World Heritage Attributes and Values Identified for Magnetic Island and the Surrounding Marine Environment

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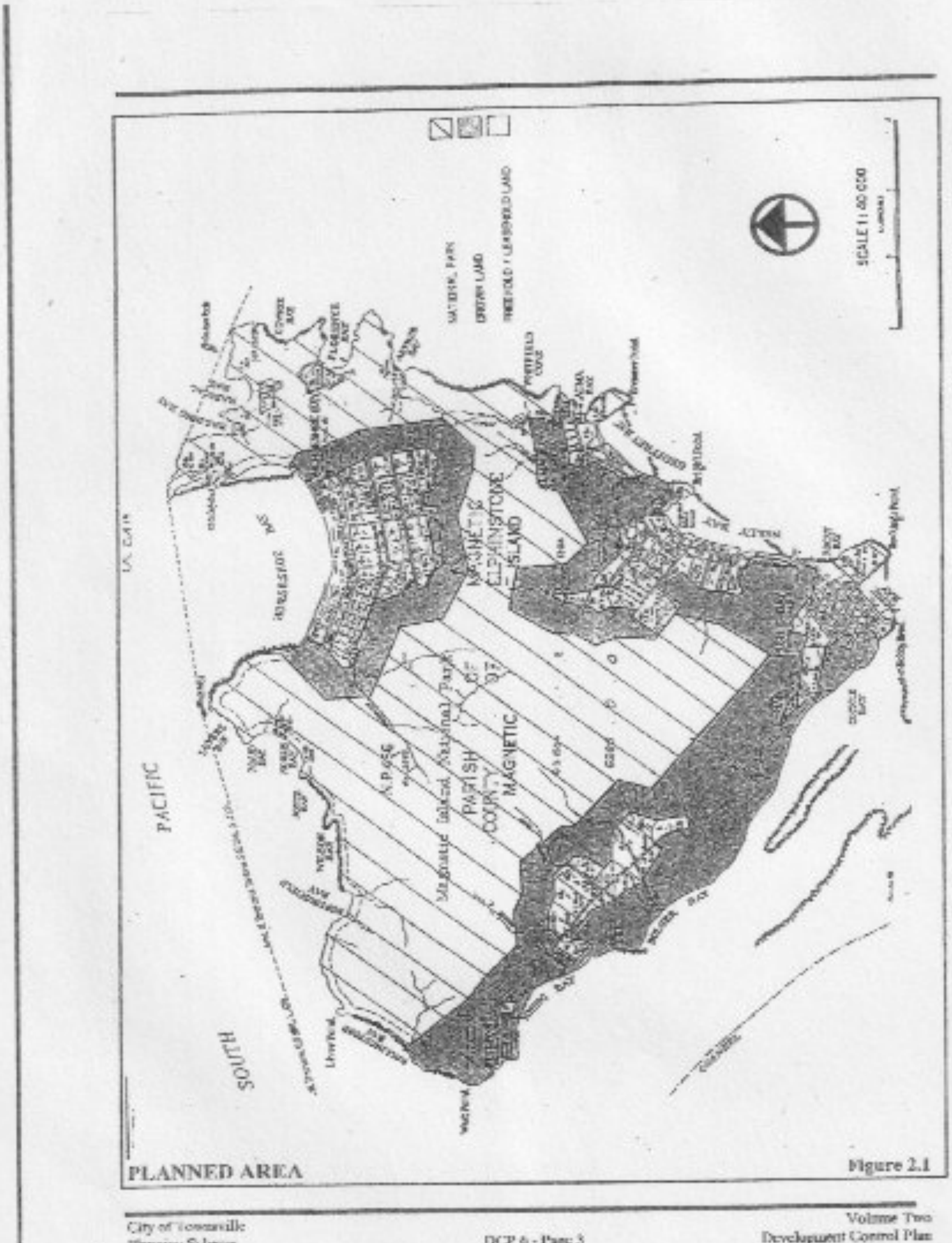


Land Tenure Magnetic Island Plan 1994
Source: City of Townsville *Development Control Plan* (1994)

Introduction

This study was commissioned by the Commonwealth Department of the Environment and Heritage to

- describe the World Heritage (WH) attributes and values identified for Magnetic Island and the surrounding marine environment (to 500m from mean low water); and
- explain both their World Heritage significance and their relative contribution to the World Heritage attributes and values of the Great Barrier Reef World Heritage Area (GBRWHA).

This report provides a systematic but local-scale collation and explanation of specific WH values or groups of values on the basis of available information. It was developed through an initial desk study of available literature. An initial draft was discussed at an Expert Workshop (Appendix 2) in Townsville to advise on omissions and errors of interpretation. Both authors made brief field visits to Magnetic Island before revising the report to take account of new information identified through the Expert Workshop and field visits. The scope of the commissioned study does not provide for consideration and consultation leading to recommendations regarding the management of those values.

The extent to which values expressed on Magnetic Island are expressed elsewhere in the Great Barrier Reef World Heritage Area is relevant to addressing the obligations of protection and conservation. This report draws on published and "grey" literature to identify Great Barrier Reef World Heritage Area values:

- which are uniquely expressed on Magnetic Island;
- for which Magnetic Island contains a highly significant expression or the majority of expressions in the GBRWHA; and
- for which Magnetic Island is a minor component of expression of a value that is widely expressed in the GBRWHA.

Within the limits of available information at appropriate scales, the report identifies locations where values or combinations of values are well expressed. It also identifies information needs for achieving better understanding of the quality and distribution of values within Magnetic Island.

World Heritage Obligations

The World Heritage Convention came into force in 1975. As a party to the World Heritage Convention, Australia has accepted an obligation to identify areas of outstanding universal value and to nominate them for inscription on the Register of World Heritage Properties. There are consequent obligations from articles 4 to 7 of the Convention to take appropriate action for protection, conservation, presentation and rehabilitation of the values of World Heritage Properties. The ongoing work of the World Heritage Committee is advised by the World Conservation Union (IUCN) with respect to natural heritage matters and the International Council of Monuments and Sites (ICOMOS) with respect to cultural heritage matters. Under Article 5 of the Convention parties have obligations for monitoring, research and reporting on the condition and management of properties.

The Great Barrier Reef was inscribed on the Register of World Heritage Properties on 30 October 1981. It was one of the earliest World Heritage nominations and it remains the largest World Heritage Property worldwide. The area nominated included all marine, intertidal and island areas within the outer boundaries of the area defined as the Great Barrier Reef Region in Schedule 1 of the Great Barrier Reef Marine Park Act (1975).

The nomination was prepared in accordance with the 1978 *World Heritage Operational Guidelines*. It addressed the detailed description and inventory of the natural and cultural heritage at the broad ecosystem scale and was not required to identify values at any greater level of specificity. It was not intended as a comprehensive document for driving management decisions.

The management basis of the 1981 nomination was that the Great Barrier Reef Region as defined in the *Great Barrier Reef Marine Park Act (1975)* would progressively be zoned to become the Great Barrier Reef Marine Park and that areas of Queensland within the outer boundaries of the Region would be managed in a complementary manner. The nomination cited Section 32(7) of the *Act*:

"In the preparation of the plan, regard shall be had to the following objects:

(a) the conservation of the Great Barrier Reef;

(b) the regulation of the use of the Marine Park so as to protect the Great Barrier Reef while allowing the reasonable use of the Great Barrier Reef Region;

(c) the regulation of activities that exploit the resources of the Great Barrier Reef Region so as to minimize the effect of those activities on the Great Barrier Reef;

(d) the reservation of some areas of the Great Barrier Reef for its appreciation and enjoyment by the public; and

(e) the preservation of some areas of the Great Barrier Reef in its natural state undisturbed by man except for the purposes of scientific research."

The nomination noted that most islands were national parks administered by the Queensland National Parks and Wildlife Service and that some land was held by private persons.

In the 30 years since the Convention came into effect, the operational emphasis has evolved from identification of new properties to include more specific requirements for management and monitoring the state of conservation of properties with respect to the values for which they were nominated. Between 1978 and 2005 the size of the *World Heritage Operational Guidelines* grew from 12 to 151 pages. The identification of values and criteria against which properties may be monitored and the interactions between natural and cultural heritage vales have become important elements of World Heritage management.

Matters relating to Australian World Heritage property obligations were first addressed by the *World Heritage Properties Conservation Act (1983)*. They are now addressed by sections 12 – 15A of the *Environment Protection and Biodiversity Conservation Act (1999)*. The issues of world heritage values and significant impacts upon those values are central to the implementation of those sections.

As World Heritage Area management and reporting practices evolved, the need for a document that systematically identified the outstanding universal values of the Great Barrier Reef World Heritage Area became increasingly apparent. The Great Barrier Reef Marine Park Authority therefore commissioned P.H.C. (Bing) Lucas, an international expert in World Heritage natural property issues, who worked with Australian specialists Helene Marsh, Peter Valentine and Trevor Webb through a broadly consultative process to prepare a report *The Outstanding Universal Value of the Great Barrier Reef World Heritage Area* (Lucas et al. 1997).

That report provides an ecosystem-scale baseline against which the GBRWHA is managed and monitored and was a major influence in the recent re-zoning to ensure a high level of protection for representative examples of all bioregions in the Great Barrier Reef Marine Park. It provided the basis for the table of Great Barrier Reef World Heritage values in Appendix 1of this report which is taken from the website of the Commonwealth Department of Environment and Heritage http://www.deh.gov.au/heritage/worldheritage/sites/gbr/values.html

Lucas et al (1997) commented on the issues of scale and management of values of ecosystem-scale World Heritage properties:

> "With smaller World Heritage Areas the whole site can be managed as a single highly protected area. It would not be feasible to allow such a high level of protection to the whole Great Barrier Reef World Heritage Area."

This report addresses values in the context of information needs for managing for multiple objectives including tourism and residential activities at the local scale.

Identifying World Heritage Values of Magnetic Island

Magnetic Island and surrounding marine areas are a small part of the GBR World Heritage Area comprising some 80 of a total area of 348,700 square kilometres. Today more than half of the Island is National Park. The Island is surrounded by the Great Barrier Reef Marine Park and is one of the most accessible parts of the GBRWHA. It is also a suburb of the City of Townsville with a large number of private land holdings. Until recently World Heritage values have not been recognised as a specific consideration in Townsville City Council planning and management of Magnetic Island. Nevertheless, sensitivity to the values of the Island has been demonstrated in:

- the design and development of advanced waste-water treatment systems;
- the setting aside of some areas as urban reserves; and
- practical policies such as dog control and using only Island-sourced mulch to avoid introduction of alien species.

Studies conducted in connection with the development of the Council's 1994 Management Plan for the Island have provided an important component of the information available for this report.

One of the four obligations of World Heritage properties is to "present"; that is to make available for public viewing and enjoyment in an ecologically and culturally sustainable manner, the outstanding universal values of properties. This is an important factor for the management of accessible parts of the GBRWHA such as Magnetic Island. The obligations of conservation, protection and rehabilitation may be partially met through restrictive management of remote areas or by limitations of access to semi-remote sites, but the obligation of "presentation" can mean that widespread values are particularly important in accessible areas.

It is clear from this study that despite its small extent, the area of Magnetic Island and immediately surrounding waters contains examples of a large range of terrestrial and shallow marine habitats and biological diversity that are expressed more widely in the Great Barrier Reef World Heritage Area. Values that are widespread throughout islands, beaches and waters of the Great Barrier Reef World Heritage Area are expressed in close proximity at Magnetic Island. This gives a particular importance to Magnetic Island because its accessibility makes it a key place for presentation, appreciation and enjoyment of values that, although widespread, are effectively inaccessible to most people.

Magnetic Island has archaeological sites providing a long record of use by Aboriginal people. European explorers and early settlers reported Aboriginal use of Magnetic Island. There was continuity of Aboriginal use by Wulgurukaba people until the turn of the 20th century when they were expelled from the Island. Wulgurukaba people re-established permanent presence in their Magnetic Island country in the 1980s.

Since the establishment of Townsville, the Island has been used for nature-based recreation and holidays based on site-related natural amenity values including walking and hiking trails, viewscapes, seascapes, accessible beaches, characteristic reefs and sheltered bays for small boats. The Island is an important centre for outdoor and environmental education, with church, scouts and national fitness camps. It has become an important field training site for James Cook University courses and Geoffrey Bay and Nelly Bay reefs have been the site of pioneering research into coral reproduction, coral survival mechanisms and coral disease.

The majority (about 56%) of the Island is National Park consisting mainly of upland areas. The lowland areas are intrinsic to the Island's relaxed, nature-based recreation, tourism and residential character. They have distinctive biophysical attributes and values that contribute to that character and they are the areas most impacted by human activity.

The Great Barrier Reef was nominated primarily on the basis of natural heritage because it met "all four criteria set out in Article 2 of the World Heritage Convention". The nomination also reflected that the area of the nomination "contains many middens and other archaeological sites of Aboriginal or Torres Strait Islander origin". Since the nomination in 1981, several archaeological sites have been identified on Magnetic Island and an Indigenous Site at Florence Bay was entered on the Australian Heritage list in 1991.

The challenge with Magnetic Island is that although it is a very small component of a very much larger World Heritage Area it is a microcosm encapsulating the contexts and challenges of values for conservation and reasonable use of the Great Barrier Reef World Heritage Area.

Using available scientific and cultural information, this report seeks to identify the geographic location and range of natural values identified on Magnetic Island and in the surrounding marine environment. In future considerations, it will be possible to overlay and compare the distribution and interaction of these values in a geographic information system.

Our literature search and Expert Workshop have revealed that there are many information gaps. Despite its closeness to Townsville and use for field teaching classes and sites for experimental studies there has been relatively little systematic study of Magnetic Island compared to the Whitsunday and Cumberland Island Group. An exception is Nelly Bay where there is considerable detailed information as a result of consultant studies in connection with the harbour reclamation and development.

Reports and studies tend to address the areas most easily accessible from land. It is probable that comparably intensive survey of remoter areas of the Island would increase the already large lists of flora and fauna. In the marine areas, the combination of seabed types, exposure, water quality and turbidity gradients provides a large range of habitat types within the shallow waters surrounding Magnetic Island. There has been systematic study of seagrass and some accessible reef sites, but it is clear that systematic survey of the range of nearshore habitats surrounding the Island would yield further increases in lists of marine flora and fauna and our understanding of the WH values of this marine environment.

There is a large literature arising from studies of biology of species occurring on Magnetic Island, but relatively little that leads to clear statements on the distribution or relative importance of species or habitat areas.

However, despite the knowledge gaps, when we combine the existing biological information with the physical information on geology, substrate and regional climate influences, it is possible to identify some very distinctive attributes of Magnetic Island. The distribution, relative occurrence and quality of these attributes provide the basis for identifying sites that are important for addressing the World Heritage obligations.

