



## World Heritage Sites

**Protected Areas and World Heritage**



## GREAT BARRIER REEF AUSTRALIA

*This is the world's largest coral reef ecosystem and one of the most complex and biodiverse natural systems on earth. The site has more than 2,900 coral reefs built of 359 species of hard coral; over 200,000 hectares of mangroves, with 54% of the world's mangrove species; over 300,000 hectares of sea grasses, 2,000 fish and 6 turtle species; 5,000-8,000 molluscs; one of the world's largest dugong populations; breeding grounds for humpback and other whales; and 2,195 species of native plants.*

### COUNTRY

Australia

### NAME

Great Barrier Reef

### NATURAL WORLD HERITAGE SERIAL SITE

1981: Inscribed on the World Heritage List under Natural Criteria vii, viii, ix and x.

### STATEMENT OF OUTSTANDING UNIVERSAL VALUE [pending]

### INTERNATIONAL DESIGNATIONS

1993: Bowling Green Bay (35,500 ha) and

1996: Shoalwater and Corio Bays (239,100 ha) designated Wetlands of International Importance under the Ramsar Convention

### IUCN MANAGEMENT CATEGORY

Ia Strict Nature Reserve

II National Park

V Managed Resource Protected Area.

The property encloses or abuts over 15 National Parks (category II) and several Habitat/Species Management Areas (category IV).

### BIOGEOGRAPHICAL PROVINCE

Queensland Coastal (6.01.01)

### GEOGRAPHICAL LOCATION

The Great Barrier Reef World Heritage Area extends for some 2,300 km along the northeastern coast of Australia from a point level with the tip of the York Peninsula on the Torres Strait to just south of the Tropic of Capricorn. It extends beyond the low water mark 60 to 290 km from the coast, between 24°30'N to 10°41'S and 145°00' to 154°00'E.

### DATES AND HISTORY OF ESTABLISHMENT

1937 & 1943: Parts of Green Island and Heron Island were gazetted as National Parks under the State Forests and National Parks Act of 1903/1948 (Queensland);

1974: Heron-Wistari and Green Island Marine Parks gazetted under the Forestry Act of 1959-1976 (Queensland) as the first Marine Parks on the reef;

1975: The Great Barrier Reef Marine Park Act 1975 provided for the establishment, control, care and development of a Marine Park covering 98.5% of the Great Barrier Reef Region as defined in that Act;

- 1976: The enacted powers were transferred to the National Parks and Wildlife Act and Fisheries Act both of 1976;
- 1979: The Capricornia Section, the first section of the Great Barrier Reef Marine Park (GBRMPA) proclaimed;
- 1981: The Cairns and Cormorant Pass sections declared part of the Marine Park. The remaining sections of the Marine Park were included between 1987 and 1989;
- 1990: Proclaimed a Particularly Sensitive Sea Area (PSSA) by the International Marine Organisation; extended in 2002 to Torres Strait.

## **LAND TENURE**

Title to the seabed inside the three-mile territorial limit is vested in the State of Queensland by the Coastal Waters (State Title) Act of 1980 (Commonwealth of Australia). It is subject to reservations, primarily by the operation of the Great Barrier Reef Marine Park Act of 1975. Exclusive rights to explore and exploit the seabed of the continental shelf beyond the territorial limit are vested in the Federal Government (Commonwealth) subject to some limited rights conferred on third parties. Within the Queensland limits, public title is vested in the State, apart from public lands owned by the Commonwealth. Some land is held privately (Kelleher *et al.*, 1989). Islands off Queensland not covered by the Great Barrier Reef Marine Park Act are not part of the Marine Park, but are included in the GBRMPA work program.

## **AREA**

The World Heritage Area is 34,870,000 ha divided between four management areas: Far Northern (8,570,000 ha), Cairns-Cooktown (3,700,000 ha), Townsville-Whitsunday (7,693,000 ha) and Mackay-Capricorn (14,477,000 ha). The Marine Park area is 34,440,000 ha. It excludes Queensland-owned islands and internal waters plus areas excluded under the Seas and Submerged Lands Act, all near the coast.

