Regional Perspective

MPRA

MARINE PARKS & RESERVES AUTHORITY

Department of Conservation and Land Management

JURIEN BAY

Regional Perspective

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Marine Conservation Branch
Department of Conservation and Land Management
47 Henry Street
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SUMMARY

All human usage of the marine environment results in some change. Defining acceptable levels of change and implementing management strategies that prevent these levels from being exceeded are essential for ensuring the marine environment is not degraded.

The Western Australian Government is committed to the establishment of a statewide system of multiple-use marine conservation reserves under the Conservation and Land Management (CALM) Act. These reserves provide for sustainable commercial and recreational use while protecting the diverse and valuable natural heritage values of our coastal environment. One of the areas that have been identified for further consideration as a marine reserve is centred on Jurien Bay.

The marine and coastal environments of the Jurien Bay area lie within the Central West Coast marine bioregion, a zone of biological overlap between the warm, tropical waters to the north and the cool, temperate waters off the south coast of Western Australia. As such the waters of the Jurien Bay region contain an interesting and unusual mixture of plant and animal communities from both tropical and temperate waters in nearly pristine condition. The offshore islands, limestone reefs, protected lagoons and seagrass meadows, together with the rocky and sandy shores, provide representative examples of many of the marine habitats which are typical of the central west coast of Australia. Whales, dolphins, Australian sea-lions and many species of seabirds are also found in these waters.

The coastal scenery, both above and below water is of outstanding quality. These features, together with the characteristically pleasant climate, sheltered lagoonal conditions and close proximity to both local terrestrial sites of interest and the Perth metropolitan area, result in the Jurien Bay region being of great value for a wide range of recreational pursuits. Commercial fishing, particularly the rock lobster fishery contributes significantly to the local economy. Other local marine-based industries, including aquaculture and tourism, provide valuable income and employment. Significant expansion of these industries is projected to occur along the central west coast during the next decade.

The long-term viability of the recreational and commercial marine resources of the Jurien Bay area is ultimately dependent on the continuing ecological integrity, or 'health', of the marine environment. Many ecosystems have some capacity to recover from minor environmental damage. However, if the cumulative impact of all human activities within an area exceeds this natural carrying capacity, then the ecosystems will eventually decline and collapse.

The Jurien Bay area is already experiencing increased commercial use and recreational visitation. Planned improvements to road access along the central west coast will undoubtedly accelerate this trend. The escalating demand on the natural resources of the Jurien Bay area will inevitably increase the potential both for damage to the environment and conflict between users.

This document provides a broad regional perspective on the ecological, cultural and socio-economic setting of the Jurien Bay area to provide background information for members of the Jurien Bay Marine Reserve Advisory Committee and for the general community who have an interest in the marine environment of the area. CALM encourages readers to contribute to the planning process for the Jurien Bay marine reserve, either via their representatives on the Advisory Committee or through the public submission process. Your efforts will help ensure sustainable use and protection of the environment for present and future generations.

Additional information about the Jurien Bay area and the planning process for marine reserves can be obtained from the following Conservation and Land Management offices:

Main Roads WA Building Moora 6510 Phone (08) 9651 1424	47 Henry Street Fremantle, 6160 Phone (08) 9432 5100	193 Marine Terrace Geraldton, 6530 Phone (08) 9921 5955

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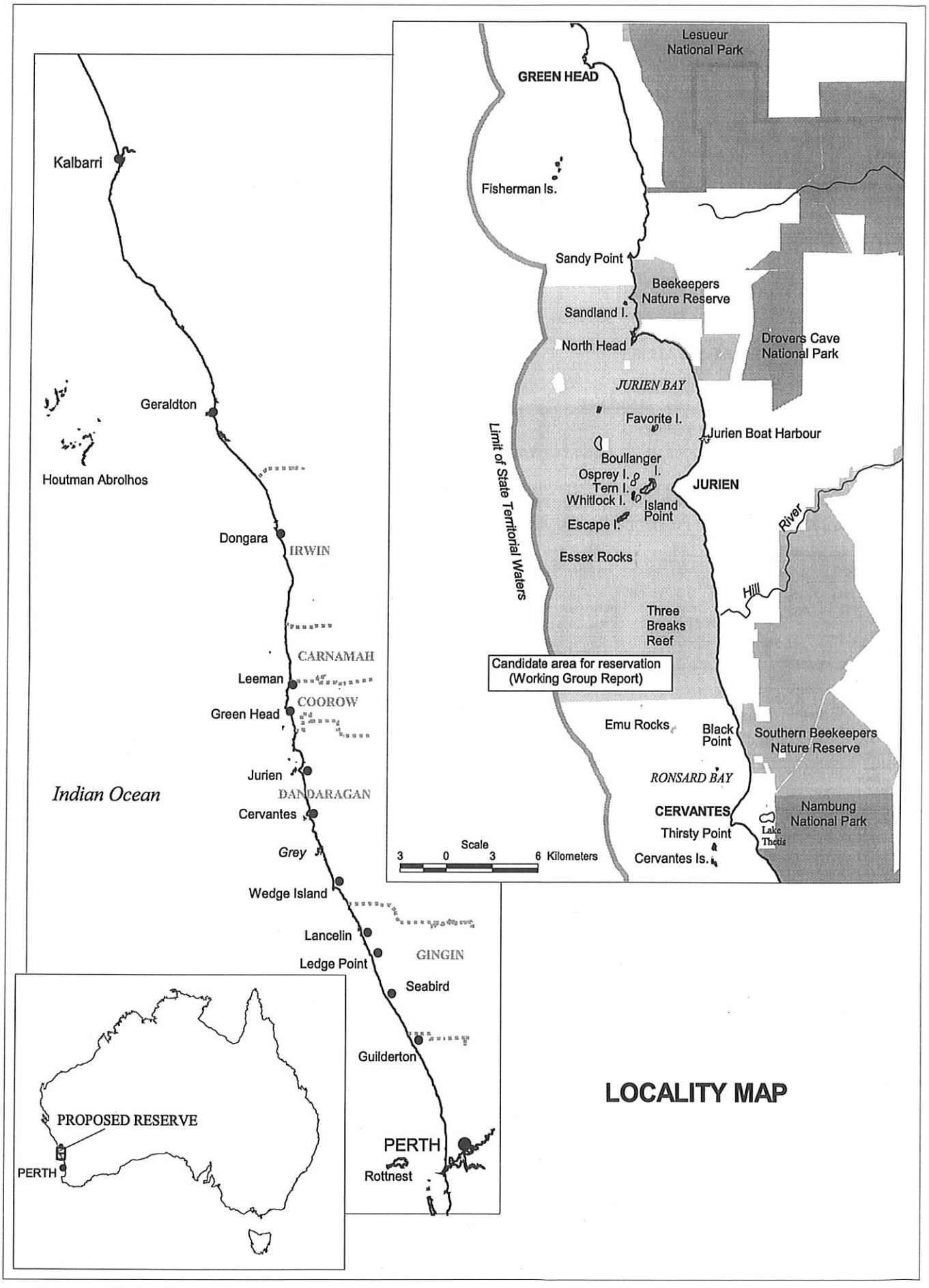
TABLE OF CONTENTS



Locality map of Jurien Bay.

INTRODUCTION

The mainland coastline of Western Australia is approximately 12,500 kilometres long and there are 3,424 offshore islands. The adjacent coastal waters support a diverse range of tropical, subtropical and temperate ecosystems including coral reefs, mangroves, seagrass meadows, algal-covered rocky reefs and both soft sediment and oceanic communities. Recreational use of the marine environment is an integral part of the Australian way of life and 'the beach' is a national icon. Our living and non-living marine resources also support major marine-based industries such as tourism, oil & gas, mining, fishing, aquaculture and pearling which are significant components of the State's economy providing employment, both directly and indirectly, for many thousands of Western Australians.

The Western Australian Government is committed to the establishment of a statewide system of multiple-use marine conservation reserves under the Conservation and Land Management (CALM) Act to provide for sustainable commercial and recreational use of these resources while protecting the diverse and valuable natural heritage values of our coastal environment. A Marine Parks and Reserves Selection Working Group was established in 1986 to identify marine areas off the Western Australian coast which were thought to be worthy of consideration for marine reserve status. Their report, entitled *A Representative Marine Reserve System for Western Australia* was released for public comment in 1994. In addition to the six marine parks and one marine nature reserve already in existence, the Report identified a further 70 areas around the coast which, if reserved, would provide a system of marine reserves representing the major ecosystems of Western Australia.

An area centred around Jurien Bay was identified in the Working Group Report as containing many of the important marine natural resources typical of the central west coast of Western Australia. These features include extensive sub-tidal and intertidal algal-covered limestone reefs, seagrass meadows, sheltered lagoons, rocky shores, sandy beaches and coastal sand dunes which together support a variety of marine flora and fauna. These areas are also characterised by offshore islands which provide sanctuaries for seabirds, sea-lions and populations of terrestrial animals which have been seriously depleted on the mainland by introduced predators.

Jurien Bay is also a popular holiday destination due to its outstanding natural attributes and its close proximity to Perth. The attractive coastal scenery, sheltered bays and clean waters provide for a variety of marine recreational opportunities for increasing numbers of visitors, particularly during the summer months. Similarly, the unusual limestone formations of the Pinnacles, in Nambung National Park, together with the prolific spring blooming of wildflowers in this area combine to offer visitors an attractive and interesting land-based experience. The area also has a rich maritime history and the local economy is still largely dependent on commercial fishing. Marine tourism and aquaculture are emerging industries in the area and are expected to expand significantly during the next few years.

PHYSICAL ENVIRONMENT

Climate

The region enjoys a Mediterranean-type climate which is characterised by cool, wet winters and hot, dry summers. Mean maximum temperatures of 26°C occur in January and February while the mean minimum temperature is 12°C during July. The average rainfall is approximately 750 mm of which 60% falls between June and August, 20% during the spring and 15% during autumn. A seasonal drought occurs during the summer months.

Weather patterns in Western Australia are largely controlled by the seasonal movement of a belt of high pressure, anticyclonic (anti-clockwise) weather systems which travel from west to east with a period of 7-10 days. During winter, this belt is centred around latitude 30 degrees south and brings cool, moist westerlies to the central and southern regions of the state and offshore easterly winds further north. During summer, the belt moves south and is centred around latitude 40 degree south bringing easterly winds and fine, warm weather to much of central and southern regions of the State. Superimposed on this general pattern is the occurrence of low pressure cyclonic (clockwise) systems, from the south in winter and from the north in summer. These systems cause periodic north-westerly gales along the southern and central regions of the State, particularly during winter and early spring. They also cause tropical cyclones in summer and early autumn. At a local level, the land, seabreeze cycle is most pronounced during the late spring and summer months.

Aerial photo (1:50000) of Jurien township and environs. There is a diversity of habitats in this region: offshore islands, lagoonal basins, subtital reef and seagrass meadows.

