the Shark Bay World Heritage Area.

The adage 'beauty is in the eye of the beholder' is perhaps never more appropriate than when reflecting on mangroves. To Western Australians familiar with the spectacular rocky shores and sandy beaches of the south-west, or the incredible coral formations of Ningaloo, the State's muddy, sometimes bug-infested and often impenetrable mangrove forests would have to be well down the list of preferred locations in which to spend some quality time. Appreciation of mangroves does require some commitment and no small measure of understanding, for it is only when you realise the incalculable positive role that these plants play in coastal ecology can you accept that they are, indeed, 'marvellous'.

What are mangroves?

A mangrove is a type of coastal plant that lives by the shoreline and is, at least sometimes, inundated by tides. They mostly occur on low-energy marine or estuarine shores and very rarely occur inland. An exception is Lake Macleod which supports the largest inland mangrove area in Australia and possibly represents a relict from about 4,000 years ago when sea levels were higher—as sea levels dropped the mangroves may have been left stranded at Lake Macleod.

Mangroves disperse by floating seeds or propagules and their presence in individual locations can be due to a complex combination of environmental factors, including coastal morphology, currents, climate and tidal range. Once established, their intricate root systems can also modify the environment by trapping sediments and dissipating wave energy. By doing so, mangroves protect the shoreline from erosion and also prevent silty run-off from smothering offshore seagrasses and reefs.

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Main A relatively open stand of inundated white mangrove at Blind Inlet, near South Passage in Shark Bay.

Left The large pale yellow seeds of white mangrove can float, which aids dispersal of the species.
Photos – John Huisman/DEC

Above A low stand of white mangrove lines the shoreline of Dubaut Creek, south of Monkey Mia.
Photo – Michael Rule/DEC

Right A cluster of white mangrove pneumatophores, which are vertical exposed roots used for gas exchange.
Photo – John Huisman/DEC

'Mangrove' can refer to a single tree or a mangrove forest, and the latter is also sometimes called a 'mangal'. Mangroves include a variety of trees, shrubs, palms and ground ferns, in Australia representing some 19 plant families, illustrating that the term mangrove does not imply a close taxonomic relationship. The species of mangroves are united by their habitat, not by their genetic similarity. However, many do share a range of adaptations that enable them to survive in their seemingly harsh saline environment. Some excrete salt through their leaves, while others have vertical roots known as pneumatophores, which facilitate gas exchange for the tree away from the sodden and frequently oxygen-depleted sediments. The trunks of mangroves are often buttressed or form multiple stilts ('prop roots') that provide support for the trees in muddy soils. This complex structure traps and stabilises sediments, enables the build up of nutrients in the mangrove habitat, and, in many cases, provides shelter for a range of other organisms.

Worldwide, some 72 species of mangrove are known and more than half of those can be found in Australia, where almost 18 per cent of the coastline is lined by mangroves. The largest area and greatest species diversity occurs in Australia's warm and moist tropics and the extent and diversity of mangroves diminishes towards the south. This pattern is reflected in Western Australia, where about 75 per cent of the State's approximately 2,500 square kilometres of mangroves occur in the Kimberley. While this northern region supports 19 mangrove species, the diversity drops to nine species along WA's arid Pilbara coast and only one species at Shark Bay. While mangrove diversity and the physical processes contributing to their existence have been studied, the relatively poorly understood marine flora and fauna that live in WA's mangroves are the focus of a new study.

Shark Bay mangroves

Most visitors are familiar with Shark Bay's arid coast of red cliffs, sandy beaches and diverse and distinctive flora and fauna that led to its World Heritage listing. However, fewer people know that numerous and often large areas of the white mangrove (*Avicennia marina*) occur around the shores of the bay. Situated at about 26° south latitude, these mangroves represent the southern-most substantial concentration of this species on the Western Australian coast, although smaller isolated stands do occur further south, at the Houtman Abrolhos Islands (at about 28° south) and in the Leschenault Estuary (at about 33° south). More broadly, this species tolerates a wide climatic range and extends as far south as the coasts of South Australia, Victoria and the North Island of New Zealand.