## **ALTITUDE**

The average sea bed level is approximately 40m. The highest point is 1,121m on Hinchinbrook Island. The Great Barrier Reef Marine Park Act 1975 applies to areas between 1,000m below the sea bed to 915m above sea level.

## **PHYSICAL FEATURES**

The property covers the most extensive coral reef ecosystem in the world, extending 2,300 km from warm temperate waters just south of the Tropic of Capricorn to tropical waters in the Torres Strait halfway to Papua New Guinea; and from the low water mark to between 60 and 320 km from the coast. The complete reef system extends to the Papua New Guinea coast. The area is largely open water but exceeds that of the states of Victoria and Tasmania combined. It comprises some 3,400 individual reefs, 2,900 within the Marine Park, including 760 fringing reefs, which range in size from under 1ha to over 10,000 ha in varying forms, and provide the most spectacular marine scenery on earth. There are some 300 coral cays, including 213 unvegetated cays, 43 vegetated cays and 44 low wooded islands. There are also 618 continental islands (GBRMPA, pers. comm., 1995). The reef is about 500,000 years old.

The form and structure of the individual reefs show great variety. Two main classes can be defined: platform or patch reefs, resulting from radial growth; and wall reefs, resulting from elongated growth, often where there are strong water currents. There are also many fringing reefs where the reef growth is established on subtidal rocks of the mainland coast or continental islands (Kelleher *et al.*, 1989). For example, the Capricorn-Bunker Group National Park encloses a terrestrial section of four islands: Fairfax Island, a coral cay of two small islands on an egg-shaped reef; Hoskyn Island similar to Fairfax, though not a cay; Heron Island, sand and broken coral on a coral and rock formation; and Lady Musgrave Island, a cay surrounded by extensive coral reefs.

The water circulation is very complex, governed by the properties of the Coral Sea, land run-off, evaporation, the southeast trade winds, upwellings forced up by strong tidal currents through narrow reef passages, coastal waters and mangrove swamps. Tides are generally semi-diurnal with diurnal inequality towards the north, becoming almost diurnal in Torres Strait. The maximum tidal range is about 3m along most of the coast, although increasing to 6 to 9m in the area around Broad Sound

between 21° and 23°S. The water is vertically well-mixed for most of the year with stratification due to the freshwater inflow between January and April. 26 river catchments drain into the Park and freshwater run-off can have significant localised physical and biological effects (Kelleher *et al.*, 1989).

## CLIMATE

The Great Barrier Reef has a tropical climate influenced primarily by two features of the southern hemisphere circulation: the equatorial low pressure zone during the summer months and the sub-tropical high pressure zone during the winter months. The area lies between continental Australia and the open ocean of the South Pacific, and its climate is strongly influenced by both. The wind pattern for most of the year is dominated by the southeast trades, but from January to March, northwesterlies prevail over the north of the Reef under the influence of the inter-tropical monsoonal front. The rainfall is seasonally and geographically variable. The wettest period is summer, under the influence of the monsoon and irregular tropical cyclones and depressions. Heavy rain may occur in the south during winter. Air temperatures vary between an average maximum of about 30°C in January and 23°C in July and an average minimum of about 24°C in January and 18°C in July. The mean water surface temperature is highest during February and lowest during July (Kelleher *et al.*, 1989). Climate warming has begun to threaten the reef as an increase of 1-2°C can be lethal to coral, which bleach on expelling their zooanthellae. There were notable bleaching episodes in 1998 and 2002, which reduced live coral cover from 25%-40% to 5% in places (Reef CRC, n.d.). The temperature in 2005 (1.1°C) was the highest recorded, exceeding the 30-year average.