We have assessed the relative significance of the attributes on Magnetic Island and in the adjacent marine environment and created a "Magnetic Island World Heritage Scorecard" in which we have addressed the issue of relative rarity. We identified 3 categories:

- unique values - only expressed on Magnetic Island;
- regionally important values – where Magnetic Island contains a highly significant expression or the majority of expressions in the GBRWHA;
- values for which Magnetic Island is a minor component of total expressions in the GBRWHA.

Accessibility and resilience can be key factors in meeting the World Heritage obligations. A site which is inaccessible can be important in meeting obligations of protection and conservation but may not be well suited for display. Conversely protection and conservation of sites that are readily accessible presents more challenges. Understanding of resilience or vulnerability of attributes to particular conditions is important for identifying conservation and preservation requirements.

The cultural elements of the outstanding universal values of the GBRWHA identified through the nomination of the Great Barrier Reef for World Heritage Listing (GBRMPA, 1981) are outstanding natural beauty of the area and the existence of significant archaeological and historical sites.

We have found that the two most difficult issues/aspects in identifying World Heritage values are:

- widely differing perceptions of the nature and consequent importance of cultural values;
- the interactions of natural and cultural components of site values.

Perceptions of aesthetics can reflect deeply-held personal values. They are experiential and typically reflect an integration of culture, education, experience and social values. Pocock (2003) reviewed the way in which aesthetics are defined and used in heritage assessments noting that "the application of these criteria focuses predominantly on particular visual qualities." She concluded that significance assessments are strongly biased towards assumptions of the "grand and elite" about architectural aesthetics and natural beauty "to the exclusion of other cultural groups and an everyday sense of place".

Magnetic Island is a point of interaction of a range of social values. There is substantial archaeological and historical evidence of indigenous social value. Greer et al. (2000) note that there is now broad recognition of indigenous Australians' attachment to places; for example, through spiritual connections, but that social value is not confined to indigenous heritage and places. The social values of Magnetic Island include a suburban culture existing in a relaxed, peaceful and tranquil atmosphere in concert with the natural environment, and recreational and vacation use from the adjacent mainland and further afield based largely on enjoyment of the natural values of the Island, its beaches and shallow seas.

This report draws on published surveys and reports of visitors and residents views of the values of Magnetic Island and the Magnetic Island experience and seeks to identify the extent to which social values derive from or overlap with components or classes of identified World Heritage values.

The issue of the extent to which the sum of individual values and the interaction of natural and cultural values combine to produce the outstanding universal value that should be recognised and maintained as World Heritage is a matter that is also of concern to cultural heritage managers. Thus the World Heritage Committee's advisory body on cultural heritage, ICOMOS (2004 p 44) noted:

> "Heritage is valued for its cultural qualities, which can be tangible or intangible, and these qualities are not absolute but reflect human value systems.
>
> What is emerging is the need to see heritage in terms of a range of cultural qualities – and in many cases natural qualities as well. Each heritage asset may reflect many qualities, some more important than others. It is the

combination of these qualities that may contribute to the outstanding universal value of cultural properties."

In the case of Magnetic Island there is a range of natural qualities that often are linked with the cultural qualities. The outstanding universal value of the Island derives from a combination of these qualities.

Terrestrial Natural Heritage Values of Magnetic Island

Magnetic Island as a Feature of the GBRWHA

While the islands of the Great Barrier Reef World Heritage Area (GBRWHA) occupy only about 5% of the total area, they contribute greatly to geomorphological and biological diversity, as well as the exceptional natural beauty of the World Heritage property. An inventory developed in the 1980s for the Great Barrier Reef Marine Park Authority revealed that there were 901 islands within the World Heritage Area and that 599 of these are continental islands. The rest are coral cays.

Magnetic Island is a high continental island that lies eight kilometres off the coast from the Queensland coastal city of Townsville. At 5184 hectares, it is the seventh largest island within the World Heritage Area (Table 1). To put this in some perspective, 348 of the 599 continental islands are <10 ha in area and only 41 continental islands are >500 hectares in area. Only eight islands within the World Heritage Area are over 3000 hectares in area.

Table 1. ***Islands in the Great Barrier Reef World Heritage Area Greater Than 500 hectares***

Island Name	*Size (ha)*	*Island Name*	*Size (ha)*
Curtis Island	46656	Leicester Island	1214
Hinchinbrook Island	39350	Scawfell Island	1090
Whitsunday Island	10927	Wild Cattle Island	1025
Townshend Island	6734	Lizard Island	1012
Great Palm Island	5666	Brampton Island	907
Long Island	5605	Dunk Island	891
Magnetic Island	5184	Goold Island	829
Hook Island	5180	Stanley Island	810
Hummock Hill	2720	Lindeman Island	790
Facing Island	2480	Haslewood Island	777
Gloucester Island	2461	Keswick Island	777
Quail Island	2136	Fantome Island	735
Shaw Island	1659	Albany Island	710
Middle Island	1658	Hamilton Island	709
South Island	1619	Goldsmith Island	648
Great Keppel	1478	Marble Island	607
Flinders Island	1460	North Keppel	588
Orpheus Island	1376	Carlisle Island	518
St. Bees Island	1295	Prudhoe Island	518
Turtle Head Island	1254	Curlew Island	517
Long Island	1215		

Source: *GBRMPA/AMCS Great Barrier Reef Resource Inventory* based on Queensland Government surveying data.

Magnetic Island also is one of the highest islands within the World Heritage property. Only eight islands have elevations in excess of 400 metres (Table 2). At 495 metres, Magnetic Island is the fourth highest island within the World Heritage Area.

Clearly, in size and elevation alone, Magnetic Island is one of the most significant islands within the World Heritage Area.

Table 2. ***The Highest Islands in the Great Barrier Reef World Heritage Area*** (heights in metres).

Hinchinbrook Island	1121
Gloucester Island	577
Great Palm Island	554
Magnetic Island	495
Hook Island	451
Whitsunday Island	437
Goold Island	418
Shaw Island	408

Source: *GBRMPA/AMCS Great Barrier Reef Resource Inventory.*

Geological and Morphological Diversity

The Australian Heritage Commission draft Statement of Significance for Magnetic Island noted, "An unusual exposure of the contact between the Permian Magnetic Island granite and an older volcanic and dyke rock complex is exposed at Huntingfield Bay, which provides evidence that the region's Permian granites are intrusive" (Register of the National Estate Database at website http://www.ahc.gov.au/register/)

The geological and geomorphological diversity of Magnetic Island, which includes bedrock, alluvial, aeolian, estuarine and marine components, has been described in Morgan (2004) and is reproduced below.

The bedrock geologies on Magnetic Island include:

- Permian volcanic rocks (Julago Volcanics), typical of a wide belt of similar rocks between Central and Northern Queensland
- Permian intrusive rocks (Magnetic Island Granites), one of a wide suite of similar granitic intrusions in North Queensland
- Exposures showing the relationship between the volcanic and granitic rocks, and demonstrating that the Magnetic Island granite and related Permian granites are younger, and intrusive into the volcanics
- Dolerite dykes intruding the granites.

The volcanic rocks generally form low domed hills with skeletal soils, and the granitic rocks form ranges and low hills with rock outcrops including tors, and deeper, coarser-textured soils. The dykes weather more easily to form valleys and saddles within the granitic landscape. Other landforms include perched valleys, captured watercourses, boulder screes, and talus slopes. Mudslides are an irregular and continuing occurrence, demonstrating a major form of mass movement in the wet/dry tropics.

The Island also has a wide range of more recent unconsolidated alluvial and Aeolian geologies. These include:

- Alluvial landscapes derived from the previous bedrock geologies, with at least three different age sequences, each having distinctive soils and landforms;
- Wetlands, including a diversity of freshwater systems lying between alluvial fans and dune systems, swales in dunes, and wetlands that alternate between fresh, brackish and saline, depending upon seasons and tides;
- Coastal aeolian landscapes, including at least three different age sequences of sand dune systems, varying in number and form according to the aspect and scale of each bay around the Island.

These landscapes include old shorelines, reflected in the different aged dune systems, cut benches in higher alluvial systems, and in silicified, calcified or ferruginized beach rock. Magnetic Island is particularly unusual in eastern Australia in having a western shoreline with a diversity of dunal systems. Remnants of an older, laterized surface also occur in some areas.

Estuarine and marine geomorphological diversity includes:

- Tidal flats, with zones of frequency and duration of inundation expressed by salt couch or samphire communities, algal or bare saline flats, various mangrove forest zones, and offshore tidal sand and mud flats with extensive seagrass beds
- Reef flats, with associated landforms, and fringing reefs, varying in form and extent according to aspect and prevailing environmental conditions
- A wide variety of beaches, varying in width and slope according to aspect and relative wave energies.

Magnetic Island is a microcosm of many of the geologies, landforms and soils found on the coastal and near coastal part of the wet/dry tropics of North Queensland. Their close proximity on the Island, relative to a similar range in landscape diversity on the mainland, provides a unique and outstanding opportunity for the conservation and study of these interrelated and interdependent geomorphologic elements, and of their associated plants and animals. In the case of this biological evidence of evolution, Magnetic Island is also significant as an environment where the impact of stock grazing, feral animals and introduced weeds is relatively minor compared with most of mainland Australia.

Flora/Vegetation

All available floristic information for the continental islands of the Great Barrier Reef collected from 1770-1996 was examined by Batianoff & Dillewaard (1997). A total of 2195 plant species have been found on the continental islands within the Great Barrier Reef World Heritage Area. This amounts to about one quarter of the total known Queensland flora growing on about 0.1% of Queensland's landmass.

The study found that the continental islands of the GBRWHA supported five distinctive floristic regions. Magnetic and Gloucester Islands were the only substantial continental islands within what they identified as the Dry Tropics Region. Batianoff & Dillewaard (1994) found that Gloucester Island was very different from the Whitsunday Region immediately to the south because the flora and vegetation types show strong affinities with granitic outcrops between Bowen and Townsville. However, Gloucester Island is quite different from Magnetic Island in that it is higher and probably wetter, with short steep catchments, an absence of permanent freshwater, and a limited area of lowlands around the shoreline (Batianoff , pers. comm.). In addition, Gloucester Island has only one fringing reef, located at its southern end (GBRMPA/AMCS Great Barrier Reef Resource Inventory). This is probably due to the high volume of freshwater runoff from the Gloucester Island catchments (Hopley, 1982).

The Batianoff and Dillewaard (1997) study found that plant species diversity on Great Barrier Reef continental islands increases linearly with island size up to about 5000 hectares. For larger islands, other factors such as habitat diversity, distance offshore, palaeoclimates and fire frequency appear to interact to become important determinants of species richness. In 1996, of the thirteen most intensively sampled continental islands in the GBRWHA, Magnetic Island was recognised as having the fifth highest number of native plant species (Table 3).

Table 3. ***Richest Island Floras in GBRWHA (1996)***

Island Name	*Native Plant Species*
Hinchinbrook Island	600
Curtis Island	590
Whitsunday Island	495 (estimated)
Lizard Island	475
Magnetic Island	457
Gloucester Island	450
Scawfell Island	393
Great Keppel Island	386

Source: *Batianoff & Dillewaard 1997*

However, more recent studies cited by Jackes (2003) and Morgan (pers. comm.) have increased the number of native plant species on Magnetic Island to 648. This is by far the largest number currently known from the GBRWHA islands. While Magnetic Island clearly is exceptional, it has been much more intensively and comprehensively studied than Hinchinbrook, which we believe may support even greater floristic diversity, hence our rating of this attribute is precautionary (see *Magnetic Island World Heritage Scorecard*).

The Batianoff & Dillewaard (1997) study also found that the granitic inshore islands with a mountainous landscape supported the greatest number of rare and endangered vascular plant species that have been found within the GBRWHA. With eleven such species, Magnetic Island ranked third after Hinchinbrook Island (16 species) and Gloucester Island (13 species).

No endemic plants are known from Magnetic Island. However, Sandercoe (1990) undertook the most extensive and detailed flora collections on the Island and considered that ten species collected could be new to science. The current status of these specimens is unknown. More recently, Morgan (2004) stated that a *Tephrosia* species (Fabaceae) has been identified on Magnetic Island that, if confirmed, is likely to be an endemic. Plants that are disjunct from their normal distribution, or occur at the extremity of their range on Magnetic Island include *Antidesma ghaesembilla*, *Atalaya multiflora*, *Brachychiton bidwillii*, *Fitzalania heteropetala*, *Glochidion apodogynum* and *Labichea nitida*.

Proximity to the mainland and the high habitat diversity probably contribute significantly to the species richness of the Magnetic Island flora. Sandercoe (1990) identified 23 vegetation types on the Island when mapped at 1:25000 scale. Morgan (2004) considered that 13 of these types are well represented in Magnetic Island National Park or Horseshoe Bay Conservation Park and that a further four are contained within the tidal areas of the adjacent Great Barrier Reef Marine Park. The remaining types are those typical of the lowlands of the Island.

More recent ecological studies (Morgan & Terry 2001 & Morgan, pers. comm.) have sought to place the work of Sandercoe (1990) in the context of the state-wide effort to determine the conservation status of Queensland's bioregional ecosystems (Appendix 3).(see also Sattler & Williams 1999).

Table 4 provides a recent detailed assessment of the extent of each of these regional ecosystems remaining on Magnetic Island. This is based on analysis of recent airphotos and field surveys compiled on a GIS (Morgan, pers. com.). His preliminary assessment indicates that Magnetic Island has significant occurrences of 2 nationally endangered ecosystems - microphyll vine thicket on sand dunes, and dry rainforest on alluvial plains.

Table 4: **The remaining extent of lowland terrestrial regional ecosystems on Magnetic Island**

Regional Ecosystem number	Pre-clear extent (ha)	Remnant extent at Dec 2004 (ha)	Remnant extent as % of pre-clear at Dec 2004	Regrowth extent at Dec 2004 (ha)	Regrowth extent as % of pre-clear at Dec 2004	Cleared extent as % of pre-clear at Dec 2004
11.2.1	89.59	52.12	58.18	0	0.00	41.82
11.2.2	29.49	19.2	65.11	0.33	1.12	33.77
11.2.3	35.99	28.87	80.22	2.94	8.17	11.61
11.2.4	3.81	2.91	76.38	0	0.00	23.62
11.3.4	19.53	16.35	83.72	0.19	0.97	15.31
11.3.9a	371.1	99.99	26.94	22.67	6.11	66.95
11.3.9b	155.35	77.09	49.62	14	9.01	41.36
11.3.11	29.72	29.51	99.29	0	0.00	0.71
11.3.12a	11.59	7.44	64.19	0.01	0.09	35.72
11.3.12b	1.11	0.83	74.77	0	0.00	25.23
11.3.25	59.32	55.25	93.14	1.05	1.77	5.09
11.3.27a	1.55	1.51	97.42	0	0.00	2.58
11.3.27b	5.71	5.41	94.75	0	0.00	5.25
11.3.27c	28.11	23.27	82.78	0	0.00	17.22
11.3.35	1.52	0.83	54.61	0.43	28.29	17.11
11.3.35a	2.64	2.55	96.59	0	0.00	3.41
Totals Lowlands	846.13	423.13	50.01	41.62	4.92	45.07
Totals Island	5024.14	4585.96	91.28	42.67	0.85	7.87

Prepared by Gethin Morgan, PO Box 50, Nelly Bay, QLD 4819

It is important to recognise that it is not just undisturbed remnant vegetation that may have World Heritage value. Some of the regrowth we observed on Magnetic Island may meet the Queensland Vegetation Management Act definition of remnant vegetation (i.e. recovered to at least 70% of the original canopy height and 50% of the original canopy cover). Urban areas also appear to retain some of their natural values and support some of the Island's wildlife.

