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Towards a scientifically based implementation plan for ecologically sustainable use and biodiversity conservation in the Great Barrier Reef World Heritage Area

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ABSTRACT

The Great Barrier Reef Marine Park and World Heritage Area functions as a multiple-use Marine Protected Area. Many human activities occur within and adjacent to the Great Barrier Reef World Heritage Area which may pose threats to the long-term ecological integrity of the system. These include fishing, shipping, tourism, recreation and run-off from urban and agricultural landuses. The social values of the area, e.g. wilderness values and traditional cultural values may also be threatened by increasing human activity of the above types. Although ecological threats to the Great Barrier Reef World Heritage Area have been identified and prioritised through comprehensive research activity, a coherent management strategy based on these priorities has not emerged.

Management of potentially damaging activities in the Great Barrier Reef is spread among a variety of agencies although the Great Barrier Reef Marine Park Authority maintains a limited level of overall coordination. Likewise, although general goals, objectives and strategies for ecological sustainable use (ESU) and conservation of biodiversity are found in the Great Barrier Reef Marine Park Act, Great Barrier Reef World Heritage Area Strategic Plan and other legislation and policies, these are very general and lack detail required for their practical implementation. Important scientific findings over the past 20 years have not been adequately used in zoning and management plans and a systematic biodiversity description of the Great Barrier Reef able to be used in representative area selection is still lacking. A scientifically-based management plan to implement ESU and biodiversity conservation is therefore of a high priority. This plan should be developed from the broad principles of ESU and biodiversity conservation, and from identified threatening human uses and impacts.

The framework for this plan is outlined in this paper and criteria are discussed for (1) identifying species requiring special management; (2) identifying potentially vulnerable species; (3) systematising an approach for conservation of ecologically important and representative habitats; and (4) prioritising management effort of human use against the severity of risk imposed.

INTRODUCTION

At the time of the establishment of the Great Barrier Reef Marine Park 21 years ago, the concept of large, multiple-use managed areas was very new, the Great Barrier Reef region and ecology of coral reefs were not well known scientifically, and the urgency for establishment of zoning plans precluded detailed baseline and theoretical scientific studies on management strategies. Nevertheless, the 'Great Barrier Reef model' which subsequently developed is widely regarded as successful and has been applied to other reef areas around the world (Kelleher et al. 1995).

The Great Barrier Reef Marine Park and World Heritage Area functions as a multiple-use Marine Protected Area (GBRMPA 1994). Many human activities occur within and adjacent to the World Heritage Area which may pose threats to the long-term ecological integrity of the system. These include commercial and recreational fishing, shipping and related port activities, tourism, recreation and coastal urban and agricultural landuses (Zann 1996). The social values of the area, for example wilderness values and traditional cultural values, may

also be threatened by increasing human activity of the above types. No formal comprehensive risk assessment for the Great Barrier Reef has been carried out but over the last decade considerable research has been carried out to identify the existing and potential threats to the system.

Over the past two decades much has been learnt about the Great Barrier Reef, of the structure and function of coral reefs and marine ecosystems, and of planning and management of marine protected areas. Environmental degradation has continued, and the goals of ecologically sustainable development (ESD) and conservation of biodiversity have also been developed as national and international priorities (CoA 1992). Zoning plans have been developed for 360,000 sq km of the Great Barrier Reef Marine Park. The Great Barrier Reef Marine Park Authority has grown from a handful of staff to a professional agency with 150 staff (GBRMPA 1996). Scientific support has increased from a handful of coral reef scientists around Australia to internationally known coral reef research centres at the Australian Institute of Marine Science, James Cook University of North Queensland and the CRC Reef Research Centre.

It is therefore timely to examine the Great Barrier Reef Marine Park Authority's planning strategies for the maintenance of the Great Barrier Reef's biodiversity in light of scientific discoveries over the past two decades, our knowledge of the main threatening activities and goals of ESD and biodiversity conservation. The following paper (1) reviews Great Barrier Reef Marine Park Authority and Commonwealth strategies for ESD and biodiversity conservation; and because a coherent biodiversity management plan is lacking, (2) recommends a framework for the development of a detailed implementation plan for ESD and biodiversity conservation in the Great Barrier Reef Marine Park.