## VEGETATION

This is the world's largest coral reef ecosystem with over 200,000 hectares of mangroves, and over 300,000 hectares of sea grasses. 4,000,000 hectares of lagoon are vegetated (Reef CRC, n.d.). There are 2,195 species of native plants, over a quarter of Queensland's species, of which three are endemic. 300-350 species are found on coral cays in the north, two being endemic, and 120 on cays in the south. The Whitsunday Islands have the highest diversity with 1,141 species. Some 70 species are nationally threatened or rare. Globally endangered plants include the orchid *Habenaria divaricata* (EN) and eight species listed as vulnerable. This is the southern limit for several pantropical species (GBRMPA, 2000). Island vegetation is dominated by *Pisonia grandis* as on Heron and Lady Musgrave islands at the southern end of the area. Forests of this tree thrive in the acidic guano produced by nesting seabirds. Near Hoskyn Island, with a forest of screw pine *Pandanus tectorius* with *Pisonia* and *Ficus apposita*, is unique to the group. Other vegetation includes the she-oak *Casuarina equisetifolia*, Indian mallow *Abutilon indicum*, *Candia subcordata*, poinsettia *Euphorbia pulcherrima* sp. and grasses such as *Thuorna insula* and *Lepturus repens*.

There are 37 species of mangrove, 54% of the world's mangrove species. Fifteen species of sea grass grow throughout the area in inshore shallows. They are rarely abundant but are an important food source for grazing animals, especially dugong (Kelleher *et al.*, 1989). Dominant species are *Halophila ovalis*, *Halodule uninervis* and *Zostera capricornis* (Reef CRC, n.d.). There are some 4-500 species of marine algae of every type, including 26 macroalgae and a recent invader from the north, the golden algae *Chrysocystus fragilis*, which blankets and kills coral. The wide range of fleshy algae, many of them small and inconspicuous, are highly productive and heavily grazed by turtles, fish, molluscs and sea urchins. The coralline algae are an important component of reef building.

## FAUNA

The Reef is one of the most complex and biodiverse natural systems on earth, with more than 2,900 individual coral reefs built of 359 species of hard coral, covering between 25% to 40% of reef surfaces and 70 distinct biological subregions. There are recorded some 1,500 species of fish, including 49 pipefish and 9 seahorses (half the world's species), 6 turtles, 15 sea snakes (all of the Hydrophiidae) and 80 genera of octocorals (soft corals, sea fans and sea pens). The immense diversity of marine life encompasses 5,000-8,000 species of mollusc. 630 echinoderms, 1,330 crustaceans, 6,000 amphipod crustaceans, 1,500 sponges, 350 ascidians (seasquirts), 3-500 bryozoans (moss animals) over 500 polychaete or bristle worms and 1,000s of platyhelminthes (flatworms) (GBRMPA, 2000). The crown-of-thorns seastar which preys on coral has been an intermittent threat for forty years, drifting on currents from north to south. Outbreaks occurred in 1979, 1994 and, in 2003, between Cairns and the Whitsunday Islands (Reef CRC, n.d.).

Terrestrial animals are few by comparison. The Proserpine rock wallaby *Petrogale persephone* (EN) is known only from the Proserpine area and a few offshore islands in the Whitsundays. Koala *Phascolarctos cinereus*, short-beaked echidna *Tachyglossus aculeatus*, possums, water rats and fruit

bats are known from islands and cays in the area, also 9 species of land snakes, 31 lizards and 7 amphibians. The site includes feeding grounds for one of the world's largest populations of dugong *Dugong dugon* (VU). 7 whales and 19 species of dolphin breed in or visit the Park, including blue whale *Balaenoptera musculus* (EN), sei whale *B. borealis* (EN), fin whale *B. physalus* (EN), humpback whale *Megaptera novaengliae*, sperm whale *Physeter macrocephalus* (VU), and the dwarf minke whale *Balaenoptera acutorostrata*, an unnamed subspecies discovered only in 1985. Dolphins include Australian snubfin *Orcaella heinsohni*, and Indo-Pacific humpbacked *Sousa chinensis*, bottle nosed *Tursiops truncates* and striped dolphins *Stenella coeruleoalba*. Spinner dolphins *S. longirostris* are occasionally seen offshore. There are 28 species of sharks and rays including three species of sawfish, dwarf *Pristis clavata* (CR),argetooth *P. microdon* (CR), and knifetooth *Anoxypristes cuspidata* (CR), whale shark *Rhincodon typus* (VU), great white shark *Carcharodon carcharias* (VU), grey nurse shark *Carcharias taurus* (VU) and brown stingray *Dasyatis fluviorum* (VU).