Within this State context, the weather patterns in the Bay area are characterised by periodic westerly gales during winter and early spring with intervening periods of fine weather and light winds. During summer, offshore, easterly winds occur in the morning followed by strong seabreezes in the afternoon that often exceed speeds of over 30 km/hr. During late summer/early autumn, the typical weather patterns of the Jurien Bay area are very occasionally influenced by tropical cyclones which can bring strong winds and heavy rain. Protracted periods of calm weather occur during mid-late spring and autumn.

An analysis of long-term weather patterns suggests that natural climatic conditions of the central west coast of Australia may be moving into a period of increasing storm activity coupled with increasing storm intensity. In addition to these natural fluctuations in climatic conditions, human-induced climate changes may also result in a higher frequency of storm events causing higher wave energy conditions during the medium to long-term.

Geology

The Jurien region is underlain by Tamala Limestone, which is covered partially by yellow quartz sand and younger sand dune systems. Tamala Limestone was deposited during the Quaternary period, about 240,000 years ago, as a series of wind-blown beach and dune sand ridges parallel to the coast. Following deposition, these sediments were slowly cemented into a porous limestone which incorporates solution pipes and dense hard capstone layers. The boundary between the limestone and yellow sand is irregular. This irregularity is demonstrated at the Pinnacles (Nambung National Park) near Cervantes, about 30 km south of Jurien, where resistant columns and plates of Tamala limestone have been exposed following wind erosion of the unconsolidated sands above.

Surface sand layers on the coastal plain are largely derived from marine sands, consisting of the skeletal remains of marine plants and animals, which have been blown up into a series of dunes and swales associated with changes in sea level. As the sea level fell and receded across the plain, a sequence of three coastal dune systems were deposited as follows:

- *Bassendean sands* were deposited during the Pleistocene about 480,000 years ago along what is now the inland side of the coastal plain;
- *Spearwood dunes* occur to the west of the Bassendean sands and were deposited about 200,000 years ago; and
- *Quindalup dunes* are banked up against the present coastline and were deposited since the last ice age 6000 to 10,000 years ago.

The sands in the region are porous, have low water-holding capacity, and are nutrient deficient and water repellent in the surface layer. The beach sands have a high sodium content from wind-driven salt spray and consist mainly of calcium carbonate, reflecting their marine biogenic origin. The calcium carbonate component of beach sand along the Jurien Bay coastline ranges from 50-95% and these levels extend, in places, up to 8 km inland.

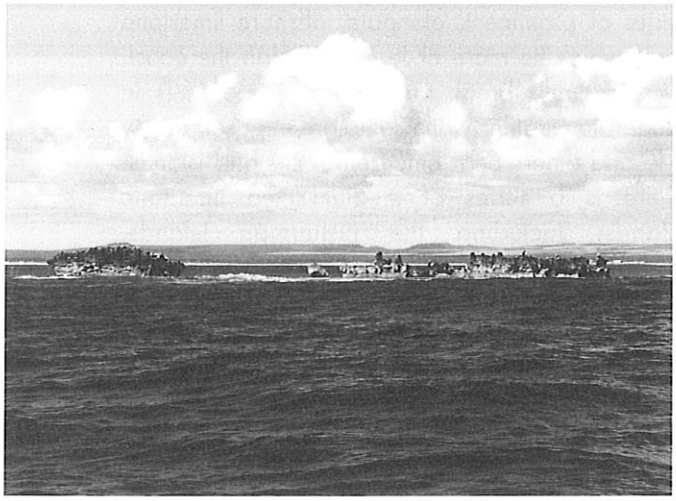
Geomorphology

The Jurien coastline has a generally north-south alignment and consists of arcuate, or curved, beaches backed by low dunes with intervening dune-covered sand promontories, or points, and rocky headlands and low cliffs of Tamala Limestone. Along some sections of the rocky coastline, horizontal erosion of the coast has been much faster than vertical erosion resulting in wide wave-cut platforms at sea level with undercut intertidal notches along their shoreward boundaries.

The seabed topography is complex close to the coast. Inside the 20 m depth contour, there are series of prominent, elongate, offshore limestone reefs which lie more or less parallel to the coast. Ocean swells break on many of these reefs in moderate weather while some are exposed at low tide and others bear emergent rocks and islands. There is a series of medium-sized limestone islands, including the Fisherman Islands, Sandland, Favourite, Boullanger, Whitlock, Escape and Cervantes islands, which have well-developed intertidal rock platforms, at least on their seaward sides. In places, these offshore reefs, rocks and islands afford protection from swell waves and provide sheltered, inshore lagoonal environments.

The two major sand spits of Island Point, near the Jurien Bay township, and Thirsty Point, at Cervantes, have developed as a result of, and in the lee of, the protective islands and reefs further offshore. Shallow sandbanks also occur between the mainland coast and islands and reefs surrounding Favourite Island, Boullanger Island, Booker Rocks, Emu Rocks and North Ronsard Rocks. These subtidal sandbanks divide the shallow (< 10 m depth), nearshore waters into separate lagoons, some of which contain slightly deeper basins exceeding 10 m. One basin occurs within Jurien Bay, behind Favourite Island and immediately seaward of the Jurien boat harbour. The other is south of Island Point, east of Essex Rocks and north of the Three Breaks Reef complex. Jurien Bay is a major embayment on the central west coast and has developed as an erosional scallop shoreward of the prominent limestone reefs and islands further offshore. Ronsard Bay, north of Thirsty Point, is similar but is less pronounced in character.

Rocky and sandy sections of coastline are inherently different in relation to shoreline stability and configuration. Rocky shores are generally stable and not subject to short-term shoreline changes. By contrast, sandy shorelines are inherently unstable and can change significantly from year to year. Some sandy sections of the Jurien Bay coastline are quite mobile. For example, the shoreline south-east of Island Point has retreated approximately 200 m during the last 105 years. The Point, itself, is migrating to the northwest and beaches to the north of Island Point are prograding (i.e. advancing seawards).



Ronsard Rocks are one of the many offshore islands which are CALM managed nature reserves.

Drainage and Groundwater

The coastal area between Sandy Point and Cervantes is influenced by two types of drainage basins. The Hill River is a small river which originates at the edge of the Dandaragan Plateau and reaches the coast forming a small estuary behind the primary dunes, almost halfway between Cervantes and Jurien. Generally the estuary mouth is blocked by a sandbar but, on occasions, the river breaks through resulting in direct flow of freshwater to the sea. The area of the catchment above Hill Springs gauging station is 692 square kilometres. The river has seasonal and erratic flows and little to no measurable flow has been recorded for up to five consecutive years. Volumes are highest during winter (July to September) and are typically between three and seven million cubic metres per annum.

The second type of drainage basin is characterised by small creeks which do not reach the sea directly but spread out and merge in the wetland troughs on the coastal plain. Some of this water eventually reaches the sea by percolating through the limestone.

Superficial (shallow) and deep aquifers occur in the Jurien Bay area and provide a significant source of potable water for the region. The main superficial aquifers of the coastal foreplain are located in the calcareous dune sand and Tamala Limestone formations. Flow is generally seaward and is unconfined. Groundwater discharge generally occurs at the shoreline where a corresponding saltwater wedge intrudes landward beneath the freshwater aquifer. Because of the low hydraulic gradients on the coast, seawater can intrude several kilometres inland. Tidal changes and storm surges can cause fluctuations within the groundwater flow system in low-lying parts of the coast around Jurien Bay and result in the mixing of saline water into the overlying freshwater layer.

Superficial aquifers are potentially vulnerable to changes in land management. For example, the replacement of deep-rooted native, woody vegetation with shallow-rooted pasture can cause water tables to rise bringing salt to the surface in places rendering formerly arable land unproductive. Superficial aquifers are also vulnerable to pollution, such as from fertilisers and biocides and the disposal of human and industrial waste. Pollutants can also permeate horizontally through the groundwater to the ocean and vertically downwards into the deep aquifer.

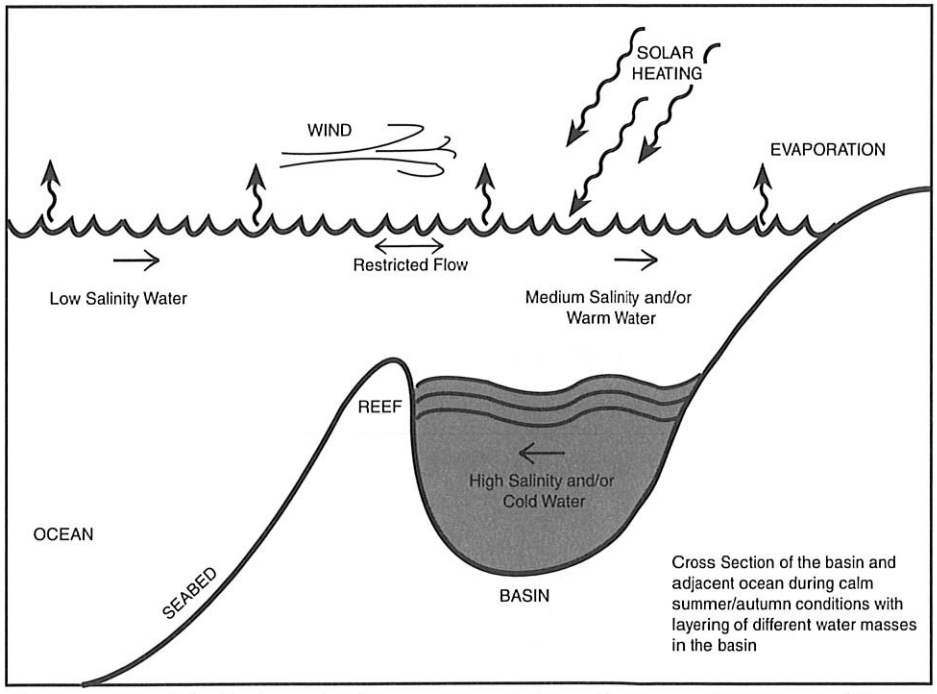
Oceanography

Water movements in each of the southern oceans of the world are characterised by an oceanic scale anti-clockwise circulation. For example, the currents off the continental west coasts of Africa and South America are generally in a northerly direction carrying cold water to mid-latitudes. In addition, offshore winds and the effect of the earth's rotation cause these northerly currents to deflect surface waters away from the coast which results in coastal upwellings of deeper, nutrient-rich water. Typically, these waters are highly productive and support significant fisheries. The currents off Western Australia, however, do not conform to this characteristic pattern. Instead, the Leeuwin Current, which is a shallow, narrow flow of tropical, low-salinity water, travels south along the continental shelf edge from the North West Shelf to Cape Leeuwin and beyond into the Great Australian Bight. This current effectively suppresses broadscale upwelling and the associated nutrient inputs that would otherwise be expected to occur along the coast of Western Australia. The Leeuwin Current flows strongly during autumn and winter but weakens during spring and summer when strengthening south-westerly winds retard the opposing southward flow of the current.