REVIEW OF GREAT BARRIER REEF MARINE PARK AUTHORITY POLICY FOR ECOLOGICALLY SUSTAINABLE DEVELOPMENT AND BIODIVERSITY CONSERVATION

Ecologically sustainable development is defined as: 'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and that the total quality of life, now and in the future, can be increased' (CoA 1992). The concept has been widely embraced by all levels of government in Australia and by economists, industrialists and conservationists in the private sector. However, ESD is an ambiguous term and widespread scepticism remains amongst ecologists on its feasibility (e.g. Ludwig et al. 1993).

Ecologically sustainable use (ESU) is the primary goal (or 'critical issue') of Great Barrier Reef Marine Park management (GBRMPA 1994). The term is analogous, but preferable to ecologically sustainable development (ESD) and is an acknowledgment that, in logic, there must be limits to continued development if renewable resources are to be sustained.

'Biodiversity' is defined here as the variety of life forms: different plants, animals and microorganisms, the genes they contain and ecosystems they form (DEST 1993). The concept particularly emphasises the interrelated nature of the living world and its processes. However, like ESU, it is a broad goal and has been difficult to develop prescriptive management objectives for the tens of thousands of Great Barrier Reef species.

Strategies for ESU and biodiversity conservation are contained in a range of legislation, regulations and policies, and in formal decisions of the Great Barrier Reef Marine Park Authority, zoning plans and other sources. The *Great Barrier Reef Marine Park Act 1975*, amendments and regulations protect corals and certain other species, prohibit certain endangering processes (e.g. mining, oil drilling), provide for development of zoning and other management plans and powers to stop threatening processes. The formal decisions of the Marine Park Authority contain general and specific strategies for managing particular issues, and reflect the evolving, issue-driven approach to management which characterises the Great Barrier Reef Marine Park model.

Other Commonwealth and State Acts protect certain Great Barrier Reef Marine Park species and prohibit certain threatening processes. Commonwealth government policies (e.g. the Ecologically Sustainable Development strategy), and bilateral and international agreements

and conventions also contain goals and objectives for biodiversity management (e.g. World Heritage Convention).

With the exception of the protected species/taxa identified, the above legislation and policies are very general, and refer to broad goals and concepts. For example, the Great Barrier Reef World Heritage Area Strategic Plan's goals are 'protection', 'maintenance of ecology' and 'ecologically sustainable use' (GBRMPA 1994). Details on the mechanisms by which these goals may be achieved are invariably lacking.

The Great Barrier Reef Marine Park Strategic Plan does attempt to provide hierarchical steps and processes to achieve ESU and biodiversity management. For example, it identifies the key issues or objectives in the management of the Great Barrier Reef Marine Park as (1) the maintenance of the ecology; (2) management to achieve ecologically sustainable use; and (3) maintenance of traditional, cultural, heritage and historic values. The main 25 year objective is 'to ensure the persistence of the Great Barrier Reef World Heritage Area as a diverse, resilient, and productive ecological system ...'. Several 'broad strategies' are given to achieve this objective (e.g. 'manage use of the Area in accordance with ecological sustainability and the precautionary principle.'). Five year objectives and strategies are given, from which the Great Barrier Reef Marine Park Authority Corporate Plan objectives may be developed (e.g. table 1).

Table 1. Some objectives and strategies in the Great Barrier Reef World Heritage Area Strategic Plan relevant to biodiversity conservation (GBRMPA 1994)

5 year objectives	Strategies
1.1. To have in place integrated management strategies for the conservation of the Great Barrier Reef WHA) and strategies to achieve them	1.1.1. Develop, in consultation with stakeholders, integrated planning for *conservation* of the Area ... 1.1.2. Document existing biological communities as appropriate ...
1.2. To have in place clear policies for the conservation of major biological communities ...	1.2.1. Develop ... policies for the conservation of the following biological communities: coral reefs, mangroves, island vegetation, seagrass, Halimeda beds, inter-reefal areas and the Great Barrier Reef lagoon.
1.4. To protect representative biological communities ... to act as source areas, reference areas, and reservoirs of biodiversity and species abundance	1.4.1. Identify and protect representative biological communities ...
1.5. To pay special attention to conserving rare and endangered species	1.5.1 Identify species which are endangered in the Area and threats to their survival
1.6. To aim to prevent ecologically unsustainable loss and degradation of marine and terrestrial biological communities ...	1.6.1. Develop mechanisms to address the cumulative impacts of localised projects through regional planning and management plans.

