
AUSTRALIAN NATIONAL PERIODIC REPORT

SECTION II

Report on the State of Conservation of Shark Bay

II.1 INTRODUCTION

a. State Party

Australia

b. Name of World Heritage Property

Shark Bay, Western Australia

c. Geographical coordinates to the nearest second

Between latitudes 24 degrees 44 minutes south and 27 degrees 16 minutes south and longitudes 112 degrees 49 minutes east and 114 degrees 17 minutes east.

Appendix I - Map showing World Heritage boundary and land tenure.

d. Date of inscription on the World Heritage list

13 December 1991

e. Organisation(s) or entity(ies) responsible for the preparation of the report

Environment Australia and the Department of Conservation and Land Management (Western Australia).

II.2 STATEMENT OF SIGNIFICANCE

Justification for Listing

At the most westerly point of the Australian continent, Shark Bay, with its remarkable coastal scenery and islands, has three exceptional natural features: its vast sea-grass beds, which are the largest (4 800 sq km) and most species rich in the world; its dugong population (estimated at 11 000); and its stromatolites (colonies of algae which form hard, dome-shaped deposits and are amongst the oldest forms of life on earth). Shark Bay is also home to populations of five species of endangered mammals and two marine mammals considered vulnerable.

Shark Bay is located on the coast in Western Australia and covers an area of 2.2 million hectares. The property is one of only sixteen inscribed on the World Heritage List for all four natural universal values:

- an outstanding example representing the major stages of the earth's evolutionary history;
- an outstanding example representing significant on-going geological processes, biological evolution and man's interaction with his natural environment; as distinct from the periods of the earth's development, this focuses upon ongoing processes in the development of communities of plants and animals, landforms and marine areas and fresh water bodies;

- containing superlative natural phenomena, formations or features, for instance, outstanding examples of the most important ecosystems, areas of exceptional natural beauty or exceptional combinations of natural and cultural elements; and
- containing the most important and significant natural habitats where threatened species of animals or plants of outstanding universal value from the point of view of science or conservation still survive.

The Shark Bay region represents a meeting point of three major climatic regions (subtropical, grasslands and desert) and forms a transition zone between two major botanical provinces - the South West and Eremaean provinces.

The number of species that reach the end of their range is a major feature of the region's flora. Twenty-five per cent of vascular plants (283 species) are at the limits of their range in Shark Bay. Many vegetation formations and plant species are found only in the interzone area.

The area south of Freycinet Estuary contains the unique type of vegetation known as tree heath. There are also at least 51 species endemic to the region and others that are considered new to science.

The Shark Bay region is an area of major zoological importance, primarily due to habitats on peninsulas and islands being isolated from the disturbance that has occurred elsewhere. Of the 26 species of endangered Australian mammals, five are found on Bernier and Dorre Islands. These are the boodie or burrowing bettong, rufous hare-wallaby, banded hare-wallaby, the Shark Bay mouse and the western barred bandicoot.

The Shark Bay region has a rich avifauna with over 230 species, or 35 percent, of Australia's bird species having been recorded. A number of birds attain their northern limit here, such as the regent parrot, western yellow robin, blue-breasted fairy wren and striated pardalote.

The region is also noted for the diversity of its amphibians and reptiles, supporting nearly 100 species. Again, many species are at the northern or southern limit of their range. The area is also significant for the variety of burrowing species, such as the sandhill frog, which, apparently, needs no surface water. Shark Bay contains three endemic sand-swimming skinks, and 10 of the 30 dragon lizard species found in Australia.

The 12 species of seagrass in Shark Bay make it one of the most diverse seagrass assemblages in the world. Seagrass covers over 4 000 square kilometres of the bay, with the 1 030 square kilometre Wooramel Seagrass Bank being the largest structure of its type in the world.

Seagrass has contributed significantly to the evolution of Shark Bay as it has modified the physical, chemical and biological environment as well as the geology and has led to the development of major marine features, such as Faure Sill.

The barrier banks associated with the growth of seagrass over the last 5 000 years has, with low rainfall, high evaporation and low tidal flushing, produced the hypersaline

Hamelin Pool and L'haridon Bight. This hypersaline condition is conducive to the growth of cyanobacteria which trap and bind sediment to produce a variety of mats and structures including stromatolites.

Stromatolites represent the oldest form of life on earth. They are representative of life-forms some 3 500 million years ago. Hamelin Pool contains the most diverse and abundant examples of stromatolite forms in the world.

Shark Bay is renowned for its marine fauna. The population of about 11 000 dugong, for example, is one of the largest in the world, and dolphins abound, particularly at Monkey Mia. Humpback whales, when migrating along the coast, use Shark Bay as a staging post. This species was reduced by past exploitation to an estimated population of less than a thousand on the west coast, however current estimates are now as high as 6 000.

Green and Loggerhead turtles are found in Shark Bay near their southern limits, nesting on the beaches of Dirk Hartog Island and Peron Peninsula. Dirk Hartog Island is the most important nesting site for Loggerhead turtles in Western Australia.

Shark Bay is also an important nursery ground for larval stages of crustaceans, fishes and medusae.

Criterion (i) : outstanding examples representing the major stages of the earth's evolutionary history

Justification - IUCN Summary

Shark Bay contains, in one place, the most diverse and abundant examples of stromatolitic microbialites in the world. Analogous structures were the dominant benthic ecosystems on Earth for 3 000 million years.

All life has evolved from a prokaryotic ancestor; the earliest record is in 3 500 million year old rocks in the Pilbara area of Western Australia.

For the next 2 930 million years (i.e., 85% of the history of life) only microbes populated the Earth. The only macroscopic evidence of their activities is preserved by stromatolites, which reached their greatest diversity 850 million years ago. The stromatolites encrypt evidence of the biology of the microbial communities that created them and the nature of the environments in which they grew. They dominated the shallow seas and formed extensive reef tracts rivaling those of modern coral reefs.

Over this period microbes modified the earth's atmosphere by producing oxygen, evolved the ability to respire oxygen, emerged from the sea to colonise the land and evolved most of the survival techniques that life uses today.

Although microbes have not declined in importance, their activity in building organo-sedimentary structures has, it being more efficient to occupy niches in reefs constructed by faster growing organisms, or indeed to occupy positions within the organisms themselves. Consequently stromatolites and other microbialites have declined in importance over this period, though they have remained locally significant in environments such as Hamelin Pool, where biotic diversity has been limited for one

reason or another. The stromatolites and microbial mats of Hamelin Pool were the first modern, living examples to be recognised as comparable to those that inhabited the early seas.

Other occurrences have since been discovered including in Lake Clifton, Western Australia, and in the Exuma Cays of the Bahamas. These, however, augment rather than duplicate those at Shark Bay with Hamelin Pool remaining the most significant known occurrence of shallow marine and intertidal benthic microbial ecosystems living on the Earth today.

Modern day analogues such as occur in great diversity and abundance in Hamelin Pool greatly assist in the understanding of the nature and evolution of the earth's biosphere up until the early Cambrian. For example, Proterozoic stromatolites are proving to be valuable tools in the relative dating of ancient rocks and are providing valuable information on interpreting palaeo-environments.

The microbial organisms living today are not primitive, but are modern organisms well adapted to and successful in their ecological niches. However, some of these organisms are phenotypically similar to forms that are millions of years old. The Hamelin Pool stromatolites are considered to be a 'classic site' for the study and classification of stromatolitic microbialites, as the morphology and biology of diverse living types can be studied through a range of environments.

Criterion (ii): outstanding examples representing significant ongoing geological processes, biological evolution and man's interaction with his natural environment

Justification - IUCN Summary

Shark Bay provides outstanding examples of processes of biological and geomorphic evolution, including the evolution of the Bay's hydrologic system, the hypersaline environment of Hamelin Pool and the biological processes of ongoing speciation, succession and the creation of refugia.

In a broad regional and global context, Shark Bay is an outstanding example of biological evolution because it forms a transition zone between major ecological provinces. It is of great scientific interest for the study of bio-geography including the evolution and extinction of species, the effects of isolation, succession, diversity and other factors such as effects of steep environmental gradients.

Marine Environment

Shark Bay has a unique hydrologic structure resulting from the restriction imposed by banks and sills, which has led to increased salinity in the southern parts of the Bay. This outstanding feature is characterised by three major water types, oceanic, metahaline and hypersaline, creating three corresponding biotic zones.

A key element of the hypersaline environment of Hamelin Pool is the growth of the Faure Sill, a barrier bank formed in the past 4 000 years which creates a landlocked marine basin partially separated from Shark Bay, where hypersaline concentrations have developed to almost twice the salinity of normal seawater. The size, depth and other geomorphologic features of the basin combine with salinity to make this an environment unique in modern seas.

These conditions give rise to a number of significant geological and biological features and outstanding among these are the stromatolitic microbiolites. There are also restricted communities of marine organisms tolerant of hypersalinity, vast deposits of organic shells, ooid shoals and lithified sediments of recent age, broad supratidal flats with evolution of subsurface evaporitic deposits, and the meromictic blue ponds, which are all rare and scientifically important.

The environmental microbiology of Shark Bay is unusual because extensive tracts of the intertidal and sub-tidal zones of the hypersaline gulfs and embayments are dominated by a wide variety of benthic microbial communities. These are best developed in Hamelin Pool and give the area the most significant assembly of phototrophic microbial ecosystems in the world.

Within the Bay, the effects of the steep environmental gradients are evident in the distribution and diversity of organisms. The most striking example is *Fragum erugatum*, one of few species to tolerate and also thrive in the hypersaline inlets of Shark Bay. Accumulations of these bivalves have, over a long period of time, resulted in spectacular white beaches and ridges such as Shell Beach and coquina (sedimentary rocks of lithified shells).

The steep environmental gradients also have produced genetic variability among populations of marine species. For example, there is variation between snapper (*Chrysophrys unicolour*) populations inside Shark Bay and those outside, and between the eastern and western gulfs inside the Bay. The genetic divergence amongst venerid clams is a further example of the high level of genetic biodiversity of the area.

As a habitat for bivalves, Shark Bay is of major significance on the western coast of Australia, with high species diversity. The distribution of bivalves within Shark Bay shows an apparent link with salinity gradients.

In terms of ongoing biological and geological processes, Shark Bay provides an impressive example of the roles that seagrasses play in the modification of a whole shallow benthic ecosystem. Seagrass, covering over 4 000 square kilometres, can be regarded as the dominant marine biota in Shark Bay. It has modified the physical, chemical and biological environment as well as the geology of the Bay.

The presence of extensive meadows of large seagrasses has influenced the water current regimes of the Bay, as the seagrasses slow the rate of water flow over the substratum. Rates of sediment accretion associated with the seagrass meadows in Shark Bay are greater than those associated with coral reefs. This is largely a function of the rapid rates of leaf turnover and the fact that the leaves carry a heavy load of calcareous epiphytes. Over geological time, these processes have led to the development of large sedimentary banks, such as the Faure Sill.

The build-up of these barrier banks and sills has restricted the circulation of oceanic seawater and in combination with low rainfall and high evaporation, has resulted in the increase in salinity observed in the inner reaches of the Bay, such as Hamelin Pool and L'haridon Bight. These hypersaline environments have been generally unsuitable for the further growth of seagrass, but have provided suitable conditions for the development of stromatolites.

Shark Bay contains the largest reported seagrass meadows as well as some of the most species-rich seagrass assemblages in the world. Twelve species of seagrass have been found in Shark Bay. Several species are at the northern limit of their range, e.g. *Amphibolis antarctica* and *Posidonia australis*. Shark Bay also contains species of tropical affinity such as *Syringodium isoetifolium* and *Halodule uninervis*. *Cymodocea angustata*, endemic to the northern section of the Western Australian coastline, is common in Shark Bay.

The Wooramel Seagrass Bank is the largest reported structure of its kind in the world, covering some 1 030 square kilometres and is a major part of the Shark Bay ecosystem. The Bank contains a variety of habitats for seagrass, molluscan faunas and mangrove and microbial mat communities in the inter-tidal and supratidal zones. The seagrasses act as organic baffles and provide habitats for organisms contributing skeletal carbonate, and as an important element in the nutrient cycles of marine biota throughout the Bay. Also, tidal waters draining from the Bank influence the hydrology of the embayment and contribute to the unusual steady-state conditions which pertain. Seagrass is also an important fish and crustacean nursery area.

In size, continuity and growth rate, seagrass surpasses most modern coral reefs. In addition, the Bank is one of the largest bodies of carbonate sediment formed by an organic baffle yet recorded from a modern environment.

The Bay is located near the northern limit of a transition region between temperate and tropical marine fauna. Of the 323 fish species recorded from Shark Bay 83% are tropical species, 11% warm temperate and 6% cool temperate species. Similarly, of the 218 species of bivalves in the region, 75% have a tropical range and 10% a southern Australian range, and 15% are west coast endemics. The coral fauna of 80 species is tropical in distribution, apart from one southern endemic species with its northern limit in Shark Bay. Six species of *Turbinaria* are abundant in the western part of the Bay.

Terrestrial Environment

Shark Bay is of great botanical and zoological importance as the habitat of many species at the end of their range. This importance relates not only to their presence but also to the inference this has for understanding biological evolution in the area.

Shark Bay represents an area where the temperate climate of the southern part of Australia gives way to semi-desert climates and where a transition zone occurs between two major botanical provinces - the South West dominated by *Eucalyptus* species and the Eremaean dominated by *Acacia* species. 25% of Shark Bay's flora is at the end of their range at Shark Bay, representing 145 species of plant at their northern limit and 39 species at their southern limit.

The sharp overlap between botanical provinces is most pronounced in the southern parts of Nanga and Tamala pastoral leases. Such pronounced overlaps between major botanical provinces are unusual in Australia and therefore, of great scientific value in determining the adaptation of species to their environment and the factors which limit distribution and abundance.

There are also a total of 51 species of vascular plants endemic to the Shark Bay region, with 28 named and 23 unnamed species. The key areas are the Tamala sandplain and the

coastal zone around Shark Bay. It is likely that new species, and expanded ranges for other species, will be found with further botanical surveys.

The Shark Bay region is also an area of major zoological importance, primarily as a result of the isolation of habitats on peninsulas and islands from disturbance which has occurred elsewhere. Five species of threatened Australian mammals are found on Bernier and Dorre Islands (refer to discussion in criterion 4). Numerous species of native mammals, reptiles and birds are at their northern and southern limits. Mammals include the ash-grey mouse (*Pseudomys albocinereus*) which is at the northern end of its range.

Shark Bay is noted for its diversity of herpetofauna supporting nearly 100 species. Many species are at their northern limit at Shark Bay and are largely confined to the western and central zones (i.e. to the country west and south of the acacia-eucalypt line). Shark Bay is generally the southern limit of the distribution of marine turtles and seasnakes, and is the southern limit of turtle nesting. Several species characteristic of the arid interior reach the coast in the Shark Bay area, and this Eremaean element is almost entirely restricted to the eastern side of the World Heritage Property. The islands, peninsulas and gulfs of the area provide a refuge for nine relict or endemic species and subspecies. The World Heritage Property is rich in old Australian elements, especially fossorial species and includes 10 of the 30 dragon lizard species found in Australia. The sandhill frog (*Arenophryne rotunda*) was thought to be endemic to Shark Bay, however recent surveys have found that this species is common in sand dune country throughout the Gascoyne and Murchison.

The Shark Bay region has a rich avifauna. Over 230 species or 35% of Australia's bird species have been recorded. A number of birds attain their northern limit and others their southern limit. In addition 11 species of marine birds breed in the area. Some other species are rare or uncommon. A subspecies of the vulnerable thick-billed grasswren (*Amytornis textilis*) has a major stronghold on Peron Peninsula. Over 35 species migrate to Asia, four breeding in the Shark Bay region.

Criterion (iii): superlative natural phenomena, formations or features of exceptional natural beauty

Justification - IUCN Summary

Stromatolites represent the oldest form of life on Earth. Hamelin Pool is the only place in the world with a range of stromatolite forms comparable to fossils in ancient rocks. Shark Bay is one of the few marine areas of the world dominated by carbonates as represented by the Wooramel Bank, which is also the largest seagrass meadow in the world.

Shark Bay comprises many superlative natural phenomena, formations and features. The Wooramel Seagrass Bank is one of the largest bodies of carbonate sediment formed by an organic baffle recorded from a modern environment and is also the largest seagrass meadow in the world. The growth of the Faure Sill through deposits of seagrass has produced and maintained a basin which is one of the few areas in the world where marine waters are hypersaline with salinities almost twice that of seawater. Stromatolites represent the oldest form of life on Earth and Hamelin Pool is the only place in the world with a range of stromatolites comparable to fossils in ancient rocks.

Shark Bay has a great diversity of landscapes, and exceptional coastal scenery is a distinctive feature of the Property. Notable sea cliffs include Zuytdorp cliffs and those along Dirk Hartog Island, Heirisson and Bellefin Prongs and Peron Peninsula. Other parts of Shark Bay are characterised by calm bays and inlets, with wide sweeping beaches of sand and shells, interspersed by rocky platforms and headlands.

Inland of the magnificent coast, there are low rolling hills interspersed with low, flat clay pans or 'birridas'. Where the sea has access to these areas, shallow inland bays of great natural beauty are created, such as Little Lagoon and Big Lagoon. The waters of Shark Bay play host to a range of large marine fauna, including dolphins, dugongs, manta rays, whales and several species of large sharks. On land, the richness of the flora contributes to an extensive wildflower display every July and August.

Criterion (iv): the most important and significant natural habitats where threatened species of animals or plants of outstanding universal value, from the point of view of science and conservation, still survive

Justification - IUCN Summary

Shark Bay has the only or major populations of 5 out of the 26 globally threatened mammal species of Australia. Twelve nationally rare and endangered endemic reptiles occur, two endangered or threatened marine turtles nest here, three vulnerable bird species, and plant species of rare, threatened, little known, undescribed or endemic status also occur.

Shark Bay is the habitat for many species of plants and animals that are recorded as rare or threatened. Importantly these habitats occur in the bio-geographically significant transition zone between the south-west and arid zones. The IUCN Red List of Threatened Mammals (1988) lists 26 species of Australian mammals. Shark Bay has the only or major populations of five of the 26 species, all of which were formerly widespread. Found on Bernier and Dorre Island these are the banded hare-wallaby (*Lagostrophus fasciatus*), western barred bandicoot (*Perameles bougainville*), Shark Bay mouse (*Pseudomys fieldi*), the mala or rufous hare-wallaby (*Lagorchestes hirsutus*) and the boodie or burrowing bettong (*Bettongia lesueur*).

Two threatened endemic land reptiles - the Baudin Island skink (*Egernia stokesii aethiops*) and Hamelin ctenotus (*Ctenotus zasicus*) have been recorded at Shark Bay.

Of the 230 bird species recorded for the World Heritage Property, 35 bird species are migratory to Asia and covered by international agreements between Australia and China and Australia and Japan. A number of bird species are considered rare or threatened: the thick-billed grasswren (*Amytornis textilis textilis*), the endemic Dirk Hartog Island white-winged fairy-wren (*Malurus leucopterus leucopterus*) and the Dirk Hartog Island subspecies of the southern emu-wren (*Stipiturus malachurus hartogi*).

The population of about 11 000 dugong (*Dugong dugon*), listed by IUCN as vulnerable, is one of the largest in the world. Humpback whales (*Megaptera novaeangliae*), also listed by IUCN as vulnerable, use the Bay as a rest area in their migration along the coast. This species was reduced from an estimated population of 20 000 on the west coast of Western Australia to 500-800 in 1962; and is now estimated at 4 000-6 000.

green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles, listed as endangered and vulnerable by IUCN, nest in the Bay - which is the southern limit of turtle nesting on the west coast of Australia. At the time of World Heritage listing, it was thought that green turtles also nested in the area, however their nesting sites are located further north.

The World Heritage Property contains many species of plants that are rare, threatened, little known or undescribed, with twenty eight named species of flora endemic to the area.

II.3 STATEMENT OF AUTHENTICITY/INTEGRITY

Evaluation of the Property - IUCN Summary (May 1991)

Shark Bay is a complete marine ecosystem containing many important features, including the Wooramel seagrass bank, the Faure sill and ecosystems dominated by benthic microbial communities, which flourish in the hypersaline embayments. The marine environment is largely undamaged and the terrestrial ecosystem greatly modified by pastoralism and other human activities. Currently 200 000ha of the total nominated site are designated as conservation areas with 686 000ha proposed for future inclusion in parks or reserves.

Any future major changes to land-use would require further public consultation and Western Australian parliamentary approval. Zonation effectively occurs already; the greatest concentration of units such as the benthic microbial communities, microbial mats and stromatolites are found within designated nature reserves. Offshore islands, including Bernier and Dorre Islands are also nature reserves managed for conservation and island reserves are recognised by restrictions on public access. Management of the trawl fishery includes restricting the number of boats, minimum mesh sizes, specifications and size of the fishing gear, setting up closed seasons and protection of the Shark Bay nursery areas.*

The township of Denham and the areas around Useless Loop and Useless Inlet are excluded from the Property although situated in the centre of the zone. The Useless Loop evaporation salt works and the gypsum mine on Edel Land have been listed as potential threats. Tourism, such as recreational boating activity, also poses a threat putting dugong, dolphin and marine turtles at risk. Insufficient staff has long been regarded as a hindrance. The construction of a new road to Denham/Monkey Mia and the building of motels, hotels and caravan parks is dramatically increasing visitor numbers to the area.