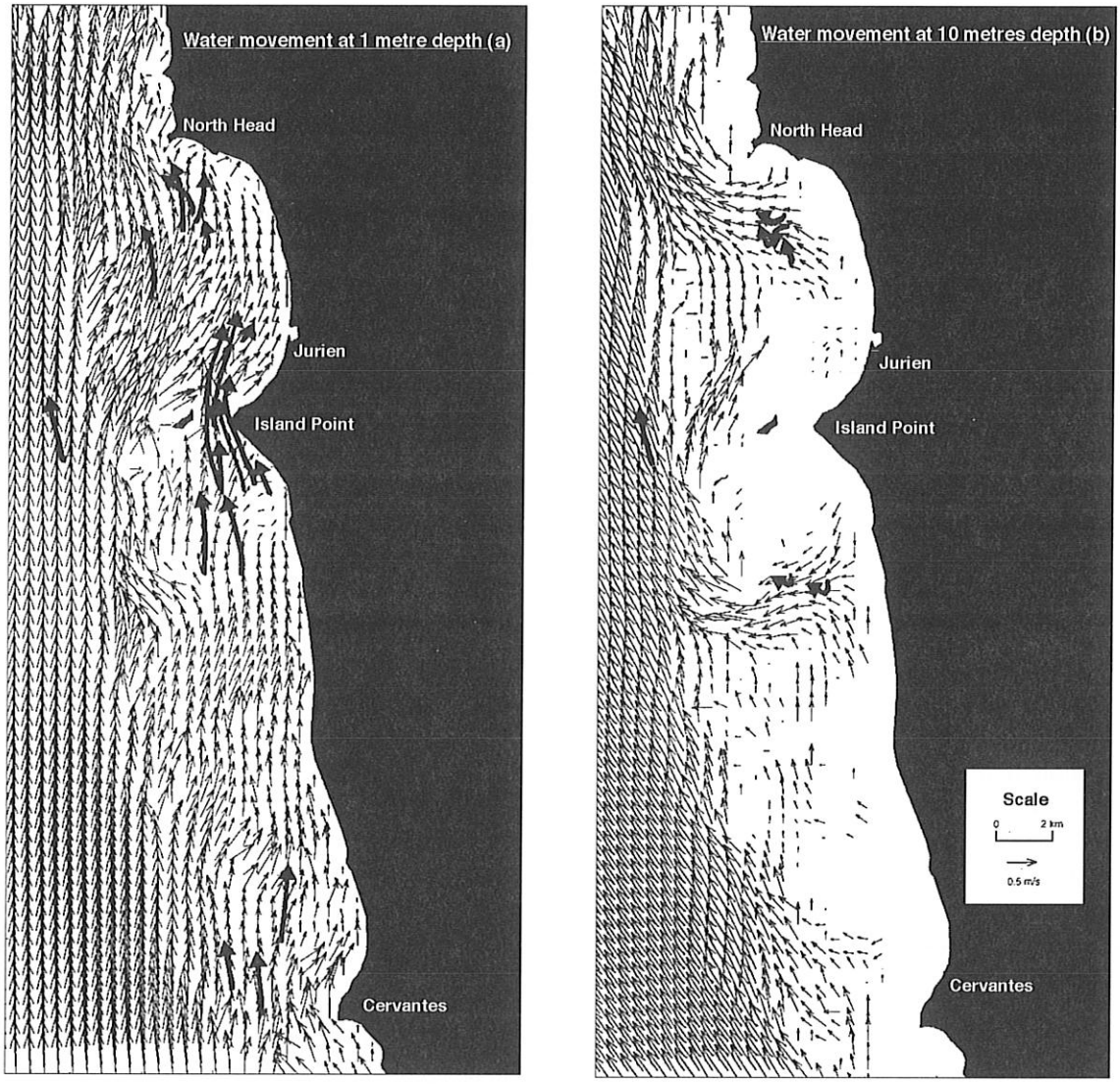
The influence of the Leeuwin Current on the hydrodynamics of Jurien Bay is yet to be investigated in any detail. However, it can be assumed that this current has a relatively minor influence on the hydrodynamics of the central west coastal lagoonal systems due to the restricting effect of the continental shelf and, more particularly, the blocking effect of islands and barrier reefs. Nonetheless, the widespread presence of many tropical marine plants and animals in the Jurien area indicates that the Leeuwin Current does impinge on the nearshore waters and, in doing so, significantly influences the biology of these waters.

The nearshore water movements and mixing patterns in Jurien Bay and adjacent waters are primarily determined by wind patterns. However, tidal movement, wave-pumping, seabed topography, the steering effect of islands, banks and reefs and the presence of salinity, temperature and density gradients are also influences. These factors, in combination with the physical blocking effect of the offshore limestone reefs and islands, retard water exchange between the coastal lagoons and the ocean.

Tides in the Jurien Bay area are predominantly diurnal (one high and low tide each day) with a maximum range of about 0.7 m. Seasonal water temperature and salinity ranges are approximately 15-25 °C and 35-37 parts per thousand. Lagoon circulation patterns are also likely to be influenced by wave-pumping of water over the offshore reef system into the lagoons but the significance of this process is yet to be investigated.



Cross section of the basin and adjacent ocean during calm summer/autumn conditions with layering of different water masses in the basin.



Computer predictions (thin arrows) and measured flow patterns (thick arrows) of water currents in the Jurien Bay region during summer sea breezes. Within the bays, both predictions and measurements for summer conditions showed the flows near the seabed were weaker and more variable than at the surface.

The wind-driven currents of the nearshore Jurien area are predominantly northwards throughout most of the year but with southward and variable currents becoming more prevalent in autumn-winter as synoptic conditions change. Wind-driven circulation patterns respond to the steering effect of changes in the seabed morphology and depth. For example, flows are deviated around banks, islands and shallow reefs and can be significantly reduced in strength at depth in the relatively deeper lagoonal basins north and south of Island Point. Current measurements have shown current speeds near the seabed of these basins can be up to 10 times slower, and in the opposite direction to those in the surface layer.

Another important feature to consider with respect to lagoon circulation and flushing is the formation of vertical and horizontal layering in the density of the water caused by temperature and/or salinity gradients. The surface water temperature is warmer during the day and cooler at night than deeper waters. Similarly evaporation in the shallow lagoon causes the salinity of the nearshore zone to be higher than in adjacent offshore waters. Cool water is denser and, therefore, less buoyant than warmer water, in the same way as saline water is denser than freshwater. When vertical mixing is limited (i.e. during warm, calm conditions), denser water settles near the seabed and can be effectively trapped for extended periods of time. If nearshore water is more dense than offshore waters, as is the case during summer, then the horizontal migration of lagoon waters will be further retarded. The environmental implications of these processes need to be considered carefully if existing or proposed developments add nutrients or other potentially harmful substances to the water, particularly in relatively poorly-flushed areas of the lagoon such as the relatively deep basins mentioned above.

NATURAL HERITAGE VALUES

Marine Biota

The marine environment of Western Australia can be divided up into different marine biogeographical regions. Western Australia has a total of 18 regions according to the *Interim Marine and Coastal Regionalisation for Australia*. In the northern bioregions, the marine flora and fauna are typical of the Indo-West Pacific which stretches from the east coast of Africa to French Polynesia in the central Pacific and from Japan to the northern coast of Australia. The marine biota of Western Australia's southern regions is typical of the cool, temperate waters which extend across the entire south coast of the continent. A high proportion of southern Australian marine species are endemic (i.e. occur nowhere else) and the temperate marine flora of this area is among the most diverse in the world.

The Jurien Bay area is located centrally in the Central West Coast marine bioregion, which stretches from Kalbarri south to Rottnest Island. This region contains one of the largest temperate, limestone reef systems in Australia (Dongara to Trigg) and the highest diversity of seagrasses in Australian waters. The marine biota is predominantly characteristic of temperate southern Australia but has strong tropical affinities as a result of the influence of the southward-flowing Leeuwin Current.

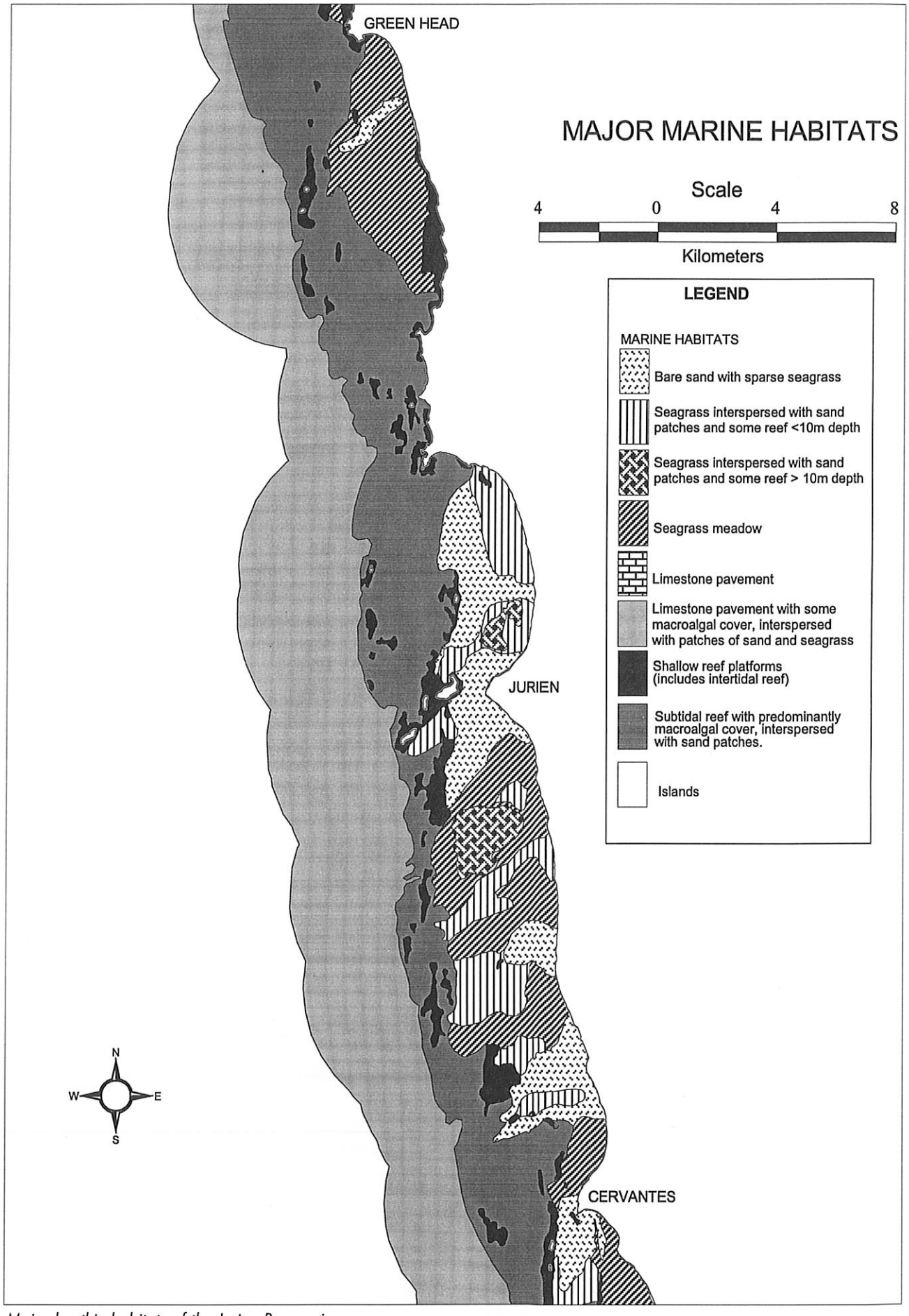
A biological survey was undertaken by CALM during April and May 1997 to provide more detailed information on the visually obvious marine biota within selected habitats of the Jurien Bay area. A preliminary analysis of survey results indicates that the marine communities of the Jurien Bay area are very diverse with about 35% of all species recorded being tropical. A total of over 400 species were recorded and included nine species of seagrass, 134 species of large algae, 205 invertebrate species (animals without backbones) and 63 species of fish. Some of the specimens collected, particularly a number of the sponges, have never been recorded before and are therefore 'new' to science. Outstanding features include extensive algal and seagrass communities, diverse invertebrate communities, and a rich fish fauna. A number of endemic southwest molluscs including the deep-water turban shell *Turbo jourdani* and the cryptic abalone *Haliotis scalaris*, are at or close to the northern end of their distributional range in this area. Jurien Bay is also the type locality of the rare and endemic cowrie, *Cypraea (Zoila) venusta*. The survey also recorded the gastropod, *Campanile symbolicum*, a 'living fossil' which flourished in the Tethys Sea of the Tertiary Period over 200 million years ago.