When the current work on the conservation status of the regional ecosystems of Magnetic Island is completed and published it will provide an invaluable guide for future management of Magnetic Island.

Island Fauna

GHD (1990b) provided fauna lists for birds, mammals and reptiles of Magnetic Island, but these lists have been updated in more recent field studies by Morgan & Terrey (2001). Sixteen native mammals, 34 native reptiles and 13 native amphibians are now known from the Island. Morgan (2004) noted that the northern quoll *Dasyurus hallucatus* is believed to have become extinct on the Island.

Birds are clearly the best known component of the fauna. Wieneke (2002) lists habitat and abundance information for the 180 species of birds recorded from the Island. Morgan (2004) noted that 18 are seabirds, 24 are waders and other shore-frequenting birds, and 32 are associated mainly with freshwater wetlands. At least 50 species are considered resident species, and a further 32 are regular summer or winter migrants.

Morgan (2004) also regarded the species data as relatively good for the larger mammals, but insects, reptiles, amphibians and the smaller mammals are still only superficially known.

Despite very limited study and systematic surveys on only a few islands, 118 species representing 30% of all known Australian butterfly species have been recorded within the GBRWHA. There are some interesting records from Magnetic Island which has a rich butterfly fauna. There are several locations where overwintering aggregations occur numbering hundreds of individuals. The overwintering sites are located in sheltered areas, typically gullies with vineforest communities that provide shade and shelter, have high relative humidity and minimal disturbance from wind and/or human activities. The aggregations may remain on-site from between the early and late dry season and may provide an opportunity for carefully managed, nature-based tourism (Valentine 2000).

Most of the species involved are in the family Nymphalidae, including the blue tiger *Tirumala hamatus*, the eastern crow *Euploea tulliolus*, and the common crow *Euploea core corinna*. Magnetic Island is one of the few known locations of a relatively rare species *Libythea geoffroy nicevillei*. In addition , the skipper butterfly, *Hesperilla malindeva dagoomba*, one of two subspecies endemic to the GBRWHA, so far is known only from Magnetic Island (Johnson & Valentine 1994, Valentine 1997, Register of the National Estate Database, National Estate Nominators Statement of Significance).

The koala has been introduced to Magnetic Island. In 1991 numbers were estimated to be of the order of 500 animals, which constituted one of the largest and most concentrated koala populations in North Queensland (National Estate Nominators Statement of Significance).

Table 5 shows the thirteen species of animals recorded on the Island by Morgan (2004) that are listed as endangered, rare or vulnerable under the Queensland *Nature Conservation Act*:. These are listed on the website at http://www.epa.qld.gov.au/nature_conservation/biodiversity/endangered_wildlife/

Table 5 : ***Rare and endangered species from Qld EPA website found on Magnetic Island*** (Morgan 2004)
Sterna albifrons little tern (Endangered)
Delma labialis single-striped delma (Vulnerable)
Esacus neglectus beach stone-curlew (Vulnerable)
Taphozous australis coastal sheathtail bat (Vulnerable
Acanthophis antarcticus common death adder (Rare)
Accipiter novaehollandiae grey goshawk (Rare)
Collocalia spodiopygius white-rumped swiftlet (Rare)
Ephippiorhynchus asiaticus black-necked stork (Rare)
Haematopus fuliginosus sooty oystercatcher (Rare)
Lampropholis mirabilis saxicoline skink (Rare)
Menetia sadlieri Sadliers dwarf skink (Rare)
Numenius madagascariensis eastern curlew (Rare)
Varanus semiremex rusty monitor (Rare)

One of the lizard species collected from Magnetic Island is believed to be endemic to the Island. This is Sadliers dwarf skink (*Menetia sadlieri*), which is one of only three Island endemic reptiles in Queensland. This skink has a major part of its habitat on the lowlands of the Island. Other endemic fauna species could be expected to occur on the larger continental islands, including Magnetic Island. Such endemic species could be expected to be restricted to rocky habitats, as these have been isolated for extended periods by grassy lowlands prior to sea-level impacts (Morgan, 2004).

Magnetic Island supports a large population of the common death adder *Acanthophis antarcticus*, instead of the northern death adder (*Acanthophis praelongus*) which is the death adder species found on the adjacent mainland. Recently the legless lizard *Anomalopus gowi* was also collected on the Island. This is a species more typically found inland from the coastal ranges (Morgan 2004).

An area adjacent to Gustav Creek at the end of Mandalay Road, Nelly Bay has been found to contain one of the highest densities and diversities of small lizards known from north Queensland. At least 15 species have been found there and densities are often as high as one animal per $4m^2$ of habitat (*ZL2104 Field Study Notes* (2004), James Cook University).

Morgan (2004) regarded Magnetic Island as a nationally significant refuge for the protection and conservation of the single striped delma *Delma labialis,* one of Australia's "legless" lizards.

Marine Natural Heritage Values of Magnetic Island

Intertidal and Subtidal Habitats of Magnetic Island

Magnetic Island has a rugged, rocky shoreline with many small embayments and headlands that represent a complex array of small-scale environmental niches for marine organisms.

Due to its location in Cleveland Bay, the marine habitats of Magnetic Island are diverse. They are characterised by gradients ranging from very wave-protected shallow muddy environments on the leeward sides to wave-exposed windward coastlines with clearer and deeper water. Associated with the high environmental diversity is a broad range of marine communities, ranging from those that are tolerant of muddy, low light conditions to those that are typically found in less turbid environments (Fabricius & Brodie 2004).

While there has been a substantial number of studies of the marine environment adjacent to Magnetic Island, most of this work focussed on particular species or specialized topics that provided little or no data that could be used for World Heritage evaluation. The section below reviews current knowledge of particular Magnetic Island marine habitats that might contain attributes of special World Heritage significance. Holistic values associated with adjacent and inter-related marine habitats are also considered.

Rocky Shores

Endean, Stephenson & Kenny (1956) studied the rocky shorelines of a coral cay (Heron Island) and ten continental islands within the GBRWHA, as well as rocky shoreline areas along 1600 kilometres of the Queensland coast (Endean, Kenny & Stephenson 1956). Their work provided descriptions of the zonation and distribution of dominant intertidal organisms, focusing on forty-eight species of marine invertebrates.

Despite its proximity to the mainland, Magnetic Island was found to be different to the "typical" North Queensland mainland localities in the following ways:

- *Nerita costata* was a dominant species;
- The zone dominated by oysters extended from well above Mean Sea Level to below Low Water Neap tide. *Tetraclita squamosa* was very sparse and extended higher than usual;
- There was a zone in which Tetraclita rosea was common. It occurred below Mean Sea Level and extended to Low Water Neap;
- Lithothamnion formed a zone below Low Water Neap;
- Below Mean Low Water corals were common but somewhat patchy in their occurrence.

These were definitive studies of rocky shorelines and provided the only published moderately detailed account of the rocky shore organisms of Magnetic Island that we have obtained. Unfortunately, there are inadequate data to assess the World Heritage significance of the rocky shorelines.

Tidal Marshes

Tidal marshes consist of small brackish marshes at the interface of *Melaleuca* stands and the landward margin of the mangrove forest, as well as salt marshes that occur within hypersaline areas in the mangrove forest. While the species of saltmarsh and brackish marsh plants present on Magnetic Island are known from the various 1976-1983 studies of Spenceley, of Sandercoe (1990) and Jackes (2003), there do not appear to have been any studies that would allow us to evaluate the World Heritage significance of this habitat on Magnetic Island. A small number of marine invertebrates and birds are recorded from this habitat but there do not appear to have been any systematic surveys of tidal marsh fauna.

Saltmarshes are fairly extensive on the western side of Magnetic Island because in the climatic regime of low rainfall and high evaporation, the nutrient poor soils in the infrequently inundated intertidal areas become too hypersaline to support mangrove forest (Macnae 1967). Drawing on the work of Batianoff & Dillewaard (1997), it is likely that the Magnetic Island tidal marshes are biogeographically unique in the GBRWHA, but currently available data on this habitat are insufficient for proper appraisal.

Mangroves

The mangrove plant species present on Magnetic Island are known from the various 1976-1983 studies of Spenceley, of Sandercoe (1990) and Jackes (2003). Sandercoe mapped the dominant mangrove communities at 1:25,000 scale.

The broad scale mangrove zonation is known from the work of Macnae (1967) and Spenceley (1982 &1983). Some notes on the mangrove invertebrate fauna and a species list of 19 crustaceans and 11 molluscs recorded during a reconnaissance of Cockle Bay were presented in Macnae (1967). The mangrove associated invertebrate fauna of the GBRWHA area was little known at this time and the species recorded by Macnae were those known from other locations in the Indo-Pacific.

Bell & Kettle (1990) concluded that Cockle Bay was the best studied mangrove location on the Island, and that the flora and fauna of the mangroves that occur in Bolger Bay and Young Bay towards West Point have not been studied in any detail.

More recently the mangroves of the Bolger Bay area were very briefly described as one of twelve land types adjacent to the Bolger Bay Nature Refuge (Morgan & Terrey, 2001), but they were outside the area for which a management plan was formulated.

A small part of the Bolger Bay area was briefly examined during a field inspection by one of us (EH) on 17/06/05. The survey followed the intertidal portion of a drainage channel that originates on the western slopes of the Island and passes through a portion of the Nature Refuge. The survey commenced at the upper intertidal at **19°08.52' S, 146° 47.93' E** and extended into the inner margin of the Rhizophora zone.

The mangrove communities in the area examined bore very little resemblance to the descriptions in Macnae (1966) or Spenceley (1976). Along the landward margin *Lumnitzera racemosa* was the dominant mangrove with stands varying in canopy density and height from shrublands to low forest. The highest intertidal portion of the drainage channel contained a small stand of *Bruguiera gymnorrhiza*, but the *Bruguiera* zone described by Macnae (1966) was absent.

It was clear that a systematic survey and fine scale mapping of Magnetic Island mangrove habitats would reveal a complex mosaic of mangrove communities that is far more diverse than indicated in previous studies.

The one indication of the possible richness of the mangrove and tidal marsh fauna of Magnetic Island was provided by an Australian Marine Conservation Society reconnaissance survey through three areas of Cockle Bay in March 1975. Thirty-nine species of molluscs were collected in twelve hours of field work (Shanco 1975).

Unfortunately, there has been no comprehensive assessment of the mangroves of the continental islands of the GBRWHA that would allow us to evaluate the significance of what little is known of the mangroves of Magnetic Island. Unpublished data from field surveys through the Whitsunday and Cumberland Islands by the Australian Marine Conservation Society suggest that the development of mangrove forests and shrublands on the continental islands of the Great Barrier Reef can be highly variable even over short distances between bays on the same island. Topography and substrate, shelter and the volume and persistence of freshwater runoff appear to be key factors influencing mangrove forest development.

As previously noted, environmental conditions are very different on Magnetic Island compared with Gloucester Island, the only other large island identified by Batianoff & Dillewaard (1997) as lying within the Dry Tropics Region of the GBRWHA. For this reason we conclude that the Magnetic Island mangrove areas are likely to be unique in the GBRWHA, but note that current data are insufficient for proper appraisal.

Seagrasses

The distribution of seagrasses in the coastal waters of the GBRWHA were mapped in broad-scale surveys from 1984-1989. Magnetic Island and Cape Pallarenda together were one of 49 major areas of seagrass habitat identified by the survey program. The seagrass beds of Magnetic Island were found to cover 12.88 km^2 (Lee Long & Coles 1997). This is barely one tenth the size of the largest seagrass bed that lies between Murdock and Lookout Points (north of Cape Flattery on Cape York) and ranks 28th in size among the major seagrass beds of the GBRWHA. However, with eleven species of seagrass, Magnetic Island ranked third among the major seagrass beds for diversity of seagrass species (Lee Long & Coles 1997). In addition, a *Holophila* plant from Magnetic Island had elongate leaves and could not be identified to species (Coles, et al. 1992). If a future revision of the *Halophila ovalis* group reveals that this is a new species, Magnetic Island would be equal to the two richest sites with twelve species out of the 14 known from the GBRWHA. In addition to the floristic diversity, eleven distinctive seagrass communities are identified on the GIS for the1984-1988 field work carried out by the QDPI team.

The Magnetic Island seagrasses were also found to have high biomass per unit area and support high densities of juvenile commercial penaeid prawns (Coles, et al., 1992). The rich seagrass beds in Cockle Bay on the south-western side of Magnetic Island have been studied by Birch & Birch (1984) and Kwak & Klumpp (2004) in addition to the QDPI research teams led by Coles and Lee Long. These seagrass beds are 200-400 metres across extending from the seaward margin of the mangrove forests to the coral debris on the inner margin of the fringing reef. Kwak and Klumpp collected 45 species of fish representing thirty families, as well as 55 species of decapod crustaceans from seventeen families. This study demonstrated that the seagrass beds of Cockle Bay function as nursery areas for marine life, including species of commercial and recreational importance. Juveniles of the important commercial holothurian species *Holothuria scabra* also are common on these intertidal areas (Brodie 2004).

Cockle Bay has been a seagrass monitoring site since 1971 (Birch & Birch 1984). This is believed to be the longest record of seagrass monitoring in the GBRWHA (H. Marsh, pers. comm.).

Seagrasses are the food source for the green turtle, *Chelonia mydas* (Lanyon 1986). These turtles not only feed in the seagrass beds, but also regularly nest in small numbers on several of the Magnetic Island beaches. Green turtle are listed an endangered species in the IUCN Red List of Threatened Animals.

Flatback turtles *Natator depressus* also nest in small numbers on the same Magnetic Island beaches. Flatback turtles feed on sea pens, sea cucumbers and soft corals. (GBRMPA website at http://www.reefed.edu.au/explorer/animals/marine_vertebrates/marine_reptiles/turtles.html). They are listed in the IUCN Red List of Threatened Animals as vulnerable to extinction (IUCN 1996).

There has been monitoring of sea turtle nesting and sightings in the Townsville area by the Indo-Pacific Sea Turtle Conservation Group. Appendix 4 contains data on nesting activity and "in-water" sightings collated by Dr Tim Harvey of the CRC Reef Research Centre.