The Shark Bay World Heritage Area contains all of the inter-related and interdependent elements necessary for the maintenance of the salinity gradient, the benthic microbial communities, microbial mats and stromatolites. The whole of Hamelin Pool and L'haridon Bight and adjacent Holocene deposits are included. The Property contains all of the elements necessary for the system to be self-perpetuating with its great size and the range of environments, including all three of the marine biotic zones. The Property contains all of the superlative natural phenomena of Shark Bay within its boundaries

The habitats of threatened and other species of special conservation significance are of sufficient size to maintain the genetic and social health of the current populations, barring stochastic events (environmental changes including introduced predators,

wildfire, etc) given the size and specific locations of current habitats. A feature of Shark Bay is the opportunity to maintain refuges on islands and some peninsulas for species that are threatened or extinct elsewhere on the mainland, due to the effects of human use, such as grazing of stock, and through the introduction of predators such as the feral cat and the fox. The survival of migratory species will depend to a degree on management of some regions beyond the World Heritage Property.

* the IUCN technical evaluation should have referred to *maximum* mesh sizes

Some highly modified enclaves were excluded from the World Heritage Property at the time of listing, namely the town of Denham and environs, Useless Loop saltworks and gypsum leases on Edel Land. Parts of the terrestrial environment of Shark Bay had experienced a degree of habitat modification prior to listing, in the same way as much of the arid zone of Australia had, from the introduction of rabbits and goats as well as predators such as the fox and the cat, changed fire regimes and grazing pressures.

The WA Department of Conservation and Land Management has acquired a number of pastoral leases within the property and incorporated them into the nature conservation estate.

Through Project Eden, a program run by the Department, attempts are being made to re-establish a number of small marsupials whose populations have become restricted to a number of islands within the property or remote pockets on the mainland. The program has two major objectives, firstly to recreate, as far as possible, a pre-European environment by fencing off Peron Peninsula (part of the Property) and systematically eradicating feral predators and competitors and secondly, to breed viable populations of the threatened species in captivity, which can then be reintroduced onto Peron Peninsula.

Maintenance of Values

Marine

Of the Property's 2.2 million hectares, approximately 70% of the area is marine waters. The marine environment has undergone some modification as a result of the past pearl shell industry, whaling, trawling and some overfishing by recreational fishers. There is an active fishing industry based on prawns, scallops, shellfish and finfish. A number of fishing methods such as bottom trawling, nets, lines and lobster pots are used.

Trawling

Parts of the marine environment have been subjected to extensive trawling operations for many years, with the prawn and scallop fisheries in operation for around 30 years prior to the Property's inscription on the World Heritage List.

Prawns

The Shark Bay prawn fishery is the largest in Western Australia. There are twelve current licences operating 27 vessels and fishing occurs within the boundary of the World Heritage Property. There are a fixed number of boats and controls on boat size, gear, season, area opening and closing times, in addition to daily fishing time controls. All prawn vessels also share the Shark Bay scallop resource with a number of dedicated scallop vessels. Although the existing licence area is extensive, the area fished in the prawn fishery is almost entirely within the waters of the Shark Bay World Heritage

Property and incorporates trawling closures on the east of Denham Sound, as well as permanent closures in nursery areas.

The Shark Bay prawn fishery has a complex series of management restrictions to sustain all of the prawn species, maintain the supporting environment and maximise the size of the prawns at capture. These include:

- small numbers of vessels and limited entry fishery
- seasonal closure between November to March to allow prawn stocks to rejuvenate
- area closures – parts of the area are permanently closed to trawling
- time closures – daily time closure for fishing between 8am and 5pm
- crew restrictions – the crew is limited to six persons
- gear controls – there is a series of gear controls including mesh size, number of nets, size of trawl otter boards and ground chains
- precautionary measures to minimise any snapper catches – including additional trawling closure on the east of Denham Sound, an independent observer program and all line fishing from trawlers south of Cape Inscription prohibited.

Scallops

There are 41 boats licensed in the scallop fishery - 14 are exclusively for scallop trawling and 27 are prawn trawlers that are permitted to keep the scallop component of their bycatch. Dedicated scallop trawlers can trawl for 24 hours a day, whereas prawn trawlers can only trawl at night. Seasonal and area closures and gear controls are management methods employed to protect the scallop breeding stock

Class A (scallop only) vessels use a mesh size of 100 mm to limit the catch to scallops. Class B (prawn and scallop) vessels use nets with 50 mm mesh. The 14 boats with class A licences take around 70 percent of the catch. There are no minimum shell size limits, with season times deliberately set to capture scallops of appropriate size. Most of the catch is marketed to eastern Asia as frozen scallop meat.

Management arrangements over the past 11 years have ensured that some spawning has occurred each year before the bulk of the stock has been taken. Whilst this maintains the stock, annual variations in recruitment appear to be dominated by environmental factors that are believed to correlate inversely with the strength of the Leeuwin Current. The status of the fishery is determined from a pre-season (November-December) survey of recruitment and residual stock. This survey enables the start date of the fishery to be determined and allows the spawning stock to be managed.

BRDs

Trials are underway to develop effective and efficient bycatch reduction devices (BRDs) for the Shark Bay prawn and scallop fleet and by 2003, as a condition of their managed fishery licence, the entire fleet will be required to use BRDs to exclude large animals and objects from their nets. Scallop vessels trawl at much slower speeds (2-2.5 knots) compared with the prawn vessels (average 3.5-4 knots), allowing most large animals and fish to orientate their bodies and swim out of the nets.

Existing seagrass beds are unlikely to be damaged by trawling, as the fishing for prawn occurs in the deeper waters of Shark Bay where there is either limited or no seagrass.

Commercial fishing

Currently, there are nine beach seine and mesh net commercial fishing licences in operation in Shark Bay, targeting whiting, mullet, tailor and bream. This is a minor fishery and one of the longest running viable fisheries in Western Australia. This fishery is limited entry with restricted family-only licence transfers and gear limitations, which ensure that virtually all fish caught are mature and there is little bycatch. The commercial catch of pink snapper by licensed seine fishermen was less than 300 (600kg) in 1999, whilst the recreational catch was about 5 404 (14 tonnes).

Recreational fishing

Shark Bay is one of Western Australia's premier recreational fishing destinations and the protected marine embayments of the western and eastern inner gulfs offer high quality fishing opportunities for small boat and shore-based anglers for key target species such as, tailor, whiting, mulloway, groper, cod, mackerel and tuna. Pink snapper has long been an icon species for the area. In recent years, the popularity of Shark Bay as a fishing destination has meant that fish populations in the inner gulfs south of Cape Inscription have come under increasing pressure and require careful management in order to ensure their future.

A boat ramp and shore catch survey conducted by the Department of Fisheries in 1998 and 1999, indicated that anglers fished for about 51 000 days in Shark Bay, 40 000 in the western gulf and 11 000 in the eastern gulf. Fishing activity is highest during the winter months between April and August. The catch survey confirmed that the key species by number landed by anglers were pink snapper and black snapper, with an estimated 12 000 pink snapper (or 37 tonnes) landed from the western inner gulf during that year.

Pink snapper reach large sizes but are generally slow growing and take between four and five years to reach maturity. A pink snapper over a metre in length and 10 kilos in weight, would be up to 30 years old. The populations of Shark Bay are very small by comparison with ocean fisheries elsewhere in the world, and the sustainable take from these stocks is therefore in the tens of tonnes, rather than hundreds of tonnes.

Stocks of pink snapper in the inner gulfs of Shark Bay are genetically separate from each other and the wide-ranging ocean stock. In 1997, following research which identified that adult stocks of pink snapper were at a critically low level, the eastern gulf was closed to the take of pink snapper. Since the closure, adult stocks have increased from less than twelve tonnes to an estimated 95 tonnes in 2001. In the western inner gulf, adult snapper stocks had also fallen to 25 tonnes in 1999, but appear to have stabilized at about 80 tonnes.

Key elements in the management package for re-building western inner gulf pink snapper stocks are:

- re-building adult stock size to a minimum target of 230 tonnes
- managing a reduction in the amount of pink snapper taken in the western inner gulf by recreational fishing,
- providing additional protection for aggregations of spawning pink snapper,
- identifying and addressing potential interactions between the commercial Shark Bay prawn trawl fishery and Denham Sound pink snapper stocks.

In the western gulf, a daily bag limit of two pink snapper per fisher applies and in order to protect adult breeding fish, only one of these may be over 70 cm in length. All pink

snapper less than 50cm in length must be returned alive to the water. Freycinet Estuary (south of Goulet Bluff) is closed to fishing for pink snapper from 15 August to 30 September to protect vulnerable snapper spawning aggregations and allow stock to rebuild.

A written exemption to take more than the inner gulf limits must be obtained from the Department of Fisheries prior to catching pink snapper north of Turtle Bay and a zero bag limit for pink snapper applies to the eastern inner gulf. The Department of Fisheries regularly reviews these regulations dependent on findings from an intensive on-going research program.

Aquaculture

Pearl oyster culture, non *Pinctada maxima*, is a newly developed industry which has already attracted considerable investment, with commercial culture expected over the next three to five years. Large pilot trial harvests will occur in the next two years and in 3-5 years, more of the current licensees will be producing larger crops. The production is almost totally hatchery based (for *P. margaritifera*), however some shell can be collected under oyster fishing licences issued to obtain fresh broodstock for hatchery use. The Shark Bay pearl oyster (*Pinctada albina*) is collected under the same licence with the collection of up to 50 000 shells permitted owing to the abundant beds found in the region.

Pond or sea cage methods are not employed, with hatcheries used for producing the juveniles. The pearl oysters are grown on standard surface or sub-surface long-lines. Whilst there are currently 10 aquaculture licences in Shark Bay, including 7 non maxima pearl aquaculture licences (operated by three companies), there is only one land based pond and tank culture operation within the Property. In terms of potential production value, the pearl production alone in 5 to 10 years could be a multi million dollar industry in the region based on an estimate of 100 000 pearls per year at an average of \$100 per piece.

Aquaculture projects in Western Australia are administered under the *Fish Resources Management Act 1994*. The Executive Director of the Department of Fisheries may grant aquaculture and pearling licenses subject to a number of conditions being satisfied. The normal process for assessment of aquaculture and pearling proposals requires:

- the consideration of advice from and the approval of relevant decision making authorities (in the Property, this also includes the World Heritage advisory committees),
- consultation with other relevant agencies and groups
- advertising in the press to provide an opportunity for public comment,
- and in some cases,
- referral to the EPA via the DEP for either a formal or informal environmental impact assessment under the *Environmental Protection Act 1986*.

The marine environment of Shark Bay is still considered to be largely undamaged, despite these commercial fisheries.

Conservation Areas

At the time of nomination of the Property, existing conservation reserves totaled approximately 200,000ha and mainly consisted of small island nature reserves, Bernier and Dorre Islands and the Hamelin Pool Nature Reserve.

Since inscription, Francois Peron National Park (52 530ha), Shell Beach Conservation Park (517ha), Monkey Mia Reserve (477ha), Zuytdorp Nature Reserve (additional 50 000ha) and Nanga pastoral lease (175 000ha) have been added to the conservation estate. With the gazettal of the Shark Bay Marine Park (748 725ha) in 1990, incorporating the Hamelin Pool Marine Nature Reserve, the total formal conservation area of the World Heritage Property is approximately 1.2 million hectares.

Negotiations have recently been concluded for the acquisition of the coastal portion of the Yaringa pastoral lease (30 464ha) which adjoins the Hamelin Pool Nature Reserve. Apart from its very high conservation values, the land will have strategic significance in bordering the World Heritage Property. Negotiations in relation to the acquisition of the remaining pastoral leases within the Property are on-going.

Visitor Numbers

The road into Shark Bay from the North West Coastal Highway was sealed in 1985 and from Denham to Monkey Mia in 1988. There were four caravan parks operating in the region, with 344 licensed bays, when the Shark Bay Region Plan was released in 1988. In addition, there was one hotel/motel with 14 units and 41 self-contained accommodation cottages.

There are currently (May 2002), 220 self-contained motel/chalet units offering accommodation within the World Heritage Area, which includes operations at Monkey Mia, Denham, Nanga and Hamelin. There are an additional 15 rooms providing designated 'backpacker' accommodation. Three caravan parks operate in the town of Denham, plus one at Monkey Mia and one each at Nanga and Hamelin Pool. In all, there are 425 licensed caravan bays and 120 tent sites.

Visitor numbers to Monkey Mia totalled 93 317 in 1991 and 101 946 in 2001, representing an overall increase of less than 10 000 over the ten years (see table below of visitation statistics by month and year).

The permanent residency growth of the area between 1978 and 1988 equalled 2.7%, with the 1986 Shire population estimated at 690. There were 960 permanent Shire residents in 2001, which equates to a 39% increase over 15 years.

The relatively low increases in both visitor and permanent resident numbers over the past ten years or so, would indicate that the prediction in 1991 of a dramatic increase in visitor numbers to the area has yet to eventuate.

Table 1 - Visitation Statistics - Monkey Mia Reserve 1991 – 2001

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
January	7,019	8,345	6,966	6,799	7,339	6,361	5,452	7,171	7,321	5,932	7,768
February	2,673	3,349	2,904	2,985	3,020	3,114	2,326	2,681	3,145	2,899	2,737
March	4,319	3,864	3,404	4,161	3,970	4,179	4,767	3,872	3,791	3,737	4,003
April	7,312	8,653	7,499	8,141	7,810	8,326	8,637	9,984	10,645	10,286	10,452
May	5,737	5,255	4,441	5,085	4,568	4,912	6,161	5,987	6,772	6,495	6,803
June	6,110	5,157	5,001	5,332	5,523	5,424	5,503	5,456	6,846	5,662	6,855
July	12,782	11,681	12,780	12,191	11,091	10,051	13,560	13,221	12,894	10,918	12,112
August	10,332	9,235	9,246	10,775	9,805	10,130	10,035	11,907	12,545	9,908	11,411
September	12,602	11,011	10,051	10,629	9,902	10,915	12,483	14,234	13,636	10,553	12,427
October	13,211	10,260	10,934	11,157	9,771	9,915	11,663	13,011	11,919	10,048	13,234
November	5,314	4,164	4,620	4,864	4,893	4,934	5,780	7,076	7,063	5,928	6,993
December	5,906	5,409	5,374	6,773	5,602	5,411	6,841	7,481	6,499	6,582	7,151
Total	93,317	86,383	83,220	88,892	83,294	83,672	93,208	102,081	103,076	88,948	101,946

Indicative Values Table

The EBPC Act prohibits actions that have a “significant impact on the World Heritage values of a declared World Heritage property”, unless the action is approved, or in accordance with an accredited management plan. The World Heritage values of a property are the natural heritage and cultural heritage contained in the property, which have the same meaning given by the World Heritage Convention.

The following indicative World Heritage values table includes examples of the World Heritage values for which Shark Bay, Western Australia was listed for each World Heritage List criterion. These are, in the Commonwealth’s view, the statements of the outstanding universal values of each World Heritage property. While these examples are illustrative of the World Heritage values of the property, they do not necessarily constitute a comprehensive list of these values.

Natural criteria against which Shark Bay, Western Australia was inscribed on the World Heritage List in 1991.	Examples of World Heritage values of Shark Bay, Western Australia for which the property was inscribed on the World Heritage List in 1991.
<p>Criterion (i) outstanding examples representing the major stages of the earth's evolutionary history.</p>	<p>Shark Bay contains, in one place, the most diverse and abundant examples of stromatolitic microbialites in the world which are analogous to structures that were the dominant benthic ecosystems on Earth for 3,000 million years. The World Heritage values include:</p> <ul style="list-style-type: none"> • diverse and abundant examples of Stromatolites/Microbial mats; and • Hamelin Pool and L'haridon Bight environment.
<p>Criterion (ii) outstanding examples representing significant ongoing geological processes, biological evolution and man's interaction with his natural environment.</p>	<p>Shark Bay provides outstanding examples of processes of biological and geomorphic evolution, including the evolution of the Bay's hydrologic system, the hypersaline environment of Hamelin Pool and biological processes of ongoing speciation, succession and the creation of refugia. The World Heritage values include:</p> <ul style="list-style-type: none"> • steep salinity gradients due to development of banks and sills in the Bay (e.g. Faure Sill); • three zones caused by differing salinity levels - oceanic, metahaline and hypersaline (e.g. Hamelin Pool); • development of a landlocked marine basin forming a reversed estuary containing hypersaline waters; • vast, rare and scientifically important deposits of organic shells (<i>Fragum erugatum</i>), coquina, ooid shoals, lithified sediments, broad supratidal flats with evolution of subsurface evaporitic deposits and meromictic blue ponds; • modification of physical environment (e.g. build up of banks and sills, and water currents, caused by vast seagrass beds); • carbonate deposits and sediments (e.g. Wooramel Seagrass Bank); • Holocene deposits adjacent to Hamelin Pool and L'haridon Bight; and • evidence of ooid formation, submarine lithification and micritisation (e.g. Hamelin Pool). • three distinct biotic zones caused by salinity gradients; • restricted communities of marine organisms that have developed physiological adaptations to tolerate hypersaline conditions including bivalve <i>Fragum erugatum</i>, zooplankton; • great genetic variability in marine species (e.g. pink snapper, venerid clams); • stromatolites, benthic microbial communities; • high species diversity and density of bivalves; • seagrass-based ecosystems, including nutrient cycling, food chain, nursery grounds, variety of habitats and creation of steady-state hydrological conditions; • largest seagrass meadows in the world; • highly species-rich assemblage of seagrasses; • physical structure of Wooramel Seagrass Bank; • isolation of fauna habitats on islands and peninsulas, and evolutionary processes illustrated in fauna such as Rufous Hare Wallaby and Banded Hare Wallaby; • isolated populations of Australian mammals demonstrating evolutionary processes; • transition zone between major marine ecological provinces including the northern limit of a transition region between temperate and tropical marine fauna, with resulting high species diversity (e.g. 323 fish spp; 218 bivalve spp; 80 coral spp currently identified); • transition zone between the Southwestern Botanical province dominated by <i>Eucalyptus</i> species and the Eremean Province dominated by <i>Acacia</i> species and including: <ul style="list-style-type: none"> - 145 known plant species at their northern limit in Shark Bay; - 39 known plant species at their southern limit in Shark Bay; - 28 known endemic vascular plant species: and - vegetation of the southern Nanga and Tamala areas (contains the most pronounced overlap between botanical provinces); • the northern end of range for numerous southern faunal species ,

<p>Natural criteria against which Shark Bay, Western Australia was inscribed on the World Heritage List in 1991.</p>	<p>Examples of World Heritage values of Shark Bay, Western Australia for which the property was inscribed on the World Heritage List in 1991.</p>
	<p>including known species of herpetofauna (e.g. frogs, lizards, skinks, snakes); and avifauna;</p> <ul style="list-style-type: none"> • coastal end of range for arid-interior species, including numerous known species of herpetofauna (e.g. frogs, geckos, skinks, monitors); • examples of 'gigantism' in flora (e.g. tree heath vegetation south of the Freycinet Estuary); and • the diversity of plant and animal species (which includes an estimated 35% of Australia's total bird species).
<p>Criterion (iii) contain unique, rare or superlative natural phenomena, formations or features of exceptional natural beauty.</p>	<p>Shark Bay contains unique, rare and superlative natural phenomena and formations and features of exceptional natural beauty. The World Heritage values include:</p> <ul style="list-style-type: none"> • stromatolites which represent the oldest form of life on Earth; • Hamelin Pool which is the only place in the world with a range of stromatolites forms comparable to fossils in ancient rocks; • Wooramel Bank which forms part of one of the few marine areas of the world dominated by carbonates and is also the largest seagrass meadow in the world; • the diversity of landscapes formed by aridity, peninsulas, islands and bays; • the exceptional coastal scenery at Zuytdorp Cliffs, Dirk Hartog Island, Peron Peninsula, Heirisson and Bellefin Prongs; • wide sweeping beaches of shells at Lharidon Bight; • great natural beauty of inundated birridas such as Big Lagoon; • strongly contrasting colours of dunes and cliffs of Peron Peninsula; • abundance of marine fauna including dugong, dolphins, sharks, rays, turtles and fish; and • extensive annual wildflower displays associated with the richness of flora.
<p>Criterion (iv) contain the most important and significant habitats where threatened species of plants and animals of outstanding universal value from the point of view of science and conservation still survive.</p>	<p>Shark Bay contains important and significant natural habitats where species of plants and animals of outstanding universal value from the point of view of science and conservation still survive. The World Heritage values include:</p> <ul style="list-style-type: none"> • habitats for species of conservation significance; • species of conservation significance including: <ul style="list-style-type: none"> - plants (including at least 28 endemic vascular plant species, 11 of which occur on Tamala Sandplain and coastal zone), new species and expanded ranges for known species. - terrestrial animals (including the only populations or major populations of Burrowing Bettong -<i>Bettongia lesueur</i>, Rufous Hare-Wallaby -<i>Lagorchestes hirsutus</i>, Banded Hare-Wallaby -<i>Lagostrophus fasciatus</i>; Shark Bay Mouse - <i>Pseudomys praeconis</i>; and Western Barred Bandicoot - <i>Perameles bougainville</i>); - marine animals (including Dugong -<i>Dugong dugon</i>, representing an estimated one eighth of the world's population of this taxon, Humpback Whale - <i>Megaptera novaeangliae</i>, Green Turtle - <i>Chelonia mydas</i> and Loggerhead Turtle - <i>Caretta caretta</i>; - reptiles (including 9 known endemic species); and - birds.

II.4 MANAGEMENT

Management structures and administration

The Western Australian and Commonwealth Governments signed an agreement in 1997 on administrative arrangements for the property. The Agreement provides for management of the Property to be carried out by the Western Australian Government in accordance with Australia's obligations under the World Heritage Convention. In addition, a comprehensive program of management and administrative structures and planning processes has been implemented with the primary aim of protection and maintenance of Shark Bay's World Heritage and other values. Under the terms of the Agreement, a ministerial council and two advisory committees were formed.

Ministerial Council

The management of the property is directed and coordinated by a Ministerial Council comprising Ministers of the Australian Commonwealth and Western Australian Governments. The Ministerial Council is supported by the Western Australian Department of Conservation and Land Management (DCLM) and Environment Australia (EA).

