Australian Government

Great Barrier Reef Marine Park Authority

Expert Ecological Advisory Workshop I

An ecological review of natural coastal ecosystems in the Great Barrier Reef

Hosted by the Great Barrier Reef Marine Park Authority (GBRMPA) and Lloyd Consulting – 23–24 June 2010

Expert Ecological Advisory Workshop I

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Published by the Great Barrier Reef Marine Park Authority

ISBN 978 1 921682 95 7

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This publication should be cited as:
Great Barrier Reef Marine Park Authority 2012, *Expert Ecological Advisory Workshop I 2012*, GBRMPA, Townsville.

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ACKNOWLEDGEMENTS
Thank you to all the participants of the workshop for sharing your skills and knowledge. This report was initiated by the Great Barrier Reef Marine Park Authority, under objective 2 of the Climate Change Action Plan 2007-2012. We would like to thank Lloyd Consulting for facilitating the workshop and preparing the workshop summary report on which this document is based.
Special thanks to Lana Heydon for the magnificent job she did of creating a conceptual model of the Great Barrier Reef pre-European catchment and the climate change responses at a moment's notice and Paul Groves for taking it from paper and creating the draft base illustrator models.

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Summary

The *Great Barrier Reef Outlook Report (2009)* identified coastal development, water quality and climate change as the biggest threats to the health and resilience of the Great Barrier Reef. While the values provided by coastal ecosystems to the health of the Great Barrier Reef have been recognised for many years, a comprehensive and quantified assessment of the values of coastal ecosystems has yet to be undertaken.

On 23 and 24 June 2010, the Great Barrier Reef Marine Park Authority hosted an Expert Ecological Advisory workshop as part of its Catchment to Reef Ecosystem Services Information project. The objectives of the workshop were to undertake an ecological review of coastal ecosystems and assess their importance for sustaining the health of the Reef. An evaluation of the impact of climate change across four scenarios was also conducted by participants. Thirty-three experts in terrestrial, aquatic, coastal and marine ecology, climate change impacts, land capability assessment, catchment management, political science and science communications participated in the workshop.

This draft Report records and summarises the extensive amount of information and knowledge developed by participants during these two days.

The outcomes of the workshop include:

- detailed notes and key points from the four working groups for Workshop Session One – ecological services assessment
- detailed notes and key points from the four working groups for Workshop Session Two – ecological services under four climate change scenarios
- material and ideas to build a conceptual diagram for whole of Reef catchments in 1850 (pre-modification) depicting the coastal ecosystems and ecological services that support Reef health
- key issues and ideas identified by participants during the workshop for the progression of this work.

1. Introduction

The *Great Barrier Reef Outlook Report (2009)* (Outlook Report) identified coastal development, water quality and climate change as the biggest threats to the health and resilience of the Great Barrier Reef. In response, the Catchment to Reef Ecosystem Services Information project was established by the Great Barrier Reef Marine Park Authority (GBRMPA) to gain a greater understanding of the role and values of coastal ecosystems in protecting and managing the health of the Great Barrier Reef World Heritage Area.

In order to identify the coastal ecosystems that are critical, we must first understand:

- How these coastal ecosystem areas function?
- What threats exist now and in the long term for these ecosystems?
- What will the consequence of these threats be on long-term health of the Great Barrier Reef?

During the initial phase of the project, a detailed literature review was conducted and profiles for each of the coastal ecosystems were developed which include their ecological functions and services, potential or actual risks from adjacent land use, and current management arrangements. The ecosystem profiles were developed prior to the workshop and reviewed externally by people with expertise in the ecology of these systems.

On 23 and 24 June 2010, an Expert Ecological Advisory workshop was held with key researchers and managers working in the Great Barrier catchment and inshore marine areas. The workshop was the first opportunity for experts from a range of scientific disciplines to come together to discuss the ecological importance of coastal ecosystems from their specialist knowledge base.

This report summarises the material that was generated at that workshop and includes detailed notes and key points from discussions by participants regarding the values and services coastal ecosystems play in protecting the health of the Great Barrier Reef World Heritage Area, along with the likely impacts of climate change.

Following this workshop, additional work will be undertaken to assess the social, cultural and economic values of areas identified as coastal ecosystems that play a critical ecological service to the Great Barrier Reef World Heritage Area.