There are nesting beaches of world significance for green turtles *Chelonia mydas* (EN), and loggerhead turtles *Caretta caretta* (EN), and habitat for four other species: hawksbill *Eretmochelys imbricata* (CR), leatherback *Dermochelys coriacea* (CR), Pacific olive ridley *Lepidochelys olivacea* (VU) and flatback turtles *Natator depressus*. The estuarine crocodile *Crocodylus porosus* can be found along the whole coast, especially in the north where the very poisonous box jellyfish *Chironex fleckeri* also occurs inshore. Freshwater crocodiles *Crocodylus johnstoni* are rarely recorded. Seasonally, between 1.4 and 1.7 million birds gather in the area. Of 215 species, at least 40 are seabirds, 29 of which breed on the Reef. Seabirds include wandering albatross *Diomedea exulans* (VU), white-bellied sea eagle *Haliaeetus leucogaster*, red-tailed tropicbird *Phaethon rubricauda*, herald petrel *Pterodroma heraldica*, little tern *Sterna albifrons*, and roseate tern *S. dougallii*, the largest roost of which in southeast Asia is on Swain's Reef. 118 species of butterfly are recorded (30% of Australia's total) (GBRMPA, 2000).

## **CONSERVATION VALUE**

This is the world's largest coral reef ecosystem, of great scientific value as one of the most complex and biodiverse natural systems on earth. It has more than 2,900 coral reefs built of 359 species of hard coral, over 200,000 hectares of mangroves, with 54% of the world's mangrove species, over 300,000 hectares of sea grasses, some 4,000 mollusc, 2,000 fish and 6 turtle species; one of the world's largest dugong populations; breeding grounds for humpback and other whales; and 2,200 species of native plants. The Park lies within WWF Global 200 Marine and Freshwater Eco-region, and a WWF/IUCN Centre of Plant Diversity. It contains two Ramsar wetlands and is an IMO-designated Particularly Sensitive Sea Area (PSSA).

## **CULTURAL HERITAGE**

Aboriginal occupation of the coast probably dates back to the earliest human occupation of Australia c.40,000 years ago and the Great Barrier Reef, particularly the northern sector, is important in both the historic and contemporary culture of the coastal tribes. Little systematic archaeological study has been done but there are large and important sites of Aboriginal and Torres Strait Islander settlements on several islands. The latter are seafarers related to the Melanesians of southeast Asia. Notable sites occur on Lizard and Hinchinbrook Islands and on Stanley, Cliff and Clack Islands near Cape Melville (14°S) where there are spectacular galleries of rock paintings. To the clansmen, the coasts of the Heritage Area are part of a living cultural landscape where the natural features are interwoven with their spiritual life, economic uses and social organisation. Their hunting, fishing and gathering within the site remain a legal right since they are recognised as the traditional owners of the Reef (GBRMPA, 2001). About 30 wrecks of historic importance exist in the area. The 1791 wreck of HMS *Pandora* lies near the northern reef to which it gave its name. The hazards of reef navigation necessitated building many lighthouses, some still historically important. Those on Lady Elliot Island (1866) and North Reef Island (1878) are fine examples of 19th century riveted steel plate construction and are still in operation (Kelleher *et al.*, 1989).