The underwater topography of the Jurien Bay area is complex with well-developed, offshore subtidal and intertidal limestone reefs, rocky shores with wide wave-cut rock platforms, limestone pavements, submerged sandbanks and several semi-enclosed lagoonal sand-covered basins. The high habitat diversity of this area supports a wide variety of marine community types. The comparative species diversity for the major marine habitat types surveyed are: bare sand - 78 species, seagrass meadows - 148 species and subtidal limestone reefs - 329 species.

Lagoonal seagrass meadows

Seagrasses are flowering plants adapted for life submerged in shallow, sheltered marine or estuarine environments. They are ecologically vital for the long-term sustainability of the coastal zone because of their high primary productivity, as habitat and nursery areas for a variety of marine life and their ability to trap and bind sediments. The productivity of seagrasses refers to their ability to convert light energy from the sun into plant material which is then used as food, shelter and nursery areas. The seagrass meadows of the central west coast are important habitats for many species, including those targeted by commercial and recreational fishers, such as the western rock lobster. Nine species of seagrass, 39 species of algae and 100 species of animals, which occurred in association with seagrass meadows, were recorded in lagoonal seagrass meadows during the survey.

Seagrass meadows are found in the lagoons of Jurien Bay region.



Major benthic habitats of the Jurien Bay region.

The most dense and therefore presumably the most productive seagrass meadows in the Jurien Bay area occur between the township of Jurien and Black Point. These areas are dominated by the perennial species *Posidonia sinuosa*, *Amphibolis griffithii* and *A. antarctica*. Perennial seagrass patches also occur in the deep sandy basins to the north and south of Island Point, although these patches are significantly less dense than the shallower meadows. In areas of relatively high energy, such as the shallow sandbanks and areas close to the shore, ephemeral seagrass species, such as *Halophila ovalis*, form sparse transient meadows that are often removed each year by winter storms.

Significant areas of seagrass meadows have been lost in Western Australia as a result of mining, pollution and mooring damage. Excessive nutrient enrichment can cause increases in suspended planktonic material and epiphyte (i.e. algae which grows on seagrass leaves) loads which reduce the amount of light reaching the seagrass leaves, causing them to die. The seagrass meadows in the Jurien Bay area are generally in excellent condition. However, some localised damage to seagrass meadows has occurred from boat moorings in Ronsard Bay near Cervantes. It is now generally well accepted that if lost the perennial seagrasses, *Posidonia* and *Amphibolis*, which are the dominant species in the Jurien Bay area, are unlikely to ever fully recover, at least not for several decades.

Aerial photograph of Cervantes (1:20000) highlighting the extensive seagrass meadows of the lagoon. Mooring damage is obvious in the seagrass meadow adjacent to the township.

Intertidal rock platforms

Rocky shores throughout the world are characterised by vertical zonation with many of the associated plants and animals being restricted to a narrow horizontal band according to their tolerance to exposure at low tide. In Jurien Bay the tidal range is less than 1m and the resulting zonation is subtle.

The intertidal limestone rock platforms in the Jurien Bay area are dominated by small red or brown turf algae with the large brown alga, *Ecklonia radiata*, occurring along the outer edges where they remain permanently submerged. Characteristically, littorinid snails or periwinkles occur on the shoreward or drier side of the platforms. Turban shells, *Turbo torquatus*, are distributed across much of the platform area and Roe's abalone, *Haliotis roei*, occurs towards the seaward extension of the platforms. The grazing activity of the common purple sea urchin, *Heliocidaris erythrogramma*, enlarges the erosional depressions which are characteristic of these limestone platforms providing refuge for a greater diversity of organisms during exposure at low tide. Cherry anemones, *Actinia tenebrosa*, are commonly seen in these depressions.

On the seaward side, intertidal limestone platforms are often undercut forming caves and ledges. These areas support a high diversity of algae and sessile, or attached, invertebrates including colourful gorgonian corals, sponges, ascidians and bryozoans. These organisms are attractive to look at but are easily damaged.

*Cray fish (*Panulirus cygnus*) are abundant in the offshore reef habitats and support a valuable commercial fishery.*

Subtidal algal covered limestone reefs

Submerged rocky substrates in the temperate regions of Western Australia provide attachment space for a variety of marine organisms. Characteristically, algae are visually dominant in well-lit areas while encrusting animals occur at greater depths and on shaded rock faces, overhangs, caves and the undersurfaces of boulders.

In the Jurien Bay area small red, green and brown algae occur on the subtidal limestone reefs. However, red algae dominate. Ninety-five species of red algae were recorded on subtidal rocky reefs, while the equivalent numbers of brown and green algae were 22 and eight respectively. The large fleshy algae provide food and habitat for fish and many other animals. Although the 1997 biological survey was restricted to the larger and more obvious marine species, a high diversity was recorded within the rocky reef habitats. A total of 198 animal species were recorded of which 36% were sponges, 24% were fish, 15% were ascidians and 12% were molluscs. Sea anemones, hard corals, crustaceans and echinoderms, such as sea urchins and starfish, were also recorded.

Although there are no coral reefs in the Jurien Bay area, small coral communities are common and 14 species belonging to 11 genera have been recorded. Most of these are tropical species with the exception being the west coast temperate endemic coral, *Symphyllia wilsoni*. Two species of *Acropora* occur in this area which, with the exception of a few colonies of *A. yongei* at Rottnest Island, are the most southerly Western Australian records of living *Acropora*.

Plant material, detached from offshore reefs by swell waves, often forms drift rafts on the surface before accumulating on the seabed and on the shore as algal wrack. Algal wrack contains large numbers of invertebrates which are a rich food source for surf-zone fish as well as providing protection from predation by seabirds such as cormorants. Decomposition and mechanical breakdown of algal wrack results in the release of nutrients and suspended particles into the water. These inter-relationships emphasise the ecological importance of marine vegetation, including the drift weed and wrack.

Marine wildlife

Several of the 35 species of cetaceans (whales, dolphins and porpoises) which have been recorded off the Western Australian coast occur in the Jurien Bay area. The largest toothed whale recorded in the area is the killer whale, *Orcinus orca*, which can reach a length of about 10 m. Family groups of the bottle-nosed dolphin, *Tursiops truncatus*, occur in the Jurien Bay area. Four other species of toothed whales have also been

recorded in this area including common dolphins, *Delphinus delphis*, striped dolphins, *Stenella coeruleoalba*, short-finned pilot whales, *Globicephala macrorhynchus*, and false killer whales, *Pseudorca crassidens*. Other types of toothed whales are likely to occur in these waters from time to time.

Baleen whales occur in the deeper waters off Jurien Bay and include the great blue whale, *Balaenoptera musculus*, which reaches 30 m in length, the humpback whale, *Megaptera novaeangliae*, the southern right whale, *Eubalaena australis*, the pygmy right whale, *Caperea marginata*, the minke whale, *Balaenoptera acutorostrata*, the pygmy blue whale, *Balaenoptera musculus brevicauda*, the sei whale, *Balaenoptera borealis*, and the fin whale, *Balaenoptera physalus*. Of these species, humpback, right, blue, sei and fin whales are listed under Western Australian legislation as rare or likely to become extinct if causal factors continue to operate. Many of these species rely on feeding grounds in the Antarctic and hunting during the whaling era has severely depleted their numbers. Recent surveys indicate that the populations of humpback and southern right whales in Western Australian waters are recovering. Humpback whales migrate to northern tropical waters to calve and mate each year. Their northern and southern migrations pass along the central west coast during spring and autumn, respectively, each year and provide significant potential for increased nature-based tourism associated with commercial whale-viewing operations.

Seals and sea-lions belong to the mammalian group called pinnepeds. Although visits by Antarctic and sub-Antarctic species are occasionally recorded, the only species which resides in the Jurien Bay area is the Australian sea-lion, *Neophoca cinerea*. Australian sea-lions are endemic to Australia and are listed as 'specially protected under the State wildlife legislation with a population estimate of about 3,000 animals currently in Western Australia waters of which 800 - 1000 are on the west coast. Australian sea-lions are unusual in that they have an 18-month breeding cycle. Buller Island, North Fisherman Island and the Beagle Islands, to the north of Jurien Bay, are the main sea-lion breeding sites on the central west coast with just a small proportion of the west coast population breeding at the Abrolhos Islands. Males, or bulls, coming from as far south as the waters off Perth to participate in breeding. Although no breeding occurs within Jurien Bay, the females and older pups often come ashore on local island beaches to rest. Sea-lions can be aggressive if approached, particularly in the breeding season. Several attacks have occurred on the central west coast, resulting in serious injuries. Signs, warning of the dangers of sea-lions, are located at strategic points along the coastline.

Marine birds are often subdivided into seabirds, and waders or shore birds. Ninety-three species of seabirds occur along the Western Australian coast and of these, 41 species breed on offshore islands thereby avoiding introduced ground predators which are common on the mainland. The small islands and rocks off the Jurien Bay area are breeding grounds for a variety of seabirds. A total of 12 species have been recorded nesting on North and South Fisherman Islands. Sandland Island is an important nesting area for the crested tern, *Sterna bergii* and the pied cormorant, *Phalacrocorax varius*. Seven other species have been recorded nesting on this island.