One of the final products of the project will be a discussion paper developed by GBRMPA for the management and protection of critical coastal ecosystems that have been identified as supporting the health and resilience of the Great Barrier Reef World Heritage Area.

1.1 Workshop objectives

Specifically, the workshop sought to engage scientific experts and practitioners in discussions of the following topics:

Day 1 – What are the critical coastal ecosystems that protect Reef health? What ecological services do they provide to the Reef?

Day 2 – How will climate change impact the critical coastal ecosystems and their ability to provide ecological services for the Reef?

1.2 Design of workshop

The workshop was designed and conducted as a facilitator-lead, interactive process with the majority of workshop sessions conducted in four working groups – terrestrial ecosystems, freshwater wetlands, estuarine wetlands and inshore marine ecosystems. Participants were organised into the working groups based on their expertise and had the opportunity to move between or change groups during the sessions.

On Day 1, introductory presentations were given by Donna-marie Audas, Manager, Coastal Ecosystems, GBRMPA on the background and context of the overall project and Mike Ronan, Manager, Wetlands, Department of Environment and Resource Management (DERM) on the Queensland Wetlands Program and links to the GBRMPA project. These presentations were followed by a series of interactive discussions and workgroup sessions (Appendix A).

An important aspect of the workshop was to provide a process for people with expertise in the ecology of the different types of coastal ecosystems to discuss and decide with their peers on the relevant importance of these functions in protecting the health of the Great Barrier Reef World Heritage Area. This was based on the assumption that different views and understanding of the issues existed between participants within the one working group. The majority of the discussions were conducted in the four working groups, namely:

- Terrestrial habitats
- Freshwater wetlands
- Estuarine wetlands
- Inshore marine habitats.

In the larger workshop group, participants discussed and agreed on the proposed tasks, their scope and terminology and shared ideas about how the tasks were working and the approach their group was taking.

1.3 Recording of outcomes

Each working group session was recorded by a dedicated table scribe to document ideas in the worksheets provided (Workshop Session One) or in alternative formats (some groups for Workshop Session Two). All large group discussions were recorded by the workshop scribe and key points raised were also recorded by the facilitator.

In the second half of Day 1, participants agreed to the need for a whole of catchment conceptual diagram to form the basis for linking the values and services of the different ecosystems across the catchment. At the start of Day 2, and following the climate change scenario discussions, key values and services and critical issues were noted for recording on the conceptual diagram.

The emphasis was on collating the initial ideas to develop a diagram that would represent a detailed understanding of the values and services of different ecosystems in a pre-European time. Participants identified other versions of the conceptual diagram that were needed to represent the current modified nature of the Great Barrier Reef catchment including the current set of issues and drivers. Differences between catchments, such as the Wet Tropics and the Dry Tropics, were also recorded by some working groups. This conceptual understanding is required as a basis for identifying the key coastal areas that would be a priority for GBRMPA and other partners to protect and manage for the long-term health of the Great Barrier Reef World Heritage Area.

1.4 Forum participants

Thirty-three people participated in the workshop from research organisations (James Cook University, Australian Institute of Marine Science, University of Queensland and CSIRO), Queensland Government agencies (Qld Fisheries and DERM), regional natural resource management bodies (Terrain NRM, NQ Dry

Tropics, Fitzroy Basin Association and Burnett Mary Regional Group), independent consultants, an interest group (WWF) and GBRMPA (Appendix B).

1.5 Outputs

The key outputs of the workshop were:

- a summary table based on the notes from Workshop Sessions One and Two for each of the four working groups
- a summary of discussions regarding issues, key ideas and priority actions.
- a pre-European 'whole of catchment' conceptual diagram
- a climate change on natural state conceptual diagram.

1.6 Participant feedback

At the close of the workshop, participants were asked to rate four aspects of the day, namely the effectiveness of the workshop, the workshop materials, the venue and catering, and the facilitation with a score from 1 (very low) to 5 (very high). In general, the effectiveness of the workshop, support materials, catering and facilitation were rated on average around 3.5 to 4.25 out of 5. The venue was rated lower, however, due to the limited working space and impact of working group discussions on other participants.

When asked to share some views about what they felt they gained from the workshop, participants offered the following:

- Opportunity for discussions with experts in other fields
- Increased understanding of coastal ecological processes from an interdisciplinary approach – linkages and connectivity (interdependence of ecosystems at a catchment scale)
- Opportunity to meet new people.