## **LOCAL HUMAN POPULATION**

Over 70 coastal clan groups maintain strong cultural relationships with the area and about 11 native-title claims are registered over parts of the property (GBRMPA, 2001). Currently, people living in Aboriginal and Torres Strait Island communities in the Great Barrier Reef area at Palm Island, Inginoo, Bamaga, Sesia, New Mapoon, Umagico, Yarrabah, Wujal Wujal, Hopevale, Cooktown and Lockhart River, as well as in other urban centres, have access to the marine and inshore resources which have been integral to their economy for several thousand years. White Australians live on various islands and a large population lives in the many cities, towns and villages of the adjoining coast. The most important economic activity of the Reef is tourism.

## **VISITORS AND VISITOR FACILITIES**

In 1993, it was estimated that 2,291,000 tourists in 542 commercial vessels, visited the Park, spending over 1.8 million visitor nights on the reefs and islands (Driml, 1994). By 2007, approximately 1.9 million tourists visited the Marine Park each year, 90% being concentrated in 10% of the Park in the offshore Cairns and Whitsunday areas. In addition, 4.9 million recreational visitors were recorded (GBRMPA, 2007) 40% of tourists arrive with ten major operators (UNESCO, 2006). Tourism is allowed under permit in all zones or 99.8% of the Marine Park. 0.2% is reserved for preservation and scientific research and designated free from tourism and fishing. This very low proportion reflects the large area of open water within the Marine Park. Resort guests make extensive use of reefs and waters for recreation, including fishing, diving and snorkelling, water sports, wildlife watching, sightseeing, reef-walking, shell collecting, sailing, power-boating, overflights and touring. A Reef Educational Program raises reef awareness for visitors to the Reef Headquarters Aquarium in Townsville, as well as throughout the country by school visits & video-link programs. A wide range of interpretive facilities include detailed zoning plans and introductory guides for each section of the Park, a Tourism Operators Handbook, an Interpretive Manual for reef guides, and numerous bulletins & leaflets (GBRMPA, 2001).

## **SCIENTIFIC RESEARCH AND FACILITIES**

The Great Barrier Reef offers unparalleled opportunities for scientific research. Researchers have been active in the area since the formation of the Great Barrier Reef Committee, now the Australian Coral Reef Society, in 1922, and the British Great Barrier Reef Expedition to the Low Isles in 1928-29. Such research has become more critical because of the World Heritage status, the outbreaks of crown-of-thorns seastar and coral bleaching, and intensifying human pressures on the Reef. Research is conducted by scientists from many Australian universities and institutions, concentrating for logistical reasons, on field research stations and North Queensland mainland centres. For local and visiting overseas scientists, field stations are operated by the University of Queensland (Heron Island), the University of Sydney (One Tree Island), and in Townsville, James Cook University, the Australian Institute of Marine Science (AIMS) and the Cooperative Research Centre (Reef CRC) established in 1993 as a joint venture between James Cook University, the Association of Marine Park Tourist Operators, the Queensland Department of Primary Industries, scientific bodies and the GBRMPA.

There are extensive coral reef research programmes covering the full range of scientific disciplines. Research into ecologically sustainable development of the Marine Park is integrated in the Cooperative Research Centre. In 2001, the GBRMPA developed a comprehensive list of high priority research needs to co-ordinate reef research. A list of about 75 websites was attached for hundreds of scientific & technical studies (GBRMPA, 2001). The GBRMPA program is currently grouped into several sub-programs, for water quality, coral bleaching, biodiversity, the effects of fishing, monitoring crown-of-thorns seastars; tourism and environmental sustainability. Research by AIMS on the mangroves of Hinchinbrook I. have made them one of the best studied mangrove systems in the world. Most research is carried out by outside agencies under contracts with the Authority (Kelleher *et al.*, 1989), but much of the monitoring activity is directly coordinated by Authority staff. Other research is listed in Frankel (1978), Baker *et al.* (1983), GBRMPA (1985), Engelhardt & Lassig (1993), Bellwood (1994), GBRPMA (1994) and Lucas *et al.* (1997).