The Strategic Plan however fails to provide unambiguous, scientifically-based targets and mechanisms for ecologically sustainable use (ESU) and biodiversity conservation. It does not attempt to define the processes by which ESU may be attained (e.g. the objective of 'prevention of unsustainable loss' is circuitously achieved by a strategy 'to develop mechanisms to address cumulative impacts'). It makes no attempt to identify threatened species, define limits of acceptable change to habitats, proportions of habitat which should be totally protected, or the number, size and spatial arrangements of protected areas or specify how representative biological communities can be identified.

The Strategic Plan recognises that management of potentially damaging activities in the Great Barrier Reef, which may adversely affect conservation values, is spread among a variety of agencies. Great Barrier Reef Marine Park Authority maintains a limited level of overall coordination. Catchment landuse activities are managed by Queensland Department of Natural Resources through the Integrated Catchment Management process; management of fisheries and fishing is by Queensland Department of Primary Industries and Queensland Fish Management Authority; shipping activities and oil spill management is by the Australian Maritime Safety Authority and Queensland Department of Transport; and urban and industrial landuse activities management is by the Queensland Department of Environment (GBRMPA 1994).

ASSESSMENT OF THREATS TO Great Barrier Reef ECOSYSTEMS

While management of use has apparently been relatively successful, in view of the current favourable assessment of the state of the Great Barrier Reef (Wachenfeld et al. 1996), pressure on the system has been generally low compared to the other major reef systems which lie in developing nations (e.g. Veron 1995). Thus management success may be partially illusory and management systems inadequate in the face of pressures from greatly increased use of the system. No consistent system for prioritising management resource allocation against risk has yet been implemented. The current crisis state of dugong populations in the southern half of the Great Barrier Reef Marine Park (Marsh et al. 1996) may mark the first evidence of significant management failure, perhaps reflecting lack of focus on managing the environmental effects of fishing.

The only identifiable catastrophic risk to a significantly sized area of the Great Barrier Reef is that posed by a major oil spill. A major oil spill, either to the east of the Great Barrier Reef or in the inner shipping channel, will cause extensive damage to nearby habitats – mangroves, intertidal seagrass and shallow reefs. There is very limited capacity to deal with such a spill (Raaymakers 1996). Measures to minimise the risk of a spill are slowly being introduced but the position of the Great Barrier Reef as an international shipping route prevents many management solutions being easily implemented. Research into clean-up technology suitable for use in the Great Barrier Reef environment is minimal.

An uncertain risk for the Great Barrier Reef is the cycles of crown-of-thorns starfish outbreaks. These have caused major apparent damage to reefs in the central part of the Great Barrier Reef but it is still unclear as to whether they are a totally natural occurrence, mainly human induced or perhaps natural but with their frequency increased by human activity (e.g. Moran and Lassig 1996).

The most important chronic threats to the Great Barrier Reef are believed to be those arising from increased terrestrial run-off of pollutants associated with agricultural and urban activity; the effects of trawling; and localised physical damage from anchoring of tourist, recreational and fishing vessels (Zann 1996). The biological level of risk and severity of damage from these impacts has been hard to quantify against the large inherent natural variability in the system. In general most habitats in the Great Barrier Reef appear to be in 'good' condition reflecting limited effects from these impacts at present.

A SUGGESTED FRAMEWORK FOR A GREAT BARRIER REEF BIODIVERSITY CONSERVATION PLAN

The development of a scientifically-based plan for ESD and biodiversity conservation is a monumental, but not impossible, task. The following briefly discusses the issues in ESD and biodiversity conservation, and suggests a framework for the development of a strategy and implementation plan. It builds on existing objectives and strategies and suggests (by way of example) some scientifically-based mechanisms for their implementation, or research which is needed to identify such mechanisms.

Ecologically sustainable use: a 'top down' approach

ESU is a modern term and is implicit in Great Barrier Reef Marine Park Authority's goal of 'wise use in perpetuity', and in the multiple use managed area model. ESU may be a simplistic concept or philosophical ideal which not easily grounded in ecological science, but it is clearly a preferable to present, unsustainable, market-driven development. ESU and the application of the 'precautionary principle', which places the onus of proof onto the developer or exploiter, reflects a new and cautious approach to resource use and environmental management (Driml and Zann 1996).

It is important that the concept or ideal of ESU is translated into practical, scientifically-based management actions by the Great Barrier Reef Marine Park Authority and the CRC Reef Research Centre. From goals can be developed principles, objectives and actions for implementation. Some practical implications of ESD/U to management of the Great Barrier Reef biodiversity are suggested in table 2.