The role of the Ministerial Council is to:

- coordinate policy between Western Australia and the Commonwealth on all matters concerning the Property;
- approve the Shark Bay World Heritage Property Strategic Plan and any revisions of it;
- provide advice to both Governments on:
 - management requirements
 - management plans
 - research and education
 - presentation and promotion
 - boundary modifications
 - community consultation and liaison; and
 - financial matters
- refer matters to the Community Consultative Committee and Scientific Advisory Committee and consider reports from these bodies; and resolve any dispute that might arise between the two Governments.

Scientific Advisory Committee

The role of the Scientific Advisory Committee is to provide advice to the Ministerial Council on:

- scientific research priorities which will contribute to the protection and conservation of the Property and understanding of its natural history;
- new information or developments in science relevant to protection, conservation, or presentation of the Property;
- the scientific basis of management principles and practices;
- appropriateness of research funded by agencies in terms of scope, quality and relevance to management of the Property; and
- maintenance of the outstanding universal values and integrity of the Property.

The membership comprises persons who have qualifications relevant to, and/or special interest in the protection and conservation of the Property (e.g. botany, zoology, ecology, marine science and geomorphology). The Chair of the Community Consultative Committee (or nominated representative) is also a member of the Scientific Advisory Committee.

Community Consultative Committee

The role of the Community Consultative Committee is to provide advice to the Ministerial Council on matters relating to the protection, conservation, presentation, and management of the World Heritage Property from the viewpoint of the community.

It comprises community representatives with knowledge or background in fields such as conservation, heritage, local government, fishing, tourism, Aboriginal matters, park management and/or agriculture. The majority of members must be residents of, or live in the vicinity of, the World Heritage Property.

The Chair of the Scientific Advisory Committee (or nominated representative) is a member of the Community Consultative Committee.

DCLM and Other Agencies

DCLM is the lead management agency for the Property, has primary responsibility for management of terrestrial and marine reserves vested with the Conservation Commission of Western Australia and Marine Parks and Reserves Authority (MPRA) respectively and also coordinates management of other tenures (within the Property) in relation to World Heritage related matters. EA has primary responsibility for implementing Commonwealth policy in relation to World Heritage.

Other Western Australian and local Government agencies involved in management of the Property are:

- Environmental Protection Authority
- WA Planning Commission
- Department of Fisheries
- Pastoral Lands Board
- Department of Mineral and Petroleum Resources
- Shires of Shark Bay and Carnarvon
- Department for Planning and Infrastructure
- Department of Agriculture
- Department of Land Administration
- Western Australian Tourism Commission
- Department of Environmental Protection
- Marine Parks and Reserves Authority
- Main Roads Western Australia
- Conservation Commission of Western Australia

Legislation

A comprehensive planning framework has been developed for Shark Bay based on the objectives of the World Heritage Convention and is primarily given effect through a range of Commonwealth and State legislation covering such matters as World Heritage, environmental protection, endangered species protection etc.

Owing to the diversity of land tenures and managing agencies and individual interests within the Property, a Strategic Plan is being prepared to develop a partnership between governments and the community. It will also provide a management framework designed to ensure the protection, conservation and presentation of the outstanding universal values of the Property. The strategic plan, while not intended to be a statutory document of any government, will fulfil the management planning requirements for the Property in accordance with the World Heritage Convention and the State/Commonwealth Agreement. Its legal basis will be provided by the various Acts and Regulations that are used to implement the strategies contained in the plan.

A range of detailed planning instruments have been or are being prepared for specific reserves (eg management plans for conservation reserves), aspects of resource utilisation (eg fisheries management paper) and specific management issues (eg tourism, roads etc). The objectives and strategies of these plans are to be consistent with the Strategic Plan where they may impact on World Heritage values.

From 16 July 2000, any proposed activity which may have a significant impact on the Property will be subject to the provisions of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), which regulates actions that will, or are likely to, have a significant impact on World Heritage values.

The Environmental Protection Authority (EPA) has State responsibility for environmental impact assessment under the Environmental Protection Act 1986 (WA). Any activity likely to have a significant effect on the environment can be referred to the Authority who must then recommend that the proposal be considered either informally or publicly.

National and State legislation and controls

The following is a list of the National and State legislation relevant to the management of Shark Bay, Western Australia.

Environment Protection and Biodiversity Conservation Act 1999 provides for the protection and conservation of world heritage properties and the application of an environmental impact assessment and approval process to activities that may have a significant impact on world heritage values. This Act replaced the World Heritage Properties Conservation Act 1983 and the Endangered Species Protection Act 1992.

Conservation and Land Management Act 1984 provides for DCLM to be responsible for the conservation of flora and fauna and for management of certain lands and waters including national parks, conservation parks, nature reserves, marine parks and marine nature reserves throughout the State.

Conservation and Land Management Regulations 2002

Wildlife Conservation Act 1950 provides for protection of native flora and fauna on all land and in all waters within State boundaries. DCLM is responsible for the administration of this Act.

Aboriginal Heritage Act 1972 provides for the protection of all Aboriginal sites and Aboriginal cultural objects in Western Australia.

Native Title Act 1993 provides for the recognition of native title rights and sets down some basic principles in relation to native title in Australia

Titles Validation Act 1995 provides for validation, under section 19 of the Native Titles Act 1993 of the Commonwealth, past acts attributable to the State, to provide for the effects of the validation, and to confirm certain rights.

Marine and Harbours Act 1981 provides for the control of navigation and shipping activities in all State waters.

Western Australian Marine Act 1982 provides for the regulation of navigation and shipping by the Department of Transport.

Fish Resources Management Act 1994 provides for the management of fish resources, and related purposes.

Fishing and Related Industries Compensation (Marine Reserves) Act 1997 provides for the payment of compensation to holders of Fisheries leases, licences and permits on account of the effect of gazettal of marine nature reserves and marine parks constituted under the *CALM Act 1984*.

Maritime Archaeology Act 1973 provides for the protection of wrecks and relics lost in State water before 1900.

Historic Shipwrecks Act 1976 provides for the protection of wrecks and relics lost in Commonwealth waters.

Town Planning and Development Act 1928 provides for the planning and development of land for urban and rural purposes.

Western Australian Planning Commission Act 1985 deals with the establishment of a body with responsibility for urban, rural and regional land use planning and land development, and related matters.

Local Government Act 1995 the Shires of Shark Bay and Carnarvon have By-Laws which prohibit or restrict certain activities in the Shires.

Land Administration Act 1997 deals with the allocation, tenure and lease of Crown land.

Soil and Land Conservation Act 1945 deals with the conservation of soil and land resources, and to the mitigation of the effects of erosion, salinity and flooding.

Agriculture and Related Resources Protection Act 1976 deals with the management and control of certain declared plants and animals, the preservation or control of the introduction and spread of exotic plants and animals, and other related purposes.

Commonwealth Petroleum (Submerged Land) Act 1967 provides for shared control between the Commonwealth and State for exploiting offshore petroleum resources. The *State Petroleum (Submerged Lands) Act 1982* allows petroleum permits to be granted in the State Territorial sea. The *State Petroleum Act 1967* provides for the granting of petroleum permits on land and internal waters. *Petroleum Pipelines Act 1969*.

Mining Act 1978 provides for exploration and mining to proceed in appropriate locations.

Environmental Protection Act 1986 provides for the prevention, control and abatement of environmental pollution, and for the conservation, preservation, protection, enhancement and management of the environment, and related purposes.

Shark Bay Solar Salt Industry Agreement Act 1983 is an agreement between the Western Australian Government and the Shark Bay Salt Joint Venture which requires Shark Bay Salt to operate in accordance with State environmental legislation and also contains provisions requiring on-going environmental investigation, monitoring and reporting for the duration of the project.

Management Plans and Guidelines

The following table lists management plans and guidelines that are applicable to the World Heritage Property.

PLAN TITLE	LEGISLATION	STATUTORY	DURATION	REVIEW
Draft Strategic Plan for Shark Bay World Heritage Property (in prep)	IGAE Intergovernmental Agreement on the Environment 1992. EPBC Act 1999, CALM Act 1984	No	10 years	not exceeding 10 years
Shark Bay Terrestrial Reserves Management Plan	CALM Act 1984 Land Admin Act 1997	Yes	2000-2009	not exceeding 10 years
Shark Bay Marine Reserves Management Plan	CALM Act 1984	Yes	1996-2006	not exceeding 10 years
Shark Bay World Heritage Property Management Paper for Fish Resources	Fish Resources Management Act 1994	Yes	1996- 2006	not exceeding 10 years
Shark Bay World Heritage Property Landscape Study		No	2001	As necessary
Tamala-Carrarang Recreation and Tourism Plan	Land Administration Act 1997 Caravan Parks and Camping Grounds Regulations 1997	No	1998- 2008	Minor- 5 yrs Major-10yrs
Communication and Interpretation Plan for the Shark Bay World Heritage Property (in prep)		No	2002-2007	5 years
Gascoyne Regional Ecotourism Strategy		No	1996	
Roads 2020 - Gascoyne Regional Road Development Strategy		No	1997	
Basic Raw Materials of the Shark Bay World Heritage Property	Environmental Protection Act 1986 Mining Act 1978	No	1996	

PLAN TITLE	LEGISLATION	STATUTORY	DURATION	REVIEW
A Quality Future for Recreational Fishing in the Gascoyne	Fish Resources management Act 1994	Yes	1999	5 years
Hamelin Pool Common Management Plan	Aboriginal Heritage Act 1972, Wildlife Conservation Act 1950, CALM Act 1984, Local Government Act 1995	No	2001	10 years
Shark Bay Regional Strategy	WA Planning Commission Act 1985	Yes	1997	5 years
Guidance for the Assessment of Environmental Factors - Guidance Assessment Proposals in the Shark Bay World Heritage Property - Guidance Statement No. 49	Mining Act 1978, CALM Act 1984, Acts Amendment (Marine Reserves) Act 1997, Environmental Protection Act 1986, EPBC Act 1999	No	2000	
Gascoyne Aquaculture Development Plan	Fish Resource Management Act 1994 Pearling Act 1990	No	1996	
Fisheries Environmental Management Review - Gascoyne Region	Fish Resource Management Act 1994	No	2000	
Environmental Values, Cultural Uses and Potential Petroleum Industry Impacts, Shark Bay World Heritage Area	Offshore Constitutional Settlement 1995, CALM Act 1984, Pearling Act 1990, Acts Amendment (Marine Reserves) Act 1997, EPBC Act 1999, Environmental Protection Act 1986, Petroleum Act 1967, Petroleum (Submerged Lands) Act 1982, Petroleum Pipelines Act 1967 and Regulations 1970, Pollution of Waters by Oil and Noxious Substances Act 1987.	No	2001	
Agreement Between the State of Western Australian and the Commonwealth of Australia on Administrative Arrangements for the Shark Bay World Heritage Property	Wildlife Conservation Act 1950, Sandalwood Act 1929 (WA), CALM Act 1984, Environmental Protection Act 1986, Fish Resources Management Act 1994 +	Yes	1997	Review as necessary to update or improve effectiveness
Monkey Mia Reserve Draft Management Plan	Local Government Act 1995, CALM Act 1984, Fish Resources Management Act 1994, Wildlife Conservation Act 1950	No	1993	not exceeding 10 years after approval

Contact details of manager

Executive Director
Department of Conservation and Land Management
Locked Bag 104
Bentley Delivery Centre
Western Australia 6983

Staffing, Financial and Training Resources

Staffing in the World Heritage Area relates to DCLM's management of vested lands and waters within the World Heritage Property and consists of a district manager, plus twenty four full time staff and six casuals, working across terrestrial and marine reserves. In addition, there are two officers dedicated full time to World Heritage, one involved with interpretation and communication and the other co-ordination of projects and funding, as well as carrying out the function of executive officer to the advisory committees. Both of these officers are on contract and are fully funded by the Commonwealth.

Currently the budget for DCLM operations in the district is approximately \$643 000 per annum from consolidated revenue funds, with the Project Eden budget an additional \$420 000, as part of the DCLM Western Shield program. Operations at Monkey Mia Reserve are funded via a trust fund whereby revenue raised as an entry fee and other charges such as commercial licence fees, are utilised to off-set the costs involved in conduct of management of the Reserve and supervision of the inshore bottlenose dolphins. Estimated budget for Monkey Mia this year is approximately \$637 700.

The Department of Fisheries expends in excess of \$500 000 annually for fisheries management in the World Heritage area.

Commonwealth funding for projects within the World Heritage Property varies significantly each year, from a high of \$674 480 in the 1997/98 round, to \$200 796 in 2001/02. DCLM operational staff are involved in the majority of work associated with World Heritage related projects funded through the Commonwealth. At the time of inscription of the Property, there was only one full-time officer employed with DCLM in Denham. Currently, there is 34 staff, including casual officers and Aboriginal trainees, and Commonwealth funding of World Heritage projects has indirectly contributed to these staffing levels.

Computer systems purchased utilising Commonwealth World Heritage funds, are used exclusively by the two contract officers funded by the Commonwealth. The system uses Office 2000 Professional and Outlook 2000 Professional software on both local area and wide area networks, connected via the DCLM Web throughout the state of Western Australia. The other twelve computers also located in the Denham district office of DCLM, operate on the same system and are all networked, with email and internet access.

Economic, cultural and social effects

The increase in DCLM and World Heritage staff in Denham and Monkey Mia, has significantly added to the overall population of the area, when considering partners and

children. Income from DCLM directly supports approximately 10% of the population of Denham, with fourteen of the current contingent of DCLM staff having been employed locally.

One of the more obvious economic impacts of escalating staff numbers on the local community, is the increase in spending on food, housing, fuel, entertainment and other similar necessities. Demand for extra services, with the resultant business expansions, is also a flow-on of additional government and personal vehicles, of the tendering of contracts to local tradesmen and of increased construction proposals relating to World Heritage projects within the district.

The flow-on to the region from World Heritage funded projects has impacted on the local economy and provided additional infrastructure to the area, benefits of which include;

- the construction of carparks, boardwalks and roading,
- erection of signage,
- hire of local charter operators (vessels, coaches, aircraft),
- contracting of venues, accommodation and catering,
- development of recreation sites, and
- provision of toilets at Steep Point.

Education, Interpretation and Awareness Raising

Community education and participation in management is an important means of generating community understanding and support for the World Heritage Property.

The World Heritage Property provides an opportunity to inform the public of the high conservation values of Shark Bay. Appreciation of these values encourages visitors in general to take a responsible approach to use of the area as well as improving the quality of the experience. Nature-based tourism provides an exciting opportunity to interpret the natural features to visitors. Effective provision of information through signs, interpretive facilities, written publications, tourist facilities, tour operators and through personal interaction with agency officers is crucial to interpreting the natural features.

There have been a variety of individuals and organisations providing information about Shark Bay in a range of locations, using varied techniques and media. This has created a situation whereby a high percentage of both visitors and residents have had some understanding of the importance of World Heritage listing and also of what features of natural significance are found in the Property. Coordination of these programs and consistency of information provided is important to ensure accurate information is disseminated, and to maximise the opportunities that exist in Shark Bay for interpretation of World Heritage values.

In August 2001, a Denham-based community education coordinator was appointed and one of the major projects for this position is to develop a comprehensive communications and interpretive plan for the Property, in consultation with the local community and key stakeholders. A comprehensive questionnaire has recently been completed by key stakeholders and the information collected will provide direction and community-based outcomes for communications and interpretive planning, and eventually, the compilation of a detailed plan for the World Heritage Area.

The communications program model which has been developed, aims to:

- increase awareness, understanding and support of the Area among residents, stakeholders and visitors,
- enhance cooperation between community and World Heritage management organisations,
- and, encourage residents and visitors to protect the World Heritage values of the Property.

It will include strategies such as; training, induction and accreditation programs, sign and graphics manuals, performance indicators and evaluation methods for communications and interpretation. The introduction of an accreditation program for tour operators and guides will be beneficial in distributing consistent information to the public with regard to the Property.

Both slide and power-point presentations regarding World Heritage Property values have been provided to various community groups, including local school children, in recent months. Posters have been produced and are displayed in the local DCLM office, at community events - such as a recent Regional Expo in Carnarvon - and on noticeboards around Denham townsite. Each month, in the publication of the local Shark Bay community newspaper, The Inscription Post, an article is published which provides information on the outstanding values and attributes of the Property. A display system, incorporating graphic panels depicting elements of the Property, has been acquired and is utilised at all appropriate events, both within the region and elsewhere in the State. The other main educational and interpretive materials available to the general public include:

- a glossy newspaper style magazine 'A Guide to the Shark Bay World Heritage Property' - which provides information on World Heritage and the values of the Property in addition to other attractions in the area,
- a landsat poster of the Property showing the boundary with photographic inserts of some of the values and brief text, and
- a collection of 25 pages of World Heritage Notes in a folder, each page providing information on various aspects of the Property.

The Department of Fisheries produces a suite of fish, aquatic habitat, fisheries and catch care publications for the World Heritage area. They also produce and distribute an adhesive fish ruler specifically for Shark Bay, which allows fishers to return undersize and excess fish alive to the water. By measuring them soon after they are caught, less trauma is experienced by the fish. The Department, often in conjunction with DCLM, conduct holiday activity programs for families in peak school holiday periods. The World Heritage website (www.sharkbay.org) is also linked to the Department of Fisheries website (www.fish.wa.gov.au).

A key component in the provision of information is the establishment of a World Heritage Interpretive Centre. The Shark Bay Regional Strategy recommended the development of a World Heritage Interpretive Centre in Denham. A concept plan to develop the Interpretive Centre in Denham, has been completed by the Shire of Shark Bay, with funding of \$A5m secured from the State Government for construction of the building and \$A1m from the Commonwealth for the provision of interpretive materials. In addition to other stakeholders, the Malgana Working Group (representing the local

native title claimants) will contribute to the interpretive component of the Centre. The Centre's facilities and information will provide opportunities to interpret the values of the Property and also World Heritage globally.

There are also other opportunities for the provision of information on the cultural heritage of Shark Bay. For example, there are sites in the Property that provide an opportunity to interpret the indigenous heritage and pastoral history of the area. Further, Cape Inscription provides an opportunity to interpret the early European exploration of Australia. Shark Bay has a long history of visits by European explorers. Dirk Hartog landed at Cape Inscription in 1616 and is the first known European to land on the Australian coast. Dutch navigator, William de Vlamingh visited Cape Inscription in 1697 and Englishman, William Dampier subsequently explored the area in 1699, naming the area "Shark's Bay".

Scientific and Technical Studies

Appendix IV provides a list of scientific and technical studies undertaken in Shark Bay with relevance to the World Heritage values.

Strategic Framework for Marine Research and Monitoring

This report outlines a framework for identifying marine research and monitoring priorities for the conservation and management of the Shark Bay World Heritage Property. A methodology to assess and rank research and monitoring projects seeking World Heritage funding is also outlined. Significant aspects of this framework are derived from the outcomes of a workshop on this issue.

Of highest priority are the development of Property-wide primary physical, biological and social datasets and a comprehensive database of past and current research. This information provides the basis for a risk assessment framework from which research and monitoring priorities are derived. These datasets include an adequate understanding of the physical environments (water circulation and transport), comprehensive marine resource inventories (habitats, marine wildlife seasonal movements, etc) and human usage patterns, trends and implications of this use on the ecology. An understanding of the nature and extent of current scientific knowledge is also essential. Without this basic information, it is difficult to develop meaningful research and monitoring programs.

Monitoring priorities should be determined on the basis of the relative conservation and socio-economic significance of the values and the relative level of human pressure on these values. In this case, the most significant and the most threatened values should be the highest priority for funding.

Changes in Ownership and/or Legal Status

The 1988 Shark Bay Region Plan recommended some changes in tenure, a number of which have been implemented. Additional tenure changes to improve management and protection of Shark Bay's natural values have been recommended in the Shark Bay Region Strategy (1997), the Shark Bay World Heritage Property Management Paper for Fish Resources (1997) and the Shark Bay Terrestrial Reserves Management Plan (2000-2009).

Discussions are progressing in relation to changes of tenure for Dirk Hartog Island pastoral lease and part of Carrarang pastoral lease. Nanga pastoral lease (175 000ha) was purchased jointly by the State and Commonwealth Governments in October 2000. Tenure change is proposed for a small area of jointly vested reserve at Monkey Mia, which will be transferred to the Conservation Commission of Western Australia. This area includes the newly developed Monkey Mia Visitor Centre.

Faure Island pastoral lease (6 000ha) has been purchased by the Australian Wildlife Conservancy for the purpose of conservation and for use in the establishment of secure populations of several native mammals currently surviving solely on offshore islands in Shark Bay. Feral cats were eradicated from Faure Island in 2001 in an operation conducted for the AWC by DCLM. Faure is now managed as a pastoral lease for sustainable conservation outcomes.

A native title claim by the Malgana People has been registered with the National Native Title Tribunal and encompasses most of the Property. A determination by the Tribunal with regard to the validity of the claim has yet to be considered.

Responses to ACIUCN Reactive Monitoring Reports

In 1997 the World Heritage Committee requested the Australian Committee for IUCN (ACIUCN) to prepare reports on the condition of the Shark Bay World Heritage Property (amongst others).

An initial report compiled by ACIUCN on the state of conservation of Shark Bay contained 15 recommendations for the future management of the Property, covering a range of issues identified as being potential threats to its integrity. ACIUCN subsequently synthesised the 15 recommendations into a more focussed and pro-active format. Five priority action areas have been identified by ACIUCN:

- Overall Management Framework
- Minerals and Petroleum – Exploration and Extraction
- Biological Resource Harvest
- Invasive Species
- Visitor Management

A State Party response to the ACIUCN report was developed jointly by the Commonwealth and Western Australian Governments, including a brief background on each of the five priority action areas, followed by a table setting out actions proposed to address the concerns raised by ACIUCN, the responsible agency/ies, the priority for each action and related achievements and commitments.