## **MANAGEMENT**

The Great Barrier Reef Marine Park Act 1975 provided for the establishment, control, care and development of a Marine Park covering 98.5% of the Great Barrier Reef Region as defined in the Act. These powers were transferred to the National Parks and Wildlife Act of 1976 and Fisheries Act of 1976 respectively. The major pieces of state legislation identified in the nomination were changed by provisions of the Nature Conservation Act 1992 and the Fisheries Act 1995. There was initial resistance to the Park's establishment and 28 coastal areas initially precluded, were only incorporated later. The Act and the responsibilities of the Authority extend over the whole region, generally up to the low water mark on the Queensland coastline and islands. Exceptions to this are primarily existing or potential harbour facilities or where potential impacts may be minimal. Its regulations and zoning plans have precedence over conflicting provisions of both Commonwealth and Queensland legislation, except for the navigation of ships and aircraft. The Queensland Government has responsibility within the area for those waters which were internal waters at the time of Federation and for all islands above the low water mark within the outer boundaries of the Great Barrier Reef Region, except for the few that are owned by the Commonwealth of Australia. The Queensland Marine Parks Act & Regulations introduced in 1982/1989 provides for zoning and management plans for areas in the region adjacent to or not included in the Marine Park. Fisheries beyond Queensland coastal waters are managed

cooperatively, most species being managed by the Queensland government (GBRMPA, pers. comm., 1995).

The 1975 Act established a Consultative Committee of representatives of government, industry and community bodies. As the islands, reefs and waters of the area up to the low water line are a continuum they are managed by the Commonwealth and Queensland governments in cooperation, with a Ministerial Council of two ministers from each government, the Consultative Committee and by close liaison at officer level. The Park Authority is headed by a Chairperson and two part-time members nominated by the Commonwealth government, one of whom represents the Aboriginal and Torres Strait Islander communities living next to the Park, and a part-time member nominated by the Queensland government. Day-to-day management of the World Heritage property is by the Queensland Parks & Wildlife Service (QPWS) in collaboration with agencies such as the Water Police, Coastwatch and the Customs National Marine Unit. Proposals have been developed by coastal Aboriginal groups to incorporate their interests in indigenous co-operative management of the Park and World Heritage property.

The value of the property is protected by the national Environment Protection and Biodiversity Conservation Act of 1999. Other relevant Acts concern sea dumping, fisheries, transport, environmental protection, coastal protection and management and integrated planning. Drilling and mining in the Marine Park are prohibited except for approved research. The 1975 Act introduced controlled multiple-use planning and management of marine areas through zoning and permissible activities. Queensland Marine Park legislation was amended to allow mirror zonings where necessary, to minimise public confusion where the two jurisdictions interfaced. Zoning plans prepared for all four management areas of the Marine Park provided increasing levels of protection for the more restricted zones, and included regulations reaching beyond Park boundaries. Since 1999, the Act can regulate activities deleterious to the Park outside the Marine Park as far as five kilometres inland. Buffer zones were incorporated to protect areas of relatively higher conservation value. In 2004 detailed revised zoning plans and regulations were mapped, published and implemented: 33% of the Marine Park will become marine sanctuaries (700 sq.km; IUCN category Ia) or 'no-take' areas (114,600 sq.km; IUCN category II) (Fernandes, L. *et al.*, 2005).

A second major management tool available to the GBRMPA acting in conjunction with the Queensland Department of Environment & Heritage, is the power to make statutory management plans for areas, species or ecosystems within the Marine Park. The Authority may grant or refuse permits for a broad spectrum of potential activities including tourist facilities and programs, education and research programs, aircraft operations, discharge of waste, resource collecting, installation and operation of moorings and traditional hunting and fishing. Since the site was inscribed on the World Heritage list, the 1975 Act was amended to provide for increased powers for inspectors and increased penalties; extended search and seizure powers outside the Marine Park; powers to remedy actual damage or prevent possible damage and to allow costs of clean-up operations to be recovered from convicted offenders, and to permit the Authority to assist other institutions and individuals on environmental issues (Anon., 1989).