Species conservation: a 'bottom up' approach

The 'top down' large ecosystem management and ESU approach (above) must be complemented by a 'bottom up' species management approach to ensure that biodiversity is retained. Many coral reef species are rare, and many are regarded as 'ecologically redundant' (not necessary for the function of the ecosystem). The following discusses some major objectives of species, community and habitat management and appropriate management or research actions.

Identification of species for special management

Corals (keystone and umbrella species) are protected under the Great Barrier Reef Marine Park Act. A range of other Great Barrier Reef species are fully protected, or subject to size or bag limits under Great Barrier Reef Marine Park and State regulations. However, these have been identified on an ad hoc basis, and there has been no systematic attempt to identify species requiring special management.

Jones and Kaly (1996) identify five types of species deserving special conservation status:
(a) Ecological indicators (species which may provide an early warning of detrimental impacts on the community, e.g. *Acropora* spp. in inner and mid-shelf reefs)
(b) Keystone species (pivotal species upon which the diversity of a large component of the community depends, e.g. seagrasses, macroalgae, corals and their key herbivores and predators)
(c) Umbrella species (species with large area requirements, which given sufficient protected habitat area, will bring many other species under protection, e.g. seagrasses, macroalgae, corals, sponges and other colonial animals)
(d) Flagship species (popular species that serve as rallying points for major conservation initiatives, e.g. corals, dugongs, turtles)
(e) Vulnerable species (those which are actually prone to extinction: below).

Table 2. Ecologically sustainable use: from ideal to action

The following attempts to define principles implicit in the concept of ESU and develop from these practical management strategies and actions:

Some general principles of ESU and management implications...

1. The maintenance of ecosystem function must be considered as the primary objective of environmental management throughout the Great Barrier Reef. (Implications: this dictates a 'top down' approach to management, and complements the 'bottom up' species approach implicit in biodiversity conservation, below).

2. A large-scale or 'systems' approach to management is essential. (Implications: this dictates integrated land/sea management, and strategic planning and management in the coastal zone.)

3. Maintenance of environmental quality and ecosystem function is a prerequisite for management in aquatic environments. Implications: this dictates a priority on water quality management.)

Some management strategies and objectives...

1. Large protected areas which encompass land and sea systems need a precautionary approach to maintaining biodiversity, for reference areas and for fisheries refugia. (Land and sea protected areas should be integrated where possible, e.g. Cape York/Far Northern Section.)

2. The maintenance of water quality is of critical importance in all areas of the Great Barrier Reef Marine Park and entering and adjacent waters. (Integrated catchment management is a State and national priority).

3. Marine Protected Areas should be of a sufficiently size and of suitable spatial arrangement to ensure that their ecological function and connectivities (larvae and adults) are maintained.

4. Management (and therefore research and monitoring) should primarily focus on maintaining the ecologically important, functional groups, critical habitats, and 'keystone' and 'umbrella' species. *(see 'Maintenance of biodiversity' section (below))*

5. In the absence of scientific understanding of the Great Barrier Reef system, an empirical , precautionary approach to environmental management is required (e.g. monitoring indicator species in protected and unprotected areas; applying techniques which have worked in other areas; managing or prohibiting activities documented as harmful in other areas) .

6. Extractive activities occurring over significant areas (meso/macroscale) require application of precautionary principle (e.g. fisheries is the major extractive use of Great Barrier Reef is fisheries; fisheries globally (and particularly on coral reefs) have not been sustained; new (and existing?) fisheries should require an Environmental Impact Statement).

7. Management should focus on mechanisms to avoid/reduce meso-scale chronic and episodic threatening processes (e.g. oil or chemical spills from mainland cities, resorts, shipping).

8. Monitoring is the basic tool under scientific uncertainty (e.g. state of the environment reporting is needed to detect cumulative impacts of multiple or chronic 'minor' disturbances).

Identification of potentially vulnerable marine species

Great Barrier Reef Marine Park, State and Commonwealth legislation protect some perceived vulnerable and threatened species such as turtles, dugongs, cetaceans and seabirds. However, there has been no systematic attempt to identify criteria for vulnerable or endangered species on the Great Barrier Reef Marine Park. The very large number of species in the Great Barrier Reef Marine Park and the fact that many coral reef species are rare, but not necessarily endangered, greatly complicates the task.

Potentially vulnerable species may be identified based on empirical and theoretical considerations. Jones and Kaly (1996) identify several types of species as potentially vulnerable and other criteria have been added by the authors:

(a) Species with unusually restricted breeding sites. (Many highly mobile marine species converge on specific breeding grounds, representing only a small part of their geographic range, e.g. whales, turtles, seabirds, some fish. Here they are potentially vulnerable to overfishing or environmental disturbances.)