The areas that participants felt could have been improved were:

- A larger venue to allow more space to move around
- Separate break-out areas to minimise noise and impacts on other working groups
- Clarification of key terms and use of terminology up front
- More interaction between the four working groups during the workshop
- Greater emphasis on the linkages between the four identified ecosystem categories
- Inclusion of experts from areas such as climatology, geomorphology and biogeochemistry
- More time overall for the workshop to allow for discussions of linkages and interactions between ecosystem categories.

1.7 This Report

This Workshop Report documents the key written outputs of the workshop, specifically the issues raised and ideas generated by participants regarding the value and services of coastal ecosystems and the likely impacts of several climate change scenarios on these ecosystems.

A 'whole of catchment' ecological services conceptual diagram and climate change on natural state conceptual diagram based on the workshop information has now been completed.

1.8 Next steps

The draft Workshop Report will be circulated to all participants for their review and amendments. Comments will be incorporated and the Workshop Report finalised by GBRMPA as a record of the key discussion points and outcomes.

The results of the workshop will then feed directly into the GBRMPA's 'Protecting Coastal Ecosystems: Discussion Paper. An Assessment of the ecological services Coastal Ecosystems provide to the Great Barrier Reef' which is now being developed.

2. DAY 1 – ASSESSMENT OF ECOLOGICAL SERVICES

2.1 General discussion

As part of the introductions, the broad range of expertise in the room was acknowledged. Participants noted a number of disciplines or specialist areas that they felt were missing including climatologists, groundwater hydrologists, coastal geomorphologists, Indigenous representatives and socio-economic perspectives. The planned approach is to include the latter two groups in coming processes that are intended to build on the ecological assessment. The focus of this workshop is on the ecological values and services of coastal ecosystems – this was thought to be sufficiently complex to warrant a dedicated workshop.

The definition of the Great Barrier Reef in terms of a focus area for discussions was raised. Generally it was agreed that a broad definition of the Reef would be useful to the discussions (e.g. the World Heritage Area, acknowledging that this included a broad range of ecosystems and habitats, and that it was more than the coral reefs), though participants were encouraged to make judgements relevant to the context of their specific discussions.

In presenting the outline of the two days, the focus of Day 2 on climate change was questioned. It was suggested by one participant that it was more important to focus on coastal development and habitat loss when considering immediacy and potential scale of impacts. The project team responded that the impacts of coastal development were more readily known and that the potential of climate change to impact on coastal ecosystems was less well understood. The workshop provided an opportunity for climate change expertise and knowledge emerging from the research to be discussed and captured.

2.2 A vision for the coast

The following key points were part of the vision proposed by Donna-marie Audas in her introductory presentation. Her vision for the Great Barrier Reef coast was typified by:

A possible vision of what the Great Barrier Reef coast will look like with changed management regimes.

The coastal waters are teaming with life – fish, seabirds, whales, dugong and turtles are abundant. Clear waters reveal vibrant and diverse coral reefs, seagrass beds and other benthic communities.

Many vessels can be seen. They are many ships showing visitors the natural wonders, locals enjoying themselves, fishers fishing and transporting bulk goods. There is no damage from anchors in the popular spots as people share access to moorings.

When you fly up the coast from Bundaberg to Cooktown you see that it is mostly undeveloped with occasional well defined centres of urbanisation or industrialisation. These development centres have lowered their impact on the surrounding environment to almost nil. Runoff is captured and reused, industrial cycles are closed with by-products captured and reused.

Occasionally between urban centres is a Port which is contained and well managed with fail-safe systems for spills and imports, while exports flow seamlessly. There are also resorts, which blend with the natural landscape, bustling with people holidaying and relaxing.

The catchments have a mosaic of forests connected by wide corridors of forest. Clear streams bounded by healthy corridors of forest wind from the top of the catchment to the coast with few or no obstructions. Areas of intensive and extensive agriculture are seen in the mosaic that is the catchment landscape. The small towns and villages also dot the landscape.

To achieve this vision of the Great Barrier Reef coast, a whole of government coastal strategy is needed. Currently, the Commonwealth, state and local governments work in a silo fashion and often issues are dealt with in isolation. GBRMPA's aim is to link information and data which is scientifically robust across all three levels of government.