Between 1991 and 1994, a 25-Year Strategic Plan was endorsed by sixty stakeholder groups, with a comprehensive table of all the associated plans for the management of the Marine Park. In 1998, the *State of the Great Barrier Reef World Heritage Area* provided the first comprehensive synthesis of all available information on the property and stated that the ecosystem as a whole was in good health (GBRMPA, 2001), though this preceded the drastic bleaching event of 2002. In late 1999, Australia drew up a set of recommendations and a management framework in five priority areas: 1) the management of land & coastal catchments, 2) the management of fisheries, 3) the management of shipping & ship-sourced pollution, 4) representative marine protected areas, and 5) resources for research & management. In 2001, the Marine Park Authority released its Great Barrier Reef Catchment Water Quality Action Plan recommending end-of-river pollution targets for all 26 catchments adjacent to the Reef for 2011. Following the bleaching event of 2002, measures such as an annual Coral Bleaching Response Plan and a 5-year Climate Change Action Plan to monitor, study and combat coral bleaching have received high priority.

Plans to counteract some of the other major pressures on the Park have been drawn up for water quality, fisheries and tourism. Water quality measures include end-of-river pollution targets; codes of practice for agricultural industries; and timelines for the upgrading of sewage discharge facilities. The Federal government is working closely with the state government on the Reef Water Quality Protection

Plan, which aims to reverse the decline in the quality of water entering the Marine Park by 2013. Fisheries measures include reducing the numbers of trawlers; by-catch reduction devices, satellite tracking with enhanced vessel surveillance, and a program increasing the extent of no-take areas (4.5% of the area in 2001). Tourism measures include statutory plans of management; a register of best environmental practices; and a reef-wide mooring policy. Another major element in managing and protecting the Reef is the education of reef users to appreciate the environment and to exercise care when visiting it. The Authority has an education/ information section which produces programs and materials for public education and assists tourist operators in the development of conservation and education activity programs for visitors (Kelleher, *et al.*, 1989). One of the highest monitoring levels of any World Heritage area is claimed for the Park. This is conducted mainly by the Cooperative Research Centre and the Australian Institute of Marine Science. Major monitoring themes are coral bleaching, long-term coral reef health, seagrass watch, chlorophyll production, and coordinated water quality. Large monitoring projects include the impacts of commercial and recreational fishing on the sustainability of fish stocks in the Park.

## MANAGEMENT CONSTRAINTS

The six main threats to the World Heritage values of the property are: coral bleaching due to climate warming; catchment water quality and run-off from coastal developments; the impacts of increasing fishing levels (bottom prawn trawling, line, net and pot fishing); the impacts of increasing tourism and recreational use; biodiversity loss from oil and other pollutants and predation by red foxes, feral cats and pigs; and cyclic outbreaks of crown of thorns seastars.

There are conflicts between the various uses of the reef and its maintenance in a pristine condition. Some parts have already reached use levels that exploit the full productive capacity of the system. Anthropogenic eutrophication, mostly from agricultural run-off, can have widespread impacts. Studies in the lagoon near the Low Isles indicated significant increases in phytoplankton concentrations in the last 65 years. Run-off from islands and the mainland contains sediments, herbicides, pesticides, nutrients, and other materials damaging to the reef (Bell & Elmetri, 1995). The hazard of oil spills from the many ports and from shipping routes carrying 6,000 ships a year, 10% of them with oil and chemicals, is greatest in the Whitsunday Islands, near Cairns and between Cape Flattery and Cape York. Pilotage for large vessels is compulsory and dumping of any kind from any vessel, aircraft or platform is illegal.