*Many seabirds such as the Crested Tern (*Sterna bergii*) nest on the offshore islands in the Jurien Bay region.*

The three small islets comprising Essex Rocks are a breeding ground for large numbers of bridled tern, *Sterna anaethetus*, little shearwaters, *Puffinus assimilis*, and pied cormorants. An additional nine less abundant species have been recorded nesting on these islets. Favourite Island is an important nesting area for the little shearwater and eight other species use this island as a rookery. Boullanger and Whitlock Islands are important nesting sites for the fairy tern, *Sterna nereis*. Significant numbers of pied cormorants also nest on Boullanger Island and large numbers of bridled terns nest on Whitlock Island. An additional eleven species nest on these two islands. Four other islands, Escape Island, Osprey Island, Tern Island and Ronsard Rocks have been surveyed and a total of eleven species of nesting seabirds were recorded.

Western Australia has 57 species of shorebirds of which 15 are resident and the remaining 42 species are regular migrants. Many shorebirds occur on both coastal and inland wetlands and the Jurien Bay area provides a diverse range of suitable habitats. In addition to the beaches, local wetlands include the estuarine lagoon associated with the Hill River plus salt lakes and blackwater wetlands. Lake Thetis, a clear, freshwater lake, is located three kilometres south-east of Cervantes and about one kilometre inland. In addition to the presence of waders, this lake contains stromatolites which have developed along its south-western shore.

Data relating to shorebirds in the Jurien Bay area indicate that the sanderling, *Calidris alba*, the red-caped plover, *Charadrius ruficapillus*, and the turnstone, *Arenaria interpres*, are common on local beaches. The hooded plover, *Esacus magnirostris*, occurs in the Jurien Bay area and this species is regarded as 'vulnerable' by Birds Australia (formerly the Royal Australasian Ornithologists Union).

	Fisherman Islands Nth	Fisherman Islands Sth	Sandland Island	Essex Rocks	Favourite Islands	Boullanger Islands	Whitlock Islands	Escape Islands	Osprey Islands	Tern Islands	Ronsard Rocks
Wedge-tailed Shearwater *Puffunis pacificus*	•	•	•	•	•	•	•	•		•	
Little Shearwater *Puffunis assimilis*	•	•		•	•	•	•	•			
White-faced Storm Petrel *Pelagodroma marina*	•	•	•	•	•	•	•	•			
Little Pied Cormorant *Phalacrocorax melanoleucos*	•		•			•					
Pied Commorant *Phalacrocorax varius*		•	•	•	•	•				•	•
Eastern Reef Egret *Ardea (Egretta) sacra*	•		•	•						•	
Osprey *Pandion haliaetus*	•	•	•	•	•	•	•	•	•	•	
White-bellied Sea-Eagle *Haleaeetus leucogster*							•				
Pied Oystercatcher *Haematopus longirostris*				•	•	•	•				
Pacific Gull *Larus pacificus*				•	•	•	•	•		•	
Silver Gull *Larus novaehollandiae*	•	•	•	•	•	•	•		•	•	
Caspian Tern *Sterna caspia*	•	•	•	•	•	•	•	•		•	
Crested Tern *Sterna bergii*	•	•	•	•						•	
Roseate Tern *Sterna dougallii*	•	•									
Fairy Tern *Sterna nereis*						•	•				
Bridled Tern *Sterna anaethetus*	•	•		•			•			•	

The distribution of nesting seabirds in the Jurien Bay region.

The leafy sea dragon, Pycodurus eques, is totally protected under the Fish Resources Management Act 1994. Although the most northerly confirmed record of this species is at Lancelin, unconfirmed sitings have been reported in the Jurien Bay area. The great white shark, *Carcharodon carcharias*, is occasionally sighted in the Jurien Bay area and this too is fully protected under the Fish Resources Management Act.

Coastal Terrestrial Biota

Plant communities on the offshore islands resemble those on the mainland coastal dunes. Primary dune plants such as spinifex, *Spinifex longifolius*, take root in bare sand. Secondary dune colonisers are typified by the fan flower, *Scaevola crassifolis*, and, if undisturbed, these communities give way to low open shrub communities which are dominated by *Nitraria* and *Acacia* thicket. Nitraria provides a suitable habitat for nesting seabirds on the islands. Several offshore islands are affected by the weed species South African box, *Lycium ferociffimum*, and pasture weeds occur on islands close to the mainland.

On the mainland sand dunes, climax communities of *Acacia* thicket are impacted by frequent fires. Fire is considered a significant threat to island and coastal dune habitats. Although the plant species on both have developed a variety of strategies to withstand fire, including vegetative regeneration from roots and stems or the survival of seeds either on the plant or in the soil, regeneration is slow and may take several years. During this time, the sandy soil is more vulnerable to wind erosion, a problem exacerbated by intensive public use. Island populations of nesting birds and the restricted marsupial and reptilian fauna on these islands, are particularly vulnerable to fires. The Shire of Dandaragan does not carry out controlled burning of these communities as a result of the increased vulnerability of the dune systems to wind erosion following fires. Fire risks on the mainland are minimised by regularly maintaining fire breaks. The prohibition of fires on islands reduces the risk of fire to island animal and plant communities.

The plant disease known as dieback has not been detected on the islands or along the coastal strip. However, all seven species of the disease-causing fungus, *Phytophthora*, occur in adjacent inland areas. Although the application of phosphite provides limited protection, no cure is known for this disease. Dieback management relies on containment and the adoption of strict hygiene procedures to ensure the fungus is not transported to the coast or islands.

The coastal dune system supports the western grey kangaroo, *Macropus fuliginosus*, the southern bush rat, *Rattus fuscipes fuscipes* and the ash-grey mouse, *Pseudomys albocinereus*, which is sometimes found in high densities. The islands support populations of skinks with the highest diversity of six species occurring on Boullanger Island. The distinctive long-tailed subspecies, *Egernis pulchra ongicauda*, does not occur on the mainland and is restricted to Favourite, Boullanger, Whitlock and Escape islands. Although some of the Jurien Bay islands appear large enough to support snakes, none have been recorded.

The rock parrot *Neophema petrophila* breeds on the islands in the Jurien Bay area. The little long-tailed dunnart, *Sminthopsis dolichura*, was found to inhabit Boullanger and Whitlock Islands. In addition, small footprints similar to those of a mouse or dunnart were found on Escape Island. However, subsequent trapping was unsuccessful.

The occurrence of a small carnivorous marsupial, the dibbler, *Parantechinus apicalis*, on Boullanger and Whitlock islands is of significance as this species is listed under the Wildlife Conservation Act 1950 as rare or likely to become extinct. Until 1985 it was thought that this animal had been completely displaced from the area as a result of the introduction of feral predators, particularly foxes and cats, and that dibblers had become restricted to a small area in the south of Western Australia. However, the offshore islands in the Jurien Bay area provide a refuge from introduced predators and the abundance of shearwater burrows provide ideal habitat for these animals. Since their discovery on Boullanger Island in 1985, the island dibbler populations have been monitored and the species is now the focus of a captive breeding and translocation program involving the Department of Conservation and Land Management, Perth Zoo and the University of Western Australia.

Mainland National Parks and Nature Reserves

There are four national parks and two nature reserves in the Jurien Bay area. Lesueur National Park is located between the Green Head and Jurien Bay access roads and extends to within two kilometres of the coast adjacent to the area under consideration as a marine reserve. Mount Lesueur is one of the most diverse botanical areas in the world, and 200 of the 900 plant species that are found there have significant conservation value with many occurring nowhere else. The rugged terrain of the area and the abundance of poison plants, spared it from agricultural clearing and the area is now a

major attraction for professional and amateur botanists and international visitors interested in our unique Western Australian flora. Drovers Cave National Park abuts the southern boundary of Lesueur and it extends to the Jurien access road.

Stockyard Gully National Park is located in rugged limestone country east of Leeman. A small intermittent stream flows west through the park and at one stage passes through a cave which tunnels 270 metres through a limestone hill. Access to this tunnel provides an additional tourist and educational attraction in the region.

Nambung National Park is located south of Cervantes. Limestone pinnacles are the best known feature of this park. However, the area is also well known for its displays of wildflowers between August and October each year. Nambung National Park is a popular destination for day visits from Perth with approximately 150,000 visitors during 1996/97. Many of these visitors are from overseas and are perhaps unaware of the other attractions in the Jurien Bay area. A change in the tourism marketing strategy to include other regional attractions, together with the availability of additional accommodation has the potential to convert a significant proportion of these day trips into overnight stays.

Beekeepers and South Beekeepers Nature Reserves cover extensive areas between Cervantes and just south of Dongara. These reserves are representative of the local flora between the coast to about 20 km inland. They also protect representative samples of karst terrain and provide a resource for the commercial production of honey. There are 300 registered apiary sites throughout the two reserves.

HUMAN USAGE

Cultural History

Aboriginal history

The Amangu and Juat clans, two of the 14 tribes of the Nyoongar people, have occupied this area for more than 30,000 years. To date, 36 aboriginal sites have been recorded in the area between Dongara and Guilderton. However, no comprehensive study has been undertaken and there maybe many more sites as yet officially unrecorded. The location of many of these sites remains confidential to avoid disturbance. Aboriginal sites are covered by the provisions of the Western Australian Aboriginal Heritage Act 1972.

There is evidence that the Nyoongars occupied limestone caves in the Jurien Bay area and although some stone artefacts have been found, there are potentially many more still undiscovered in other caves in the area. The coastal area between Green Head and Jurien Bay has the largest number of midden deposits in the whole of the south-west of Western Australia. Most of the small middens are made up of marine shells including limpet, turban, whelk, abalone and chiton shells and some have fish remains, particularly wrasses and leatherjackets. These sites are culturally significant as they provide important evidence that marine molluscs and fish were a food source in the traditional Aboriginal diet. The coastal dunes in the area were used as burial sites and human skeletal remains have been exposed, from time to time, by dune blow-outs. The Nyoongars also collected yams from the area and these yam grounds are still evident in the fertile soils of Cockleshell Gully and Hill River.

Maritime history

It is thought that the first white people to live in the central west coast area were probably survivors from the *Gilt Dragon*, a Dutch East Indian Company ship wrecked in 1656 about 150 km south of Jurien. However, there is currently no substantive evidence to support this assertion. The town of Leeman, approximately 40 km north of Jurien, is named after the Dutch navigator Abraham Leeman who was on the Dutch East India Company ship *Watch Buoy* which was sent to the Western Australian coast in 1658 to search for survivors of the *Gilt Dragon*. Leeman and 13 crew were in a smaller search boat when a storm struck causing their boat to hit a reef near Fisherman Islands, about 16 km north of the present Jurien township. Although the *Watch Buoy* searched for Leeman's party, it eventually departed leaving Leeman and his crew behind. Realising he was marooned, Leeman decided to sail to Batavia, now Jakarta, in the Dutch East Indies, now Indonesia. He repaired the small boat, loaded it with dried seal [sea-lion] flesh, sea 'celery' and water and, five months later, Leeman and three survivors arrived in Batavia.

It wasn't until 150 years later, in 1801, that a French exploratory and scientific expedition of three sailing ships, the *Geographe, Naturaliste* and *Casuarina*, explored and charted much of the central west coast.

Commander Baudin who was the captain of the *Geographe* and also the expedition leader, named Jurien in honour of Charles Marie Jurien of the French Naval administration.