Seagrass beds provide the main food source for the dugong *Dugong dugon* that live in these waters (Marsh & Corkeron 1997; Lawler, et al. 2002), and the primary food source is found along a relatively narrow band close to shore (GBRMPA 1997). Dugong are listed in the IUCN Red List of Threatened Animals as vulnerable to extinction (IUCN 1996).

Cleveland Bay and the seagrass beds and waters around Magnetic Island are, in fact, considered crucially important dugong habitat and are recognized as one of the seven most important habitats to ensure the survival of dugong in the GBRWHA from Hinchinbrook Island southwards. On August 14, 1997 the Great Barrier Reef Ministerial Council established a chain of dugong protection areas over these seven areas. Because it was considered a key threatening process, gill netting was prohibited in all seven areas (Great Barrier Reef Ministerial Council 1997).

The Queensland Department of Primary Industries and Fisheries recently conducted an excellent desktop review of the marine habitats in Cleveland Bay and the fisheries resources dependent upon them (Baker & Sheppard 2005). Unfortunately the study area did not extend as far north as Magnetic Island.

Reef Flats and Fringing Reefs

Bell & Kettle (1990) provided a brief description of the lower intertidal and subtidal areas of each bay on Magnetic Island. The fringing reefs of the Island have been studied and various features described by many authors including Smith (1978), Morrissey (1980), Bull (1982), Hopley, et al. (1983),Collins (1987), Mapstone, et al. (1989), Brodie (1991), and Kaly, et al. (1994). Most studies have focused on the reefs and reef flats of Geoffrey Bay, Nelly Bay and Cockle Bay, while there appears to have been quite limited study of the reefs in the bays on the northern shore, although Smith (1978) noted that an extensive fringing reef is found on the eastern shore of Horseshoe Bay and "large stands of live hard corals" are found on the floors of some of the smaller bays along the north-western shore from Huntingfield Bay to Lovers Bay.

Hopley & Partain (1987) stated that there are 545 fully developed fringing reefs within the Great Barrier Reef Marine Park and a further 213 (largely rocky) incipient fringing reefs. The total area of fringing reefs is about 350 km2. The eleven fringing reef areas on Magnetic Island have a total area of about 3.7 km2 (Collins 1987).

The approximate sizes of the individual Magnetic Island reefs are reproduced from Collins (1987) and shown in Table 6. These sizes refer only to the reef areas where living coral may be encountered and does not include the sand, mud and rocky rubble flats that form behind the larger reefs (Cockle, Geoffrey, Nelly and Picnic Bay reefs). It is difficult to define the area where living coral exists on the Cockle Bay reef so the size is only a rough estimate. Isolated coral colonies and small coral communities are also found along many of the rocky shores. Collins (1987) felt that these only should be considered reefs if an adequate accumulation of reef material was present. The reefs in Wilson and Alma Bays were regarded as close to the lower size to be considered as fringing reefs.

Table 6. ***Size of Coral Reefs Around Magnetic Island*** (in hectares).

Wilson Bay	1.4	Alma Bay	1.0
Maud Bay	5.2	Geoffrey Bay	31.0
Horseshoe Bay	1.8 (est.)	Nelly Bay	43.0
Gowie Bay	1.9	Picnic Bay	10.0
Florence Bay	5.1	Cockle Bay (isolated reef)	47.0
Arthur Bay	5.3	Cockle Bay (main reef)	218.0

The fringing reefs of Magnetic Island are exposed to conditions that range from very protected to moderately exposed. Mapstone, et al. (1989) found that the south-eastern bay reefs were qualitatively similar to each other but distinct from other reefs around Magnetic Island. Reefs around the north-western shoreline were found to be mostly granitic or were shallow mudflats that were fundamentally different in physical and biological structure from the fringing reefs along the south-eastern side of the Island.

On the leeward sides, coral communities are composed of a number of species that are tolerant of high turbidity and sediment deposition. These include one of the most extensive colony stands of *Montipora digitata* recorded on the Great Barrier Reef (Fabricius & Brodie 2004). On the windward sides, coral communities are more diverse and contain several massive coral colonies that are hundreds of years old. Magnetic Island reefs also show more pronounced depth gradients compared with most other reefs of the GBR due to the high water turbidity. For example, the rare soft coral *Nephthyigorgia* sp, that normally only occurs in deep and dark places (Fabricius &Alderslade, 2001), has been recorded at depth of just 8 metres near Florence Bay, and so far nowhere else in the GBRWHA (Fabricius & Brodie 2004).

This range of conditions on the Magnetic Island fringing reefs has permitted a rich diversity of hard corals to develop. Bull (1982) found 69 species in Geoffrey Bay and 42 species in Cockle Bay with 33 species common to both. In all, over 100 species of hard corals have been recorded from the Magnetic Island fringing reefs (see Appendix in Collins 1987). This is more than one quarter of the total known GBRWHA coral fauna. The reef flats and reefs also support a wide variety of other marine fauna, but these organisms do not appear to have been sufficiently studied for us to evaluate their significance.

One relatively recent study provides a limited, but interesting, perspective on the condition of at least one bay. Wachenfeld (1998) compared five historic photographs of reef flat substratum in Geoffrey Bay that dated from 1952 with the field situation in 1995 and concluded that there was no evidence of change in the reef-flat benthic communities.

Cockle Bay appears to represent an outstanding example of the inter-related intertidal and subtidal marine habitats that can be found in association with large continental islands of the GBRWHA. An extensive mangrove forest has formed on the upper tidal slope, below which there are broad seagrass-covered mudflats and an extensive intertidal reef flat. The large size and sheltered nature of this reef flat make it unique within the Dry Tropics. The fringing reef on the seaward margin of this system is by far the largest adjoining the Island.

Whales

Humpback whales *Megaptera novaeangliae* are frequently sighted in the bays and close to the shoreline of Magnetic Island. While we did not find any details on this in the scientific literature, visits by the whales are frequently mentioned in the local press. Some examples that were available on the internet are reproduced in Appendix 5

Humpback whales are listed in the IUCN Red List of Threatened Animals (IUCN 1996) as vulnerable to extinction.

Underlying processes sustaining diversity

Magnetic Island is located off the dry tropical coast and typically experiences several months each year with little or no rainfall. Because of this the natural process linkages of drainage and soil properties - particularly water retention, are crucially important for some lowland, wetland and intertidal communities. They are thus crucial elements sustaining the natural values of Magnetic Island.

The map and annotations in Appendix 6 provide a summary of current knowledge of the distribution and classes of soils on Magnetic Island and update the summary provided by Sandercoe (1990).

Many components of natural values derive from the Island's plant communities. On Magnetic Island as with other GBRWHA continental islands, the distribution and survival of many communities depend strongly on the drainage characteristics of the substrates. For example in the Bolger Bay mangrove areas that we inspected, the mangrove strands along a drainage line were totally different in species composition and structure from the adjoining mangrove zones which characterise the intertidal slope of the western side of the Island.

The existence of plant communities and associated fauna is linked to the processes of soil and the flow, persistence and quality of water with respect to the nature and availability of nutrients and minerals. Changes in these properties at one location can thus have a substantial downstream impact on natural values at another location. The following box presents a summary account prepared by Drs Chris Cuff and Cecily Rasmussen of the linkages and interdependence of soil and plant communities in Horseshoe Bay.

Linkages and interdependence of soil and plant communities in Horseshoe Bay

The over-riding value of the geomorphological features of the Horseshoe Bay complex is that it encompasses a variety of landforms within a very short (~2km) traverse. Where present in other areas along the North Queensland coast, these features occupy a distance of 20 km or greater.

Horseshoe Bay features a narrow coastal zone that supports a series of well-defined habitats and ecosystems of reasonably high quality that is unique to Magnetic Island. In an approximate 2 km north / south traverse across the Bay, the array of geomorphological formations and supported habitats represents a more traditional 20-30 km transect of the seasonally arid coastal zones of North Queensland. These features comprise:

- A beach sequence that borders a series of frontal dunes featuring a *Casuarina* woodland.
- Frontal dunes separated from a secondary dune sequence by a series of swales containing vine thicket vegetation. The vegetation of the secondary dunal system is sparse littoral scrum.
- Secondary dunes separated from the historic dunes / shoreline by an older swale system of lagoons and ephemeral wetlands. These swales support *Melaleuca* forests (including *M. leucadendra, M. nervosa*, and *M.viridiflora*), *Pandanus* spp, and *Timonius timon*. These wetland systems are host to the seasonally migratory *Tirumala hamata* (Blue Tiger) butterfly.
- Vegetation of the historic dunes is predominantly comprised of open woodlands of *Eucalyptus teriticornis, Corymbia clarksonia* and vine thickets.
- Alluvial / colluvial flats and plains behind the historic dunes. These features extend to the base of scarp. The most common vegetation unit across these flats and plains is *Corymbia tesselaris* woodlands.
- Alluvial / colluvial fans at the base of scarp that are vegetated by *Corymbia tesselaris and clarksonia, Planchonia* and *Pandanus* spp. This zone serves as a vital recharge zone for the shallow aquifers between the scarp and the lagoons and ephemeral wetlands. The zones fed by the recharge areas at the base of the scarp, generally have shallow aquifers present (typical groundwater levels occur at less than 50cm) with flow towards the ephemeral wetlands and lagoon systems acting as a drip-feed mechanism which sustains the wetlands during periods of seasonal aridity. The sub-surface flow pathways are marked by *Pandanus* spp, *Melaleuca* spp, and *Timonius timon* and generally mark the presence of old stream channels of reasonable porosity and permeability. Downflow, these old sub-surface stream channels probably lead to old tidal creek channels or the location of ancient swale systems.
- Areas of cracking/expansive/dispersive clay occur between the old sub-surface channelways. These clay zones occasionally exhibit unique hummock type topography that is unique to the region.
- Sub-surface flow pathways that supplement the current, irregular, surficial flow pathways and their existing riparian zones. These flow pathways ensure the viability of the present lagoon. Without the supplementary flows provided by the sub-surface flow pathways, the lagoonal system would be highly degraded, or would cease to exist.

Source: Dr C. Cuff and Dr C. Rasmussen

Cultural Values from History and Use of Magnetic Island

Archaeology and history of Aboriginal use of Magnetic Island

Several categories of sites with cultural material evidence for past and continuing Aboriginal use of the terrestrial and marine resources of Magnetic Island have been documented. (Veth and George 2004). The locations of many of these sites are confidential and there is no available comprehensive map. During field reconnaissance of the western mangroves on 17/06/05 , we used a hand held GPS to record the locations of 2 very extensive middens.

An Indigenous site at Florence Bay was entered on the Register of the National Estate in 1991. There is no report of systematic evaluation of Magnetic Island to identify and evaluate places of cultural significance in accordance with article 26 of the Burra Charter and Guidelines (Australia ICOMOS 1999)

Gorecki and Greer (1988) reported on an archaeological survey of Nelly Bay which identified hundreds of prehistoric artefacts. The dominant material was pebble with many unbroken products such as stone axes indicative of the presence of a prehistoric camp site. On the basis of the types of tools found at the site they considered that the site was probably less than 5,000 years old but noted that the predominance of pebble material could indicate earlier, Pleistocene, origin. Their report mentions artefact records from Nelly, Florence, Huntingfield, Picnic, Bolger and Young Bays but there has been no systematic archaeological survey of likely sites on Magnetic Island.

The first European record of Aboriginal activity on the Island is James Cook's note of fires as he passed some 10km to the east - not close enough to determine whether it was an island or a cape at the mouth of a bay. Gibson-Wilde (1989) reports that Philip Parker King commander of HMS Mermaid undertook survey soundings to the south of Magnetic Island in 1819. Like Cook he recorded bush fires. There is no record of a landing on the Island but he recorded sighting several Aboriginal people on the sandy beach at the northern end of the Island (Brayshaw 1990). HMS Beagle spent some time in Halifax Bay in 1841 when John Lort Stokes spent a considerable time in Halifax Bay but left little record of encounters with Aboriginal people and none relating to Magnetic Island (Brayshaw 1990).

The next record of contact was that of Dalrymple. After an encounter on 15 September 1860 at Cape Cleveland in which Europeans opened fire killing at least one Aboriginal person, he moved on September 17 1860 to Magnetic Island, where he saw Aboriginal people and a number of canoes and reported that "their smokes rose from every part of the Island". He landed and cut hoop pine for a spar for the topmast of his vessel the Spitfire. Two days later armed Aboriginal warriors attacked Stokes' vessel and were repulsed by the discharge of a brass cannon (Gibson-Wilde, 1989).

These encounters occurred in the course of explorations and surveys that led to the selection in 1864 of Cleveland Bay as the site for a port to service the Herbert/Burdekin area and the rapid establishment of the township of Townsville. (Gibson-Wilde 1984).

Thereafter the exploration and use of Magnetic Island was closely linked with the development of Townsville and there are only passing records of Aboriginal activity on Magnetic Island. From contemporary records Gibson-Wilde (1989) reports that:

- the first picnic party crossed Cleveland Bay to Magnetic Island in April 1865 and was greeted by a large party of Aborigines who were apparently friendly;

- people held in a quarantine camp at Picnic Bay in the 1870s obtained food from Aborigines;

- for many years Ned Lee employed Aborigines as beche-de-mer gatherers and established a camp near Ned Lee's Creek where he remained with the Aborigines during seasons when not collecting beche-de-mer. He married an Aboriginal woman;

- after Lee's death in 1898 his camp, the last resort of the Island Aboriginals, was apparently broken up and the Aboriginals removed to the mainland

An area with an approximate eastern boundary decribed by a line from Mount Elliott to Cape Cleveland, a western boundary by a line from the coast to Palm Island extending inland to the Burdekin River is identified by Brayshaw (1990) as the indicative extent of the lands of the Wulguru Language group. The *AusAnthrop Australian Aboriginal Tribal Database* (http://www.ausanthrop.net/resources) identifies Cape Cleveland; Great Palm Island; Magnetic Island; Palm Island; Ross River as places that are often associated with the Wulgurukaba people. Magnetic Island is a traditional seasonal home of Wulgurukaba people. Since about 1980 it has become the contemporary home of their descendants.

European history and use of Magnetic Island

Picnic Bay received its name in the earliest days of Townsville. Magnetic Island has been valued as a place for recreation and rest from the pressures of the city ever since. The first recorded European residents lived in Nelly Bay in 1867 and 1868 where they cut hoop pine used in the building of Townsville.

Survey and settlement occurred in the 1880s with the first recorded sale of Island land occurring in 1887. By the late 1890s there were holiday cottages and a hotel at Picnic Bay and a guest house and holiday cottages at Arcadia. The introduction of regular ferry services by Robert Hayles in 1899 consolidated the role of Magnetic Island as a retreat and holiday area for Townsville citizens and visitors.

In 1918 Magnetic Island was incorporated within the boundaries of the City of Townsville, becoming the only Queensland island recognised as a suburb of a city.