Two reports (Hillman, 1996; McPhail, 1996) warned that increasing recreational use had become a problem. Unacceptable ecological impacts from reef-based tourism include the discharge of waste, litter and fuel, physical damage to reefs from anchors, people snorkelling, diving and reef walking, disturbance of fauna, especially seabirds, and over-fishing or collecting. With other factors these have contributed to the decline of turtle and dugong populations. All of these impacts may be managed to some extent by design, prohibition or limitation (Kelleher *et al.*, 1989). However, the Port Hinchinbrook Resort (1,500 beds, 250-berth marina with jet airstrip and seaplane access proposed) was built in the 1990s on the Hinchinbrook Channel within the World Heritage area (but outside the Marine Park) at Oyster Point near Cardwell. It had local, state and federal support and was completed despite strong opposition from environmentalists, taken as far as the Federal court (GBRMPA, 2001). Its impacts are strictly monitored but, in addition, the development set a precedent for similar activities (Haigh, 1997). The development of faster speedboats mean that 81% of the park can now be accessed on a day-trip. Numbers of fish and other marine fauna are declining; there has been an apparent 90% decline in dugong numbers south of Cooktown since the 1960's and a 70-90% decline in loggerhead turtles since 1970. The various turtle populations are threatened by habitat loss, fishing net kills and hunting (Hillman, 1996; GBRMPA, 2001).

However, in 1998 and 2002, major bleaching events occurred and since 2002 climate warming has become a severe threat even though most of the reefs escaped extensive mortality. The World Heritage site is vulnerable to any change in sea level rise, sea temperature increase, storm frequency and intensity, precipitation, drought, land run-off, changing oceanic circulation, and ocean acidity. In 2002, according to the World Heritage Committee Climate Change Working Group (2006), between 60 and 95 per cent of the Barrier reefs were affected. Most of these recovered well but about 5% suffered high mortality, losing between 50 and 90% of their corals. In response, a AUD\$2 million Climate Change Response Programme for 2004 to 2008 was developed to prepare an annual Coral Bleaching Response Plan and a Climate Change Action Plan by 2007.

Assessments made include a Coral Bleaching Forecast system, ecosystem vulnerability, resilience indicators, defining social resilience and frameworks for social assessments. Outcomes include policy congruence, international recognition, research coordination and investment, stakeholder and NGO partnerships, community partnership teams, programs such as Bleach Watch, part of an early warning system, and production of a Tourism Leaders Forum and a Manager's Guide to Coral Bleaching. The Coral Bleaching Response Plan to detect and measure bleaching and other impacts using satellite imagery, aerial and underwater surveys, and community observations received worldwide recognition. The Authority's bleaching management programs are recognised as the world's best practice. The Great Barrier Reef has had relatively low bleaching to date, but further events will be inevitable. The main challenge is to increase the broad resilience of the Marine Park and in 2004, the GBRMPA increased the percentage of no-take area in the Park from 4.5% to 33% (UNESCO WHC, 2006; WWF, 2006; Rothwell, 2004).

## STAFF

In 2001, the Authority had 157 staff, operating from its main office in Townsville working with some 94 staff in the Queensland Parks & Wildlife Service in daily management. Field officers are limited in number with only seven being available on any given day to supervise the 800 km between Cooktown and the end of the Cape York Peninsula (Kelleher *et al.*, 1989). In 1995 there were 300 Marine Park inspectors working within a range of federal and state services (GBRMPA, pers. comm., 1995). In 1996 there were also nine staff in Canberra (GBRMPA, pers. comm., 1996).

## BUDGET

The total gross expenditure by government on the Marine Park for the 2000-2001 financial year was estimated at AUS\$78 million (US\$46.8 million), including funds from the government, universities and the private sector. The operating expense for the Park was about AUS\$30.6 million (US\$18.4 million). Matching funds were provided under the 1979 Emerald Agreement, by the Commonwealth and Queensland Governments for park management (GBRMPA, 2001). In the early 1990s tourism generated an estimated AUD\$1 billion (US\$750 million) a year (Driml, 1994; McPhail, 1996).

## LOCAL ADDRESSES

Great Barrier Reef Marine Park Authority, PO Box 1379, Townsville, QLD 4810.

GBRMPA, (Canberra Office) GPO Box 791, Canberra, ACT 2601.

Department of the Environment, Sports & Territories, PO Box 787, Canberra, ACT 2601.

## REFERENCES

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## DATE

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