Australia's response to the ACIUCN was subsequently accepted by the World Heritage Committee at its twenty fourth session in Cairns, Australia, 27 November to 2 December 2000. For details of the recommended actions and responses, see pages 59 - 70 of this report. *[An extract containing actions identified from Australia's response is at Appendix II]*

II.5 FACTORS AFFECTING THE PROPERTY

Development Pressures

Minerals and Petroleum – exploration and extraction

At the time of nomination, a number of mining activities were occurring or were proposed within or adjacent to the Property prior to World Heritage listing. These included solar salt production and shell extraction, and Shark Bay was accepted for inscription on the World Heritage List on this basis. The solar salt production lease and previously worked gypsum leases were excluded from the Property, as they were highly modified areas. The cancelled gypsum mining leases at Brown Inlet are excluded from the Property.

Mineral resource development

Any future proposals for mineral resource exploration and development will be subject to assessment that they may be undertaken provided they can be carried out in a manner that is consistent with the protection of World Heritage values. In applying this test, it is clear that mineral resource development in some parts of the Property will not be compatible with the protection of World Heritage values. In these parts of the property, mineral resource exploration and development will not be permitted. The Western Australian Government has already identified a number of such areas by declaring that drilling for petroleum exploration and development would not be permitted in Hamelin Pool Nature Reserve or in sanctuary and recreation zones of the Shark Bay Marine Park.

Applications are currently active to evaluate mineral sands extraction in the southern terrestrial portion of the Property. At the moment, this is occurring outside the Property and any proposal to explore within the Property will be viewed in accordance with the assessment process set out in the 1997 Inter-governmental Agreement and relevant State and Commonwealth legislation, and will be subject to the above test regarding the protection of World Heritage values. Those areas where the exploration permit extends into the Property are currently the subject of a ‘no mining’ condition.

Basic raw materials

A variety of basic raw materials are extracted from the Property and are primarily used in local construction activities, these include gravel sand, limestone, gypsum and shell grit. Authority for the approval for extraction is vested in a number of different agencies and private landholders, depending on the tenure of the land involved. Standards of management of basic raw materials extraction and rehabilitation vary depending on the operator and the controlling authority. These activities have the potential to impact particularly on the aesthetic values of the property. Where such activities are likely to have a significant environmental impact, they are subject to assessment under State and Commonwealth environmental protection legislation.

Shell mining

The *Fragum* deposits at L'haridon Bight are one of the identified World Heritage values of the Property and Australia is committed to their sustainable management. Research has been undertaken on accretion rates of *Fragum*. Conditions imposed by the Environmental Protection Authority regulate shell extraction to ensure that it is sustainable in the long term. Further research is required to refine management criteria for the sustainable use of the resource. Shell extraction and processing infrastructure has the potential to impact on aesthetic values and will be managed to address this.

Coquinite (consolidated *Fragum* shell) is extracted from a quarry reserve near the Hamelin Pool Telegraph Station. This resource is limited and as such must be carefully managed. The Shire of Shark Bay manages this area in accordance with the Hamelin Pool Common Management Plan which was finalised in March 2001. Coquinite has been traditionally used in the construction of buildings, many of which have heritage value. Continued strictly regulated use of the deposits is necessary for the maintenance of these heritage buildings.

Shell deposits are extracted from a mining lease and a quarry on Reserve 41076 adjacent to L'haridon Bight. The shell deposits are used primarily for the production of high quality extender and filler material. The mine provides granulated shell for the poultry industry, which aids in egg production and hardening of shells. It is also used as a basic raw material within the Shark Bay area. Extraction is currently undertaken according to the conditions of an environmental management plan and any new proposals would require environmental assessment in accordance with State and Commonwealth legislation.

Petroleum resource development

Petroleum resource development and associated infrastructure have the potential to adversely affect World Heritage values through disturbance of the seabed and consequent impacts on geomorphological and/or biological processes. Australia is committed to ensuring that no petroleum development will be permitted where it may threaten World Heritage values.

In 1994, the then Western Australian Government announced its policy on petroleum exploration and development in marine conservation reserves. This policy prevents drilling or production in Marine Nature Reserves or in Sanctuary or Recreation Zones in marine parks. These activities are permitted in General Use Zones where it has been established that such activities will not impact on sensitive marine habitats. Drilling and production will not be permitted in Special Purpose Zones where they are not compatible with the purpose of the zone. Seismic surveys may be permitted into areas that are not available for drilling. Any proposals for exploration or production are referred under the State and Commonwealth environmental protection legislation.

Those parts of the Property excluded from drilling and production under these provisions are: Hamelin Pool Marine Nature Reserve, 8 Sanctuary Zones and 3 Recreation Zones (about 7.5% of the total area of the Property). There are also 6 Special Purpose Zones (8%) within the Shark Bay Marine Park where such activities

may not be allowed if assessed as incompatible with the conservation purpose of the zone.

The Shark Bay Region has not seen active petroleum tenements for over 20 years. However, one petroleum exploration tenement currently exists in the Property, extending from Bernier and Dorre Islands to the Carnarvon coast.

The policy to be applied in relation to petroleum resource development in the Property is currently under review (Environmental Values, Cultural Uses and Potential Petroleum Industry Impacts, August 2001). In order to progress this review, the Intergovernmental Agreement sets out a process for addressing the issue of whether petroleum exploration and extraction is compatible with the protection of World Heritage values. Ultimately the Shark Bay Ministerial Council will decide whether petroleum exploration and development are compatible with the protection, conservation and presentation of the Property, and if so, will agree on a framework for the administration and regulation of these activities.

From 16 July 2000, any proposal for petroleum industry activity which may have a significant impact on the Property would be subject to the provisions of the Commonwealth EPBC Act.

Salt production

The Shark Bay Salt operation at Useless Loop and Useless Inlet was established in 1965, prior to World Heritage listing. The area was excluded from the Property because it had been highly modified and would not meet the required conditions of integrity. Some activities of the operation occur within the Property. It is important to ensure that rigorous controls and monitoring are applied to any of the operation's activities that may impact on the Property to prevent or minimise any adverse effects.

The salt operation is managed in accordance with *the Shark Bay Solar Salt Industry Agreement Act 1983*, an agreement between the Western Australian Government and the Shark Bay Salt Joint Venture. The Agreement requires Shark Bay Salt to operate in accordance with State environmental legislation and also contains provisions requiring on-going environmental investigation, monitoring and reporting for the duration of the project. Environmental reporting is on a three-year cycle of two annual interim reports and a detailed triennial report. The reporting process allows the State or the developer to seek amendments to existing environmental programs.

All salt extracted from the Useless Loop operation is sold for export, using about 40 ship loadings per year and with an output in 2001 of just over 900 000 tonnes. At current average Australian prices, this export is valued at approximately \$A25m. There is a workforce of 57 people employed at the salt works

The most significant potential impacts on World Heritage values from the salt operation are risk of oil spillage from ships loading salt for export and the possible introduction of exotic biota from ballast water discharge. These issues are addressed elsewhere in this report.

Bitterns and additional discharges from the salt operation and other operations such as dredging of shipping channels, will be managed in such a way that there is no

significant adverse impact on World Heritage values.

In September 1999, the State Government passed a variation to the Shark Bay Solar Salt Industry Agreement Act 1983, allowing for the submission of a lease extension proposal for the solar salt operation at Useless Loop. This lease extension would expand into the World Heritage Property and it is possible that a proposal will be submitted in the near future. Before any development could proceed, a mining lease under the Mining Act would be required and the proposal would be subject to environmental assessment under both State and Commonwealth legislation. Any proposed extension to the salt works would be subject to the provisions of the EPBC Act. Following assessment, a decision would be made as to whether, and under what specific conditions, development might be permitted

Biological resource harvesting

Fishing and aquaculture

Commercial fisheries are an important economic and social feature of Shark Bay worth approximately \$A50 million and employing about 1 000 people in the region. Some aquaculture (including pearling) occurs in Shark Bay. Recreational fishing is a major activity of visitors and locals and is a significant tourist attraction. Commercial and recreational fishing occurred prior to World Heritage Listing.

Commercial and recreational fishing and aquaculture operations are controlled and regulated under the *Fish Resources Management Act 1994* (WA) and managed by Department of Fisheries on the basis of ecological and fish stock sustainability. The Department of Fisheries has prepared a management paper for the fish resources in the Property. This paper addresses potential impacts on World Heritage values by fisheries activities and recommends appropriate management strategies to ensure maintenance of these values. This has been prepared in conjunction with, and complements, the Shark Bay Marine Reserves Management Plan prepared by DCLM for the marine reserves in the Property. The management paper provides a detailed basis for management of Shark Bay's fish resources.

The demand for sites for aquaculture within the waters of Shark Bay is increasing (refer to Maintenance of Values). Careful planning for the future development of this industry is required so as not to adversely impact on the marine environment and aesthetic values.

The Department of Fisheries has prepared an Aquaculture Development Plan for the Gascoyne (1996), which includes the Shark Bay area. The Plan identifies areas potentially suitable for aquaculture activities taking account of environmental conditions and the needs of other user groups. The Plan also identifies possible environmental impacts which could result from aquaculture activities and management actions which may mitigate these impacts.

The Department of Fisheries is committed to the implementation of Ecologically Sustainable Development (ESD) for the management of the State's fish resources. Since the idea of ESD was developed and discussed at the Earth Summit in Rio in 1992, a lot has been done in developing a way to apply it to a whole range of diverse industries, especially those that use natural resources. The *Fish Resources Management Act 1994*

allowed the Department to take a more pro-active role in the sustainable management of marine, estuarine and riverine ecosystems and establish a Fish and Fish Habitat Protection Program.

In accordance with the national strategy, ESD considers environmental, social and economic well-being issues associated with the activity being examined. A National ESD framework for fisheries has been created. Each fishery can be assessed, taking into account issues such as technological changes, natural cycles of fish species, market supply and demand, and job creation in new fisheries. By 2003, only fisheries that harvest in an ecologically sustainable manner, i.e. can show that their fishing operations and methods are not endangering any species or ecosystem, will be allowed to continue operation and be granted export approval. Environment Australia is the body responsible for assessing whether a fishery is able to demonstrate that it is harvesting in an environmentally sustainable manner

Pastoral use

Approximately 42% (277 770ha) of the terrestrial area of the property is currently Crown land leased for pastoral use. Given this large area of the Property under lease, pastoralists are important resource managers in the Property. They are consulted wherever the management of the property impacts on pastoral leases.

Pastoral leases are managed in accordance with the Land Administration Act and administered by the Pastoral Lands Board. The lessee is subject to many requirements including those related to rent, improvements to the property, stocking levels, land degradation, and cultivation of exotic species and vegetation clearing.

Leases with a seaward boundary are generally not fenced along the coastal strip and in some cases stock graze the coastal fringe. Fencing is generally not required and grazing which occurs outside the lease is permitted provided World Heritage values are not threatened. Any fencing required will be carried out in liaison with relevant pastoralists.

Activities on pastoral leases that may impact on World Heritage values must be properly managed to avoid any adverse impacts. Such activities include overstocking, clearing of native vegetation, introduction or enhancement of exotic species and increased use of feral animals as commercial stock.

Environmentally significant activities will be subject to the environmental impact assessment process under relevant State and Commonwealth legislation (including the EPBC Act).

Other land uses

A number of smaller commercial industries utilise natural resources within the Property. These include craft wood production, wildflower picking, seed collecting and apiculture. There is potential for other natural resource use industries to develop in the Property. To ensure that World Heritage values are adequately protected, any new resource development will be appropriately assessed before commencing.

There is increasing interest in the establishment of land bases for aquaculture and for the use of artesian water for aquaculture. These proposals will be evaluated by existing mechanisms, i.e. consideration by Department of Fisheries in consultation with the interdepartmental Committee on Aquaculture and the application of environmental impact assessment processes, including those provided for under the EPBC Act.

Harvesting by indigenous people

Use of flora and fauna by Aboriginal people is provided for under the *Wildlife Conservation Act* 1950. Flora and fauna can be taken by Aboriginal people as food for consumption (not sale) except for species declared as threatened or specially protected under the *Wildlife Conservation Act*. The only exception is the dugong, which, although classified as a species in need of special protection, may still be taken. Species that are known to be taken include small numbers of dugong, green turtles and kangaroos.

Hunting has been addressed in the Shark Bay Marine and Terrestrial Reserves Management Plans and there are attempts currently underway to involve the local indigenous population in the management of hunting. The taking of flora and fauna outside of the marine and terrestrial reserves will be managed in accordance with relevant legislation and policy. The local indigenous community has a high conservation ethic and is actively involved in management.

The use of fish resources by Aboriginal people is managed through the Fish Resources Management Act. This use has been considered in the Shark Bay World Heritage Property Management Paper on Fish Resources.

It is important that the Aboriginal use of resources is monitored to ensure that World Heritage values are not threatened. If certain activities have potential to impact on these values, then, in liaison with local communities, the issue will be reviewed and appropriate action taken.

Environmental Pressures

Invasive Species

The major environmental pressure on Shark Bay's World Heritage values arises from the presence, and potential introduction, of foreign organisms including feral animals, weeds and exotic marine organisms.

Feral animals

Feral and introduced animals pose a threat to the values of the Property through predation, competition and habitat modification. The most significant are foxes, cats, rabbits and goats. These species predate on native fauna, compete for food and shelter and damage native plants, habitats and landforms. At present there are no feral animals on Bernier and Dorre Islands Nature Reserve as feral goats were eradicated in the 1980's. Given the conservation significance of the islands for five threatened mammal species, the potential for the introduction of feral animals (particularly predators) is a threat.

Landowners, managers and occupiers are responsible for controlling and eradicating feral animals declared under the Agriculture and related Resources Protection Act, including foxes, rabbits and goats, which along with cats, represent a major threat to some of the Property's values. Significant and successful control programs for feral animals have been implemented in various parts of the Property. Cooperation between management agencies and landholders has been a key to the success of these programs.

For example, Project Eden was commenced in 1994 to control feral animals on the Peron Peninsula to enable the reintroduction of threatened fauna. A total of 17 236 sheep and 12 200 goats have been removed from Peron Peninsula since 1991 and from 1995 goat eradication programs have been funded by World Heritage Commonwealth funds. Rabbit Calicivirus Disease was released into the rabbit population in 1996 and again in 1998, with limited effect. Although Myxomatosis was introduced in 1994 and is well established, rabbit numbers remain moderately high with regular seasonal fluctuations.

Of the initial estimated 2 500 foxes on Peron, 95% were eradicated as a result of aerial baiting in 1995. Utilising Commonwealth funding, and in collaboration with local pastoralists, aerial fox control programs have been carried out on an annual basis on pastoral leases both within and bordering the World Heritage Property, since 1996.

The populations of foxes, cats and goats have all been significantly reduced, to the point where five locally extinct native species (bilby, western barred bandicoot, banded hare wallaby, mala and malleefowl) have already been reintroduced on the Peron Peninsula, and others are being considered.

The eradication or control of feral herbivores on Peron Peninsula has resulted in the regeneration of native plants and vegetation structures and significant increase in shrub density and recruitment of seedling. The decrease in feral carnivores has allowed the recovery of extant species, particularly reptiles - including the threatened woma python. There have also been increases in numbers of emu, euro, echidna and small vertebrates.

Managed by the Heirisson Prong Community Biosphere Reserve group, Heirisson Prong is a conservation site that contains reintroduced populations of three of Australia's rarest mammals - burrowing bettongs, western barred bandicoots and greater stick-nest rats. The group is a partnership of the Useless Loop community, CSIRO and the Shark Bay Salt Joint Venture. Management of the site includes aerial and ground baiting to exclude foxes, maintenance of a barrier fence across a narrow peninsula, erection of signage and track maintenance.

Weeds

Sixty four species of terrestrial weeds or exotic plants have been recorded in the Property. They vary in their distribution and the degree of threat posed to World Heritage values. Weed invasions are usually associated with physical disturbance due to natural or human causes. Weeds have the potential to impact upon World Heritage values through displacement of native species and destruction of habitat. Weeds may also impact on pastoral values and degrade aesthetic and recreational values.

Landowners, managers and occupiers are responsible for controlling and eradicating weeds declared under the Agriculture and Related Resources Protection Act 1976. Currently there is no legislative requirement to control weeds in the Property that are not declared under the Act. Administration of the Act is the responsibility of the Department of Agriculture, Western Australia. State weed programs are based on ecological weeds, rather than those declared under the Act. Weed control and monitoring programs are a high priority in the Terrestrial Reserves Management Plan.

Specifically, doublegee (*Emex australis*) and ruby dock (*Rumex vesicarius*), ice plant (*Mesembryanthemum crystallinum*) and calthrop (*Tribulus terrestris*) have the potential to impact significantly on natural vegetation and fauna habitats within the World Heritage Property. The Commonwealth is currently funding collaborative projects between the Shire of Shark Bay, Main Roads WA and DCLM that aim to control these weeds in environmentally sensitive areas and disturbed sites within the Property.

Exotic marine species

Exotic marine animals and plants introduced in ballast discharge from ships are a potential threat. In Shark Bay, there is regular shipping activity associated with the loading of salt at Useless Loop and also frequent movements of both recreational and commercial boats around Denham, Monkey Mia and Nanga. Whilst there are currently no known occurrences of exotic marine species in Shark Bay, a range of measures are being developed to manage and monitor any threat from exotic marine organisms. A Commonwealth funded World Heritage project currently underway is investigating the risks associated with introduced marine pests and the threats to the Property values. Recommendations for management of the risks will form part of the final report.

Natural disasters and preparedness

The Shark Bay region is generally not prone to natural disasters. It is geologically stable, the topography is relatively flat and the climate though hot and arid, is generally benign.

Cyclones

The region is subject to occasional cyclones which can severely impact on both marine and terrestrial ecosystems. However there is little which can be done from a management perspective to mitigate or repair the consequences of cyclones, which are a natural occurrence.

Fire

Fire is a natural process that occurs in the semi-arid environment and has had an important role in determining vegetation structure and composition. There is little known about the effect of fire on vegetation communities in the World Heritage Property. Vegetation structure has been modified through grazing on pastoral leases and this has probably altered natural fire regimes in parts of the World Heritage Property. Further knowledge on fire ecology and the requirements of species and communities within the World Heritage Property is required.

There is minimal documentation of fire history in the World Heritage Property. Aerial photography and satellite images provide evidence of numerous small fires in the last 50 years in the World Heritage Property and some of the fires have resulted from human activities. Appropriate management of fire is essential, since some fire regimes could degrade World Heritage values. In situations where the information on the impact of fire is limited, fire will be used conservatively as a management tool.

Fire represents a significant threat to populations of threatened species which have become highly restricted in their distribution as a result of the activities of Europeans. Fire is a particular threat to populations of species which only survive on islands and which could be destroyed by a single fire.

The Shark Bay Terrestrial Reserves Management Plan addresses fire management on conservation reserves in the World Heritage Property, including Bernier and Dorre Islands Nature Reserve, Francois Peron National Park, and Zuytdorp Nature Reserve.

Fire can threaten human lives and resources valued by the community. There is a responsibility under the Bush Fires Act 1954 to protect community values from wildfire. The protection of World Heritage values should be considered in wildfire suppression activities conducted for the protection of life and other community values.

Visitor/tourism pressures

A wide range of activities occur on the lands and waters in the World Heritage Property. A user survey for the World Heritage Property was conducted by DCLM between June and November 1993. The survey provided baseline data on visitors and visitor use of the World Heritage Property.

Visitors surveyed originated from the Perth metropolitan area (29.9%), country WA (28.4%), interstate (17.1%) and overseas (5.2%). The most popular recreation sites within the World Heritage Property were Monkey Mia, Francois Peron National Park, Shell Beach Conservation Park, Hamelin Pool and Steep Point.

The most popular land-based activities included viewing the Monkey Mia dolphins (73.9%), sightseeing (62.25%), photography (57.8%), and picnicking or barbecuing (49.6%). The most popular water-based activities undertaken in the World Heritage Property were line fishing (45.5%), swimming (37.9%) and power boating (28%).

A number of recreational sites have been developed within the World Heritage Property. Remote camping is provided for at Francois Peron National Park, South Peron, Gladstone, Bush Bay and at Carrarang and Tamala Stations. Day use facilities are provided at Shell Beach Conservation Park, Hamelin Pool Marine Nature Reserve, Francois Peron National Park and Shire managed sites at Bush Bay, New Beach, Little Lagoon and Eagle Bluff.

Some existing recreational use is adversely impacting on World Heritage values. For example, use of the coast for remote camping and fishing is degrading coastal landforms on some areas. It is essential recreation sites and activities are controlled and managed to prevent degradation of coastal features and other values of the Property.

There are a number of recreation opportunities that could be provided with minimal impact to World Heritage values. These would provide visitors with opportunities to view and enjoy the values of the World Heritage Property. Furthermore, well-managed recreation has the potential to generate greater support for the conservation of Shark Bay's World Heritage values. Completion of the Cape Peron recreation management project later this year will provide wildlife and coastal scenery viewing opportunities for visitors. The project will provide appropriate mechanisms to control vehicle and pedestrian access at recreation sites around Cape Peron, whilst protecting and rehabilitating coastal landscapes damaged by uncontrolled access. Walk trails and lookout facilities will be developed at strategic sites within the area and interpretive signage erected to provide information on World Heritage values associated with the natural coastal features and the marine mega-fauna.

Management plans for the marine and terrestrial conservation reserves and environments contain detailed strategies for the management and provision of recreation facilities and activities. A number of recreation areas outside of conservation reserves are being managed by local government authorities and land managers, generally in accordance with site development plans. Heavily used sites are receiving priority management attention.