2.3 Categories of ecological function

In their four working groups, participants reviewed and discussed the proposed six categories (Appendix C) for use in the first workshop session. The following changes were made as a result of the groups' discussions:

- 'Foodwebs' was renamed as 'Biological Processes' and was agreed to include:
    - biodiversity
    - nursery grounds
    - oxidization of water
    - bio-engineering (e.g. plants and animals have an effect on their physical environment)
    - replenishment of ecosystems (e.g. colonisation, reproduction, breeding, genetics).
- 'Nutrient Regulation' was renamed as 'Biogeochemical Cycling' and agreed to include:
    - movement of chemicals, effects of acidification, carbon sequestration, oxygenation of water
    - biological nutrient translocation (including nutrient cycling, regeneration, provisioning)
- 'Physical (supporting) Habitats' was agreed to mean 'Habitat Structure'
- 'Disturbance Regulation' was agreed to apply in extreme conditions (ie. cyclone or flooding that occurs every 200 to 500 years and is not captured under other categories).

2.4 Ranking of ecological function

Participants also reviewed the ranking system provided for ecological services. Some groups prioritised their focus on the high and moderate ecosystem services and so did not deal with those they believed to be of low or no ecological value and service. Some groups, such as the terrestrial working group, ranked in terms of area/volumes of the ecosystem within the catchments and then scaled that up to arrive at a ranking of importance.

The large group identified important differences between 'ideal' values and services of an unmodified landscape and the current situation with large areas cleared or significantly modified. It was agreed by participants to take a pre-modified landscape view when considering ecological values and services in Workshop Session One.

2.5 Working group outputs

The following are key points that emerged from each working group taken from the detailed notes documented for Workshop Session One. These have been summarised in tabular form (Appendix D).

2.5.1 Terrestrial working group

Rainforests have a significant influence due to their high productivity. They act as a major source of nutrients to food webs and sediment to the Great Barrier Reef World Heritage Area, and affect rainfall and microclimates.

Woodlands cover a large area adjacent to the World Heritage Area – as a result they play an important role in its functioning. The key services offered by woodlands are the provision of nutrients and sediment and the control of hydrological flows.

Riparian/riverine systems provide a means of transport for sediment and nutrients to the World Heritage Area (positive aspects), while filtering surface and ground waters before they enter the area..

Grasslands and sedgelands were not identified as presenting any major ecological services to the Great Barrier Reef World Heritage Area, having only limited capacity to influence water quality and movement.

Tea-tree swamps provide an important filter function to waters before they enter the World Heritage Area.

In addition to the natural ecosystems, agro-ecosystems were also addressed, as the working group identified these as having a significant yet detrimental impact on the World Heritage Area. While they provide an over-abundance of sediment and nutrients to the World Heritage Area, agricultural areas do provide some functions compared with areas devoid of terrestrial vegetation.

Floodplains are able to mitigate the impact of floods through the removal of water, energy, and contaminated substances from floodwaters, while freshwater wetlands form important habitats for aquatic ecosystems.

2.5.2 Freshwater wetlands working group

Floodplain wetlands provide both detention and retention functions, which in turn facilitate groundwater recharge and discharge processes in lake, swamp and riverine systems in the floodplain.

Floodplain and riverine systems enhance connectivity and transfer energy between catchment areas. They also influence nutrient uptake and cycling are able to oxygenate waters that flow to the Great Barrier Reef World Heritage Area and facilitate movement of many aquatic species.

2.5.3 Estuarine wetlands working group

Estuaries are identified as a major carbon sink, while tidal wetlands provide an out-welling function in the carbon cycle.

Tidal wetlands provide essential nutrients (nitrogen and phosphorous) to the Great Barrier Reef World Heritage Area. They have high biodiversity (both ecological and genetic) and also facilitate flocculation at the saltwater/freshwater interface.

Mangroves are able to hold sediment and therefore stabilise the coastal geomorphologic structure.

Salt marshes provide carbon for the food chain, while mangroves sequester carbon.

2.5.4 In-shore marine working group

Reef systems act as a buffer for other habitats through dissipation of wave energy.