(b) Species that are very large, long-lived and/or of low fecundity. (Typically, these species are also naturally rare and aggregated, slow to mature and have consistently low recruitment. These characteristics make them prone to over-exploitation and slow to recover. Examples include giant clams; large, live-bearing fish such as sharks and rays; and most marine reptiles and mammals are particularly susceptible to over-exploitation.)

(c) Species subject to large-scale mass mortality. (A number of marine species exhibit catastrophic declines in abundances over a short period e.g. seagrasses subject to die-back, and mass mortality of marine mammals.)

(d) Species subject to prolonged recruitment failure. (While most marine species exhibit variable recruitment and 'year-class phenomena', this may occur over long periods in some species, e.g. potato cod).

(e) Species highly susceptible to environmental stresses. (These may be the first to become extinct locally, and may be the first to succumb to global threats such as ocean warming. They may be used as 'early warning' indicators of changes, e.g. sediments and nutrients may affect seagrasses and corals.)

(f) Species that are extreme habitat specialists. (For example, symbiotic species associated with a one or a few species of host, e.g. some anemone fish (*Amphiprion* spp); turtle and dugong barnacles (*Platylepas* spp.)

(g) Obligate supra-tidal, intertidal, estuarine and coastal embayment species. (These are potentially limited habitats and their susceptibility to human disturbances makes these vulnerable, e.g. to overharvesting for food, bait and curios, and oil and other surface layer contaminants.)

(h) Species subject to excessive exploitation. (A growing number of marine reptiles, mammals, fish and invertebrates in Australia have been over-exploited, e.g. turtles, dugongs, tunas.)

(i) Species subject to indirect, chronic or episodic disturbances or impacts. (e.g. by-catch from netting or trawling affects dugongs, turtles and shelf benthos.)

(j) Inshore species subject to eutrophication or sedimentation from terrestrial run-off. (e.g. seagrasses, inshore corals)

(k) Endemic species, particularly those with narrow ranges. (Most Great Barrier Reef mid- and outer-shelf species have a very wide Indo-Western Pacific distribution. Inner-shelf habitats appear to have a higher proportion of endemics e.g. the gastropod family Volutidae, some nudibranchs.)

While insufficient is known of the status of almost all species in the Great Barrier Reef Marine Park, the above criteria are useful in identifying such species. A matrix approach may be useful in identifying the most vulnerable species (table 3).

Table 3. Matrix for identifying potentially vulnerable species (see text 2.2. for legends a–j). Species with highest scores (x) may be most vulnerable.

Species	sci	abund	a	b	c	d	e	f	g	h	i	j	total
dugong	A	UC (decl)		xx	xx			x		x	x	x	8
green turtle	F	UC (decl?)	xx	xx		xx				xx	x		9
Irrawaddy dolphin	NR?			xx					x		x	4?	
tiger shark	N	UC?			xx							x	3?
Volutidae spp.	N	C–R?							x?			x	2?
Platylepas spp.	N	R	x	xx*	xx*			xxx		(xx)	(x)	(x)	12
seagrass (inshore)	A	A			xx		x		x	x		xx	7

Sci (scientific knowledge): A: adequate; F: fair; N: nil
Abund (abundance): A: abundant; C: common; UC: uncommon; R: rare; ?: unknown (guess)
Decl: declining population

Habitat/community conservation: practical unit for management

The ecosystem and species approaches meet at the habitat/community level, the most practical level for biodiversity conservation. While space prevents a detailed review of the research issues and possible management mechanisms, implications are briefly discussed.

Need for inventory of Great Barrier Reef Marine Park habitats and communities
No inventory of habitats and communities has been developed for the Great Barrier Reef Marine Park, despite their high priority within the Strategic Plan. Systematic benthic surveys were initially used to identify habitats and reef types in the first Capricorn Zoning Plan. However the large size of the later Marine Park Sections and time and funding constraints resulted in use of more a descriptive, 'Delphic' approach, based on the opinion of experienced researchers on patterns of community/reef types in the area. While systematic surveys have not been undertaken for the entire Great Barrier Reef Marine Park, the REEF GIS database being developed by the Great Barrier Reef Marine Park Authority and the AIMS monitoring database have descriptions of around 500 different reefs (e.g. Oliver et al. 1995) which could form the basis of a comprehensive inventory.