The significant and diverse range of natural values and features represents a major resource for expansion of nature-based tourism in Shark Bay. Nature-based tourism represents an opportunity to increase community knowledge and enjoyment of the Shark Bay environment with minimal impact on the integrity of World Heritage values. Furthermore, well-managed tourism has the potential to increase community support, and generate essential funds, for the conservation of Shark Bay's World Heritage values.

Private tourism developments exist and others are likely to be proposed for the World Heritage Property. It is important that, monitored through the approvals process, they do not adversely impact on World Heritage values. Existing tourism facilities in Shark Bay range from hotel and caravan park accommodation with associated facilities and services at Denham, Monkey Mia and Nanga, with a small caravan park located at the Hamelin Pool Telegraph Station. Dirk Hartog Island also provides tourist accommodation and services. Camping sites with composting toilets are also provided at Steep Point.

Management plans for both marine and terrestrial conservation reserves contain strategies for management and facilitation of nature-based tourism opportunities. These plans will be compatible with the development of tourism in the region as outlined in the Shark Bay Regional Strategy. Management should provide equity between users (for example, consider visitors, boat users, tour operators) and provide for a broad spectrum of activities.

Knowledge of visitor use, patterns, needs and expectations through social research and monitoring are important components of effective management. They provide a basis for improving management practices and to be able to predict, and respond to changes in visitor patterns and demands.

There is some data on visitation and visitor use within the World Heritage Property. Visitor records have been kept at Monkey Mia since 1986, and this data provides an

indication of visitation patterns and demographics of visitors. In addition, road counters have been in place for approximately 5 years at Francois Peron National Park, Shell Beach Conservation Park and the Hamelin Pool Marine Nature Reserve visitor site. Currently, there are no pedestrian counters installed within the World Heritage Property, although these are planned for the Monkey Mia walk trail and the proposed wilderness walk between Monkey Mia and Herald Bight.

A user survey for the World Heritage Property was conducted by DCLM between June and November 1993, and this provided beneficial baseline data. The University of Notre Dame has undertaken some limited questionnaire surveys in the Shark Bay area and a visitor satisfaction survey was conducted in December 1995 by Reark Research. A visitor survey (landscape assessment) was undertaken as part of the Landscape Study 2001, to investigate community perceptions of Shark Bay landscapes. Findings were that the most beautiful places were natural, not human-modified, and that water and coast are relatively consistent attributes of beautiful places. This correlates with the 1993 visitor survey, where the most common comment for future management was 'leave it as it is' and people expressed a desire for a low level of development in the area.

In June 2002, visitor surveys will commence at Monkey Mia, Peron Homestead, Cape Peron, Hamelin Pool and Shell Beach and be undertaken by volunteers every six months thereafter. The data collection will identify visitor numbers, their point of origin, what activities they undertake, length of stay and their level of satisfaction. A site specific questionnaire will be compiled for Monkey Mia, whilst data collection at the other sites will utilise the standard DCLM VISTAT questionnaire. VISTAT is the Department's visitor information and statistics data collection system which provides for the capture and recording of data on visitor numbers across areas managed by DCLM, as well as feedback from people visiting these areas. This collection plan will continue on a six monthly basis until 2005 and all data collected will be entered onto the VISTAT database managed by the Park Policy and Tourism Branch of DCLM.

This research will be conducted to ascertain the quantitative and qualitative aspects of visitor use (types and patterns of use and visitor expectations and perceptions). The data will then provide the basis of improving opportunities for presenting the World Heritage values.

Access

Access is the prime factor that affects use of the World Heritage Property. Access to the World Heritage Property is possible by road, air and water. Currently the main access is by road via North West Coastal Highway from north and south, and then from the Overlander Roadhouse to Denham. With the exception of roads to Denham, Monkey Mia and Shell Beach, access within the World Heritage Property comprises mainly unsealed roads and tracks. Pastoral station roads and tracks are also used.

Air access is via airstrips at Denham, Carnarvon, Useless Loop and Nanga. Denham and Carnarvon have sealed airstrips with regular airline services. Services are also provided by commercial passenger airlines from Perth and Carnarvon, with charter flights available from Geraldton and elsewhere. Most pastoral stations have private airstrips. Boats provide access to marine waters and remote coastal areas inaccessible by road.

In a number of instances, access to the coastline in the World Heritage Property has become an issue requiring more careful management. The open and fragile shrubland vegetation communities of the coast are prone to ad hoc establishment of numerous trails and campsites, with subsequent degradation (clearing, erosion and weed infestation) to the coastal dunes and beaches. In some locations access by a relatively small number of people has caused significant damage, such as along the western coast of northern Peron Peninsula. Uncontrolled access to the coast is a threat to the World Heritage values of the Property.

It is being addressed by the Tamala-Carrarang Recreation and Tourism Plan (1998) has identified access management requirements for that section of coast.

The demand for access within the World Heritage Property is likely to increase. The ROADS 2020 Regional Road Development Strategy (Main Roads Western Australia, 1997) detailed proposals and priorities for upgraded road access within the region. This includes the following road developments in the World Heritage Property: upgraded access to Hamelin Pool; upgraded access to Useless Loop and Steep Point; upgraded road access in the Francois Peron National Park.

Improved access throughout the World Heritage Property needs to be balanced with an assessment of the human activity carrying capacity, and the ability to provide adequate management resources for the particular area. This is important so as not to adversely impact on the World Heritage values, yet allow for access and appreciation of the World Heritage Property. Existing inappropriate access should be closed and action taken to prevent establishment of any further uncontrolled access.

Number of inhabitants

The major population centres in the region (Denham and Useless Loop) are excluded from, but adjacent to, the Property. The current population of the Shark Bay Shire is approximately 960 people, with 800 living in Denham, 120 at Useless Loop and the remainder on pastoral leases and at roadhouses within the Shire. This number could increase with the expansion of tourism; however, the numbers involved are unlikely to have a significant impact on Shark Bay's World Heritage values. There does not appear to be any obvious reason why the populations of these centres would increase markedly in the foreseeable future.

A small number of people (approximately 16) associated with the tourism industry, reside at Monkey Mia within the Property. A concept development plan has recently been completed to expand the lease area for the Monkey Mia Dolphin Resort from 3.74 to 6.84ha. If, following an environmental assessment, the proposal is accepted, expansion of the resort will allow for an increase in capacity to accommodate up to 1 200 people. Currently, the resort can accommodate around 600 people and an increase in staffing numbers would therefore be necessary to service the additional visitors.

Pollution

There are no known point sources of pollution within the World Heritage Property.

A range of potential pollution sources exist which could impact on World Heritage values, particularly in the marine environment. Potential sources of pollution include:

- atmospheric pollution, for example, emissions;
- marine pollution, for example, fuel and oil spills, littering (especially plastics and fishing line) and sewage;
- chemical, nutrient, or exotic biota pollution from existing industries, such as salt mining and aquaculture, and associated shipping activities;
- land pollution, for example, littering and urban, industrial and agricultural pollution;
- groundwater pollution, for example, seepage from septic tanks, and nutrients and chemicals from agricultural activities; and
- noise pollution.

The Gascoyne and Wooramel rivers drain into Shark Bay, but their flow is intermittent and runoff small. It is possible that large-scale activities in the Gascoyne and Wooramel River Catchments could result in pollutants entering the World Heritage Property through the flowing of the watercourse. There is little surface runoff in Shark Bay because of low rainfall, high evaporation and permeable soils, however there is active regional groundwater flow.

Shark Bay is a semi-enclosed embayment, with a low flushing rate. Pollutants are likely to be slow to disperse which may increase the impacts on the marine environment.

The Department of Environmental Protection is responsible for pollution control and abatement. The Department of Transport is responsible for shipping activities in State waters. In regard to oil spills, a statewide oil spill plan exists, however a plan specifically for the Shark Bay World Heritage Property should be prepared detailing how an incident would be handled to minimise the impacts of such an event on the marine environment.

The Water and Rivers Commission (WRC) is responsible for managing water resources generally, and the Water Corporation (WC) and/or the local authority is responsible for the disposal of sewage. Marine sullage is the responsibility of the Department of Transport.

II.6. MONITORING

Current Monitoring Program

Marine

Loggerhead Turtle Surveys

This program commenced in 1994 and monitoring is conducted annually during the summer. It involves the field sampling and monitoring of the adult female loggerhead turtles as they come to the beach for nesting at Dirk Hartog Island. Data collected is input into the Western Australian Marine Turtle Program database, which is managed by the Department's Science Division. The data is then utilised for species management across the State and is available to other agencies e.g. Department of Fisheries -by-catch program. Information on tagged turtles captured and released from boats working in the Shark Bay prawn trawl fishery is also collected.

Baseline marine water quality

The main aim of this program is to provide a comprehensive quantitative baseline data set of the physical, chemical and biological characteristics of the near-shore waters off the Peron Peninsula between Monkey Mia and Cape Peron and to establish a network of long-term water quality monitoring sites. The initial field study was conducted in 1998 and was successful in returning a baseline dataset on nutrients, chlorophyll-a, salinity, temperature and light at nine re-locatable permanent monitoring sites in the area. This baseline data will be used to underpin future assessments of trends in water quality that may be attributed to increases in human activity, such as aquaculture and tourism.

At each of the nine monitoring sites, the following variables were monitored: total nitrogen, total inorganic nitrogen, total phosphorus, total inorganic phosphorus, chlorophyll-a, total suspended solids, salinity, temperature and light attenuation. The survey was carried out during the autumn period, which was identified by historical studies as a time when water quality parameters are likely to exhibit their greatest seasonal variation.

Dugong monitoring

A winter aerial population monitoring program of dugongs in the World Heritage Property is conducted on a five yearly basis with surveys conducted in 1989, 1994 and 1999. An initial summer population census was completed during early 2002. The estimate of dugongs falls within the range of previous winter surveys, however, distribution was markedly different. The surveys also provide population and distribution information for other marine megafauna (for example, turtles and bottlenose dolphins).

A long-term dugong monitoring and conservation program involving the utilisation of state of the art GPS satellite radio tracking and other data retrieval technologies has been conducted since 2000. This project is a partnership between State scientists and the Aboriginal community of Shark Bay. It will determine the feasibility of tracking individual dugongs and measuring their dive behaviour in the World Heritage Property in order to describe temporal and spatial distribution with particular reference to human activities and current Marine Park boundaries.

The outcome of these monitoring programs provides essential knowledge for the protection and management of dugongs within the Property.

Benthic monitoring program

The main objective of these surveys has been to establish a long-term monitoring program and provide baseline quantitative benthic habitat data along re-locatable transects to enable changes to the key conservation attributes of the Shark Bay Marine Park to be detected before unacceptable or irreversible impacts occur. Position fixing of each transect has been achieved by differential GPS to better than 3m accuracy. High quality video footage is taken along three 50m transects per site. The original monitoring sites were established in August 1996, with further sites initialised in March and June 1997.

Knowledge of the shallow water marine benthic habitats and seagrass habitats of the Property are well documented, however, since ephemeral seagrasses (*Halodule sp*, *Halophila sp*, *Syringodium sp*) are important foraging habitat for dugongs, it is

important to map their distribution. Knowledge of most other benthic habitats (corals, filter feeders communities, subtidal reef, silt, sand, mangroves, stromatolites, saltmarsh, mudflats and algal mats) that occur in the Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve, is variable and on some of these, comprehensive research work has been carried out. Some further ground-truthing of marine benthic habitats occurred in March 2002. This survey targeted areas in deeper water, such as offshore basins and channels. The marine habitats encountered were macro algae covered reef, filter feeder communities, sand, silt and algal mat covered sediments.

Monitoring of Visitor Sites

The primary objective of this monitoring program is to ensure that the recreation and tourism activities in the Property are ecologically sustainable. Monitoring stations have been established at key sites to provide quantitative data on key benthic habitats. Over time, this program will facilitate the detection of human induced changes to these seagrass meadows and coral reefs before unacceptable or irreversible impacts occur.

Approximately half of the 77 monitoring sites were established in areas of low human usage to act as 'controls' and assess natural variability, whilst the other half were in areas of high human usage to assess the human impacts. There are 56 permanently marked transect sites established in both low and high human usage areas to monitor broad scale natural events such as storms, and human impacts such as nutrient leaching. There are also 21 non-transect sites established in areas of high human usage to monitor localised impacts such as anchor damage.

The benthic communities have been described, visible impacts recorded and permanent photographic evidence taken using underwater video cameras. The initial field surveys were undertaken during 1996 and 1997 and evidence of human activity including litter and physical damage to coral and seagrass communities was found at 13 of the 77 sites. Overall the results suggest that the impacts of human activity on the benthic communities are localised to the main recreational areas such as Steep Point and Monkey Mia, are ecologically insignificant and that the major seagrass meadows and coral reefs are in excellent condition.

Sites identified as having a 'high' level of risk from recreational activities will be monitored every three years, or sooner if there are significant increases in the level of human usage in the area. In May 2002, the last of the sites will have been established for approximately five years and existing monitoring sites are to be re-surveyed during 2002/03 when an assessment will be made on whether additional monitoring sites will be required.

Risk management of marine introduced pests

This project is currently underway and will:

- document the existing shipping activity, including current ballast management practices,
- complete a risk assessment for the Property,
- conduct an initial investigation of key sites for the presence of marine biota,
- design and develop a monitoring program that provides for on-going identification of the presence of foreign marine biota.

Measuring recreational fish catch

The surveys to measure the recreational fish catch in Shark Bay have been conducted over the past five years, with the World Heritage funded component of this project completed in 2001. The surveys have provided data for the monitoring of fish stocks in Shark Bay and were conducted by the members of the Research Division of the Department of Fisheries. Recreational catch and effort (total fishing time) was collected and is being used to assess the conservation of fish stocks and the sustainability of recreational and charter boat fishing. The total annual boat-based recreational fishing effort for Shark Bay was 36,000 fisher days (2000/01) and the total catch of all finfish species in Shark Bay was 50 tonnes. The most common species kept by recreational fishers were – in order of weight kept – pink snapper (25.3 tonnes), blue-lined emperor (11.6 tonnes), baldchin groper (3.2 tonnes) and mulloway (3.2 tonnes).

Important baseline data on the catch per unit effort, size, composition, mortality and variety of species caught will be used to determine the sustainability of fishing activities and the conservation of fish stocks and habitats. Funding is currently being sought to continue the surveys for a further twelve months, as it is imperative to continue to monitor the catches to ascertain whether management limits set to ensure the recreational catch is sustainable are not exceeded.

Pink Snapper sustainability

As described under Maintenance of Values – Marine – Recreational fishing (page 14), Shark Bay is one of Western Australia's most popular recreational fishing destinations with fishing activity highest during the winter months between April and August. The boat ramp and shore catch survey conducted by the Department of Fisheries between March 1998 and 1999, indicated that an estimated 12 000 pink snapper were landed by anglers from the western gulf during that year. It usually takes approximately four to five years for pink snapper to reach maturity at about 40 – 45cm. This allows snapper at least one spawning season before they can be legally caught, however older fish produce many more eggs than younger ones – research has shown that female snapper will produce 150 000 eggs at four years, increasing by the same quantity every subsequent year, until captured. Pink snapper over a metre in length and up to 10 kilos in weight could be nearly 30 years old and produce over 500 000 eggs.

Stocks of pink snapper in the inner gulfs of Shark Bay, are genetically separate from each other and the wide-ranging oceanic stock. The snapper that form these stocks do not migrate, have a limited 'home range' in which they forage, and do not interbreed with each other. The pink snapper populations of Shark Bay are very small by comparison with ocean fisheries elsewhere in the world.

The Department of Fisheries has introduced a fisheries management package for the gulf pink snapper, following research findings from the fourth year of an intensive research program. In 1997, it was identified that adult stocks in the eastern gulf were at a critically low level and the area was closed to the take of pink snapper. Adult stocks have since increased from less than 12 tonnes, to an estimated 95 tonnes in 2001, which is on target to reach the minimum target sustainable breeding stock of 150 tonnes.

Following the decline in snapper stocks in Denham Sound and Freycinet Estuary, further management measures for pink snapper were introduced and include – a closure to take in Freycinet Estuary between 15 August to 30 September (which protects

snapper spawning aggregations and allows stock to rebuild), a minimum size limit of 500mm and a bag limit of two per fisher, only one of which may be over 700mm in length. Monitoring of recreational fishing catches of pink snapper in both the eastern and western gulfs is on-going and future management decisions will be based upon the data collected. In 2002, the Minister for Fisheries established a Shark Bay pink snapper working group to consider future management arrangements for pink snapper within the inner gulfs of Shark Bay.

Monitoring of bycatch – Shark Bay prawn and scallop fishery

The relatively unselective nature of trawl operations and the conduct of this fishery within the Shark Bay World Heritage Property, have combined to make it a priority for bycatch management within Western Australia. The fishery is highly valued, being worth approximately \$34 million per year, and is a major contributor to the economy and employment of the region.

Fishing gear used to trawl for prawns often affects additional untargeted organisms. Some species of untargeted fish are caught in the nets, but a high portion of these are not commercially valuable and are subsequently discarded either dead or alive. Some fish are discarded for other reasons, including legal prohibitions on their take, but other commercially valuable species are often retained. All these organisms are regarded as bycatch.

Bycatch Reduction Devices (BRDs) are devices fitted to existing fishing gear in order to reduce the amount – or change the nature – of bycatch collected during fishing. There have been several types of BRDs designed for trawl gear. Trials of BRDs commenced in the Shark Bay Prawn Managed Fishery in 1998/99. The aim of the trials were to test the two main types of BRDs used in prawn fisheries – grids (which exclude large organisms such as turtles, sharks and rays) and fish exclusion devices (which allow actively swimming fish to escape). An observer program is run concurrently with the trials to record information on the level of bycatch from both the standard net and the BRD net. Monitoring of BRDs is continuing to ascertain which designs are most effective, especially in areas where there are high volumes of detached weed. BRDs were introduced in 2000 for one net on each prawn trawler, and in 2001 to both nets. Scallop trawlers began using BRDs on one net in 2002 and in 2003, full implementation will take place and all vessels in both fisheries will be required to have BRDs fitted to nets.

Vessel Monitoring system (VMS)

A satellite-based GPS vessel monitoring system was introduced into the Shark Bay prawn and scallop fisheries in 1999/2000. The VMS, using a global positioning system (GPS), provides a level of compliance monitoring not previously possible with traditional ‘at sea’ techniques using expensive sea-going patrol vessels. The system tracks trawlers 24 hours a day and can report when vessels approach or enter trawling closure areas. The VMS also provides flexible future management options for the prawn and scallop fisheries. The system monitors the trawlers in the prawn and scallop fisheries in Shark Bay and ensures that fishermen are acting responsibly in the protected waters of the World Heritage Property. Vessels are required to nominate to enter the fishing grounds and also nominate to enter or be underway in closed waters. Department of Fisheries officers are able to locate vessels 24 hours a day utilising the VMS.

Monitoring of Shark Bay's commercial fisheries

Ongoing research and monitoring of these commercial fisheries provide advice for management of the region's fisheries to ensure that the fish resources are maintained at ecologically sustainable levels, whilst maximising economic and social benefits.

Beach seine and net fishery

Net fishing commenced in Shark Bay in the late 1920's when pearl shell started to show signs of over-exploitation. When the market for pearl shell fell after the war, net fishing increased significantly. Catch and effort increased steadily until the early 1960's when catch and catch per unit effort declined sharply. From 1965 onwards, effort also decreased, and since 1971 the fishery has been stable. Research undertaken by the Department of Fisheries during the 1960s determined sustainable target effort levels. The target species were initially whiting and mullet, but this expanded to include bream, tailor, garfish and snapper.

The Shark Bay fishery was declared restricted entry in December 1978. When the Managed Fishery came into effect in January 1993, eight limited entry fishery licences were issued. This number is now ten, due to recent applications. Each fishing unit consists of a mother-ship and up to three dinghies. Fish stocks targeted within the beach seine and mesh net fishery are considered healthy. Commercial snapper catches are minimal, with the key target species (mullet and two species of whiting) at present not being taken in any large quantity by recreational fishers. Catch per unit effort has slowly increased over the past ten years.

Over a very long period of time, a database has been kept by the Department of Fisheries of the 'catch returns' from the fishery, with commercial fishers sending returns in monthly which are monitored. These returns indicate the species caught, weight of catch, time taken to fish, and areas fished. They are incorporated into the Catch and Effort Statistical System (CAESS) and subsequently analysed.

Prawn fishery

Twenty-seven vessels operate in the Shark Bay prawn fishery. King prawns are the dominant species, representing about 65 percent of the catch, with tiger and endeavour prawns making up the remainder. There are strict gear controls in the fishery which include mesh sizes, maximum length of the trawl net head rope, and otter board (boards which maintain the horizontal opening of the net) sizes. In addition, there are a number of permanent trawling closures which protect shallow nursery habitats, and a variety of spatio-temporal closures that are used to control spawning stock levels and catch sizes. Closures of between 3-7 days also occur with the full phase of the moon to protect soft shelled prawns.

There is a statutory licence requirement by the vessel skippers to submit monthly returns indicating the level of catch and effort. In Shark Bay, trawler skippers also voluntarily complete daily log sheets. These data are monitored and used to calculate the spawning stock index.

Scallop fishery

Annual catches of saucer scallops in the Shark Bay scallop fishery tend to be highly variable due to major variations in recruitment and the short lifespan (2+years) of scallops. The catch is taken by a fleet of 14 vessels licensed only to trawl for scallops with 100mm mesh nets, and also the 27 vessels of the Shark Bay prawn fishery which

are licensed to trawl prawns and scallops using nets with a mesh of 60mm or less. Like the prawn fisheries, the primary form of management is input controls (gear controls, boat numbers, season duration), while the spawning stock and size at capture is controlled through the timing of the season.