Reef and seagrass systems offer refugia and nursing grounds, thereby supporting and promoting biodiversity. They are also a food source for primary and secondary production, and provide replenishment, recruitment and bioengineering functions.

Seagrass and plankton systems play a key role in nutrient cycling, as they are the first to receive of dissolved nutrients. They also oxygenate the water.

Unstructured, soft bottom areas trap and accumulate sediment.

2.6 Key ideas from Workshop Session One

A number of common points were raised across the working groups. These are discussed below.

All wetland landscapes provide essential habitat for coastal ecosystems (including migratory species), and act as nurseries and breeding grounds. They are therefore vital for the preservation of genetic diversity.

Rivers deliver sediment to the lower catchment, which is then used to create and replenish hard substrates and filter surface and ground waters before they enter the Great Barrier Reef World Heritage Area. Floodplains are able to mitigate the impact of floods through the removal of water, energy, and contaminated substances from floodwaters. Tidal wetlands reduce overland flows and act as natural buffers against storm surges, thereby protecting terrestrial areas.

Reflections from Workshop Session One included the fact that some habitats could not be scaled. Working groups had to change groupings in order to meet the needs of the exercise.

Overall, some participants felt the exercise maintained the existing silos of habitat groups. There was a lot of 'categorising' and what was also needed was exploration of the linkages and connections between the groups. A separate table for those who had a keen interest in taking a whole of catchment approach was proposed, however, most of the participants wanted to participate in that group. It was therefore proposed that each group contribute to the whole of catchment diagram with some critical ideas and values that emerged from their working group's discussions. This process was agreed to be run at the beginning of Day 2.

2.6.1 Conceptual diagram

Key ideas were reported back by each working group to the large workshop group regarding ecological services and values of different habitats. These are recorded as part of the preliminary conceptual diagram.

The pre-European catchment model and the pre-European climate change model, based upon scenario 3, were created in Adobe Illustrator version CS2. These conceptual models were based upon the pictorial representation (and post-it notes) compiled during the workshop by Lana Heydon and supplemented with notes from the workshop worksheets. These models are only in draft form and may not represent all of the processes presented due to difficulties encountered in representing some of them. The models will be finalised using Adobe illustrator CS5 and will include any feedback received from this report.

The next conceptual models will include:

- a generalised 20th century modified catchment for both the wet and dry tropics
- a conceptual model for a specific sub-catchment in the Mackay-Whitsunday region

- conceptual process models for physical, chemical and biological processes as a layer for the generalised 20th century models
- connectivity models.

3. DAY 2 – CLIMATE CHANGE SCENARIOS

3.1 General discussion

Four scenarios over the period to 2050 were considered for climate change in the workshop session on Day 2. These were proposed and agreed to by participants before commencing the session. The four scenarios were:

Scenario 1 – plus 1^0C warming, 20% less rainfall, longer dry season, sea level rise by 30cm

Scenario 2 – plus 1^0C warming, 20% more rainfall, shorter dry season, sea level rise by 30cm

Scenario 3 – plus 3^0C warming, 20% less rainfall, longer dry season, sea level rise by 68cm

Scenario 4 – plus 3^0C warming, 20% more rainfall, shorter dry season, sea level rise by 68cm.

3.2 Working group outputs

Some groups chose to focus on Scenario 3 as it was the most extreme of the range and had likely greatest impact on the ecological functioning of the terrestrial and aquatic systems (with some differences noted with response by marine systems).

Draft conceptual model started for scenario 3.

The following are key points that emerged from each working group for Scenario 3 taken from the detailed notes documented for Workshop session II.

3.2.1 Terrestrial working group

Rainforest

The consequence of Scenario 3 is likely to be major. Impacts include: decrease in extent, reduced primary productivity, increased sediment release, areas more susceptible to burning and decreased water retention. The resultant consequences to the Reef are likely to include: reduced carbon input to Reef, reduced downstream flow, dry season flow and runoff.

Woodlands

The consequence is likely to be major. Impacts include: less productivity and carbon sequestration, exposure of soils to erosion due to reduced vegetative cover and increased sediment export. The resultant consequences are likely to include an increased sediment flux.

Riparian

The consequence is likely to be minor to moderate. Impacts include: decreased productivity, increased mortality, reduced connectivity to other catchments, less erosion with lower rainfall, less natural regeneration and recovery, more bank erosion with increased cyclone activity and reduced density of vegetation cover in riparian areas. The resultant consequences are likely to include a lower quality habitat for fish and other aquatic species.