The early buildings were mainly light tropical cottages and houses open to the breeze and mostly designed for temporary occupation. There is relatively little surviving built heritage. In March 1903 Cyclone Leonta demolished many of the buildings on the Island. The original Picnic Bay Hotel survived the cyclone but was burned down in the early 1920s. The replacement and a number of other older buildings were destroyed by cyclone Althea in 1971.

The Urbis settlement analysis and context report (2003) lists 75 buildings of heritage significance. None of these date from the earliest phase of European use of the Island; 6 are from the 1920s and 15 from the 1930s.

Contemporary use of Magnetic Island

Magnetic Island falls within the boundaries of the city of Townsville. It has four main settlement areas, Picnic Bay, Nelly Bay, Arcadia and Horseshoe Bay all located in lowland areas. These can be characterised largely as contemporary low density suburban culture existing in a relaxed, peaceful and tranquil atmosphere in concert with the natural environment.

Preliminary 2001 Census figures put the Island's settlement population at 3,278. (Urbis, 2003). There are about 2355 beds for tourists and substantial numbers of day trippers – sometimes 1-2000/day, visit the Island. (*Magnetic Times* 12 October 2004). The Island is served by a ferry service from Townsville which operates to a terminal at Nelly Bay in an area which is being developed with high density apartments.

Tourist attractions are mostly based on natural attributes of the island.

Cultural values of Magnetic Island from Social Analysis

Article 2 of the World Heritage Convention identifies science, conservation and natural beauty as the three points of view for assessing or assigning the outstanding universal value of natural sites. In the course of an inquiry into Australia's coastal zone the Resource Assessment Commission (1993) noted that values may be assessed by:

- what people say: for example formal hearings, meetings, in-depth interviews and questionnaire interviews;
- what people do in terms of conduct and behaviour: for example purchasing, voting and patterns of resource use;
- what people create: for example submissions to formal inquiries, existing law and policy, journalism, literature, art and other cultural products.

Sources of information include :

- Magnetic Island Visitor surveys conducted in July 2002 (Tourism Queensland) and May 2004 (MICDA);
- a report prepared by Economic and Market Development Advisers (2002) for Townsville Enterprise in conjunction with Tourism Queensland;
- a survey of Townsville and Magnetic Island residents and Magnetic Island visitors undertaken by GHD in connection with preparation of the Magnetic Island Management Plan 1990;
- the history of use of Magnetic Island since 1865 (Gibson-Wilde 1989);
- a visual assessment of landscape values of Magnetic Island undertaken by GHD in connection with preparation of the *Magnetic Island Management Plan* 1990;
- a detailed preliminary assessment of World Heritage Values of Magnetic Island compiled by members of Magnetic Island's resident scientific community under the auspices of the Magnetic Island Community Development Assoc. Inc MICDA and Magnetic Island Nature Care Assoc. Inc. (MINCA) (2004).

Visitor Surveys and market analysis

Whatever their assessment criteria may be, the most frequently cited elements of the appeal of Magnetic Island are its relaxed, peaceful, tranquil atmosphere and its natural beauty, with 97% of visitors expressing satisfaction with the natural appeal of the Island. The methodology of the visitor survey questionnaires is not described sufficiently to allow strict comparisons between the 2002 Tourism Queensland and 2004 MICDA surveys because the total in the 2002 tabulation adds to 185% while that in the 2004 survey adds to 100%. Despite this, both surveys reveal a close similarity in the top 7 appealing aspects, as summarised in Table 7.

Table 7: ***Most Appealing Aspects of Magnetic Island***

Attribute	Tourism Qld July 2002	MICDA May 2004
Beaches/Bays/water	38%	14%
Weather	24%	6%
Laid back/relaxed	17%	7%
Peaceful/quiet/tranquil	16%	17%
Scenery	14%	16%
Natural beauty/unspoiled	9%	9%
Beautiful/beauty	9%	Linked as scenery/beautiful

Drawing from the Survey (2002), the Economic and Market Development Advisers summarised:

"

- the core appeals for Magnetic Island are the Beaches and Bays, the Natural Beauty and the relaxing, peaceful atmosphere.; and
- taking a holiday is the overwhelming reason for going to Magnetic Island."

Harrington (2004) discusses the culture and views of Magnetic Island residents and the interactions of a range of views on levels of access and amenity for residents and visitors. In terms of what people say and do, the appeal for residents and visitors lies in natural beauty which is a core element of the outstanding universal values for which the Great Barrier Reef and its islands were nominated for the World Heritage Register in 1981.

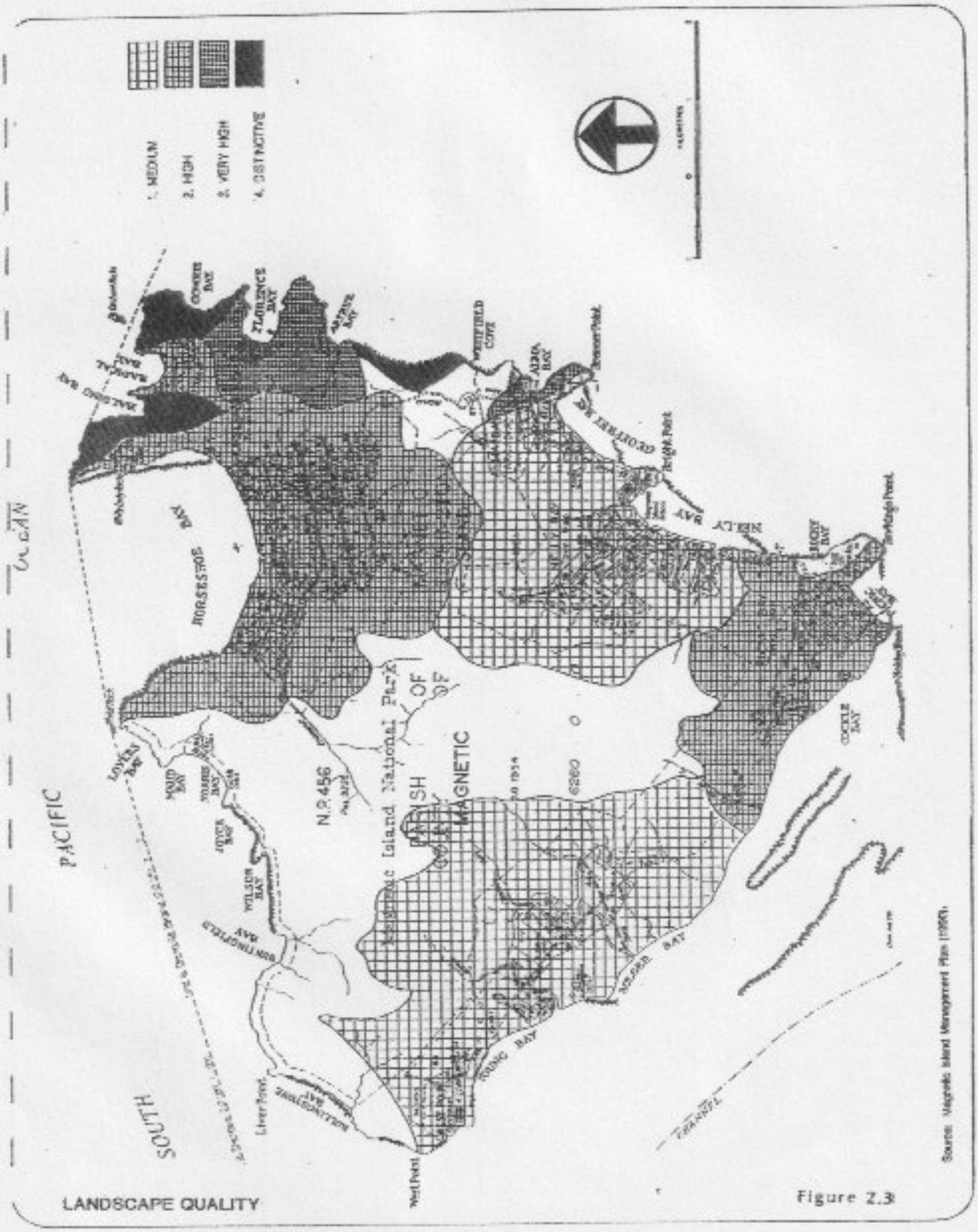
Visual Landscapes

The systematic visual assessment of Magnetic Island conducted by Wilson Morrison and Partners (Appendix 5 of GHD: *Magnetic Island Management Plan,* 1990) provides a useful basis for identifying areas of high natural beauty. This may be used in parallel with other attributes to identify visual landscape contribution to outstanding universal value and social value within the Magnetic Island context. The systematic methodology has clear qualitative criteria and applies these to mapped subunits of the visual field from identified locations. The study did not address all the Island or the distinctive characteristic visual fields from the sea looking in towards the Island.

We have limited expertise in social science and cultural assessment but are aware that methodologies are developing rapidly. We include as the best currently available information a *Landscape Quality Figure* from the Townsville City Council's Magnetic Island Management Plan 1994(a) that was produced using the methodology described by Wilson, Morrison and Partners (1990).

Landscape Quality Figure

Source: Townsville City Council Magnetic Island Management Plan (1994)



Cultural Landscapes

The concept of "landscapes" or "cultural landscapes" has been developed in social science to address interactions of human activity at a number of scales filling in the "blank spaces" between points such as archaeological sites (Greer et al 2000). The concept can also be applied to address the broader context or setting of contemporary sites of use or settlement within areas of high natural value.

Issues of cultural landscape and the interactions of cultural and natural values are becoming increasingly important in World Heritage management (IUCN, 2002, ICOMOS, 2004) Perceptions of cultural issues and aesthetics often reflect deeply-held personal values. However because they are experiential and reflect an integration of culture, education, experience and social values they are dynamic and can change substantially within societies over time.

Daley (in prep) has described substantial changes in attitudes concerning uses and impacts in the Great Barrier Reef World Heritage Area since European settlement. Pocock (2003) gives the example of the changes associated with the introduction of external cultural models in the GBRWHA. Where beach *Casuarina* trees and native vegetation were regarded as core elements of the GBR island experience in the mid 20th century. they nave been relaced in the early 21st century by coconut palms, lawns and lush gardens of exotic plants. On contemporary Magnetic Island the opportunity to see koalas, rock wallabies and bush thick knees at close quarters is a valued component of the experience for visitors and residents.

Pocock (2003) studied the implications of a conclusion of Greer et al (2000) that social values are an important aspect of heritage values often overlooked by management. Pocock (2003) used an interview technique that sought to redress a strong emphasis on visual responses and to identify a collective integration of all sensual experiences of the Great Barrier Reef. A paper prepared for the Australian Heritage Commission (2003) addresses methods for assessing inspirational landscapes and discusses indicators of aesthetics, spiritual, local knowledge and experience.

In this context, assigning cultural values to the recent and contemporary buildings on Magnetic Island is beyond our area of expertise. Recent and contemporary building of Great Barrier Reef islands were not identified as a component of the values in the nomination of the GBRWHA (GBRMPA, 1981). They would probably now be identified as an element in the context of current concepts of interaction of natural and cultural elements within landscapes of high aesthetic value. The Urbis settlement analysis and context report (2003) lists 75 buildings of heritage significance. None of these date from the earliest phase of European use of the Island; 6 are from the 1920s and 15 from the 1930s. They would seem to be an important element of the contemporary local suburban culture and cultural landscape but we are not qualified to make any more detailed assessment.

Contribution of Magnetic Island to GBRWHA values

Magnetic Island has a unique role in the context of addressing the three obligations under the World Heritage Convention of protection, conservation and presentation of cultural and natural heritage. As a large island it has characteristic scenic diversity, high botanical diversity, distinctive wetlands, fringing reefs and seagrass beds. It also has a broad range of natural values shared with smaller islands of the central GBRWHA. Relative to most of the GBRWHA the values expressed on Magnetic Island are highly accessible to visitors and residents.

Clearly there is an obligation to identify, protect and conserve the values that are particularly characteristic of Magnetic Island. There is also the obligation to address the display of the Outstanding Universal Values of the GBRWHA. Because of the easy accessibility of Magnetic Island, that obligation may place high local value on more widespread but generally inaccessible values of the GBRWHA. In common with the surrounding Great Barrier Reef Marine Park, the challenge is to achieve a framework of conservation and reasonable use of the outstanding universal values of the GBRWHA.

Magnetic Island World Heritage Values

Magnetic Island's World Heritage values are identified according to the criteria used in the 1981 nomination of the GBRWHA and are scored as follows:

- *** **A value uniquely expressed on Magnetic Island**
- ** **A Value for which Magnetic Island contains a highly significant expression or the majority of expressions in the GBRWHA; and**
- * **A value for which Magnetic Island is a minor component of expressions in the GBRWHA**

Many of the identified values are not uniformly expressed on Magnetic Island or within the areas in which they occur. In the context of management of a site or area where a particular value occurs, it is generally necessarily to understand the condition and contribution of that site to the conservation and protection of that value in Magnetic Island as a whole.