The status of the stock for this fishery is determined from a pre-season (November-December) survey of recruitment and residual stock. This survey enables the start date of the fishery to be determined and allows the spawning stock to be managed. The skippers of the vessels must submit a monthly logbook return as a requirement of their licence but, as with the prawn trawlers, Shark Bay skippers also voluntarily complete daily log sheets. Monitoring of this data is carried out by the Research Division of the Department of Fisheries.

Marine debris monitoring and removal

The initial phase of this project removed accumulated litter from 30 beaches on three islands within the Property - Bernier, Dorre and Dirk Hartog Islands. The litter accumulated on the beaches may be a potential risk to the unique, threatened and diverse mammal fauna of Dirk Hartog, Bernier and Dorre Islands. The islands are inter-tidal and have a high incidence of debris accumulation. Dirk Hartog Island is becoming an increasingly popular site for campers and fishers and purchase of the pastoral lease is under negotiation for addition to the conservation estate.

The project has now entered the monitoring phase which is additional to the clean up of re-accumulated debris from targeted beaches, and will involve visual monitoring (utilising the CALM vessel, Siernia II) every twelve months with a full scale monitoring survey (a 5 day exercise) every 5 years.

Monitoring of shell accumulation and mining

As part of the Environmental Management Plan (1998) relating to the shell harvesting operation on Reserve 41076 - L'haridon Bight shell grit project, monitoring of shell accumulation occurs annually. Three monitoring sites have been established along the shoreline and are surveyed on an annual basis. The monitoring sites are not subjected to any extraction during the life of the project and data from each of three sites describe the current profile and detail the changes that have occurred.

Monkey Mia Lagoon Flushing and Water Quality

Nutrient and bacterial levels in the beach water and seawater were initially monitored monthly over a period of 12 months at Monkey Mia in 1991. This monitoring program was established to examine the temporal variation in nutrient parameters and bacterial counts and to provide baseline data for future reference. The program has continued since that time, with samples being taken from bores off the beach and seawater every three months. Water samples are then analysed by the State government chemical laboratories to ascertain the nutrient and bacterial levels.

Flushing studies of the Monkey Mia lagoon and adjacent waters were conducted in September 1996 and 1998 and involved a grid of 31 sites which were visited repeatedly during the field period of the program in order to establish the flushing behaviour of the lagoonal waters under the influence of tides, winds and density gradients during typical early-spring conditions. Computer based modelling of water movements (currents) and flushing of the lagoon were also conducted, based on the results of the two field surveys.

Monkey Mia Resort Wastewater Monitoring

Wastewater is collected from the Monkey Mia Resort and DCLM's facilities via a system of pipes that gravitate towards a pump station located within the Resort. It is then macerated and pumped up the hill to wastewater treatment ponds located about 1km south of the Resort. The wastewater treatment and disposal system is comprised of two facultative ponds followed by two infiltration swales.

A total of 7 monitoring bores exist between the wastewater treatment and disposal facility and the coastline. The bores are monitored quarterly by the Resort, in association with DCLM, to determine if any changes are occurring to the groundwater quality. Monitoring data is also forwarded to the Department of Environmental Protection, as part of the Resort's licence conditions.

Dolphins and Dugongs - tourism activity

This project researches the management of commercial boat operations, human-dolphin interaction and control of boat traffic in the Shark Bay Marine Park at Monkey Mia. Data collection is carried out each year, from March to October, and will continue for a period of three to four years (2000-2003). A detailed report on analysis is compiled annually. The main aims of the study are to:

- develop complementary research methodologies to assess potential impacts of vessel activity on dugongs and dolphins
- identify potential effects of vessel (commercial and recreational) activity on dolphins and dugongs in the Monkey Mia area, and
- develop recommendations to minimise impacts on targeted animals that will help ensure sustainability.

A 15 metre tower has been erected on the Monkey Mia Reserve which is used as a platform from which theodolite observations of dugong/dolphin-vessel interactions are made. These observations form part of the research program aimed at assessing potential impacts between both commercial and private vessel operations and the dolphin and dugong populations in the Park.

Impacts of uncontrolled tourism could have serious consequences for target animals, with repeated encounters having potentially detrimental effects. Cumulative impacts may reduce the biological fitness of an animal and population by disruption of critical energy, breeding success, feeding activity and resting opportunities. The observations are accompanied by measuring changes in bottlenose dolphin vocal and non-vocal behavioural reactions to physical and acoustic vessel presence in regard to age, sex, group-member relatedness, dolphin activity and time of day. In addition to observations from the tower, acoustic recordings and behavioural observations are taken from two different boat platforms, a commercial dolphin-watching vessel and an independent research vessel. Observations are being carried out at two sites - Monkey Mia, where dolphins and dugongs are targeted by tourism ventures and at a control site - where animals are not targeted by tourist activities.

Tiger Shark Behaviour and Ecology

Tiger sharks are a predator at the top of the food chain in the marine ecosystem of the Property and part of one of the most diverse marine faunal assemblages. The Bay supports the world's highest diversity of seagrasses, which provide food for dugongs and turtles, which in turn are prey for tiger sharks. This project aims to monitor the

distribution and seasonal abundance of tiger sharks in Shark Bay, and ultimately the affect they have on the distribution of dugongs, sea turtles and seabirds. Large tiger sharks are likely to be keystone predators responsibility for maintaining stability of the ecosystem. A study was initiated in 1997 to investigate seasonal abundance, habitat use and predatory behaviour. It resulted in the tagging of 127 large tiger sharks and monitored the distribution, seasonal abundance, habitat, predation rates and degree of site fidelity. Monitoring and further tagging of tiger sharks has continued annually at Monkey Mia since 1997 and is conducted for approximately 4-6 months each year.

Monkey Mia Dolphin Research and Monitoring

Since 1982, during the winter months at Monkey Mia, researchers from various countries throughout the world conduct research into and monitoring of, varied aspects of dolphin behaviour. Researchers have completed thousands of hours of systematic data collection and many more in the laboratory. Hundreds of dolphins are surveyed and catalogued each year. Their behaviour, ecology, genetics, development, communication, social structure, predators and prey are all being researched and monitored, making Monkey Mia one of the most important dolphin research sites in the world. For approximately eight months each year, international researchers conduct long-term study and monitoring of the dolphins in the Shark Bay Marine Park, particularly within the Monkey Mia lagoon. Appendix V lists the current research projects.

Terrestrial

Vegetation Monitoring

Floristic survey of Peron Peninsula

A floristic survey of the Property was initiated with the field survey of Peron and Edel Land Peninsulas in 1997 and Bernier and Dorre Islands in 1998. A total of 127 (30x30m) square site-plots (quadrats) were established, with 90 located on the peninsulas, 21 on Bernier Island and 16 located on Dorre Island. The Lower Gascoyne study established many plots in Zuytdorp Nature Reserve and surrounding areas, which can be relocated both for flora and fauna. Plots have recently been established on Faure Island, and the floristic survey will be completed once Dirk Hartog Island has been purchased for addition to the conservation estate.

A total of 383 vascular plant taxa were recorded with 373 of these represented in one or more site-plots and of these 37 were weeds. If sufficient resources are available, these permanently marked quadrats throughout the Property will be reassessed every 10 years, in order to determine the long term changes in floristic composition, and after catastrophic events, such as fire.

Thick Billed Grasswren surveys

Two grasswren (endangered species) surveys were conducted in 1997 and 1998 and covered Peron Peninsula and the northern end of Nanga, Hamelin, Carbla and Woodleigh pastoral leases. Vegetation structure and composition was sampled at a total of 55 vegetation survey sites and 157 spot survey sites. Each survey was conducted during the breeding season, since the Grasswren is found to call more frequently at this time of the year. Grasswrens were recorded at 60 (28%) of the sites extending throughout Peron Peninsula and along the Taillefer Isthmus. Methods used and results of these range and habitat characteristic surveys provide a baseline for

further monitoring of this subspecies. If sufficient resources are available, a monitoring protocol is to be established which will monitor the number, distribution and sizes of all known Thick-billed grasswren populations.

Visitor surveys and monitoring

Operational park management staff record visitor statistics weekly at recreational sites on Peron Peninsula, at Shell Beach and Hamelin Pool which are uploaded into the VISTAT (DCLM) database on a regular basis. In conjunction with these statistics, observations are recorded as part of the recreational site management. These include: erosion (caused by pedestrians, vehicles, climatic conditions) and health of plant communities.

Visitation statistics and usage have been recorded at Monkey Mia via the entry station since 1986, and road counters have been in place in Francois Peron National Park, at Shell Beach and Hamelin Pool since 1997. In 1993, a user survey for the Property was undertaken which provided valuable baseline data. Visitor surveys will commence in June 2002 and continue on a six monthly basis to provide data relating to a variety of visitor usage and perceptions of the World Heritage Property.

Fire buffer zone monitoring

With reduction in feral herbivores on the Peninsula since the early 1990's, the grazing pressure on the natural vegetation has significantly reduced. As a result, vegetation density and ground litter has increased. Concurrent with this change, the potential for an entire habitat type being burnt in a single wildfire event has also increased.

Widespread destruction of habitat, be it temporary or otherwise, is likely to jeopardise the recovery of rare or endangered fauna on the peninsula.

To reduce the wildfire risk, habitat protection cells were established in 1996 by establishing fuel reduced strips on an east to west basis across the peninsula at strategic locations. As part of the asset protection program, these buffer zones are maintained and surrounding areas monitored for increases in plant communities and vegetation density.

Heirisson Prong Community Biosphere Reserve Project

This project was initiated in 1989 by the Useless Loop community, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the salt mining company Shark Bay Salt Joint Venture. The Heirisson Prong project aims to re-establish rare and endangered mammals on a mainland peninsula in Shark Bay, to understand why species become extinct and to develop and implement management techniques which allow re-establishment of those species of endangered animals surviving on offshore islands.

The survival of the species that have been released is critically dependent on the absence of feral predators and considerable effort has been directed at establishing effective methods for the eradication of foxes and cats from the Prong. Monitoring of foxes, cats and rabbits to determine their presence and abundance, occurs utilising spotlight and trapping techniques.

Burrowing bettongs were released in 1992, western barred bandicoots in 1995 and greater stick-nest rats in 1999. Since the inception of the project more than ten years ago, over

1 000 bettongs, several hundred bandicoots and 20 stick-nest rats have been born on the site, with some being transferred to establish new populations elsewhere. Reintroduced populations have been monitored at 3-4 month intervals over 10 years, using a combination of cage traps, spotlighting and radio-tracking.

'Project Eden' - monitoring

Feral Animal Fauna

With Project Eden's management focus on controlling feral animals and recovery and reintroduction of native fauna, there is considerable monitoring of these populations on the Peron Peninsula, on a regular basis.

- **Comprehensive Cat Track Counts**

A cornerstone of the monitoring of large vertebrate fauna (both feral and native) is the comprehensive track count, which has been performed monthly since baseline data was first recorded in November 1994. This measure involves 'sweeping clean' 240km of sandy track each month and identifying and counting the number of tracks of large fauna present over the previous night.

This monitoring activity provides ongoing information on all feral animal species (foxes, cats, goats, rabbits) as well as recovered and reintroduced native fauna (echidnas, euros, emus, malleefowl, bilbies, woylies, mala and banded hare wallabies)

- **Cat home range size and activity**

This project was conducted from November 2001 to April 2002. It has provided detailed information through radio telemetry of short to medium term home range size of female cats on Peron Peninsula. At the end of this period, a broad scale, aerial 1080 baiting program for feral cats was carried out and the subsequent mortality of the radio-tagged cats was used as an indicator of effectiveness of the baiting.

- **Cat susceptibility to toxic bait**

The bait susceptibility of cats is monitored every 1-2 months using bait uptake trials, which involve laying 600 baits in 60 klm and observing the percentage of cats encountering a bait and those that eat one or more of them.

Additional trials were performed in March 2002, using aerial baits with Rhodamine B biomarker, and recording the percentage of cats to subsequently have this marker present in its body.

- **Cat population dynamics and diet**

Regular trapping and destruction of feral cats since 1995, has resulted in over 4 000 records of individual cats with size, weight, sex, reproductive status and stomach contents over the last 7-8 years. This information provides a method of monitoring the changes in the population ecology over time and in response to management activities and other variable environmental factors (weather, resource availability, competitors, etc) that have been monitored over the same period.

Remnant Fauna Populations

- **Small Vertebrate Monitoring**

Small vertebrate fauna (small reptiles, small mammals) is monitored twice yearly on permanent grids in representative habitat. There is consideration being given to

increasing this to four times per year, if resources permit. A more intensive comparison of small vertebrate fauna diversity and density in different fire history vegetation was carried out in 2001, as a university honours project.

Small and medium sized mammals and reptiles (woylies, bilbies, hopping mice, dunnarts and sand goannas) are also monitored twice yearly using cage trapping on management tracks across the peninsula. Survival, recruitment, reproductive status, condition, size and weight are all monitored in this way.

- **Woma Python Monitoring**

This species in Shark Bay is part of an endangered population and is monitored from regular observational records completed by agency staff and the public. This information provides data on age, sex and size and indicates the breeding and recruitment that is occurring. A program of long-term monitoring of habits, habitat and ecological requirements of this species, was established in 2001 with radio-telemetry of individual pythons.

Reintroduced Fauna Populations

In addition to the regular monitoring of all fauna previously described, reintroduced animals are also monitored using radio-telemetry. Early released animals of all species (malleefowl, woylie, bilby, mala, banded hare wallaby) are radio-tagged and information collected on survival and movement/dispersal.

Intensive radio-telemetry monitoring on mala and banded hare wallabies released in 2001, as part of a university masters degree is providing information on diet, parasites and refuge habitat selection.

Malleefowl dispersal and breeding is monitored by yearly observations of malleefowl nesting mounds for signs of activity, and periodic ground surveys for location of malleefowl tracks and new mounds. New records are GPS positioned for reference. Sightings of individuals are also recorded. All these indicators have increased since reintroduction of birds to the Peron in 1997.

- **Monitoring on Salutation Island**

A population of sticknest rats was established on Salutation Island in 1991 and the size of the population and their dispersal across the island is monitored every two years with Eliot trapping and nest surveying.

Disease monitoring

In 2001, as a result of the discovery of two viral diseases of concern in the captive breeding populations of the western barred bandicoot, a survey of all mammal species (five of which are listed as threatened or endangered) on Bernier and Dorre Islands was carried out. It took place over eight nights, and at four different locations and found evidence of both diseases in western barred bandicoots on one island and also of one of the diseases in several other species.

These populations have not yet been surveyed sufficiently to determine full distribution of these, or other, diseases due to relatively small sample numbers. At this stage, it is not known how long these diseases have been present in the wild populations, or if they

pose a threat to the survival of these species (banded hare wallaby, rufous hare wallaby [island sub-populations], western barred bandicoot, Shark Bay mouse, boodie).

Climate

Project Eden is also involved in the collection and monitoring of long-term climatic data (rainfall, temperature, dewpoints, humidity, wind, etc.) to link with other ecological data monitoring in an attempt to illuminate ecological links and interactions within the ecosystem.

Climatic records detailing rainfall and minimum and maximum daily temperatures have been collected for the Bureau of Meteorology since 1978 from Hamelin Pool, Nanga and Denham.

Landsat satellite monitoring

Monitoring the terrestrial ecology of the Property is underway utilising Landsat imagery. The Landsat satellite passes over the Shark Bay World Heritage Property every 16 days and this facilitates the acquisition of remotely sensed data appropriate to this area. The local office of DCLM has acquired a historical sequence of this imagery dating back to 1972 and each of these geo-referenced images cover an area of 22,000 square kilometres. Comparison of these images over time enables the monitoring of ecological change.

Landsat supplies information in the visible as well as the infrared portions of the spectrum. The infrared information is successful in showing variations in vegetation and applying established techniques to the historical sequence of the imagery and can show vegetation trends which when compared to aerial photographs or ground-truthed, determine the cause of the change.

Calibration of the results is achieved by establishing ongoing monitoring sites within the Property. The general outcomes of the monitoring fall within the following areas:

- the spatial recording of change due to destocking and management of the area over time
- the recording of fire events and ensuing vegetation trends
- the recording of long-term dune transitions

Additional monitoring required

A considerable amount of scientific knowledge about Shark Bay's natural environment exists, however there are gaps. Further management-oriented research is required, particularly on the impact of human activities and threatening processes.

Currently, there is no regular monitoring of mammal fauna on Bernier and Dorre Islands. The last broad estimates of population sizes and distribution on both Islands were in the late 1980's and early 1990's. In light of the situation previously described with regard to viral diseases in mammal populations on the Islands, close monitoring could be even more important. From anecdotal comparisons made during the 2001 disease monitoring expedition, the populations of most species would appear to be relatively low at this time, however there is no baseline data available to support this.

Projects which are yet to be undertaken include:

- Measuring patterns and trends of human usage in the Property
- Development of an oil/contaminant spill contingency plan
- Geological oceanography of inlets
- Genetic variation in the Shell Beach cockle
- Geology and biology of birridas
- Mangrove distribution and management
- Biology of the endangered woma python
- Vegetation and condition of the Property
- Investigations into Dugong breeding behaviour
- Survey of sediment contaminants in Monkey Mia Lagoon
- Determining and mapping current and mixing patterns
- Mapping of marine wildlife
- Monitoring of impacted coral and seagrass sites
- Loggerhead turtle tracking

Outcomes of ACIUCN Reactive Monitoring Reports

Extract from the twenty-fourth session of the Bureau of the World Heritage Committee held Paris, UNESCO Headquarters 26 June - 1 July 2000

IV.23 Shark Bay, Western Australia

The Bureau reviewed the overall report entitled "Shark Bay World Heritage Area (Australia): Condition, Management and Threats", that provides a comprehensive assessment of issues at Shark Bay and noted that the Australian Government prepared a response dated 21 June 2000 which was transmitted to the Centre on 26 June 2000.

The ACIUCN's comprehensive monitoring exercise for this site involved a series of stakeholder consultations and extensive joint involvement of government and NGO's. The report identified five priority action areas:

1. The need to complete the strategic framework for the site as quickly as possible.
2. The need to ensure that, where any exploration and extraction of minerals and petroleum take place, they do not cause damage to the World Heritage values. ICUN noted that shell mining and salt extraction were existing activities at the time of inscription of the site and the State Party agreement to the listing assumed their continuation. The Committee agreed to this at the time.
3. The need to ensure that any harvesting of biological resources is ecologically sustainable, such as in relation to aquaculture.
4. The need to eradicate or at least control invasive species, and
5. The need to develop an overall visitor management strategy.

The Delegate of Australia commended the progress made with the ACIUCN monitoring process for this site and noted that the site is a complex one, inscribed under all natural criteria. It has also significant social and economic values.

The Observer of the United States pointed out that the component of the ACIUCN report relating to mining is based on the "WCPA Position Statement on Mining and Associated Activities in Relation to Protected Areas" and that this position statement was not adopted by IUCN, or the World Heritage Committee.

The Bureau noted the report provided and welcomed the fact that the State Party had prepared a consolidated response outlining proposed actions to implement the recommendations of the report. The Bureau requested ICUN to review this report and provide information to the twenty-fourth extraordinary session of the Bureau.

Extract from the twenty-fourth session of the World Heritage Committee held in Cairns, Australia 27 November - 2 December 2000

IUCN noted that the ACIUCN report for the site was discussed at the twenty-fourth session of the Bureau. ACIUCN has advised some amendments of the Focused Recommendations on mining consistent with the original ACIUCN recommendation to emphasise that no mineral sands mining or exploration should be allowed if it damages the World Heritage Area and values. ICUN welcomed the State Party's response to the five Focused Recommendations and looked forward to the completion of the strategic plan for the property and offered to work with the State Party to establish time frames for actions identified.

The Bureau commended the State Party and ACIUCN for successfully repeating the process applied to the Great Barrier Reef for the Shark Bay World Heritage area. The Bureau urged them to develop a Framework for Management that could be used as a basis for annual monitoring of progress in the implementation of the five Focused Recommendations, submit it to the consideration of the twenty-sixth session of the Bureau in 2002, in the context of periodic reporting.

ACIUCN Focused Recommendations

Overall Management Framework

ACIUCN recommends that

- a) the Shark Bay World Heritage Property Draft Strategic Plan be completed and implemented as a matter of high priority.*
- b) Outstanding reserve proposals identified in existing planning documents be implemented as a matter of priority*
- c) Appropriately resourced and staffed management arrangements be instituted.*

Response - Completion of the Shark Bay World Heritage Property Draft Strategic Plan is awaiting resolution by both the State and Commonwealth Governments on matters relating to mining proposals in the Property.

Minerals and Petroleum: Exploration and Extraction

Activities relating to the exploration, extraction or production of geological resources and salt have the potential to impact on the World Heritage values of the property.

ACIUCN recommends that no such activities should take place where they are likely to cause damage to world heritage values.

Response - Appropriate legislation and environmental assessment procedures are in place to ensure that developments and activities that can potentially impact on Property values are subjected to the highest levels of appraisal.

Biological Resource Harvest

There are grazing leases in parts of the terrestrial area, aquaculture operations, proposals for further aquaculture developments and a number of fisheries in the marine area.

ACIUCN recommends that management plans be developed and implemented that ensure that grazing activities, aquaculture and fisheries are ecologically sustainable and not likely individually or cumulatively to cause adverse impacts on world heritage values.

Response - Aquaculture proposals are progressed according to a government approved inter-agency assessment process. All applications for licences to engage in aquaculture in coastal waters are assessed in accordance with Department of Fisheries Ministerial Policy Guideline No 8 entitled *Assessment of applications for authorisations for Aquaculture and Pearling in coastal waters of Western Australia*. This process includes referring applications to relevant decision-making authorities, other involved agencies and relevant interest groups. Applications within the Property are also referred to the World Heritage advisory committees and are also advertised for public comment. The Department of Fisheries will be implementing Ecologically Sustainable Development for the management of the State's fish resources and this will involve the prawn and scallop trawling industries in Shark Bay.