Grasslands and sedgelands

The consequence is likely to be minor. Impacts include: decreased productivity, exposure of soils to erosion due to reduced vegetative cover, sedgelands are likely to suffer more and some sedgelands may be exposed to sea level rise. The resultant consequences are likely to include: increased erosion, decreased coverage and/or coastal squeeze in the Burdekin and Wet Tropics regions.

Tea tree swamps

The consequence is likely to be major to catastrophic. Impacts include: reduced total habitat area, landward invasion of rainforest species, seaward invasion of mangroves and reduced quality of habitats. The resultant consequences are likely to include: reduced breeding and refuge areas and in some locations, complete loss of this habitat.

Floodplains

The consequence is likely to be moderate. Impacts include: reduced connectivity, less frequency of flooding, and greater frequency and extent of saline intrusion in near-coastal areas. The resultant consequences are likely to include a loss of productivity and habitat filter function.

3.2.2 Freshwater wetlands working group

Upper catchment – low order streams

The consequence is likely to be major. Impacts include: less reliable base flow, annual discharge and recharge functions, reduced groundwater inputs, loss of refugia and a decreased interception of sediment. The resultant consequences are likely to be a reduced landscape resilience and assimilation capacity.

Upper catchment – plateau/alluvial areas

The consequence is likely to be moderate. Impacts include a lower capacity to dissolve oxygen and sea level rise over the floodplains.

Lowland river channels – low order

The working group is unsure of the likely consequence for lowland river channels. The impacts are likely to be a reduced dissolved oxygen capacity and sea level rise over the floodplains. The resultant consequences are likely to be a loss of refugia, increased weed invasion and resultant loss of quality, poorer quality peak discharges and loss of food chain carbon.

Coastal floodplain

The consequence is likely to be major to moderate. Impacts include: lower dissolved oxygen capacity, greater weed invasion and growth, greater evaporation and increased salinity/conductivity. The resultant consequences are likely to include infestation and invasive by non-native species and a loss of riparian communities due to loss of the freshwater lens.

Floodplain (distributory)

The consequence is likely to be minor. Impacts include: more peak flow events (scouring/geomorphic change with sediment increase), loss of refugia, decreased recharge to groundwater (aquifer recharge), greater likelihood of saltwater intrusion, greater acid sulphate soil exposure with impacts on water quality, loss of connectivity and poorer quality of food web (weed species dominant). The resultant consequences are likely to include greater aquatic habitat stress due to reduction in inundation and flushing, reduced nursery habitat and function and increased competition with other species.

Coastal dune swamps

The working group is unsure of the likely consequence for coastal dune swamps. Impacts include: geomorphic impacts, loss of freshwater dependent vegetation, loss of turtle breeding and bird habitat and loss of productivity and biodiversity. The resultant consequences are likely to include a greater instability of coastline and changes in the sex ratio of reptiles (e.g. turtles).

3.2.3 Estuarine wetlands working group

Mangroves

The consequence is likely to be major. Impacts include a shift inland of mangrove occurrence, loss of species and species longevity and a loss of productivity. The resultant consequences are likely to include a reduced ability to buffer extreme events.

Saltmarsh/pan

The consequence is likely to be major to catastrophic. Impacts include a shift inland and from adjacent habitats, decreased overall area, reduced ephemeral wetland production and heat stress of species. The resultant consequences are likely to include: *Casuarina* and *Melaleuca* species likely to shrink in overall occurrence area due to restricted opportunity to migrate.

Estuaries (fish)

The working group is unsure of the likely consequence for fish species. Impacts include: fewer recruitment events, high chance of wetlands drying up, decreased dissolved oxygen capacity, increased salinity (hypersaline) and increased concentration of agro-chemicals. The resultant consequences are likely to include a lack of connectivity for a range of species.

Beaches/headlands

The consequence is likely to be major to catastrophic. Impacts include: greater erosion of sandy beaches and mudbanks and some impacts on rocky headlands with possibility of some becoming cut off forming small islands. The resultant consequences are likely to include greater areas of hard substrate exposed as sea level rises, a loss of fauna associated with sandy beaches and mudbanks and an increase in fauna associated with rocky foreshores.