While protection in the Great Barrier Reef Marine Park to date has largely centred on coral reefs, the Great Barrier Reef Marine Park and the Great Barrier Reef World Heritage Area include many other communities: saltmarsh, mangroves, estuaries, hard and soft shores, seagrass beds, macroalgal assemblages and other inshore communities; virtually undescribed continental shelf hard and soft bottom benthic communities; the interconnecting shelf watermasses, plankton and nekton communities; coral reefs; islands; and the continental slope and adjacent waters benthic and planktonic communities of the Coral Sea.

Paradoxically, mid- and outer-shelf emergent coral reefs have been disproportionately more protected (because they are visible and 'glamorous') although they are probably under

lesser threat, and may have a lower species diversity and low proportion of endemics than inshore areas.

Need for bioregionalisation
No comprehensive bioregionalisation has been developed for the Great Barrier Reef Marine Park, again despite its high priority within the Strategic Plan. The most important regionalisation used in zoning plans has been the cross-shelf (inner, mid, outer) zonation developed by AIMS, although a lack of consistency of the model in north-south direction has posed problems between Sections. A preliminary macroscale bioregionalisation of the Great Barrier Reef World Heritage Area has been independently proposed under the Ocean Rescue 2000 National Network of Marine Protected Areas (Thackway et al. 1995), but requires refinement and testing.

Need for research on community management strategies
Research is required to develop scientifically-based strategies for habitat and community management, particularly: keystone habitats and communities; optimal and minimal sizes of protected areas for each community type; migration/larval connectivities; and functional relationships. A systematic approach such as that suggested by Jones and Kaly (1996) for species management would be useful.

While adequate scientific understanding of the Great Barrier Reef system is a distant prospect, the Great Barrier Reef Marine Park Authority precautionary model for large marine protected areas for coral reefs should be equally applied to other habitats and communities within the Great Barrier Reef Marine Park and the Great Barrier Reef World Heritage Area.

Risk prioritisation as a basis for management response

At present there is no coherent system of prioritising the risks to the ecosystems and values of the World Heritage Area such that management resources can be effectively distributed and applied. This lack is compounded by the commonly held misapprehension that the Great Barrier Reef Marine Park Authority has a legislative role to manage all activities impacting on the ecological and socio-cultural values of the World Heritage Area or the Great Barrier Reef Marine Park. If we consider the principal potentially impacting activities to be fishing, shipping, terrestrial run-off, tourism and recreation (with global climate change as a poorly known contributor) it may be seen that for only tourism and recreation is the Great Barrier Reef Marine Park Authority the lead management agency in the Great Barrier Reef. While the Great Barrier Reef Marine Park Authority has a reserve power to intervene in the management of any of these activities where they are impacting on the ecology of the Great Barrier Reef this power has not been exercised. Thus the largest slice by far of management resources within the Great Barrier Reef Marine Park Authority goes to managing tourism with minimal resources going to managing the effects of fishing, terrestrial run-off or shipping.

The quantification and prioritisation of the threats to ecology and values of the World Heritage Area should be carried out in a formal way. The results of this can then be incorporated into the Strategic Plan to prioritise the management strategies developed in the Plan. The allocation of management responsibilities and resources can then be attempted to be made using a systematic approach.

SUMMARY AND CONCLUSIONS

It is concluded that the Great Barrier Reef Marine Park Authority lacks a coherent, scientific-based implementation plan for ESU and biodiversity conservation. The broad goals, objectives and strategies for biodiversity conservation are to be found in existing legislation, but policies and agreements have not been collated or synthesised into an ESU and biodiversity conservation policy and necessary implementation plans. This lack of a formal framework for ESU and biodiversity conservation has resulted in inconsistencies among Section zoning plans (e.g. the adjacent Far Northern Section and Cairns Section Zoning Plans are inconsistent in objectives and design), difficulties in evaluating zoning plans (e.g. in reviewing the Far Northern Section), an ad hoc approach to scientific research (e.g. many of the Strategic Plan 5-year research objectives have not been commenced), a

continuing uncertainty on the status of all but a few species in the Great Barrier Reef Marine Park, and an ability to target management to the highest priority issues.

The development of a scientifically-based management plan for ESU/D and biodiversity conservation in the Great Barrier Reef is a high priority. This plan should synthesise the goals of ESU/D and biodiversity conservation, apply current scientific knowledge of the Great Barrier Reef system and theory of marine protected area design, and develop practical management objectives and prescriptions to be used in planning and management in the Great Barrier Reef Marine Park.

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