Grazing and stock levels on pastoral land is conducted according to the stock carrying capacity determined by the Pastoral Lands Board. Feral goats are being farmed commercially by some pastoralists and the impact of this increase in goat numbers additional to the carry capacity is an issue.

Invasive Species

Pastoral activities, aquaculture and ballast discharge from ships present current and potential threats of feral animal and exotic plant introduction with consequent impacts on world heritage values.

ACIUCN recommends that strategic plans be developed and implemented to eradicate or adequately control feral and exotic species which currently occur and to prevent future entry and establishment of invasive species.

Response - Development of an approach to the management of introduced exotic marine organisms is currently underway. Aquaculture developments are subject to the Gascoyne Aquaculture Development Plan (1996) and the assessment process described previously. Co-ordinated fox control occurs on pastoral leases throughout and adjacent to the Property, with aerial fox baiting being conducted on an annual basis.

Visitor Management

The natural attractions of Shark Bay include many of the features for which the area is World Heritage listed. In addition, Shark Bay is considered one of the most popular recreational fishing locations in Western Australia.

ACIUCN recommends that an overall visitor management strategy be developed as a matter of priority, with particular reference to areas of high nature conservation value,

to ensure that tourism and recreational fishing are consistent with maintenance of World Heritage values.

Response - A current project aims to prepare a plan for an overall recreation and tourism strategy for the World Heritage Property. The study will assess current and future recreation and tourism uses and impacts, as the basis for recommending future levels of visitor use and policies for visitor management.

There are increasing numbers of recreational fishers in the region and bag and size limits are the main control on this activity. The level of compliance with the limits is managed by the Department of Fisheries.

II.7. CONCLUSIONS AND RECOMMENDED ACTION

a. Main conclusions regarding the state of the World Heritage values of the property

The integrity of the Shark Bay World Heritage Property has been maintained since its inscription in 1991. Management arrangements have been, and continue to be, developed and implemented to ensure that actions taken to address potentially threatening processes are undertaken in such a way as to minimise any impact on World Heritage values.

Combined with adequate planning, this will ensure that the ecological and evolutionary processes in the Property will continue unimpeded and that the diversity and complexity of the terrestrial and marine ecosystems will be perpetuated.

b. Main conclusions regarding the management and factors affecting the property

The Western Australian Government has primary responsibility for maintaining the status of the World Heritage Property and co-ordinating implementation of the actions outlined in the ACIUCN Reactive Monitoring Report. The Department of Conservation and Land Management (DCLM), as the lead agency, will liaise with other agencies in regard to an implementation program. In some instances, agencies or authorities are carrying out initiatives, outlined in the report, under existing programs.

Implementation of the actions identified in this report will be closely linked to the availability of resources. In the first instance, agencies will commit available resources to actions that have been identified as having high priority. The Shark Bay Ministerial Council will provide direction in the identification of priority actions for implementation, with further advice from the Community Consultative and Scientific Advisory Committees.

c. Proposed future action/actions

The following projects are proposed for implementation during the next 5-6 years (prior to the second periodic reporting period), dependent upon available resources.

- Completion of a management plan for South Peron
- Dirk Hartog Island tenure transferred to national park

- Completion of a management plan for Edel Land
- Extension of the Shark Bay Marine Park to include waters adjacent to Bernier, Dorre and Dirk Hartog Islands
- Finalisation of the Strategic Plan for the Property
- Completion of a Communication Plan for the Property
- Completion of the World Heritage Interpretive Centre
- Continued involvement with indigenous interest groups
- Continued feral predator control to support native fauna re-introductions

d. Responsible implementing agency/agencies

Apart from construction of the World Heritage Interpretive Centre, for which the Shire of Shark Bay is responsible, other proposed prospective actions require the direct involvement of the Department of Conservation and Land Management and the Western Australian State Government. Completion of the Strategic Plan for the Property requires resolution by both State and Commonwealth Governments on matters pertaining to mining proposals within the Property. In the first instance, extensions to the Marine Park require the approval of the Marine Parks and Reserves Authority.

e. Timeframe for implementation

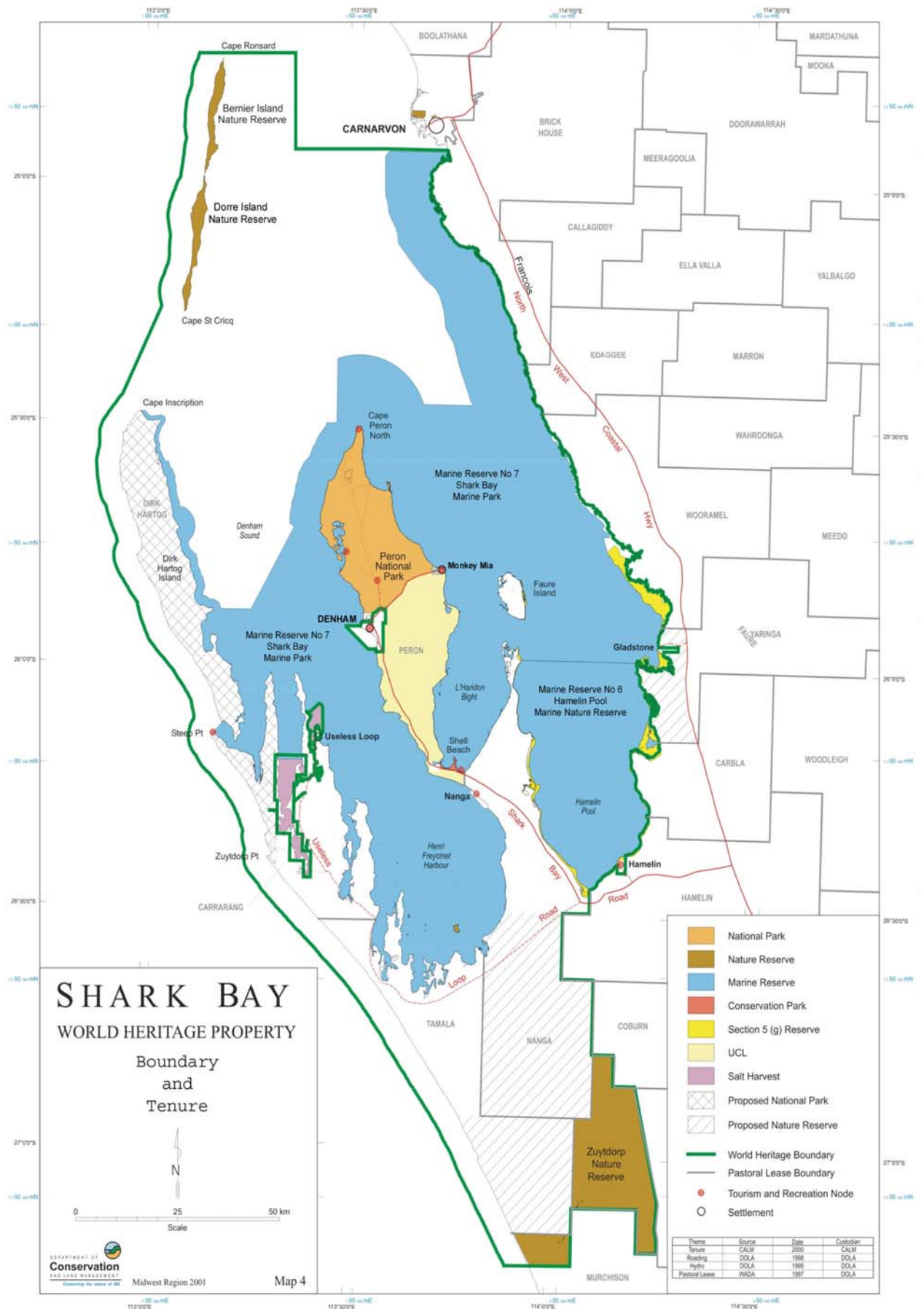
f. Needs for international assistance

g. Experience relevant to other States Parties

URL Address

More detailed general information on the World Heritage values and current projects and monitoring can be accessed on the website at: www.sharkbay.org

APPENDIX 1



APPENDIX II

ACIUCN Reactive Monitoring Report on the Shark Bay World Heritage Property:

Identified Actions - Extract from

Australian Government Response

21 June 2000

Introduction

In 1997 the World Heritage Committee requested the Australian Committee for IUCN (ACIUCN) to prepare reports on the condition of the Great Barrier Reef, the Wet Tropics of Queensland and Shark Bay World Heritage properties. The Great Barrier Reef report has since been accepted by the World Heritage Committee.

An initial report compiled by ACIUCN on the state of conservation of Shark Bay contained 15 recommendations for the future management of the Property, covering a range of issues identified as being potential threats to its integrity. In accordance with the thinking of the World Heritage Committee in relation to the Great Barrier Reef report, ACIUCN subsequently synthesised the 15 recommendations into a more focussed and proactive format. Five priority action areas have been identified by ACIUCN:

- Overall Management Framework
- Minerals and Petroleum – Exploration and Extraction
- Biological Resource Harvest
- Invasive Species
- Visitor Management

This report, which has been developed jointly by the Commonwealth and Western Australian Governments, includes a brief background on each of the five priority action areas, followed by a table setting out actions proposed to address the concerns raised by ACIUCN, the responsible agency/ies, the priority for each action and related achievements and commitments.

The actions identified in this report have been extracted from those foreshadowed in the draft Shark Bay Strategic Plan. It is intended therefore that they be implemented primarily through the implementation processes proposed for the Strategic Plan.

The Western Australian Government has primary responsibility for reporting on the status of the World Heritage Property and coordinating implementation of the actions outlined in this report. The WA Department of Conservation and Land Management (DCLM) as the lead agency, will liaise with other agencies in regard to an implementation program. In some instances, agencies or authorities are carrying out initiatives in this report under existing programs.

Consistent with government policy on visitor fees and commercial license and lease fees for conservation reserves, the user contribution approach will be progressively implemented and revenue will be used to assist with the management of conservation reserves and provide for the protection, conservation, rehabilitation and presentation of World Heritage values.

Implementation of the actions identified in this report will be closely coupled to the availability of resources. In the first instance, agencies will commit available resources to actions that have been identified as having high priority, or are of necessity an on-going priority. The priorities in this report may be varied as new knowledge becomes available or new developments or issues arise. The Shark Bay Ministerial Council will provide direction in the identification of priority actions for implementation, with advice from the Community Consultative Committee and Scientific Advisory Committee.

1. Overall Management Framework

ACIUCN recommends that the Shark Bay World Heritage Property Strategic Plan be completed and implemented as a matter of high priority. ACIUCN further recommends that outstanding reserve proposals identified in existing planning documents be implemented as a matter of priority and that appropriately resourced and staffed management arrangements be instituted to ensure that the World Heritage values of the Property are maintained

Australia supports this recommendation. Actions relevant to implementation of this recommendation are already well advanced. A draft Strategic Plan is in an advanced stage of development and is a high priority for both Governments. A comprehensive package of management structures and administrative arrangements for the Property are in place and have been working effectively since 1997. The recommended tenure changes are considered to be a high priority

Action	Responsibility	Priority	Achievements/Commitments
<ul style="list-style-type: none"> Finalise and progressively implement Strategic Plan according to priorities and available resources 	DCLM, EA, other responsible agencies	High and ongoing	Draft at advanced stage. Will be released for public comment following agreement of both governments in latter half of 2000.
<ul style="list-style-type: none"> Manage the World Heritage Property in accordance with the intergovernmental Agreement 	DCLM, EA, other responsible agencies	Ongoing	The majority of structural and legislative requirements under the Agreement are in place. Implementation of the Strategic

Action	Responsibility	Priority	Achievements/Commitments
			Plan will enhance coordination and clarify responsibilities of different agencies.
<ul style="list-style-type: none"> Provide relevant information to all authorities and agencies with management responsibilities in relation to values and management obligations. 	DCLM	High	The Strategic Plan will provide a clear indication to authorities and agencies of their respective responsibilities/obligations within the World Heritage Property with respect to WH values.
<ul style="list-style-type: none"> Apply the provisions of the EPBC Act to actions that will, or are likely to, have a significant impact on World Heritage values. 	EA	Ongoing	The EPBC Act will have effect from 16 July 2000.
<ul style="list-style-type: none"> Consult with resource managers, land owners and occupiers where they are likely to be affected by requirements for management and protection of World Heritage values. 	DCLM, EA, other responsible agencies	Ongoing	Matters relating to management and protection of WH values are considered by Scientific Advisory and Community Consultative Committees (SAC and CCC) who initiate consultation with landowners and/or resource managers. CALM has undertaken extensive consultation during the preparation of the Shark Bay Marine Reserves Management Plan, the Draft Shark Bay Terrestrial Reserves Management Plan and the Tamala and Carrarang Stations Recreation and Tourism Plan. Forthcoming plans – such as the Indicative Management Plan for South Peron will follow the same model. Fisheries WA has prepared a management plan for Fish Resources and is producing a draft aquaculture management plan for Shark Bay, both of which have undergone extensive consultative processes. The draft Shark Bay World Heritage Property Strategic Plan will be available for public comment in 2000.
<ul style="list-style-type: none"> Implement the tenure recommendations in the Shark Bay Regional Strategy (1997) and other approved plans 	DCLM, FWA	High	An Indicative Management Plan for South Peron will be prepared during 2000 following which tenure will be resolved. Negotiations are progressing with the lessees of Dirk Hartog Island, Nanga pastoral lease and Carrarang pastoral lease for the transfer /purchase of recommended areas to be added to the conservation estate.

2. Minerals and Petroleum – Exploration and Extraction

ACIUCN recommends that no such activities should take place where they are likely to cause damage to World Heritage values.

Australia supports this recommendation. Existing activities are highly regulated and any new proposals subject to rigorous environmental assessment to ensure there is no damage to World Heritage values.

Action	Responsibility	Priority	Achievements/Commitments
<ul style="list-style-type: none"> Manage mineral resource exploration and development in accordance with relevant State and Commonwealth legislation 	DME , EA, DEP, EPA, DRD, other relevant agencies.	Ongoing	Mineral sands exploration proposals in the southern portion of the Property have been managed in accordance with State processes. The WA EPA has prepared a draft guidance statement for development proposals in the Property.
<ul style="list-style-type: none"> Apply the provisions of the EPBC Act to actions that will, or are likely to, have a significant impact on World Heritage values. 	EA	Ongoing	The EPBC Act will have effect from 16 July 2000.
<ul style="list-style-type: none"> Identify areas where mineral resource development is likely to be incompatible with the protection of World Heritage values 	DCLM other relevant agencies	High	Areas have been identified in the Shark Bay Marine Reserves Management Plan
<ul style="list-style-type: none"> Refer relevant mineral resource exploration and development proposals through the environmental assessment process and include specific consideration of the impacts on World Heritage values and on the overall integrity of the Property. 	DME , DEP, EPA, EA, other relevant agencies	Ongoing	WA EPA has prepared a draft guidance statement for development proposals within the Property that specifically identifies the need for proponents to address potential impacts on World Heritage values. Under the terms of the Intergovernmental Agreement, exploration and mining proposals are considered according to WA State processes.
<ul style="list-style-type: none"> Apply, where appropriate, the annual monitoring of impacts as a condition of approval for exploration and mining activities in the Property. 	DME , DEP, EPA, DCLM	Ongoing	Environmental conditions are imposed as part of the approval process and monitoring of compliance is conducted by DME and DEP.

Action	Responsibility	Priority	Achievements/Commitments
<ul style="list-style-type: none"> Ensure that environmental assessment processes apply to environmentally significant proposals for basic raw material use. 	DEP, EA, LGA's, DME	Ongoing	The WA EPA has prepared a draft guidance statement for development proposals in the World Heritage Property. Environmentally significant basic raw materials extraction proposals will be referred to the DEP.
<ul style="list-style-type: none"> Prepare a basic raw materials plan for the Property, and manage extraction in accordance with this plan 	DME, LGAs, DRD, MRWA, DCLM, WRC, DT	High	A basic raw materials inventory has been completed. A basic raw materials strategy addressing resource allocation is in preparation.
<ul style="list-style-type: none"> Identify opportunities and facilitate research into the natural processes which influence the shell deposits at L'haridon Bight 	DCLM, DME, DEP	High	
<ul style="list-style-type: none"> Manage sustainable extraction of <i>Fragum</i> shell deposits on the eastern shore of L'haridon Bight in accordance with environmental conditions established under relevant legislation such as the Environmental Protection Act and Mining Act. 	DEP, EPA, DME, LGA, DCLM	Ongoing	An environmental management plan has been prepared and compliance is monitored by DME, DEP and CALM.
<ul style="list-style-type: none"> Manage extraction of Coquinite in accordance with the Hamelin Pool Common Management Plan. 	LGA	Ongoing	Plan under development.
<ul style="list-style-type: none"> Review the environmental aspects of petroleum exploration and development activities within the Property, in accordance with the process specified in the intergovernmental Agreement. 	EPA, DEP, EA	High	A Section 16E advice under the WA Environmental Protection Act is being prepared by DEP for petroleum exploration and extraction.
<ul style="list-style-type: none"> Regularly monitor and report on environmental management of the operations of Shark Bay Salt in accordance with the Agreement Act. 	DRD, DME, EPA, DME	Ongoing	The Company provides environmental reports on a three-year cycle. This consists of two interim annual reports followed by a detailed triennial report. CALM provides comment to DEP on this report.

3. Biological Resource Harvest

ACIUCN recommends management plans be developed and implemented that ensure that any grazing activities, aquaculture, fisheries are ecologically sustainable and not likely either individually or cumulatively to cause adverse impacts on World Heritage values.

Australia supports this recommendation. A range of legislation, regulation, environment assessment and planning instruments are in place or are being developed, to ensure these activities do not damage World Heritage values.

Action	Responsibility	Priority	Achievements/Commitments
<ul style="list-style-type: none"> Manage fisheries and aquaculture in accordance with the Shark Bay World Heritage Property Management Paper for Fish Resources, controls and regulations provided under the Fish Resources Management Act and relevant Commonwealth Legislation. 	FWA	Ongoing	<p>The goals of the Fish Resources Management Paper include ecologically sustainable use of fish resources and minimum impacts on World Heritage values.</p> <p>The taking of pink snapper from the Eastern Gulf was prohibited by the Minister for Fisheries in 1999. This situation will remain until stocks have recovered. Fisheries WA is monitoring the status of stocks in the Western Gulf.</p> <p>Aquaculture proposals are assessed under an assessment process established by the Minister for Fisheries and managed by Fisheries WA.</p>
<ul style="list-style-type: none"> Regularly monitor and report on the status of targeted fish species in the Property 	FWA	Ongoing	Recreational fishing activity is monitored by Fisheries WA. Scallop and Prawn trawl fisheries are monitored by Fisheries WA.
<ul style="list-style-type: none"> Assess aquaculture proposals in accordance with appropriate environmental assessment processes and procedures established under the Fish Resources Management Act and include specific consideration of impacts on World Heritage values. 	FWA, DEP, EPA, DCLM	Ongoing.	Aquaculture proposals in the World Heritage Property are referred to the SAC and CCC for comment as part of the assessment process, to ensure adequate consideration of WH values.
Manage pastoral activities in accordance with the Land Administration Act, the Soil and Land Conservation Act and other relevant State and Commonwealth legislation.	PLB , DOLA, AGWA, other relevant agencies	Ongoing	
<ul style="list-style-type: none"> Evaluate and apply, where appropriate, pastoral lease conditions that provide for the protection and conservation of World Heritage values 	PLB , DOLA, DCLM	High	

<ul style="list-style-type: none"> • Liaise regularly with Shark Bay pastoralists on matters of common interest in relation to the management of World Heritage values and pastoral leases. 	DCLM, AGWA, other relevant agencies.	Ongoing	Liaison occurs regarding feral goat and fox control within and adjoining the World Heritage Property. Recently discussions have taken place regarding the implementation of the Interim Recovery Plan for the Thick Billed Grasswren, including for populations on Hamelin and Woodleigh stations.
<ul style="list-style-type: none"> • Evaluate new natural resource development proposals through impact assessment processes with specific consideration of World Heritage values. 	All relevant management agencies.	Ongoing	WA EPA is preparing a draft guidance statement for development proposals within the Property.
<ul style="list-style-type: none"> • Provide for Aboriginal use of resources, in accordance with relevant legislation such as the Wildlife Conservation Act and the Fish Resources Management Act. 	DCLM, FWA	Ongoing	
<ul style="list-style-type: none"> • Manage Aboriginal resource use in conservation reserves in accordance with the terrestrial reserves and marine reserves management plan 	DCLM, FWA	Ongoing	DCLM has a commitment in the Shark Bay Terrestrial Reserves Management Plan and the Shark Bay Marine Reserves Management Plan for ongoing liaison with aboriginal interests within the World Heritage Property.
<ul style="list-style-type: none"> • Regularly monitor use of traditional resources in partnership with local Aboriginal communities. 	DCLM, FWA	Medium	DCLM has embarked on a joint project with Yadgalah Club, an aboriginal organisation in Denham to consider dugong movement in Shark Bay and resource use by indigenous people.
<ul style="list-style-type: none"> • Apply the provisions of the EPBC Act to actions that will, or are likely to, have a significant impact on World Heritage values. 	EA	Ongoing	The EPBC Act will have effect from 16 July 2000.

4. Invasive Species

ACIUCN recommends that strategic plans be developed and implemented to eradicate or adequately control feral animal and exotic species which currently occur and to prevent future entry and establishment of invasive species.

Australia supports this recommendation in principle. Invasive species in general are currently managed under a range of State legislation and programs. Specific management arrangements have been developed for targeted areas of the Property (eg Peron Peninsula). The proposed Shark Bay Strategic Plan will contain high priority actions for the control and eradication of invasive species.