Criterion from 1981 Nomination	Identified Magnetic Island component value	Relative WH contribu-tion
i) outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features	• It is the largest continental island in the Dry Tropics of the GBRWHA and the seventh largest and fourth highest island within the entire World Heritage Area	***
	• The island provides significant examples of high geological and geomorphological diversity	**
ii) outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals	• Combination of high terrestrial diversity and a high diversity of tidal and marine habitats in a relatively small area makes the island significant for addressing the range World Heritage obligations with respect to the natural and cultural values of the GBRWHA	**
	• The intact and regenerating ecosystems of the island provide a significant local example of the ecological processes of resilience in response to present and past impacts of stock grazing, feral animals and introduced weeds	*
	• The marine ecosystems and communities are structurally and biologically diverse reflecting a gradient of exposure to marine and coastal	**

	influences and differences in oceanographic processes in their community composition Cockle Bay represents an outstanding example of the inter-related intertidal and subtidal marine habitats that can be found in association with the continental islands of the GBRWHA. Cockle Bay is the longest established sea grass monitoring site in the GBRWHA • The nearshore seagrass beds are significant nursery areas for penaeid prawn species and fishes of recreational and commercial importance to GBRWHA visitors and residents	** *
(iii) contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance	• The island has mountainous terrain and a shoreline with a rich variety of landscapes and seascapes of exceptional beauty	***
(iv) contain the most important and significant natural habitats for in situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation	• With semi-permanent freshwater areas and a fairly large area of lowlands, the island supports a dry tropical, granite-associated continental island flora that is unique in the GBRWHA • Magnetic is the only Dry Tropics continental island in the GBRWHA with highly varied fringing reefs formed in many of the shoreline embayments • The island is one of the two most botanically diverse of the continental islands of the GBRWHA. It supports over twenty-five distinctive terrestrial ecosystems in less than 5,200 ha. • The island supports the third largest number of rare and endangered vascular plants species of the continental islands within the GBRWHA • The island has a rich butterfly fauna and supports an endemic butterfly subspecies - one of the two known from the GBRWHA • The island supports Sadliers dwarf skink that is one of only three known island endemic reptiles in Queensland • The general diversity of habitats, makes the island a nationally significant refuge for many	*** ** ** *** *** *** ***

	species. These include the single striped delma and twelve other species of animals that are listed as endangered, rare or vulnerable under the Queensland Nature Conservation Act • Part of the Gustav Creek Area supports one of the highest known densities and diversities of small lizards known in North Queensland • The nearshore seagrass beds associated with the island support the third highest diversity of seagrass species known from the GBRWHA and provide important nursery habitat for many fish and invertebrate species • The nearshore seagrass beds are a crucially important habitat for the survival of dugong in the southern GBRWHA and also are used as a feeding area by the endangered green and turtle, which nests in small numbers on several island beaches • The fringing reefs vary in physical and biological structure, are easily accessible and support a significant percentage of the total number of hard coral species known from the GBRWHA • One of the island's shallow water fringing reefs supports a rare deepwater soft coral that is not known from any other location in the GBRWHA	* ** ** ** ***
The area in this nomination contains many middens and other archaeological sites of Aboriginal or Torres Strait Islander origin	• Indigenous Place, Florence Bay recognized on Register of the National Estate • Features identified as culturally significant for the Wulgurukaba people. Locations and details not available: ○ Middens ○ Archaeological sites ○ Quarry sites ○ Stone artefact scatters ○ Burial sites ○ Fish traps ○ Rock shelters with cultural deposits ○ Contact sites where middens incorporate European materials in their upper levels ○ Historic camping and fishing locations	*** **
There are over 30 historic shipwrecks in	• The national shipwrecks database records 553 wrecks within the GBRWHA. Seven of these	*

the area	are recorded for Magnetic Island: <u>Bee</u> 17/03/01 Picnic Bay <u>City of Adelaide</u> 01/01/1915 Cockle Bay <u>Fate</u> 01/01/1896 Magnetic Island <u>May Queen</u> 01/01/1913 Magnetic Island <u>Moltke</u> 01 /01/91 Geoffrey Bay <u>Norseman</u> 04/02/1893 Horseshoe Bay <u>Presto</u> 01/01/ 1896 Nelly Bay None is noted as having particular historic significance. A further 6 shipwrecks in Magnetic Isalnd waters are identified by the Maritime Museum of Townsville. These are: Burdekin, George Rennie, Magnet, Octopus, Palmosa and Platypus (Vivienne Moran pers comm.)	
on the islands there are ruins and operating lighthouses that are of cultural and historic significance	• Places on Register of the National Estate - Forts Complex, Radical Bay Road	***

Sources of heritage information include:

Australian National Shipwreck database http://cicd.deh.gov.au/nsd

Register of the National Estate http://www.ahc.gov.au/register

Australian Heritage database http://www.deh.gov.au/heritage

Queensland Heritage Register
http://www.epa.qld.gov.au/projects/heritage/listing.cgi

Conclusions

In preparing this report we have been struck by the diversity of terrestrial and marine habitats represented in the relatively small area of Magnetic Island. Our personal experiences have included visits to more than half of the Great Barrier Reef World Heritage Islands. This leads us to conclude that the World Heritage values of Magnetic Island have tended to be taken for granted and undervalued in the past. The Island is a readily accessible suburb of Townsville and the fact that it is special may be overlooked by those who may regard the Island primarily as a recreation and tourism asset for the city.

The World Heritage values of Magnetic Island give rise to the relaxed, peaceful and tranquil atmosphere that forms the basis of Magnetic Island's appeal for visitors and residents. The privilege of residents and visitors enjoying the display of those values brings added responsibilities and costs. A high standard of management is required to address the objectives of conservation and reasonable use and to ensure that the World Heritage values are maintained. This principle has been reflected in aspects of Townsville City Council's development control planning and management of the Island. We hope that this study can provide a basis for further work to better define the issues and to develop effective solutions.

The issue of scale is particularly important in the context of management of Magnetic Island. Several of the data sources arise from site studies that have subsequently been extrapolated and mapped at a scale of 1:25,000 yet soil distributions and water gradients on land and substrates and depth profiles in the marine areas are such that some distinctive biological communities are represented in areas totalling much less that 20 hectares. The Expert Workshop considered that studies and mapping at a scale of 1:5,000 or even 1:3,000 was needed to address the distribution, functioning and management of biological communities. A logical and functional progression from our overview study would be the development of a GIS capable of displaying layers of data at scales relevant to studies and management by the range of government agencies with responsibilities for Magnetic Island

We have included maps of soils and land tenure and a partial map of landscape values. We have assessed the natural heritage values of the flora of Magnetic Island at a time when a revision of the Queensland EPA Regional Ecosystem mapping of Magnetic Island is at an advanced stage. That revision is currently undergoing a process that includes peer review of documents prepared by Mr Gethin Morgan which he kindly made available to us for our study. The outcome of the revision will be an important baseline for future studies and management.

Considering its accessibility to the research centres in Townsville, we were also struck by the scarcity of time series and spatial research data for natural or cultural values of Magnetic Island. In the course of the Expert Workshop it was pointed out that was considerable capacity for such research through supervised graduate and postgraduate student studies.

Because of its accessibility, range of terrestrial and marine values and uses, and the potential for graduate student and community involvement Magnetic Island would seem to us to be an attractive primary location for future research into better understanding and managing the World Heritage values of GBRWHA.

Acknowledgements

This report has been prepared on the basis of the best information that we could obtain in the time available. The GBRMPA library was particularly helpful in providing a range of materials and advice. We are very grateful to the participants in the Expert Workshop and many other people whose identification and provision of information and whose help in discussion of a draft has helped us improve and expand the coverage of this report.

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Appendix 1 : Great Barrier Reef World Heritage Values

http://www.deh.gov.au/heritage/worldheritage/sites/gbr/values.html

The Great Barrier Reef was inscribed on the World Heritage List in 1981. The World Heritage criteria against which the Great Barrier Reef was listed remain the formal criteria for this property. These criteria have been included in the Values Table below. The World Heritage criteria are periodically revised and the criteria against which the property was listed in 1981 are not necessarily identical with the current criteria. Examples of the World Heritage values for which the Great Barrier Reef was listed are included in the Values Table for each criterion. These examples are illustrative of the World Heritage values of the property, and they do not necessarily constitute a comprehensive list of these values. Other sources including the nomination document and references listed below the Values Table are available and could be consulted for a more detailed understanding of the World Heritage values of the Great Barrier Reef.

Values Table

Natural criteria against which the Great Barrier Reef was inscribed on the World Heritage List in 1981.	**Examples of World Heritage values of the Great Barrier Reef for which the property was inscribed on the World Heritage List in 1981.**
Criterion (i) an outstanding example representing a major stage of the earth's evolutionary history.	The Great Barrier Reef is by far the largest single collection of coral reefs in the world. The World Heritage values of the property include: • 2904 coral reefs covering approximately 20 055km^2; • 300 coral cays and 600 continental islands; • reef morphologies reflecting historical and on-going geomorphic and oceanographic processes; • processes of geological evolution linking islands, cays, reefs and changing sea levels, together with sand barriers, deltaic and associated sand dunes; • record of sea level changes and the complete history of the reef's evolution are recorded in the reef structure; • record of climate history, environmental conditions and processes extending back over several hundred years within old massive corals; • formations such as serpentine rocks of South Percy Island, intact and active dune systems,

undisturbed tidal sediments and "blue holes"; and

- record of sea level changes reflected in distribution of continental island flora and fauna.

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

Biologically the Great Barrier Reef supports the most diverse ecosystem known to man and its enormous diversity is thought to reflect the maturity of an ecosystem, which has evolved over millions of years on the northeast Continental Shelf of Australia. The World Heritage values include:

- the heterogeneity and interconnectivity of the reef assemblage;
- size and morphological diversity (elevation ranging from the sea bed to 1142m at Mt. Bowen and a large cross-shelf extent encompass the fullest possible representation of marine environmental processes);
- on going processes of accretion and erosion of coral reefs, sand banks and coral cays, erosion and deposition processes along the coastline, river deltas and estuaries and continental islands;
- extensive *Halimeda* beds representing active calcification and sediment accretion for over 10 000 years;
- evidence of the dispersion and evolution of hard corals and associated flora and fauna from the "Indo-West Pacific centre of diversity" along the north-south extent of the reef;
- inter-connections with the Wet Tropics via the coastal interface and Lord Howe Island via the East Australia current;
- indigenous temperate species derived from tropical species;

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

- living coral colonies (including some of the world's oldest);
- inshore coral communities of southern reefs;
- five floristic regions identified for continental islands and two for coral cays;

- the diversity of flora and fauna, including:

- Macroalgae (estimated 400-500 species);
- Porifera (estimated 1500 species, some endemic, mostly undescribed);
- Cnidaria: Corals - part of the global centre of coral diversity and including:
    - hexacorals (70 genera and 350 species,

including 10 endemic species);
  - octocorals (80 genera, number of species not yet estimated);
- Tunicata: Ascidians (at least 330 species);
- Bryozoa (an estimated 300-500 species, many undescribed);
- Crustacea (at least 1330 species from 3 subclasses);
- Worms:
  - Polychaetes (estimated 500 species);
  - Platyhelminthes: include free-living Tubelleria (number of species not yet estimated), polyclad Tubelleria (up to 300 species) and parasitic helminthes (estimated 1000's of species, most undescribed);
-
- Phytoplankton (a diverse group existing in two broad communities);
- Mollusca (between 5000-8000 species);
- Echinodermata (estimated 800 extant species, including many rare taxa and type specimens);
- fishes (between 1200 and 2000 species from 130 families, with high species diversity and heterogeneity; includes the Whale Shark *Rhynchodon typus*);
- seabirds (between 1.4 and 1.7 million seabirds breeding on islands);
- marine reptiles (including 6 sea turtle species, 17 sea snake species, and 1 species of crocodile);
- marine mammals (including 1 species of dugong (*Dugong dugon*), and 26 species of whales and dolphins);
- terrestrial flora: see "Habitats: Islands" and;
- terrestrial fauna, including:
  - invertebrates (pseudoscorpions, mites, ticks, spiders, centipedes, isopods, phalangids, millipedes, collembolans and 109 families of insects from 20 orders, and large over-wintering aggregations of butterflies); and
  - vertebrates (including seabirds (see above), reptiles: crocodiles and turtles, 9 snakes and 31 lizards, mammals);

- the integrity of the inter-connections between reef and Island networks in terms of dispersion,

	recruitment, and the subsequent gene flow of many taxa; • processes of dispersal, colonisation and establishment of plant communities within the context of Island biogeography (e.g. dispersal of seeds by air, sea and vectors such as birds are examples of dispersion, colonisation and succession); • the isolation of certain Island populations (e.g. recent speciation evident in two subspecies of the butterfly *Tirumala hamata* and the evolution of distinct races of the bird *Zosterops spp);* • remnant vegetation types (hoop pines) and relic species (sponges) on islands. • evidence of morphological and genetic changes in mangrove and seagrass flora across regional scales; and • feeding and/or breeding grounds for international migratory seabirds, cetaceans and sea turtles.
Criterion (iii) contain unique, rare and superlative natural phenomena, formations and features and areas of exceptional natural beauty.	The Great Barrier Reef provides some of the most spectacular scenery on earth and is of exceptional natural beauty. The World Heritage values include: • the vast extent of the reef and island systems which produces an unparalleled aerial vista; • islands ranging from towering forested continental islands complete with freshwater streams, to small coral cays with rainforest and unvegetated sand cays; • coastal and adjacent islands with mangrove systems of exceptional beauty; • the rich variety of landscapes and seascapes including rugged mountains with dense and diverse vegetation and adjacent fringing reefs; • the abundance and diversity of shape, size and colour of marine fauna and flora in the coral reefs; • spectacular breeding colonies of seabirds and great aggregations of over-wintering butterflies; and • migrating whales, dolphins, dugong, whale sharks, sea turtles, seabirds and concentrations of large

	fish.

Criterion (iv) provide habitats where populations of rare and endangered species of plants and animals still survive.
 	
Criterion (iv) provide habitats where populations of rare and endangered species of plants and animals still survive.
	The Great Barrier Reef contains many outstanding examples of important and significant natural habitats for *in situ* conservation of species of conservation significance, particularly resulting from the latitudinal and cross-shelf completeness of the region.
	
	The World Heritage values include:
	
	• habitats for species of conservation significance within the 77 broadscale bioregional associations that have been identified for the property and which include:
	
	• over 2900 coral reefs (covering 20 055km^2) which are structurally and ecologically complex;
	• large numbers of islands, including:
	    ○ 600 continental islands supporting 2195 plant species in 5 distinct floristic regions;
	    ○ 300 coral cays and sand cays;
	    ○ seabird and sea turtle rookeries, including breeding populations of green sea turtles and Hawksbill turtles; and
	    ○ coral cays with 300-350 plant species in 2 distinct floristic regions;
	• seagrass beds (over 5000km^2) comprising 15 species, 2 endemic;
	• mangroves (over 2070km^2) including 37 species;
	• *Halimeda* banks in the northern region and the unique deep water bed in the central region; and
	• large areas of ecologically complex inter-reefal and lagoonal benthos; and
	
	• species of plants and animals of conservation significance.

Appendix 2: Expert Workshop

Agenda of Expert Workshop

RAC Marine Pty Ltd

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Workshop "Magnetic Island (Great Barrier Reef World Heritage Area) Values"

OBJECTIVE: ***To provide a forum for expert comment on a draft report with particular attention on omissions, inaccuracies and additional published or grey sources of information for finalisation of the report.***

LOCATION: ***CRC REEF, Flinders Street, Townsville***

DATE AND TIME: 15 June 2005. 1000 – 1600

AGENDA

1. Opening
2. Background to the study
3. Workshop Approach
Morning Tea
4. Introductions
5. Brief overview of draft report
6. Biological communities
Lunch
7. Ecosystem processes
8. Cultural and amenity
9. Discussion and Conclusion - next steps
10. Close

Discussion will be facilitated to enable identification of locations and processes that reflect the World Heritage values of Magnetic Island.