Despite being recognised for their conservation significance, the mangroves of Shark Bay are poorly understood and some areas are known to be suffering from adverse visitor impacts. In June 2009, marine scientists from the Department of Environment and Conservation's (DEC's) Marine Science Program and Western Australian Herbarium joined DEC Shark Bay District staff to begin a study that will increase our understanding of mangroves in the Shark Bay World Heritage Area and contribute to future monitoring of these habitats. Fifteen major mangrove sites were visited on the Wooramel Coast, Faure Island, Peron Peninsula, Dirk Hartog Island and in the South Passage area.

At each site the tree and pneumatophore densities were mapped, individual trees were tagged, measured and photographed for monitoring purposes, and samples of epiphytic seaweeds, sediments and associated in-fauna examined or collected.

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Left Unsightly rubbish at Uendoo Creek.
Photo – Alan Kendrick/DEC

Below The green seaweed *Acetabularia* growing on pneumatophores.
Photo – John Huisman/DEC

The reasons that dense mangrove stands only occur in particular locations in Shark Bay are not clear. They can be found along linear shores, filling shallow embayments, growing along the narrow channels associated with creeks or birrida-type (claypan) lagoons and within small coastal lagoons that have formed behind accreted sand banks. In addition to these relatively dense mangroves, many trees also occur in low densities along sheltered shores. Interestingly, the dense mangrove stands were found to vary widely in their size and structure. Some comprise mature trees with thick trunks and branches that are four to five metres in height. While these stands were relatively open beneath the canopy, others consisted of apparently younger trees only two to three metres high, but which were so dense that entering the mangrove proved extremely difficult. In some stands, the trees were low and sparse. However, their thick and gnarly trunks suggested they were quite old but stunted and had not grown to their potential height. Small seedlings were also plentiful in most areas, these presumably becoming established when dying trees open a gap in the canopy, allowing light to penetrate.

Living with mangroves

Numerous plants and animals live among the Shark Bay mangroves, benefiting from the shelter and protection they provide, as well as the hard, stable surfaces that are relatively rare in such environments. Only a small number of seaweeds attach to mangroves, but they are typically species that are rarely found in other habitats and occur in unique associations on mangrove's vertical pneumatophores.

Above Leafy green seaweed *Gayralia oxysperma* on pneumatophores at Guichenault Point.

Right Littorinid snails (*Littoraria* sp.) cluster together on an *Avicennia* trunk just above water level.
Photos – John Huisman/DEC