3.2.4 In-shore marine working group

Reef

The consequence of Scenario 3 is likely to be catastrophic. Increased temperature will destroy coral reefs. Sea level rise will outpace the capacity of the reefs to grow which is more of an issue in turbid waters due to light penetration. The resultant consequences for the Reef overall are likely to include a major impact on biodiversity and loss of species.

Seagrass

The consequence is likely to be moderate. Photosynthesis will likely be slowed by heat damage to the photosystem. Desiccation and burning will likely occur through exposure to hotter air temperatures in the intertidal areas. There is also likely increased respiration and reduced productivity with reduced light at depth. The resultant consequences for seagrass are likely to include the loss of some areas of intertidal seagrasses, possible species shifts and southward migration, altered growth, biomass, morphology and physiology, shoreward migration of seagrass until reaching barriers and contraction of seagrass distribution at the deep water's edge.

Pelagic (plankton)

The consequence is likely to be minor. A longer dry season and less rainfall will reduce overall production by pelagic (plankton) systems. The resultant consequences for pelagic (plankton) are likely to include a change of biological properties of plankton.

3.3 Key ideas from Workshop Session Two

A number of common points were raised across the working groups. These are listed below.

- Increased saltwater intrusion events are likely to occur in near coastal areas
- Inland shift of mangroves and saltmarsh communities
- Weed and non-native species invasions causing increased competition within ecosystems and decrease in condition
- Poorer quality food webs
- Alterations to physical and chemical properties of water
- Loss of habitat for aquatic species
- Reduced connectivity between catchment areas
- Reduced capacity for water to carry dissolved oxygen
- Loss of breeding grounds and nursery functions in wetlands
- Reduced productivity of plant species
- Decreased biodiversity.

4. KEY ISSUES & FUTURE ACTIONS

The key issues that emerged during the two-day workshop included:

- The wetland agenda has suffered because of a lack of process in linking to other ecosystems. This needs to be built into an adaptive management process with rich data bases and conceptualization already in place that is available to be built on.
- Consideration of climate change impacts needs to address the synergistic effects that are likely/will occur. The impacts are therefore likely to operate in concert and have greater combined impacts than any one alone.
- Reference to key documents such as the vulnerability assessments of inshore and estuarine areas e.g. *Climate Change and the Great Barrier Reef (2007)* as important sources of information, in addition to the *Great Barrier Reef Outlook Report 2009.*
- Existence of significant knowledge gaps – e.g. functioning and role of groundwater systems and their interaction with the surface water and coastal ecosystems needs addressing.
- Danger of continuing to work in isolation – need to encourage work across terrestrial, aquatic, in-shore marine systems and landscapes.
- Need to now move to thinking about current conditions and modified nature of many of these ecosystems.

The conceptual model that was commenced during the workshop and the important ideas that were contributed by the participants needs to be formalised and completed to a stage suitable for circulation and refinement.

In progressing this work in light of the current, modified conditions of the catchments, the extensive information contained in the relevant Water Quality Improvement Plans and the catchment characterisations that have been developed in support of the *Temporary State Planning Policy for the protection of wetlands of high ecological significance in the Great Barrier Reef catchments* (SPP 01/10) needs to be investigated. In particular, good information has been collated regarding dominant land uses and characteristics for many of the catchment areas.

In further refinement of the conceptual model, participants recommend the differences between catchments such as the Wet Tropics and Dry Tropics be addressed.

The social, cultural and economic values need to be progressed. It is proposed that the important coastal ecosystems and habitats that have been identified in this workshop be used as a basis and starting point for overlays of social, cultural and economic considerations.

APPENDIX A – Workshop program

Expert advisory panel - Catchment to Reef connectivity, ecological services and climate change vulnerability – managing the catchment for Reef health and resilience to climate change

When: 23 June 2010 10:00-17:00 hrs to 24 June, 2010 08:00 to 15:00 hrs.
Location: TBA, Townsville

Background: *Various ecological services are provided by the Great Barrier Reef catchments that are important to the health and resilience of the Great Barrier Reef. Using relevant literature, the Great Barrier Reef Marine Park Authority has compiled:*

- *a summary of these services*
- *identified the ecosystems (terrestrial, coastal and inshore marine) that, through connectivity, provide these services to the Reef*
- *the threats to these ecosystems, both now and under a changing climate.*

The focus of this workshop is to discuss and confirm these ecosystem functions, establish ecosystem thresholds and to complete a risk assessment for these ecosystems under a changing climate. This information will be used to develop sound packaged information to be made available to those in the catchment community (such as planners) who can influence the health and resilience of the Reef through their actions on the land.