An increase in shipping along the Western Australian coastline followed the settlement of the Swan River in 1829. Navigation on the west coast was dangerous due to poor charts, unknown currents and unpredictable, violent winter storms. The islands around Jurien Bay were considered a serious hazard by mariners in the nineteenth century and as a testament to their concerns, there are four recorded historic shipwrecks along the 30 km stretch of coastline between Cervantes to North Head and these are managed under the Maritime Archaeology Act 1973. The shipwrecks are:

- the American whaling ship *Cervantes*, wrecked off what is now known as Cervantes Island, in 1844;
- the *Maid of Lincoln*, wrecked off Jurien Bay in 1891;
- the *Europa* (known locally as the 'grog ship') wrecked offshore from the Hill River mouth in 1897; and
- the remains of the steamship *Lubra*, which foundered in 1898, located immediately off the Jurien township with its engine block still protrudes out of water amongst the breaking surf. These engine remains were used as a navigational aid to mark the South Passage into Jurien Bay up until 1989 when navigational pylons were erected.

In response to the number of sea disasters along this stretch of coast, a lighthouse was erected on Escape Island in 1930. This facility originally operated on butane gas but was converted to solar power in 1986.

Farming and fishing

Farming commenced in the Jurien hinterland around the 1850's. Western Australia's first official millionaire, Walter Padbury, was the first person to acquire land for agriculture in the Jurien area and many of the local pioneering farming families are remembered in the street names of the Jurien townsite. Around 1885, a 30 m long wooden jetty was constructed at the end of Hasting Street, to facilitate the loading of wool, cattle and horse hide. However, by the early 1900's, the surrounding waters were silting up and became too shallow for larger boats to use. A bushfire in the 1930's destroyed most of the jetty but remnants can still be seen protruding from the water.

During World War II rumours were rife that Japanese submarines were using the sheltered waters of Jurien Bay to surface and recharge their batteries. These rumours were so persistent that the Australian Army constructed a road into Jurien and stationed soldiers to keep watch from concrete bunkers that can still be found at North Head, on the northern extremity of the bay. This period was also the beginning of what was to become the area's most lucrative industry; the western rock lobster fishery. Rock lobster tails were canned for export to American troops stationed in the South Pacific and, after the war, exported directly to the United States. The industry has continued to grow and in the early 1960's two processing factories were built. Today the area has a modern fishing fleet of about 140 boats and is the backbone of the local economy.

Squatters shacks

Coastal squatter development has been present in the area for several decades. The first 'shacks' were built by farmers who spent their holidays by the coast. After the second World War, cray fishermen built shacks for use as temporary accommodation at safe anchorages during the fishing season. Over the last twenty years, increasing numbers of holiday makers and recreational fishers from surrounding towns and the Perth metropolitan area, have also erected shacks. Some of the former squatters' settlements have been upgraded to legal townsites, for instance, Cervantes and Green Head. In 1988, the Western Australian Government endorsed a Squatter's Policy for the administration and subsequent progressive removal of coastal squatter shacks along the central west coast. There are currently approximately 1,000 existing structures in the Shire of Dandaragan of which 670 are classified as shacks and the remainder being other structures such as lean-tos, outhouses, storage, boat and generator sheds. The shacks are clustered into recognisable communities at Wedge Island (370 shacks), Grey (130 shacks), Booker Valley (20 shacks), Pumpkin Hollow & North Head (20 shacks), Sandland Island & Kings Bay (60 shacks) and Sandy Cape (10 shacks). The squatters now have leases with the Shire at an annual cost of $648 which expire on the 1 June 2001. After that date, the leasees have until the end of 2001 to demolish and remove their structures.

Current Administrative Setting

Local government authority

The proposed Jurien Bay marine reserve lies within the 90 km coastline of the Shire of Dandaragan. The Dandaragan Shire has an area of 6,934 square kilometres and has four major town sites of Dandaragan, Badgingarra, Cervantes and Jurien. Although Dandaragan is the administrative centre, Jurien and its environs is the Shire's fastest growing centre. Presently, the Shire of Dandaragan has a population of approximately 2,700 residents of whom 950 live in Jurien and 400 live in Cervantes. Since the construction of the new coast road between Jurien and the townships of Greenhead and Leeman in the Shire of Cooroy to the north, the populations of these towns (total 1000) have also been using Jurien as their regional centre. The Jurien townsite was gazetted in 1956 and is located 260km north of Perth. The town was established initially as a centre for the commercial crayfishing industry. However, it has since evolved into a major rural coastal town with a flourishing tourism industry. In recent years, there has been an increase in the percentage of aged persons in the population because the area is seen as a desirable retirement location. Currently, Jurien has an average annual population growth of about 4 %.

There are four major industries within the Shire of Dandaragan. These are:

Agriculture - consisting of mainly cattle and sheep grazing which has expanded more recently into wheat and white lupin cropping and native seed and wildflower collecting.

Commercial fishing - consisting mainly of rock lobster fishing with some wet-lining for finfish. Aquaculture is a developing industry in this region.

Mineral sands mining - at Cooljarloo near Cataby. This industry has been developed by the TiWest Joint Venture Mineral Sands Project.

Tourism - the natural landforms and the flora and fauna of the Nambung, Lesueur, Badgingarra and Drover's Cave National Parks annually attract large numbers of tourists.

Infrastructure and facilities

For many years, the Shire of Dandaragan, in conjunction with the other central coast local government authorities, has been arguing a case for a coast-aligned link road between Dongara and Lancelin. The link to the north of Jurien has been completed and the alignment of the section of the link road south to Cervantes has been approved. The link road will improve access among the central coast communities and with Perth. This is expected to result in an increase in tourism, a reduction in the social isolation of communities, improved access to education institutions, and easier access to the coast in between towns.

A marina complex was built in 1988 to both improve facilities for the commercial fishing fleet and to cater for increased recreational boating. The marina has 72 berths plus public jetties.

The Jurien boat harbour services both recreational and commercial fisheries.

There are authorized landing areas/airstrips at Jurien and Cervantes. However, there are no proposals to upgrade these to 'licensed aerodromes' in the next decade. The Civil Aviation Authority restricts the use of these airstrips to private or charter planes with a maximum take-off and landing weight of 5.7 tonnes. The recent Central Coast Regional Strategy recommended the Shire of Dandaragan investigate upgrading these airstrips.

Tenure

The seaward limit of state territorial seas is designated as being three nautical miles from the territorial sea baseline. In the Jurien Bay and Cervantes region, this baseline varies according to different geographical features to ensure all offshore reef structures are well inside the State Territorial Seas limit and under State jurisdiction. The baseline is determined in the following way:

- in the case of the islands with fringing reef, the baseline is the seaward low water line of the fringing reef;
- a straight line drawn between the seaward low water marks of North Head and Island Point is the baseline of this section of the coast; and
- the baseline is the low water mark along the coast, including the coasts of islands under Western Australian jurisdiction.

The mainland shore adjacent to the proposed Jurien Bay marine reserve, has a variety of purposes and vestings with a mixture of high and low water coastal boundaries. These include:

- The Jurien townsite;
- Foreshore Reserves for public recreation vested in the Shire of Dandaragan;
- "C" Class Nature Reserves;
- "A" Class Island Nature Reserves;
- Freehold land; and
- Public utilities such as jetty and harbour facilities.

Escape Island is gazetted freehold land and is currently owned by the Commonwealth Government and vested in the Australian Maritime Safety Authority because of their role in servicing the Escape Island lighthouse.

Native Title

There are several applications on the Register of Native Title Claims which refer to lands and waters in the Jurien Bay region. Four claims have been accepted for mediation by the National Native Title Tribunal and five claims are yet to be accepted.

Commercial Activities

Australia's ocean resources are largely under-developed and unexplored yet have the potential to make a significant contribution to Australia's economy. Marine-based industries were valued at approximately $16 billion annually in 1987 and $30 billion in 1994 and make a major contribution to our export sector of $6.6 billion (i.e. 7% of Australia's total exports) and employ over 220,000 people.

Commercial fishing

The western rock lobster, *Panulirus cygnus*, fishery has the highest value of any commercial single species fishery in Australia with a total annual production value of $300 million. This industry is of great importance to the local Jurien Bay economy and makes a significant contribution to the State economy. The western rock lobster fishery extends between Exmouth and Augusta with most of the 611 vessels operating between Fremantle and Geraldton. This area is the most productive part of the fishery. The industry is based on the use of pots and over 69,000 commercial pots are licensed in Western Australia.

Up to 140 rock lobster boats work the Jurien Bay area from bases at Green Head, Jurien and Cervantes and catch a total of about 1.6 million kilograms live weight of lobster each season. The rock lobster fishing season is from 15 November to 30 June. The western rock lobster fishery is managed on a sustainable basis by monitoring puerulus larvae recruitment as an indicator of future stock densities and subsequently adjusting management strategies accordingly. A rock lobster fishing exclusion zone is located in an area roughly bordered by Boullanger Island, Osprey Islet and Whitlock Islet. This is an area in which puerulus larval recruitment is monitored and no lobster fishing is permitted within the boundaries of this area.

Rock lobster processing facilities have been established at Jurien and Cervantes. An additional facility at the Jurien boat harbour is planned for the near future. Lobsters are processed in different ways to suit the various markets and include tails only, whole lobster and cooked, raw and live lobsters. Most of the catch is exported primarily to Japan, Taiwan, the USA, Hong Kong and China.