Attendance at Expert Workshop

Whom	Organisation
Cr Ann Bunnell	Townsville City Council
Mr Jason Vains	GBRMPA
Ms Gail Barry	GBRMPA
Mr Greg Bruce	Townsville City Council
Mr Ben Cuff	C&R Consulting
Dr Chris Cuff	C&R Consulting
Dr Libby Evans Illidge	AIMS
Ms Maryanne Humphreys	Department of Environment and Heritage
Dr Betsy Jackes	JCU
Mr Scott Laidlow	Department of Environment and Heritage
Prof Helen Marsh	JCU
Ms Di Mead	Department of Environment and Heritage
Mr Gethin Morgan	
Prof Richard Pearson	JCU
Mr Richard Quincey	EPA
Dr Cecily Rasmussen	C&R Consulting
Mr Nick Wynn	GBRMPA
Mr Don Kinsey	

Eddie Hegerl, Richard Kenchington, Carol Kenchington

Appendix 3 : Regional Ecosystems of Magnetic Island and their General landscape context and functon

Revised RE	Sandercoe 1990	Short Description	Landscape processes
11.1.1	Not allocated	*Sporobolus virginicus* grassland with *Melaleuca spp* and *Eucalyptus tereticornis* emergents	Subject to periodic inundation during highest tides; freshwater seepage from adjacent terrestrial areas for most of the year.
11.1.2	4	Salt pans and samphires	Subject to periodic tidal inundation, significant fisheries habitat
11.1.3	6a	Bulkuru swamp	Subject to periodic tidal and freshwater inundation, significant fisheries habitat
11.1.4x1	1	*Rhizophora apiculata, R. stylosa* closed forest	Tidal. coastal stabilization, significant fisheries habitat
11.1.4x2	2	*Avicennia marina* closed forest	Tidal. coastal stabilization, significant fisheries habitat
11.1.4x3	3	*Ceriops tagal* mixed shrubland	Tidal. coastal stabilization, significant fisheries habitat
11.2.1	7	Dunes with bloodwood woodland	Generally older hind dunes. Groundwater recharge.
11.2.2	5	Beach and strand, *Casuarina equisitifolia*	Includes foredunes. Subject to periodic erosion and replenishment.
11.2.3	10	Vine thicket on sand dunes	Generally older hind dunes with deeper soils. Groundwater recharge.
11.2.4	6	Dune swales with *Melaleuca leucadendra*	Intermittent wetlands between dunes.

Revised RE	Sandercoe 1990	Short Description	Landscape processes
11.3.4	8	*E. tereticornis* forest on alluvial plains	Most fertile habitat and tallest forest on island. Periodically flooded. Groundwater recharge
11.3.9a	7	Mixed tall woodland dominated by bloodwood and *E. platyphylla* on higher and older alluvial fans	Old higher surface adjacent to hills. Major area of groundwater recharge on the lowlands.D28
11.3.9b	7	Bloodwood, *E. platyphylla* and *M. leucadendra* tall woodland on younger and sandier alluvial plains	Recent and current alluvial surfaces with a variety of associated soils and processes. Includes both recharge and discharge areas. Numerous habitat hollows in older trees
11.3.11	10	Vine thicket on alluvium and colluvium	Areas of deeper soil usually adjacent to scree slopes with a better water balance and fire protected.
11.3.25	8	*E. tereticornis* and *M. leucadendra* open forest fringing major watercourses	Watercourses and associated fringing vegetation that controls erosion and helps maintain water quality. Significant refugial habitat for many species, and major seasonal food source.
11.3.27a	6	Freshwater wetlands with *Melaleuca leucadendra*	Seasonal wetland significant for freshwater aquatic species. Major seasonal food source. Groundwater recharge.
11.3.27b	6a	Bulkuru swamp	Seasonal wetland significant for freshwater aquatic species. Groundwater recharge.
11.3.35a	7	*E. platyphylla* with *M. viridiflora* on hard setting soils derived from Julago volcanics	Seasonal wetland, numerous habitat hollows in older trees.
11.12.4a	13	Vine thicket on granite scree	Refuge for specialized flora. Essential habitat for rock wallaby
11.12.4b	13	Vine thicket on Julago Volcanics scree	Refuge for specialized flora.

Revised RE	Sandercoe 1990	Short Description	Landscape processes
11.12.4c	14	Tall vine thicket on granite scree	Refuge for specialized flora. Essential habitat for rock wallaby
11.12.9	9	*E. platyphylla* woodland on foothills on igneous rocks	Recharge, numerous habitat hollows in older trees.
11.12.12	11	*Araucaria cunninghamii* on rocky slopes	Generally fire protected sites
11.12.13	17	Mixed Eucalypt woodland incl. *E. crebra, E. acmenoides, Corymbia sp.*	Major mid-altitude community of deeper soils
11.12.13	19	Mixed Eucalypt woodland incl. *E. crebra, E. acmenoides, Corymbia sp.*	Major mid-altitude community of deeper soils
11.12.14	20	*Lophostemon confertus* mallee woodland	Fire maintained mallee woodland on exposed sites
11.12.15	21	*Livistona decipiens* and *C. torulosa* woodland on dolerite dyke at high altitude	Restricted fertile habitat near Mt Cook
11.12.15x1	17	*E. acmeniodes* and *Casuarina torulosa* woodland on structured earths on high altidude areas above about 340 metres.	High dissected plateau with cooler temperatures and cloud moisture, and well developed organic soil surface. Restricted habitat for specialized flora.
11.12.15x1	21	*E. acmeniodes* and *Casuarina torulosa* woodland on structured earths on high altidude areas above about 340 metres.	High dissected plateau with cooler temperatures and cloud moisture, and well developed organic soil surface. Restricted habitat for specialized flora.
11.12.15x1	22	*E. acmeniodes* and *Casuarina torulosa* woodland on structured earths on high altidude areas above about 340 metres.	High dissected plateau with cooler temperatures and cloud moisture, and well developed organic soil surface. Restricted habitat for specialized flora.
11.12.16	12	Mixed low woodland to shrubland on rock outcrop and sleletal soils	Semi-deciduous communities of shallow soils and rock pavements. High runoff

Revised RE	Sandercoe 1990	Short Description	Landscape processes
11.12.16	15	Mixed low woodland to shrubland on rock outcrop and sleletal soils	Semi-deciduous communities of shallow soils and rock pavements. High runoff
11.12.16	16	Mixed low woodland to shrubland on rock outcrop and sleletal soils	Semi-deciduous communities of shallow soils and rock pavements. High runoff
11.12.16	18	Mixed low woodland to shrubland on rock outcrop and sleletal soils	Semi-deciduous communities of shallow soils and rock pavements. High runoff
11.12.16x1	23	Mixed low woodland to shrubland on Julago volcanics	Semi-deciduous communities of shallow soils and rock pavements. High runoff
regrowth	24	Regrowth	Characteristics depend on the regional original ecosystem
Cleared	24	Cleared	Characteristics depend on the original regional ecosystem and current land use.

Source : Prepared by Gethin Morgan, PO Box 50, Nelly Bay, QLD 4819

Appendix 4. Records of Turtles Associated with Magnetic Island

Source: ***Pers. comm. from Dr Tim Harvey. Indo-Pacific Sea Turtle Conservation Group, Australian Institute of Marine Science***
(Group General Website: http://www.aims.gov.au/ipstcg)

The following data are for the period November 2001-January 2002 inclusive (nesting activity) and November 2001-June 2002 (in-water sightings).

I have included figures that we know about for the Townsville region as a whole and broken down the figures for Magnetic Island to give an indication of the proportion of sea turtle activity associated with Magnetic Island. As a proportion of the whole it is significant.

It should be noted that these are figures collected through our network. There may be other figures but as far as we know we are the only people actively gathering this information in this area.

Nesting activity

Species composition

Only two species of sea turtle were encountered, either on beaches nesting or attempting to nest, or in the water; Green turtles (*Chelonia mydas*) and Flatback turtles (*Natator depressus*).

Track counts

Ninety four 'sets' of tracks were recorded for beaches in the Townsville region between November 2001 and January 2002 (Table 1). 'Sets' of tracks refers to pairs of tracks (ie. each 'set' comprises of an 'up' track and a 'down' track) seen on beaches, indicating possible nesting. The peak nesting activity occurred in November 2001 with 56 sets of tracks sighted (58% of total), (Table 1).

Table 1. Number and locations of sets of sea turtle tracks on beaches in the Townsville region from November 2001 to January 2002

Location	***Months***			***Total***
Mainland	**November 2001**	**December 2001**	**January 2002**	
Bushland Beach	6			6
Cape Bowling Green	15			15
Cungulla Beach	2	2		4
Pallarenda Beach	1			1
Shelley Beach		1		1
AIMS	4	4	2	10
Total	**28**	**7**	**2**	**37**

Balding Bay			1	1
Horseshoe Bay	8			8
Huntingfield Bay	3	1		4
Joyce Bay	3			3
Magnetic Island (location not specified)		12		12
Maud Bay		10		10
Norris Bay	4	3		7
Radical Bay	8		2	10
Wilson Bay	2			2
Total	**28**	**26**	**3**	**57**
Total (T/ville Region)	**56**	**33**	**5**	**94**

Locations and numbers of sets of tracks sighted on mainland beaches between November 2001 and January 2002 is shown in Figure 1. Locations and numbers of sets of tracks sighted on Magnetic Island beaches between November 2001 and January 2002 is shown in Figure 2.

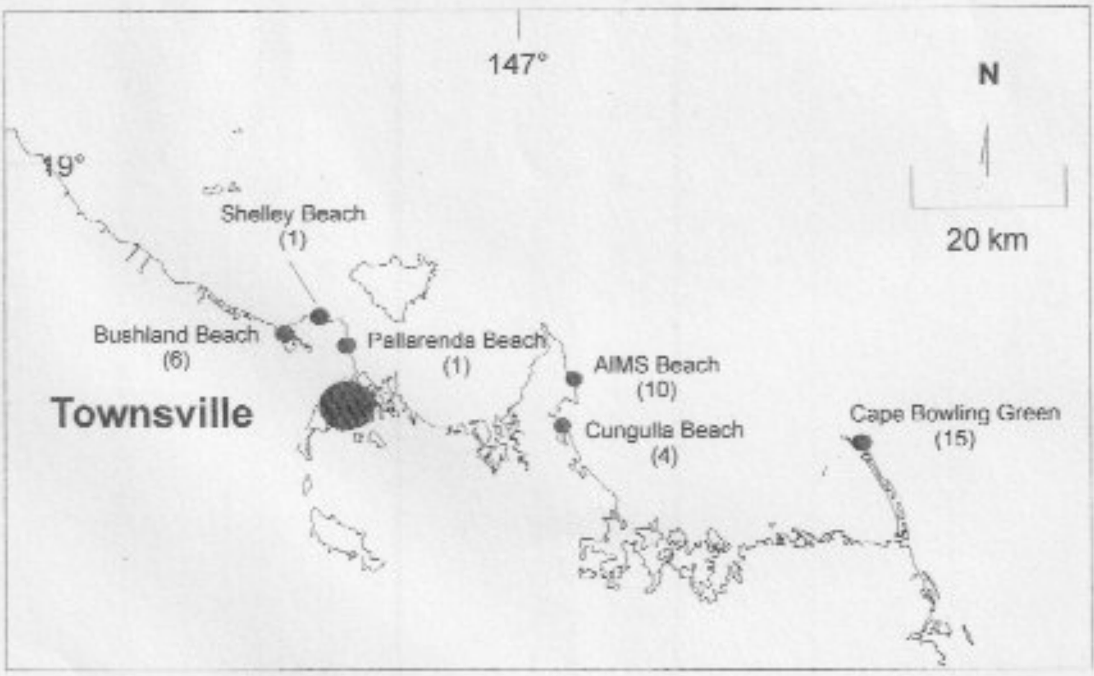

Figure 1. Number and locations of sets of sea turtle tracks sighted on mainland beaches in the Townsville region between November 2001 and January 2002 (includes Pallarenda Beach track (Oct 2001))

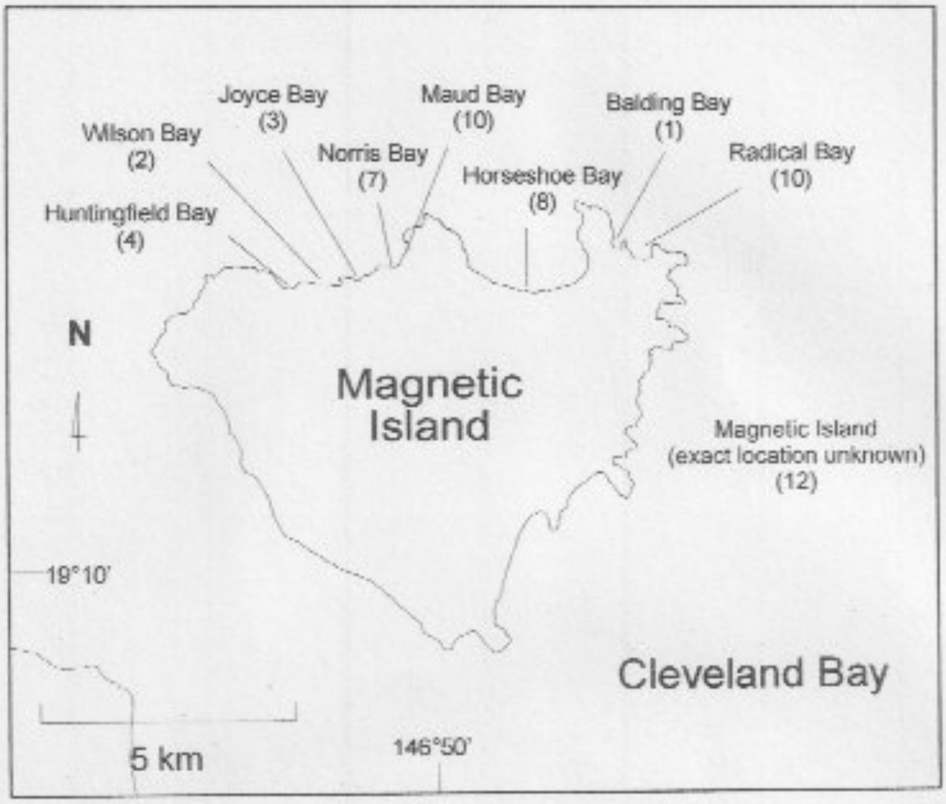

Figure 2. Number and locations of sets of sea turtle tracks sighted on Magnetic Island beaches between November 2001 and January 2002

'In-water' sightings

Four hundred and ninety-eight sightings were recorded of turtles in the waters around Magnetic Island between December 2001 and June 2002 (see Table 2). Sightings reached a peak in January 2002 with 110 recorded sightings. One hundred and eighty six sightings were recorded during the two months of the main nesting season that were monitored (December 2001 and January 2002), with a mean of 93 for these two months. The mean for the months February to June was 62.4 sightings.

Table 2. Number of sightings of sea turtle in the waters off Magnetic Island between December 2001 and June 2002

Months	*Total*
December 2001	76
January 2002	110
February 2002	46
March 2002	81
April 2002	51
May 2002	61
June 2002	73
Total	**498**

Some observations on data

Nesting activity

The 2001/2002 nesting season was the first dedicated survey of sea turtle nesting activity in the Townsville region. The lack of previous baseline data makes it impossible to compare the nesting density and distribution for the 2001/2002 season with other years in this region. Moreover, conclusions drawn from such a limited number of observations should be viewed with caution. A more complete picture of turtle nesting activity in the region will only be gained after many years of careful observation.