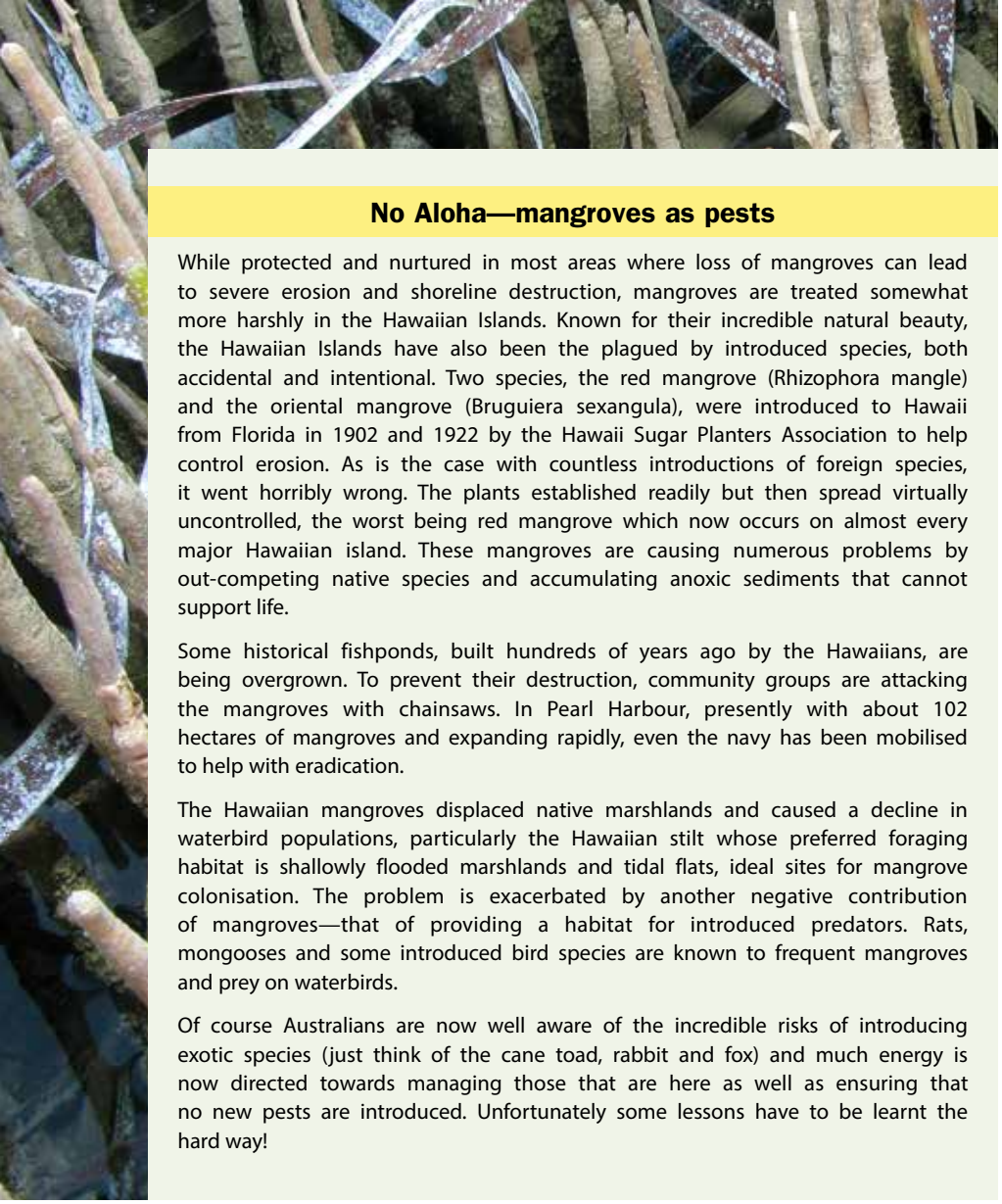
Two red algae, *Caloglossa* and *Bostrychia*, are often found growing together, plus other unusual green and brown seaweeds. The diversity of these mangrove-associated seaweeds in Shark Bay has never been studied in any detail, and preliminary results from the expedition have recorded a species, *Acetabularia peniculus*, not previously known to grow on mangroves, plus one not before recorded from WA, *Boodleopsis siphonacea*. These, and the numerous other specimens collected during the expedition, will be incorporated into the Western Australian Herbarium's algal collection and be a permanent record of the species' existence.

Littorinid snails (*Littoraria* spp.) are abundant on trunks and branches at and above water level, while mudwhelks (*Terebralia sulcata*) can occur in large numbers where the muddy bottom is not overcrowded with pneumatophores. Several crab species, including the famously edible mud crab (*Scylla* spp.), burrow into the muddy mangrove sediments, while many fishes enter mangroves on flooding tides to feed and shelter among the complex roots. Even marine turtles are known to forage in mangroves.

It's not only the marine life that Shark Bay mangroves support. Like any tree, a mangrove can be an important habitat for birds and insects. More than 200 species of birds are known to live in mangrove forests in Australia and about 25 of those are regarded as mangrove specialists. Shark Bay has the largest population of pied cormorants in WA and these can often be seen nesting in the mangroves. They frequently use pieces of the seagrass *Amphibolis antarctica* as nesting material, which is certainly plentiful as Shark Bay also supports the largest known seagrass bed in the world. Large concentrations of cormorants were seen nesting in mangroves near Big Lagoon on the Peron Peninsula and at Faure Island. So many birds nest at these sites that the rookeries can actually kill areas of trees because of the high levels of urea the birds excrete.