Crown Reserve	Class	Name	Tenure	Purpose	Vested	Comment
1221	C		non-CALM Act - general	Water & stopping place	Shire of Dandaragan	
11882	C		non-CALM Act - general	Trigonometrical station		
14924	C		non-CALM Act - general	Lighthouse		
18865	C		non-CALM Act - general	Excepted from sale		
19206	C		non-CALM Act - general	Parkland, Recreation & letting of cottages thereon on 14/1/95	Shire of Dandaragan.W.P.L. expiring on or before 30/6/2001	Gazetted to Low Water Mark
2252	C		non-CALM Act - general	Parkland, Recreation & letting of cottages thereon on 20/3/1988	Shire of Coorow (Special Conditions)	Gazetted to Low Water Mark
24496	C	Beekeeper's Nature Reserve	Nature Reserve	Protection of flora	NPNCA	
24522	A	Nambung National Park	National Park	National Park & water	NPNCA	Gazetted to Low Water Mark
28541	C	Casuarina Park	non-CALM Act - general	Foreshore management & recreation	Shire of Dandaragan	
29251	A	Boullanger, Whitlock, Favorite, Tern & Osprey Islands Nature Reserve	Nature Reserve	Conservation of flora & fauna	NPNCA	Gazetted to Low Water Mark
29255	A	Sandland Islands Nature Reserve	Nature Reserve	Conservation of flora & fauna	NPNCA	Gazetted to Low Water Mark
29256	A	Fisherman Island Nature Reserve	Nature Reserve	Conservation of flora & fauna	NPNCA	Gazetted to Low Water Mark
29257	A	Essex Rocks Nature Reserve	Nature Reserve	Conservation of flora & fauna	NPNCA	Gazetted to Low Water Mark
29258	A	Outer Rocks Nature Reserve	Nature Reserve	Conservation of flora & fauna	NPNCA	Gazetted to Low Water Mark
29260	A	Ronsard Rocks Nature Reserve	Nature Reserve	Conservation of flora & fauna	NPNCA	Gazetted to Low Water Mark
29373		Memorial-R.M. Bartle	Memorial	Shire of Dandaragan		
30838	C		non-CALM Act - general	Caravan park	Shire of Dandaragan. W.P.L. 21 yrs,	
31229	C		non-CALM Act - general	Parking and recreation	Shire of Coorow	
31303	C	Thirsty Point Reserve	non-CALM Act - general	Recreation	Shire of Dandaragan	Gazetted to Low Water Mark
33167	C		non-CALM Act - general	Harbour purposes	Ministry for Transport	
33168	C		non-CALM Act - general	Harbour purposes	Ministry for Transport	
34039	C		non-CALM Act - general	Navagational beacon	Ministry for Transport	
34040	C		non-CALM Act - general	Navagational beacon	Ministry for Transport	
34294	C		non-CALM Act - genera	Parking & recreation	Shire of Danadaragan special conditions	
37298	C		non-CALM Act - general	Harbour purposes	Ministry for Transport	
37810	C		non-CALM Act - general	Sand dune protection	Shire of Dandaragan	
38041	C		non-CALM Act - general	Navigation beacon	Ministry for Transport	
38042	C		non-CALM Act - general	Navigation beacon	Ministry for Transport	
38043	C		non-CALM Act - general	Navigation beacon	Ministry for Transport	
38044	C		non-CALM Act - general	Navigation beacon	Ministry for Transport	
39419	C		non-CALM Act - general	Harbour purposes	Ministry for Transport	
40534	C		non-CALM Act - general	Quarry (shell)	Shire of Dandaragan	
40544	C		non-CALM Act - general	Parkland and recreation	Shire of Coorow	
40739	C		non-CALM Act - general	Jetti facilities	Ministry for Transport	
Cert-ificate of Title 1020 /972		Escape Island	Private (Comm. Govt)	Lighthouse	Australian Maritime Safety Authority Government	Private property owned by the Commonwealth

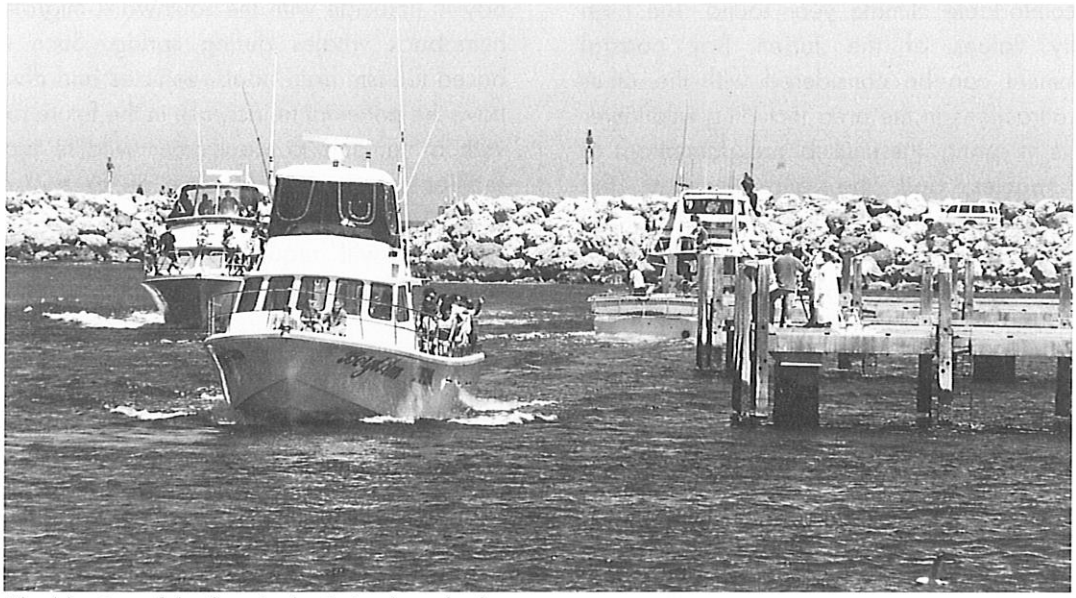
Vestment and tenture of lands in the Jurien Bay region ("A" class reserve can not be cancelled or amended without Parlimentary approval, "C" class reserve may be altered at the discretion of the Minister for Lands).

A small commercial scale/fin fishery operates in the Jurien Bay area with up to four vessels targeting sharks, West Australian jewfish, *Glaucosoma hebraicum*, pink snapper, *Pagrus auratus*, and baldchin groper, *Choerodon rubescens*. The fish are sold primarily on the domestic market in Perth.

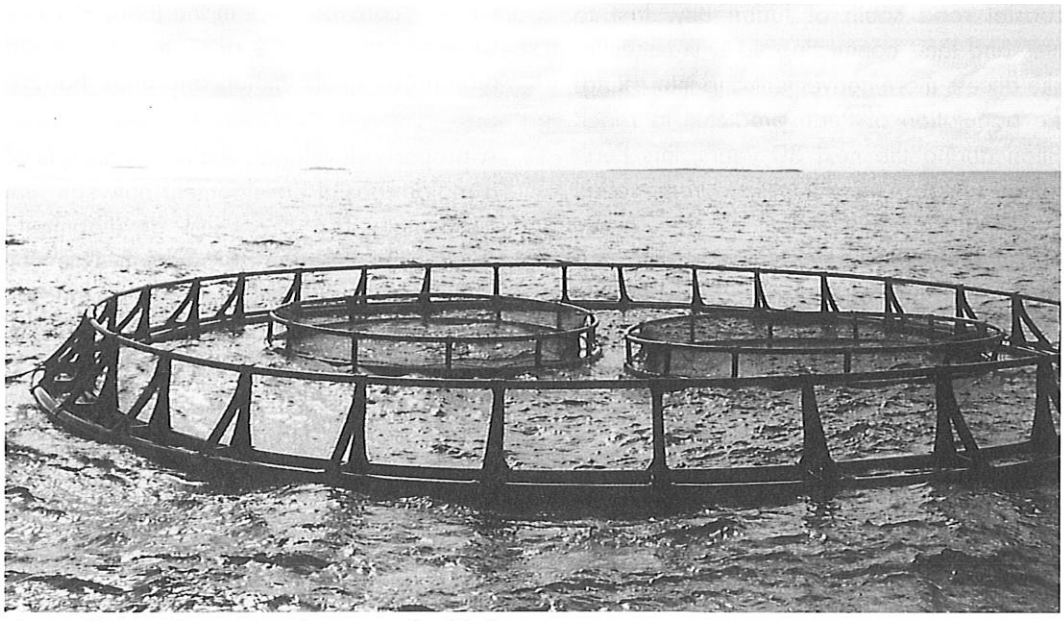
Although commercial collecting for shells takes place occasionally in the Jurien Bay area, there are no resident commercial collectors. However, permits issued under Fisheries legislation generally permit collecting along the whole coastline of Western Australia so collectors from outside the area sometimes visit for short periods of time.

Fish farms

Aquaculture is expanding rapidly throughout Western Australia although this industry is still in the early stages of development. The sheltered, pristine waters of the Jurien Bay area have significant potential for aquaculture. There is a hatchery currently operating within the Jurien marina. In addition, a marine grow-out area for species such as black bream, *Acanthopagrus butcheri*, and pink snapper, *Pagrus auratus*, has been constructed in the lagoon waters approximately seven kilometres south of Jurien.



The blessing of the fleet in the Jurien boat harbour.



Aquaculture marine grow-out pens south of Jurien.

Tourism

Tourism has become a major industry in Western Australia and provided 3.7% of the Gross Domestic Product of the State for 1995/96. The Jurien Bay area has a thriving tourism industry with great potential to expand. The coast is scenically attractive, with clean, relatively sheltered waters, white sandy beaches and extensive recreational opportunities.

Most of the tourism activity currently takes place during spring and autumn, when average temperatures are higher than in the south of the state and winds do not normally exceed 20 to 30 kilometres per hour. During the summer months, coastal seabreezes have a cooling effect resulting in a comfortable climate year round. The high amenity values of the Jurien Bay coastal environment can be considered with the other major attractions in the area including wildflower displays in spring, the unusual rock formations at the Pinnacles and the attractions of the surrounding national parks. Visitor records of the Department of Conservation and Land Management indicate that around 150,000 tourists visited the Pinnacles in the Nambung National Park during 1996/97. From a regional perspective, the combination of these natural features offer an attractive destination with the potential to occupy and entertain an increasing number of visitors for several days at a time.

Jurien Bay tourism statistics indicate that Perth residents make up about 90% of visitors. The close proximity to Perth provides an accessible and relatively inexpensive destination. The construction of a coastal road south of Jurien Bay, first to Cervantes and later connecting up with Lancelin, will make access more convenient and interesting. With the population of Perth predicted to reach two million during the next 30 years, this Perth metropolitan sector of the domestic tourism market is likely to increase significantly.

According to the Tourism Forecasting Council, the number of international visitors to Australia is expected to approximately double from 4.2 million in 1996 to 8.2 million by 2005. Currently, half of the visitors to Western Australia are from southeast Asian countries. This sector of the overseas market currently prefers to relax in comfort in a city location, but enjoy short tours to gain typical Australian experiences. The Jurien Bay area is well located to cater for this day-tour demand. There are currently more than 50 coach tour operators who bring visitors to Nambung National Park and viewing the Pinnacles is the most popular day-tour out of Perth. Although these tours are set to increase further, trends in the international market indicate that visitors are now demanding more unique and individual holiday experiences. Once again, the central west coast has the potential to cater for those seeking a destination which embraces the Western Australian Tourism Commission's slogan of "*Fresh, natural, free and spirited*". Commercial whale-watching tours have been operating out of Jurien Bay to coincide with the southward migrations of humpback whales during spring. Such nature-based tourism from boats, vehicles and dive tours have the potential to increase in the future together with a demand to view other wildlife including sea-lions, animals which live on or nest on the islands, plus the stromatolites at Lake Thetis. These demands will require careful management if wildlife disturbance is to be minimised.

Tourism industry statistics relating to the Jurien Bay area are analysed as part of a large region which encompasses the whole of the wheatbelt. It is therefore difficult to extract data which is specific to the coastal area of interest. However, if behaviour patterns at Jurien Bay reflect those in the wider region, the majority of visitors stay in private accommodation which is owned by a friend or relative. Caravan parks provide a popular form of accommodation and Jurien caters for this market with 99 caravan bays in the Jurien caravan park. Currently about 16% of visitors to the wheatbelt region use hotels, motels and guest houses.