The species of turtle, Green (*Chelonia mydas*) and Flatback (*Natator depressus*), observed nesting and foraging in this study, represent the two most abundant species in the region. As monitoring was only carried out between November 2001 and January 2002 at selected sites, the data provides only a sub-set of the total number of Green and Flatback turtles nesting within the Townsville region during the season. Despite this, the information can be used to estimate the relevance of particular beaches as turtle habitat, and consequently this has implications for the future development of these areas, and for future monitoring.

Track counts

Although 94 sets of tracks were observed in the region during the nesting season, this would not indicate 94 individual turtles. Female sea turtles will come ashore several times to lay during a nesting season, therefore it is not impossible that, although 94 tracks were noted, as few as 20 individual turtles may have come ashore.

The total number of tracks should also be viewed with caution. Although the tracks at the beach at AIMS were systematically noted, and those on mainland beaches were counted only once, some of the tracks on Magnetic Island may have been counted twice, by different observers. However, it is worth noting that the peak track count was in November 2001, and that few tracks were noted by January 2002. This agrees with previous studies along the east coast of Queensland that report peak nesting for Green and Flatback turtles is in November. The number of tracks sighted on Magnetic Island, even allowing for the possibility of double counting, was far greater than that for the mainland. This would suggest that Magnetic Island is an important site for nesting turtles in Cleveland Bay. Further loss of nesting habitat on the Island would therefore be a major loss for turtles in the area.

Location of nesting activity

Although most tracks were noted on the north coast of Magnetic Island, the location of tracks does not necessarily reflect the only nesting locations. Because of the difficulty in monitoring such a large area the locations reflected the concentration of the monitoring effort. This was especially true of Magnetic Island.

Although turtles can be extremely cautious when coming ashore eight sets of tracks were observed on the beach at Horseshoe Bay on Magnetic Island. This is a very popular beach for tourists and has a well established and growing community. However, the beach at Horseshoe Bay is quite extensive and the exact location of the tracks is not known. Anecdotal evidence suggests that in previous years turtles have nested on several of the beaches north of Townsville and on several of the beaches on the south-east coast of Magnetic Island, areas which have comparatively large human populations. Ten sets of tracks were seen at Radical Bay, the proposed site of a new tourist development. This bay is small and secluded and the loss of this possible nesting site could be highly detrimental to the sea turtle population in the region.

Successful nesting

Although 94 sets of tracks were noted in the season, this would not have resulted in 94 successful nestings. Many of the turtles coming ashore would have returned to the sea without nesting, despite digging several body pits. A number of turtles fail to nest on their first attempt and emerge over consecutive nights to lay. There are a number of possible reasons for this mentioned in several reports. It may be normal behaviour by a small proportion of the nesting population. The turtle may be disturbed during the crawl up the beach or while digging the nest. This disturbance may be caused by a number of things including clouds, shadows, lightning, storms, and debris. It can happen as a result of a monitoring team patrolling the beach, a factor that needs to be considered for all beaches patrolled at night. On beaches with relatively high nesting density some turtles are unable to successfully nest on a particular night because of disturbance from other nesting turtles, although this is not likely to be the case in the Townsville region. A turtle will return to the water if attempts at digging a nest are unsuccessful, which can result from dry sand collapsing the egg chamber, or roots, rocks, etc. obstructing the digging process. Animals with damaged or missing hind flippers may experience considerable problems during the egg chambering process, resulting in a failure to lay eggs.

Only five observed successful nestings took place, four of which were at the beach at AIMS. This, however, reflects monitoring concentration rather than the beach at AIMS being the only successful nesting habitat. Anecdotal evidence suggested that three turtles had successfully nested in Radical Bay on Magnetic Island and two had nested at Cungulla Beach. Successful nestings at AIMS were spread over November and December 2001 and January 2002, which suggests that although nesting activity usually peaks in November successful nesting does occur throughout the nesting season in the region. This has management implications, as any possible restrictions of access to some beaches, for example for 4WD vehicles, will need to be for at least these months.

The number of successful nests at the beach at AIMS, the only systematically monitored beach in the study, represented 40% of the sets of tracks recorded at that beach. If it were possible to extrapolate this figure to other beaches in the region this would result in 38 successful nests. However, although it can be assumed that a percentage of turtle tracks will result in successful nesting, without actually be present when a turtle nests it is virtually impossible to tell whether a successful nesting has occurred. Furthermore, the number of individual turtles successfully nesting cannot be estimated. Only one turtle at the beach at AIMS was observed to nest more than once. Sea turtles usually nest several times in a season, so it may be that the remaining six tracks at AIMS were made by the four turtles that were tagged, or it may be that more turtles were involved. The number of sightings is too small to draw any conclusions.

'In-water' sightings

Four hundred and ninety-eight sightings were recorded of turtles in the waters around Magnetic Island between December 2001 and June 2002 . This does not suggest that there were 498 individual turtles but it does suggest a large amount of turtle activity in these waters. The extremely high number of sightings in January 2002 could be the result of monitoring effort rather than increased numbers of turtles. However, there were still a very high number of sightings for all months from December 2001 to June 2002. The high number of turtles observed in the waters adjacent to Magnetic Island from April to June 2002 indicates that a resident population of turtles forage in these waters outside of the nesting season. As the sightings were made primarily by kayakers the exact location of each sighting was not recorded and the species of turtle at each sighting was also not determined. Anecdotal evidence suggests that turtles are to be found in many other areas of Cleveland and Halifax Bays, especially near seagrass beds and around Rattlesnake and Herald Islands. A number of large Green turtles are also known to forage off the tip of Cape Cleveland, although counts have never been undertaken. This foraging population of turtles in the region may have implications for current and future management for the area, especially for boat users. Implications for future development in the area will need to be addressed by Townsville and Thuringowa councils.

Information collated by Dr Tim Harvey, Indo-Pacific Sea Turtle Conservation Group

Appendix 5 : Recent Press Reports on Humpback Whale Sightings at Magnetic Island

We found the following recent newspaper accounts of the sighting of humpback whales in the inshore waters of Magnetic Island. The text is reproduced directly from the *Magnetic Times* website at http://www.magnetictimes.com

Front page August 10th 2002: **Radical Whales**

Developers and conservationists may not be the only groups showing a keen interest in Radical Bay.

Cairns visitor to the Island, Ms Kym Joseph told MT, "Last Wednesday (3rd July) we spent the day at Radical Bay and around late morning, whilst sitting on the sand admiring the great beauty of the bay, my friend Ed said 'there's a whale!'. We sat and watched 2 or 3 small whales cruising into the bay to the right towards the 2 yachts at anchor, one whale coming right along side the boats only a 100 meters from the shore. We could see the blows and the backs of the whales and the disturbed water and we were jealous of the people on the yachts who would have been only a few meters from the whales. We watched for five minutes or more until the whales turned and headed out of the bay, one did a huge breach as it left the bay and created great 'woohooo' from the people on the beach. Yachts travelling around the bay towards Horseshoe undersail had the whales travel right through them, many people must have seen the whales. It made our holiday very very special"

On the same day a group from Magnetic Island Sea Kayaks sighted a humpback whale near the eastern point of Horseshoe Bay.

According to tour operator, Steve Rowland, the group saw the whale coming across the mouth of Horseshoe Bay towards them, so they paddled back in towards the rocks, by Horseshoe Bay Point. The whale made an obvious detour to swim over to the group and then turned to pass underneath the group, within metres of the coast, before heading back out of the bay and out around the point and off in the direction of Radical Bay.

Some years ago, the then caretaker of Radical bay, Ms Jenny Brizzi, witnessed , with her family, what they believed to be the birth of a whale at Radical Bay.

Ms Kirstin Dobbs, the Great Barrier Reef Marine Park Authority's Species Conservation Officer told MT, "Humpback whales travel north every year for calving. This year the whales have arrived earlier than normal as the season usually begins at the end of July or early August". She was not surprised that Radical Bay may be a calving location, noting that, "Islands provide shelter for calving" and that it was important that people take extra care when calves are around.

Regulations stipulate that unless a whale decides to move towards a boat, people are not permitted to move to within 100 metres of whales if they know them to be there. Engines should be cut 300 metres from a sighted whale.

Steve Rowland, told MT, "This was the earliest I have seen whales. Last year we had 11 sightings of whales on our tours, so hopefully this will be another good year".

Steve thought the whale may have been curious to find out what was making the "slapping" sound produced by the kayak's oars.

A rally to protest against the Juniper Development Corporation's resort development for Radical Bay is planned for this Saturday at Radical Bay.

Photo: A whale breaches the surface beside a yacht in Radical Bay Photographer: Kym Joseph

Front page August 7th 2003: **Magnetic Island's humpback whales arrive**

Since the weekend, a number of whales have been spotted around the waters of Magnetic Island and Cleveland Bay. Yesterday a pod of whales, thought to be humpback whales, were spotted just off Coconuts Resort in Nelly Bay. Coconuts bus driver Daniel Daniels told Magnetic Times that the three whales were seen frolicking just 150m off the shoreline. "They were really easy to spot and have been seen there for the last few days."

Passengers on the Sunferries Reef Trips have also been spotting whales off Horseshoe Bay. Sunferries Marketing Manager, Christine Woods, told Magnetic Times, "Passengers on nearly every reef trip this week have been able to see whales - it's a fantastic and memorable experience for our guests on board"

Yesterday, on the workers' ferry home (the 5.45pm) passengers were treated to a sighting of a whale coming to the surface for a breath and much to the delight of passengers water could be seen spouting from its blow hole.

Sightings of humpback whales in late July and early August are now a regular occurrence, around Magnetic Island and Townsville waters, as they travel north to calve and escape the winter cold.

If you are lucky enough to be on a boat when you spot a whale be aware that there are strict regulations that stipulate that, unless a whale decides to move towards a boat, people are not permitted to move to within 100 metres of whales if they know them to be there. Engines should be cut 300 metres from a sighted whale.

17 September 2003: **Whales at play in Island's Bays**

Two adults and one calf humpack whale were spotted and photographed yesterday making their way past Horseshoe, Balding and Radical Bays on Magnetic Island.

Eco-tour operator, Steve Rowland, from Magnetic Island Sea Kayaks, spotted the whales claiming it the first time he'd witnessed two adults and a calf together. "I've seen individual whales, a number of adults together, single adults with a calf but never two adults and a calf."

Spotting some activity in the water Steve paddled towards the commotion and discovered it to be whales. "I was about 100 metres away when I saw them" he said. "For about five minutes there was one whale which I think was the calf standing on its nose and slapping the surface of the water with its tail," said Steve.

The whales played in Radical bay as they passed by about 50 metres from the coastline Steve told Magnetict Times, "The whales followed the coastline past Horseshoe Bay then along the coast (East) towards Eagle Rock on the headland of Balding Bay about 50 metres from the shore". Steve observed the whales having a little play in Radical Bay where some years ago the Brizzi family, who were caretakers there, believed they witnessed the birth of a humpback whale.

Steve thinks the sighting to be fairly late for the whale spotting season which began this year in mid-June.

Last month world-wide attention was drawn to the sighting of a white (thought to be an albino) whale, given the name of Migaloo, in local waters between Magnetic and Palm Island.

Front page : August 4th 2004: **Injured whale calf in local waters**

A pair of humpback whales, thought to be a mother and calf, entered close in to Horseshoe Bay this afternoon delighting beach goers and yacht owners as they swam amongst the moored vessels. The same pair may, however, also be the whales spotted over the last couple of days in Cleveland Bay of which the calf has been observed to be injured by propeller marks.

Magnetic Times spoke to Steve Rowland from Magnetic Island Sea Kayaks who was returning into Horseshoe Bay with his daily tour party. "We first saw them about 200 - 300metres off the beach after we had paddled towards the centre of the bay. They were heading towards the anchored yachts and swam around them for a few laps then headed out past the oyster lease and off to the south," said Steve.

According to Steve the sighting lasted about 25 minutes after 12 noon.

Observing strict guidelines on keeping a distance from the leviathans Steve and his party never got close enough to the whales to confirm if the calf was the reported injured animal.

The injured calf was first reported on 11.30am on Monday from a member of the public through the Townsville Coastguard. The report was of two whales (a mother and calf) in Cleveland Bay. The calf was reported as being injured with what appeared to be propeller marks. Queensland Parks and Wildlife Service (QPWS) staff from Magnetic Island responded but were unable to locate the whales.

A second report was received at later around 2pm. This report also came from a member of the public through the Townsville Coastguard. The report was of a mother and calf 2 nautical miles north of Townsville Port. The report stated that the baby whale was not injured.

A third report was received on Tuesday at around 7.45am from a Townsville Port worker who said that there was a mother and calf in the shipping channel holding up ships.

Another report was received yesterday at the Magnetic Island QPWS office at around 9.20am regarding two whales in the shipping channel. The baby was reported as having marks or scars on its back.

QPWS staff from Magnetic Island are understood to be once again searching for the whales.

Anybody who sights the whales and can provide a location, particularly if the injured calf is observed, should immediately call the Marine Animal Hotline on 1300 130 372.

Appendix 6 : Distribution and Classes of Soils Magnetic Island

NOTES FOR SOILS MAP

GEOMORPHOLOGY

DESCRIPTION

Coastal Zone:

- Sediments / deposits of the coastal zone are predominantly of the current cycle (post 6,500 years) as are the current stream and channel deposits within the coastal zone.
- The current stream and channel deposits sit on comparable sequences of previous cycles of lower sea levels.
- Sodic soils are extensively developed in both the alluvial and colluvial material.
- Coastal deposits are dominantly sandy, stranded beach ridges with mangrove muds and salt pans adjacent to tidal inlets.
- Riverine silcrete is often associated with many of the older stream channel deposits, often dipping beneath the Holocene beach deposits to outcrop on the lower beach.
- Very little lateral continuity in the sub-surface deposits of the silcrete layers.
-

Colluvial / Alluvial Slope Wash Deposits:

- From base of scarp to approximately 3.5 to 6.0m AHD, a series of colluvial / alluvial slope wash deposits (fans and plains) occur.
- Sediment deposition processes grade from colluvial to alluvial dominance with distance from source.
- These deposits have been dissected by ephemeral streams flowing from the scarp to marine / coastal / estuarine environments.
- Successive deposits have formed over at least the last 18000 years against a background of sea level variability.
- The current morphology reflects the current sea level.
- The coalescing deposits overlap, and absolute height has no age implications. Stratigraphic superposition of the deposits is age determined.
- There is no absolute evidence of older and younger alluvial terraces on Magnetic Island. The terraces concur with a continuum against sea level variability and a gradual 1:100 slope.
-

Base of Granitic Scarp:

- Varies from approximately 20 to 30m to just above 3.5m AHD (e.g. along West Point Road and western end of Horseshoe Bay).
- Base of scarp often marked by a water flow channel. This may be occupied by *Melaleuca* wetlands.

Source: C & R Consulting, May 2005

Map
Soils of Magnetic Island
Supplied by C & R Consulting, May 2005