Action	Responsibility	Priority	Achievements/Commitments
<ul style="list-style-type: none"> Investigate and report on the status and distribution of weeds in the Property and their potential impacts on World Heritage values. 	DCLM, AGWA	High	This action is high priority for implementation of the Terrestrial Reserves Management Plan. Weed control programs for calthrop and doublegee are already occurring in Francois Peron National Park.
<ul style="list-style-type: none"> Identify and document priorities for weed control in the property 	DCLM, AGWA	High	
<ul style="list-style-type: none"> Facilitate and ensure coordinated weed control programs are undertaken according to priorities. 	AGWA, DCLM, all landholders and agencies	High	Current priorities in Francois Peron National Park are calthrop and doublegee.
<ul style="list-style-type: none"> Through regular monitoring and investigation of sighting reports, prevent the introduction of additional weed species infestations and rapidly eradicate any new weed populations which occur 	AGWA, DCLM, , all landholders and agencies	Ongoing	
<ul style="list-style-type: none"> Develop procedures and a monitoring program that aims to prevent the introduction and establishment of exotic marine plants in the Property 	AQIS, DCLM, FWA, DEP, DT	High	An exotic marine pests management plan will be prepared in 2000 in conjunction with DEP, Shark Bay Resources, AQIS and other key stakeholders with financial support from the Commonwealth.
<ul style="list-style-type: none"> Monitor the status of priority weeds and the success of control programs. 	AGWA, DCLM	High	This is a key action from the Terrestrial Reserves Management Plan. Monitoring of calthrop and doublegees at recreation sites in Francois Peron National Park is occurring.
<ul style="list-style-type: none"> Investigate and report on the status and distribution of feral animals in the Property and their potential impacts on World Heritage values. 	DCLM, AGWA	High	Goats remain a significant feral animal in the World Heritage Property. Goat numbers have been significantly reduced in Francois Peron National Park and South Peron and this program will continue with the aim of eradication in 2000. Goat numbers elsewhere in the Property are still high and have the potential of impacting on the integrity of flora values in the transition zone and damaging land forms. Foxes and

Action	Responsibility	Priority	Achievements/Commitments
			cats are the target of an intensive control program on the Peron Peninsula as a component of Project Eden. Fox control elsewhere in the Property has been implemented through the Shark Bay LCDC with assistance from WH funding. Control of foxes and cats is imperative for the long term aim of reintroduction of locally extinct threatened fauna species to the mainland.
<ul style="list-style-type: none"> Identify and document priorities for feral animal control in the property 	DCLM, AGWA	High	<p>The Project Eden strategic plan identifies the eradication of foxes, cats, goats and potentially rabbits from Peron Peninsula as a priority.</p> <p>The control of cats and foxes on Heirisson Prong is also a priority to ensure the survival of reintroduced species.</p>
<ul style="list-style-type: none"> Facilitate and ensure coordinated feral animal control programs are undertaken according to priorities. 	DCLM, all land managers	High	Co-ordinated fox control occurs on Hamelin and Nanga pastoral leases in association with AgWA and the LCDC, supported by WH funding.
<ul style="list-style-type: none"> Through regular monitoring and investigation of sighting reports, prevent the introduction of additional feral animal species infestations and rapidly eradicate any new populations which occur 	AGWA, DCLM, , all landholders and agencies	Ongoing	Introduction of cats and foxes onto Bernier and Dorre Islands, or any of the other islands, will have severe impacts and these areas are monitored regularly.
<ul style="list-style-type: none"> Develop procedures and a monitoring program that aims to prevent the introduction and establishment of exotic marine animals in the Property 	AQIS, DCLM, FWA, DEP, DT	High	A management plan will be completed in 2000 that includes the operations of the Shark Bay solar salt shipping activities. This plan will include baseline studies.
<ul style="list-style-type: none"> Encourage and facilitate community involvement in feral animal control programs 	AGWA, DCLM	Low	AgWA and the LCDC undertake joint fox control on Nanga and Hamelin pastoral leases. DCLM encourages Denham townspeople to voluntarily have their cats sterilised and permanently identifiable through the implant of a micro chip.

5. Visitor Management

ACIUCN recommends that an overall visitor management strategy be developed as a matter of priority, with particular reference to areas of high nature conservation value, to ensure that tourism and recreational fishing are consistent with the maintenance of World Heritage values.

Australia supports this recommendation in principle. Visitor management is currently regulated under a range of instruments based on location (eg Marine and Terrestrial Reserves Management Plans), activity (eg Fisheries Management Paper) and provision of infrastructure (Roads 2020). Research on visitation and visitor behaviour is considered a high priority. The proposed Shark Bay Strategic Plan contains high priority actions for visitor management.

Action	Responsibility	Priority	Achievements/Commitments
<ul style="list-style-type: none"> Facilitate and provide a range of appropriate planned recreation opportunities in the Property 	DCLM, LGAs, land managers	High	Opportunities and recommendations are contained in the Draft Shark Bay Terrestrial Reserves Management Plan
<ul style="list-style-type: none"> Evaluate and regularly monitor the impact on World Heritage values of the development and management of recreation opportunities and of visitor numbers in the property 	DCLM, LGAs, other land managers	Ongoing	Visitor numbers are monitored at Francois Peron National Park and Monkey Mia by DCLM. WATC maintains statistics on tourism figures for Shark Bay. Impacts are monitored at key sites by DCLM.
<ul style="list-style-type: none"> Identify and prioritise degraded recreation sites for rehabilitation requirements and where appropriate, upgrade facilities in accordance with site development plans. 	DCLM, LGAs, other land managers	High	Site evaluation for recreation sites has been included in the Draft Shark Bay Terrestrial Reserves Management Plan.
<ul style="list-style-type: none"> Evaluate tourism development proposals, including infrastructure associated with the developments by referral through the environmental assessment process 	DEP, EPA, DCLM, LGAs	Ongoing	A draft guidance statement for proponents has been prepared by WA EPA. All recreational development proposals that may have a significant impact on the environment within the World Heritage Property will be assessed by the EPA.
<ul style="list-style-type: none"> Develop and implement a program to upgrade the land and marine access network in the Property. 	LGAs, MRWA, DCLM, DT	Ongoing	
<ul style="list-style-type: none"> Refer new access proposals through the environmental assessment process, ensuring that impacts on World Heritage values are considered 	LGAs, MRWA, DCLM, DEP, EPA, DT	Ongoing	All proposals that have the potential to impact on WH values will be referred to the EPA for assessment.
<ul style="list-style-type: none"> Restrict access and close tracks where they are adversely impacting on World Heritage values 	DCLM, LGAs, pastoral lessees	High	This is best addressed through management plans. Access proposals for conservation reserves in the World Heritage Property are contained in the Shark Bay Terrestrial Reserves Management Plan.

<ul style="list-style-type: none"> Identify and implement priorities for the management and restoration of degraded coastal recreation sites. 	DCLM, LGAs, FWA, WATC, DME	High	These are identified for conservation reserves in the Shark Bay Terrestrial Reserves Management Plan. Other areas will be considered in other planning documents, such as the South Peron Indicative Management Plan.
<ul style="list-style-type: none"> Identify and determine priorities for visitor research and monitoring 	DCLM, WATC, FWA, LGAs	High	This is currently being developed as part of a project to develop sustainable tourism and recreation in Shark Bay.
<ul style="list-style-type: none"> Develop and implement a collaborative standard visitor monitoring program and provide regular reports on the outcomes of the program 	DCLM, WATC, FWA, LGAs	High	This is currently being developed as part of a project to develop sustainable tourism and recreation in Shark Bay.
<ul style="list-style-type: none"> Facilitate the use of visitor research outcomes in the planning, assessment and development of recreation, tourism, access and education proposals for the Property. 	DCLM, WATC, FWA, LGAs other relevant agencies.	Ongoing	A current project looking at the impact of visitor activities on WH values will provide a strong basis for the utilisation of visitor research.

APPENDIX III

SCIENTIFIC AND TECHNICAL STUDIES RELATING TO SHARK BAY WORLD HERITAGE PROPERTY VALUES

TITLE	AUTHOR	DATE
The distribution and abundance of the dugong in Shark Bay	Marsh H, Prince R.I.T	1994
Conservation issues in the Shark Bay Region	Nevill J, Lawrence R	1985
Carbonate sediments and sedimentation Hopeless Reach, Shark Bay	Tuppin N K	1969
The Geobiology of Hamelin Pool	Baas Becking Geobiology Laboratory	1990
Waterbirds at remote wetlands in WA	Jaensch R, Verest R	1990
Research in Shark Bay: Report of the France-Ausrale Bicentary Expedition	Berry P F, Bradshaw S D, Wilson B R	1990
Analysis of water quality in Shark Bay and Coral Bay	Stoddard J	1990
The Sea Pigs of Shark Bay	Anderson P K	1991
Grasses of the Sea	Walker D	1991
Managing for diversity	Shepherd R	1991
The Shearwaters of Shark Bay	Serventy D L	1971
Water Quality at Monkey Mia	Trayler K, Shepherd R	1993
Shark Bay World Heritage Area; an important loggerhead turtle nesting site	Prince R.I.T.	1994
Winter distribution and abundance of dugongs, turtles, dolphins and other large vertebrate fauna in Shark Bay	Preen A R, Prince R I T, Shepherd R	1995
Shark Bay deep water seagrass survey; an assessment of deep water populations of <i>Halophila spinulosa</i>	Montgomery S C, Grey K A, Walker D I	1996
Benthic macroalgae of Shark Bay	Kendrick G A, Huisman J M, Walker D I	1990
The ecology of <i>Fragum erugatum</i> (Mollusca:Bivalvia:Cardiidae) in Shark Bay	Berry P F, Playford P E	1996
Distribution and abundance of dugongs, turtles, dolphins and other large megafauna in Shark Bay	Preen A R, Prince R I T, Shepherd R	1997
World Heritage Area: loggerhead turtle investigations	Prince R I T	1994
History of carbonate sedimentation, quaternary epoch, Shark Bay	Logan B W, Read J F, Davies G R	1967
The role of microbial activity in early cementation of beackrocks (intertidal sediments)	Neumeier U	1996
Baseline water quality survey of the Cape-Peron Monkey Mia Region	D'Adamo N, Bancroft K P	1998
Initialisation of long-term monitoring sites, Shark Bay Marine Reserves	D'Adamo N, Coleman J G, Pobar G J	1996
Initialisation and re-sampling of long-term monitoring sites Shark Bay Marine Res.	Cary J L	1997
Further groundtruthing of habitat map, Shark Bay Marine Reserves	Cary J L	1997
Baseline studies and monitoring of visitor sites in the Shark Bay Marine Park	Cary J L	1997
Unearthing Shell Beach secrets	Berry P, Playford P	1998
Heavy metals in marine biological material, sediments and waters from Shark Bay	McConchie D	1984

TITLE	AUTHOR	DATE
Application of spatial analysis to coastal and marine management in the Shark Bay World Heritage Area	Bruce E	1997
A hydrodynamic investigation summary of scientific results of the flushing studies of the Monkey Mia lagoon and implications for management	Luketina D A, Lyons L M, King I P	1998
The hydrodynamics of the Monkey Mia Lagoon	Blyth C	1997
Monkey Mia flushing study and summary of scientific results	Blyth C, D'Adamo N, Ivey G N, Pattiaratchi C	1996, 1998
Flushing study of the Monkey Mia Lagoon and adjacent waters	Hunt D R, D'Adamo N	1998
Dugong Tourism in Shark Bay	Gerrard C	1998
Dugong Studies at Shark Bay	Anderson P K	1998
Sedimentation in a hypersaline basin; L'haridon Bight, Shark Bay	Collins L B	1967
Recent and Pleistocene carbonate sedimentation, eastern Shark Bay	Davies G R	1967
Carbonate bank sedimentation, eastern Shark Bay	Davies G R	1970
A new species of <i>Ruppia</i> in high salinity in Western Australia	Davies J S, Tomlinson P B	1974
Vegetation and flora of Shark Bay	Keighery G J	1990
The vegetation of the Shark Bay and Edel Areas	Beard J S	1976
Search for mainland populations of the Shark Bay Mouse, (<i>Pseudomys praeconis</i>)	Morris K D, Sanders A	1990
Birds of the Bay	Morcombe M, Burbidge A	
Recovery plan for the Shark Bay Mouse (<i>Pseudomys fieldi</i>)	Orrell P, Morris K	1991
Shark Bay '81 - environmental assessment wildlife vegetation - Shark Bay	Teves B, Parish D	1983
Flora of the Shark Bay World Heritage Area and environs	Trudgen M E, Keighery G J	1995
Flora and vegetation: Useless Loop, Shark Bay	Mattiske Consulting Pty Ltd	1996
The fluctuating abundance of endangered mammals on Bernier and Dorre Islands	Short J	1997
The hidden treasures of Shark Bay (vegetation) Shark Bay	Keighery G, Trudgeon M Wilson B	1991 1988
Fish and benthos of near-shore seagrass and sand flat habitats at Monkey Mia	Black R, Robertson A I, Peterson C H, Peterson, N M	1990
Conservation of Hamelin Pool: a marine-basin environment with unique algal stromatolites	Logan B	1971
Fishes from the hypersaline waters of the stromatolitic zone of Shark Bay	Lenanton C J	1977
Effects of fish trapping on the Shark Bay snapper fishery	Moran M J, Jenke J	1989
The flora and fauna of Dirk Hartog Island, WA	Burbidge A A, George A S	1978
The breeding seabirds of Shark Bay Western Australia	Burbidge A A, Fuller P J	2000
Project Eden: reconstructing mammal biodiversity on Peron Peninsula, Shark Bay in semi-arid Western Australia	Brown P	1999
Historical changes in the bird fauna of the Shark Bay region	Burbidge A H	1999
Shark Bay dugongs (<i>dugong dugon</i>) in summer	Anderson P K	1998
The range and habitat characteristics of the thick-billed grasswren <i>Amytornis textilis</i> in the Shark Bay region	Booker B	1999
A floristic survey of the Shark Bay World	Claymore S J, Markey A J	1999

TITLE	AUTHOR	DATE
Heritage Area -interim report on surveys of Peron Peninsula, Edel Land, Bernier and Dorre Islands		
Non-geniculate species of Corallinaceae (Corallinales, Rhodophyta) in Shark Bay Shark Bay-Edel, Western Australia (Geology)	Barry G C	1995
Marine biological survey of Bernier and Dorre Islands, Shark Bay	Butcher B P, Van de Graaff W J, Hocking, R M	1984
Shark Bay dugongs in summer. I, lek mating	Hutchins J B, Hill A	1995
Changes in distribution of macro-algae eiphytes on stems of the seagrass <i>Amphibolis antarctica</i> along a salinity gradient in Shark Bay.	Anderson P K	1997
Scarring and photo identification of dugongs (<i>Dugong dugon</i>) in Shark Bay	Kendrick G A	1988
Dugongs of Shark Bay	Anderson P K	1995
Shark Bay dugongs (<i>Dugong dugon</i>) in summer. II. foragers in a Halodule-dominated community	Anderson P K	1998
Dugongs of Shark Bay: seasonal migration, water temperature and forage	Anderson P K	1986
Review of environmental impacts of water-based tourism at Monkey Mia	Wilson B	1996
Conservation of Hamelin Pool - environmental protection stromatolites	WA Department of Environmental Protection	1975
The distribution, relative abundance and habitat preferences of rare macropods and bandicoots on Barrow, Boodie, Bernier and Dorre Islands	Short J, Turner B, Majors C	1989
The Shark Bay Dugong Herd: Status Biology and recommendations for research and management	Anderson P K	1985
Dugong behaviour: Observations, extrapolations and speculations	Anderson P K	1981
Microbial mats in marginal marine environments: Shark Bay and Spencer Gulf	Bauld J	1984
The Mammals of Shark Bay, Western Australia	Baynes A	1990
Subtidal origin of club-shaped stromatolites, Shark Bay	Burne R V, James N	1986
Biological aspects of the carbon metabolism of microbial mat communities	Chambers L A	1985
Microbial mats and modern stromatolites in Shark Bay Western Australia	Golubic S	1985
Modern algal stromatolites at Hamelin Pool, a hypersaline barred basin in Shark Bay	Playford P E, Cockbain A E	1976
The biology of <i>Arenophryne rotunda</i> (<i>Anura:Myobatrachidae</i>): a burrowing frog from Shark Bay Western Australia	Roberts J D	1990
Population density estimates for <i>Arenophryne rotunda</i> : Is the round frog rare?	Grigg G, Shrine R, Ehmann H	1985
Birds of the Shark Bay Area, Western Australia	Storr, G M	1990
Amphibians and reptiles of the Shark Bay area, Western Australia	Storr G M, Harold G	1990
Seagrass in Shark Bay, Western Australia	Walker D I	1990
Seagrass in Shark Bay - the foundations of an ecosystem	Walker D I	1989
Subtidal stromatolites of Shark Bay	Walter M R, Bauld J	1986
Predation on Dugongs, attacks by Killer Whales	Anderson P K, Prince R I T	1985
The flora and fauna of Dirk Hartog Island	Burbidge A A, George A S	1978
The birds of Dirk Hartog's Island and Peron	Carter T, Matthews GM	1916-17

TITLE	AUTHOR	DATE
Peninsula, Shark Bay		
The status of birds on Peron Peninsula and Dirk Hartog Island, Shark Bay	Davies S J J F, Chapman G S	1974
Effects of hypersalinity gradients on epiphytic corallinaceae (<i>Rhodophyta</i>) in Shark Bay	Harlin M M, Wofiker W J, Walker D I	1985
Inventory of diagenesis in Holocene - Recent carbonate sediments, Shark Bay	Logan B W	1974
Algal mats, cryptalgal fabrics and structures, Hamelin Pool Western Australia	Logan B W	1974
Shark Bay mouse <i>pseudomys praeconis</i> and other mammals on Bernier Island	Robinson A C et al	1976
New and interesting records of sixteen bird species from Bernier , Dirk Hartog Islands and Peron Peninsula, Shark Bay	Robinson A C	1976
Herpetofauna of the Shark Bay region	Storr G M, Harold G	1978
	Additions	1980
Herpetofauna of the Zuytdorp coast and hinterland	Storr G M, Harold G	1980
Correlations between salinity and growth of seagrass <i>Amphibolis antarctica</i> (Labill) Sonder and Aschers in Shark Bay	Walker D I	1985
Distribution of seagrasses in Shark Bay	Walker D I, Kendrick G A, McComb A J	1985
Lilliput's castles: stromatolites of Hamelin Pool	Burne R V	1992
Annotated list of birds of Dorre Island	Kale P G	1992
Shark Bay deep water seagrass survey	Montgomery S C, Grey K A, Walker D I	1996
Islands of contrast	Morris K, Alford J, Shepherd R	1992
Stratigraphy and geological evolution of the Wooramel Bank	Thorpe D C	1992
Bernier and Dorre Islands management plan for conservation of fauna	Dept of Fisheries and Fauna, WA	1970

APPENDIX IV

SUMMARY OF ON-GOING RESEARCH ON SHARK BAY DOLPHINS (*Tursiops aduncus*)

Study of Male Alliances

- Dr Richard Connor

Males form co-operative long-term alliances to herd cycling females and exclude other males from gaining access to females. Major findings include the discovery of several levels of alliance formation, a pattern found only in humans and *Tursiops*.

Study of mother-calf behavioural ecology and female reproduction

- Dr Janet Mann

Major findings include that calves nurse for 3-6 years, that calf mortality is linked to both behavioural and ecological factors, and, contrary to common belief, 'babysitting' does not occur in Shark Bay *Tursiops*. She has also studied the effects of provisioning on dolphin behaviour.

Study of DNA, paternity and population genetics of Shark Bay dolphins

- Dr William Sherwin and Michael Krutzen.

Sherwin and Krutzen sampled dolphins from the east and west sides of Peron Peninsula and other parts of coastal Australia. Their research will help determine breeding patterns both within and between populations.

Study of dolphin communication and ranging in collaboration with Mann

- Dr Vincent Janik

Recent findings include the context of whistle use in mother-calf pairs. Calves and mothers whistle during separations (up to hundreds of metres) but calves whistle much more often than mothers do.

Study of juvenile behavioural ecology from weaning to reproduction

- Dr Amy Samuels

Focusing on why dolphins have such a prolonged juvenile period (about 10 years) and sex differences in behaviour during development. Also studying dolphin-human interaction and juvenile transition to provisioning at Monkey Mia.

Study of community structure and beaching behaviour at Peron

- Dr Per Berggren

In a few places around the world, dolphins beach themselves to catch fish. In Shark Bay, a few dolphins specialise in this foraging technique at risk of stranding themselves.

Study of female mating strategies

- Jana Watson

Watson is beginning her dissertation research on female mating strategies. Specifically, she is examining the effects of herding by male alliances on females and how the females might minimise or counter the costs of herding.

APPENDIX V

ABBREVIATIONS

DCLM	Department of Conservation and Land Management
EA	Environment Australia
MPRA	Marine Parks and Reserves Authority
CCC	Shark Bay World Heritage Property Community Consultative Committee
SAC	Shark Bay World Heritage Property Scientific Advisory Committee
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act
DF	Department of Fisheries
DEP	Department of Environmental Protection
EPA	Environmental Protection Authority
LGA	Local Government Authority
MRWA	Main Roads Western Australia
WRC	Water and Rivers Commission
DT	Department of Transport
PLB	Pastoral Lands Board
DOLA	Department of Land Administration
AGWA	Department of Agriculture Western Australia
ACIUCN	Australian Committee for International Union of Conservation for Nature
AQIS	Australian Quarantine Inspection Service
LCDC	Land Conservation District Committee
WATC	Western Australian Tourism Commission
DMPR	Department of Mineral and Petroleum Resources
MC	Shark Bay World Heritage Property Ministerial Council
DPI	Department for Planning and Infrastructure
CCWA	Conservation Commission of Western Australia
AWC	Australian Wildlife Conservancy