Saltmarshes

Coastal saltmarshes, which are often associated with mangroves, are also common at Shark Bay. Saltmarshes principally comprise herbs and low shrubs, whereas mangroves are dominated by trees, and they typically grow on the landward side of the mangroves where they are less frequently inundated by tides. While saltmarsh is often referred to as the 'poor cousin' of mangroves due to its low and scrubby appearance, awareness of its ecological significance has been growing in recent



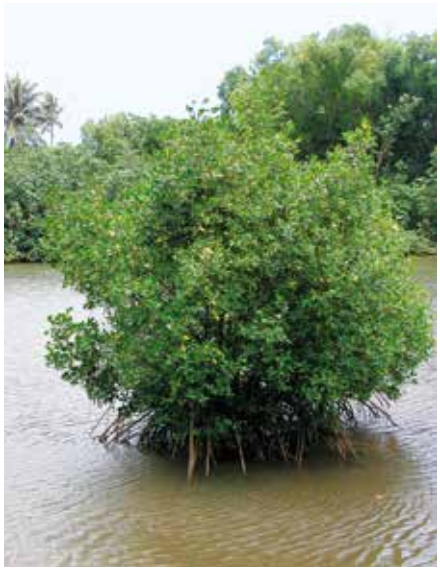
No Aloha—mangroves as pests

While protected and nurtured in most areas where loss of mangroves can lead to severe erosion and shoreline destruction, mangroves are treated somewhat more harshly in the Hawaiian Islands. Known for their incredible natural beauty, the Hawaiian Islands have also been the plagued by introduced species, both accidental and intentional. Two species, the red mangrove (Rhizophora mangle) and the oriental mangrove (Bruguiera sexangula), were introduced to Hawaii from Florida in 1902 and 1922 by the Hawaii Sugar Planters Association to help control erosion. As is the case with countless introductions of foreign species, it went horribly wrong. The plants established readily but then spread virtually uncontrolled, the worst being red mangrove which now occurs on almost every major Hawaiian island. These mangroves are causing numerous problems by out-competing native species and accumulating anoxic sediments that cannot support life.

Some historical fishponds, built hundreds of years ago by the Hawaiians, are being overgrown. To prevent their destruction, community groups are attacking the mangroves with chainsaws. In Pearl Harbour, presently with about 102 hectares of mangroves and expanding rapidly, even the navy has been mobilised to help with eradication.

The Hawaiian mangroves displaced native marshlands and caused a decline in waterbird populations, particularly the Hawaiian stilt whose preferred foraging habitat is shallowly flooded marshlands and tidal flats, ideal sites for mangrove colonisation. The problem is exacerbated by another negative contribution of mangroves—that of providing a habitat for introduced predators. Rats, mongooses and some introduced bird species are known to frequent mangroves and prey on waterbirds.

Of course Australians are now well aware of the incredible risks of introducing exotic species (just think of the cane toad, rabbit and fox) and much energy is now directed towards managing those that are here as well as ensuring that no new pests are introduced. Unfortunately some lessons have to be learnt the hard way!



Background left White mangrove pneumatophores.

Above The introduced red mangrove in the Hawaiian Islands, where the species is a major pest.

Below Pied cormorants crowded together in a rookery on Faure Island.
Photos – John Huisman/DEC

years. In fact, saltmarsh occupies a greater area than mangroves in WA and it can support up to three times the number of plant species found in mangrove communities. At Shark Bay, mangroves and saltmarshes are often interspersed; with the latter typically dominated by samphires (possibly of the genus *Sarcocornia*).

Conservation

Increasing our knowledge of mangroves and their associated biota in the Shark Bay World Heritage Area will assist DEC to better manage these habitats. Unfortunately, some areas of mangrove and saltmarsh around Shark Bay have been adversely impacted by unmanaged camping, vegetation removal and four-wheel driving. It can take many years before the slow-growing mangroves recover from such damage. The knowledge gained from this project will enable us to understand and manage these habitats better. While mangroves may not be the most visually stunning aspect of the Shark Bay landscape, they play an important role in maintaining shoreline integrity and providing habitat for a range of other organisms. For these reasons, it is imperative that they be protected from damage caused by irresponsible human behaviour. Marvellous they may well be, but immortal they are not.

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