A property developer, Ardros Estates, is planning a major coastal development between Jurien and Cervantes. The proposed development would result in the creation of an urban extension to the Jurien townsite as well as providing land for tourist resort development, commercial and other uses. The area of the proposed development is 2,062 hectares and it is located between Jurien and the Hill River. Long-term development could see the creation of 8,000 residential lots and over 1,000 hotel beds.

Recreational Activities

Recreational fishing

In Western Australia, recreational fishing is enjoyed by about 30% of the population across all groups over 16 years of age and is equivalent to 500,000 people. The Jurien Bay area offers excellent fishing and it is one of the most popular recreational activities for both visitors and local residents alike. The whole of the Jurien Bay coast is currently open to beach fishing. In addition, the groynes at Jurien boat harbour together with jetties at Jurien and Cervantes provide convenient facilities. Beach anglers target tailor, *Pomatomus saltatrix*, whiting, *Sillago sp.*, Australian herring, *Arripis georgianus*, squid, *Sepioteuthis australis*, and skipjack, *Peudocaranx dentex*. Line fishers from boats target the same species plus the Westralian jewfish, *Glaucosoma hebraicum* and baldchin groper, *Choerodon rubescens*. The most popular locations for fishing from boats are in the lee of the offshore islands or, when weather permits, near the offshore reefs. The recreational line fishery is managed through a system of size restriction and bag limits.

Spearfishing is currently permitted throughout the Jurien Bay area. Spearfishers target jewfish and baldchin groper and both size restrictions and bag limits apply. Divers also take abalone, *Haliotis roei* and *Haliotis scalaris*, and western rock lobster by hand. However, these activities require a recreational fishing licence from the Fisheries Department and licence conditions include size restrictions and bag limits. The spearing of rock lobster is not permitted.

Western rock lobsters are taken by hand and in pots. Licensed recreational lobster fishers are allowed up to two pots each with a maximum of four pots per boat. Licence conditions require pots to be pulled within limited hours and both size restrictions and bag limits apply. Breeding female lobsters may not be taken.

Recreational net fishing is common along the coast but is prohibited along the Jurien Bay foreshore from a point adjacent to the end of Shingle Street, at the southern end of town, to a point 400 metres north of the boat harbour. Net fishers require a licence and nets must meet Fisheries Department specifications. Size restrictions and bag limits apply. The main species targeted by net fishers are mullet, *Mugil sp.*, and whiting, *Sillago sp.*

Diving, snorkelling and swimming

Gently sloping beaches with small waves are characteristic of the Jurien Bay area. These beaches are ideal for families with small children. While seabreezes are often strong, a variety of aspects are provided by the offshore islands and small coves tucked in amongst the headlands north of Jurien Bay. As a result, shelter from the wind is nearly always possible. The shallow lagoon and offshore rocky reefs provide good recreational opportunities for snorkellers. Generally clear water and an abundance of marine life make this an enjoyable and rewarding pastime.

It is estimated that about 15,000 SCUBA divers are trained in Western Australia each year. While many of these people are from overseas, a significant number remain in Western Australia and subsequently seek new diving destinations and holidays. The underwater scenery, abundance of marine wildlife and easy access to Jurien from Perth make the Jurien Bay area an attractive option for this activity. A diving instructor operates out of Jurien. Instruction and dive tours are available and the business owns and operates a small licensed diving dinghy to provide access to offshore sites. A separate retail outlet stocks a limited range of mainly snorkelling equipment and compressed air is purchased from the Jurien Fire Brigade.

A larger SCUBA diving business is based at Leeman which sells air, a range of dive equipment plus diving instruction and dive tours on a larger vessel. This business operates mainly to the north of Jurien Bay. However, occasional visits further south are undertaken. The most popular locations for diving in the Jurien Bay area are on the reefs off North Head, on the seaward side of Favourite Island, on the wreck of the *Lubra* and, when weather conditions permit, on the rock walls, overhangs and caves at North Tail, Seaward Ledge and The Boomer.

Boating

Boating is a popular recreational activity in Western Australia, with a total of 57,000 private vessels registered with the Department of Transport. The sheltered waters and islands off Jurien offer good quality boating experiences. Firm and gently sloping beaches facilitate access for small vessels while the launching and retrieval of larger trailered vessels are catered for at the

boat ramp within the marina. For touring vessels and those too large to be transported by road, the Jurien Bay area offers several naturally sheltered anchorages and the marina provides a safe haven with limited facilities. Access to jetties at Jurien and Cervantes provides additional facilities to the boating public.

In the interest of public safety, and to minimize conflict among the variety of commercial and recreational activities in the area, the Department of Transport has gazetted some restrictions relating to boating activities in the Jurien Bay area. These include:

- A six knot speed limit has been applied to the waters inside the Jurien marina and to an area extending outside the entrance within a 50 m radius.
- Apart from the area defined above and a water-ski take-off and landing area, an eight knot speed limit is operational within a 200 m strip along the coastline between North Head and Island Point.
- Boating is prohibited within the south-western inside corner of the Jurien marina where a swimming area has been located.
- Boating is prohibited within an area 40 m into the water between the two southern groynes and 50 m into the water between the northern groynes.
- A Mooring Control Area exists in waters east of North Head to the back of Whitlock Island and is gazetted under Department of Transport legislation.
- Boating is prohibited within a designated swimming area consisting of a 75 m wide strip along the shoreline, defined by a point on the Cervantes foreshore adjacent to Talavera Street and extending north for 360 m.
- Boating is prohibited within an area starting on the Cervantes foreshore, at a point 50 m south of the public carpark at Corrunna Road and extending 550 m in a southerly direction within 75 m of the shoreline.

Surface water sports

Persistent seabreezes and relatively sheltered waters provide good conditions for sailing. A yacht club located at Cervantes was very active until about five years ago with regular races and excursions. More recently, sailing interests have been directed towards wind surfing. The yacht club facilities are still used and although they may need to be relocated if the proposed Cervantes Keys development goes ahead, the club is expected to become more active again in the future when access to Jurien and Lancelin is improved. There is no yacht club at Jurien Bay.

Wind surfing has become very popular at Cervantes with some activity at Jurien Bay. Additional sites for wind surfing are likely to be

Jurien jetty provides boating facilities to the public.

Windsurfing is a popular recreational water sport in the Jurien Bay region.

used between Jurien Bay and Cervantes when the new coastal road improves access to the coast. A major wind surfing event is held at Cervantes each year. Until this year, this was a two day event with one day of wave sailing at Hangover Bay, 10 km south of Cervantes, and a second day of slalom events off Thirsty Point at Cervantes. Both of these events are part of the 'pro-am' circuit with about 100 participants from all over the world. This year (1997) is the first year that the Cervantes wind surfing event has also included the Asia Cup which is a preliminary for the World Cup to be held one week later in Perth. This larger competition is planned to take seven days and it may become a regular event at Cervantes.

The conditions for water skiing in Jurien Bay are ideal and in addition to participation by local residents, some visitors come to Jurien primarily to water ski. The Department of Transport has designated a water ski area which includes all of the waters of Jurien Bay between North Head and Island Point apart from waters within 200 m of the beach. A take off and landing area has been designated on the foreshore between Shingle Avenue and a line 50 m north of Shingle Avenue. Surfing takes place on breaks associated with outer rocky reefs particularly off Escape Island, The Boomer and Seaward Ledge. Mainland shore breaks are small along this section of coast so that access to high quality surfing spots is by boat.

Jet-skiing and parasailing are undertaken infrequently but there is the potential for increased participation in these activities in the future.

Coastal land based activities

Many people use 4WD vehicles either along the beaches or through the coastal dunes in order to access favourite beaches and fishing spots. While most drivers are responsible, some drive off existing tracks creating new ones which are then adopted by other drivers. As a result, some dune areas are badly scarred by networks of tracks which are then vulnerable to wind erosion and the development of blowouts. Some steep, unvegetated dunes in the area are used for 4WD driving practice and sport. Dune boarding, or riding a flat board down slopes, is also popular, particularly with young people.

Educational Values

Many of the Jurien Bay attractions which were discussed in the tourism industry section of this document are valuable as educational resources. In fact, nature-based tourism often provides an educational experience and educational groups could be considered as a specialist sector of the tourism market. The Jurien Bay area offers educators a wide range of natural and cultural resources which provide 'hands on' experiences for students undertaking courses in karst geology, coastal geomorphology, marine and terrestrial biology, Aboriginal history and the production of minerals and energy plus agricultural and marine products. Protective offshore reefs and persistent seabreezes also provide opportunities for less academic courses in water sports and other marine skills.

Jurien currently has one school which ranges form pre-primary to year 10. While occasional vocational courses are run in Jurien, nearly all tertiary courses are available to residents of the area by correspondence only. Children in the neighbouring towns of Cervantes, Dandaragan and Badgingarra have their own town primary schools. However, they either go away to boarding school or commute to Jurien District High School for their secondary schooling. All of the local schools include course material which relates to the marine environment. In addition, many other school groups visit Jurien Bay because of its educational resources and its proximity to the major centres of Perth and Geraldton. The majority of these school camps are based at the Jurien Apex Camp where dormitory accommodation, catering and limited classroom facilities are available. The Apex Camp has 180 beds and the educational programs are primarily designed for school groups between years seven to ten. The students participate in a variety of outdoor activities including caving, bush walking, farm visits and sport. Marine studies are sometimes included in the program depending on the availability of teaching staff.

COMMUNITY INVOLVEMENT

The marine environment of this State is owned by all Western Australians. Unlike the land, where usage rights are defined by titles and boundaries, the sea is not private property but is a common asset available to all users. While the freedom of open access is cherished by most Western Australians, experience elsewhere clearly demonstrates that increasing levels of human usage lead to conflict among users, and eventually to environmental degradation.

The establishment of a marine reserve in the Jurien Bay area will provide a framework to ensure environmental protection, maintain human usage at a sustainable level and minimise conflict among users. The planning process for the establishment of a marine reserve relies heavily on community input. Access to local knowledge and experience of the area, and the representation and mutual understanding of all interests, are essential ingredients in achieving the best outcome to protect the environment and accommodate the widest range of uses.

As facilitator of the planning process, CALM urges readers to become involved, either via their representatives on the Advisory Committee or through the public submission process.

For further information about Jurien Bay and the marine reserve planning process, contact the following Conservation and Land Management offices:

Main Roads WA Building
Moora 6510
Phone (08) 9651 1424

47 Henry Street
Fremantle, 6160
Phone (08) 9432 5100

193 Marine Terrace
Geraldton, 6530
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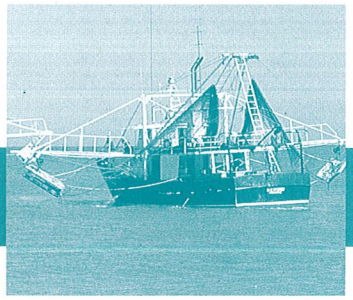

MARINE PARKS AND RESERVES AUTHORITY

For more information contact:

Marine Parks and Reserves Authority
Department of Conservation and Land Management
Hackett Drive
Crawley WA 6009
Ph: (08) 9442 0300 Fax: (08) 9386 1578

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47 Henry Street
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