Agenda

INTRODUCTIONS AND WELCOMES

SESSION 1: CATCHMENT TO REEF ECOLOGICAL SERVICE INFORMATION - PROJECT BACKGROUND & SCOPE

Presentation on the project and the scope of this study – catchment to inshore coastal water, and the reasons behind this lineation. Overview of CESA – definitions.

Discussion:

- Current extent of each CESA
- Development of agreed 'current condition' statements for each CESA.

SESSION 2: CATCHMENT TO REEF ECOLOGICAL SERVICES

Presentation of identified ecological roles of terrestrial and inshore marine ecosystems and their relation to the health and resilience of the Great Barrier Reef.

Discussion:

- Ranking of ecological service importance to Reef health and Reef resilience
- Discussion on thresholds for these ecosystems and the services they provide.
- Resilience mapping of CESAs

SESSION 3: ECOSYSTEM RISKS AND RISK ASSESSMENT

Presentation of the threats to these ecosystems (both natural and anthropogenic).
Discussion:

- Development of a risk assessment for the likely impacts to these ecosystems under a changing climate
- The likely effects on the ecological services provided by them, to the Reef
- Impact of cumulative effects of climate change and anthropogenic impacts
- Ranking of threats to CESAs using methods detailed in the Outlook report

SESSION 4: STRATEGIES FOR PROMOTING ECOSYSTEM RESILIENCE

What strategies can be employed to promote ecosystem resilience?
Discussion:

- Criteria for the measurement of catchment ecosystem resilience
- Prioritisation of sites for protection/rehabilitation based upon resilience mapping
- Strategies that managers and planners can apply that collectively hold promise to increase ecosystem viability and resilience
- Tools and methods for improving CESA resilience

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APPENDIX B – List of workshop participants

Attendee	Affiliation	Area of expertise	Group
Russell Reichelt	Chairman GBRMPA	Marine scientist	Marine
Cherie Malone	GBRMPA/SDC	Spatial data	All groups
Michelle Walker	Lloyd Consulting	Facilitator	All groups
Lana Heydon	DERM	Modeller	Estuary
Judith Wake	CQU	Mangroves	Estuary
Marcus Sheaves	JCU	Fish ecologist	Estuary
Nick Heath	WWF	Water quality	Estuary
Norm Duke	UQ	Mangroves	Estuary
Sue Sargent	BMRG	NRM	Estuary
Hugh Yorkston	Director GBRMPA	Water Quality / Catchment management	Estuary
Paul Groves	GBRMPA /CEWQ	Marine Scientist	Estuary
Michelle Waycott	JCU	Seagrass	Estuary
Alf Hogan	Consultant	Wetlands/fish ecology	Freshwater
George Lukacs	JCU	Wetlands	Freshwater
Jim Tait	Consultant	Wetlands	Freshwater
Richard Pearson	JCU	Freshwater indicators	Freshwater
Maria VanderGragt	DERM	Wetland modelling	Freshwater
Mike Ronan	DERM	Wetlands in general	Freshwater
Niall Connolly	DERM	Wetland ecology	Freshwater
Shannon van Nunen	FBA	NRM	Freshwater
Peter McGinnity	General Manager GBRMPA	Marine Park Management	Freshwater
Donna Audas	GBRMPA /CEWQ	Coastal Management	Freshwater
Alana Grech	JCU	Spatial mapping; seagrass	Marine
Jon Brodie	ACTFR	Water Quality	Marine
Katharina Fabricius	AIMS	Inshore marine	Marine
Len McKenzie	DEEDI	Seagrass	Marine
Peter Doherty	AIMS	Open coastal	Marine
Steve McDermott	Terrain	NRM	Marine
Chloe Schauble	GBRMPA/Climate Change	Climate Change	Marine
Clare Harding	Lloyd consulting		
David Hilbert	CSIRO	Ecosystem services	Terrestrial
Ian Dight	NQ Dry Tropics	NRM	Terrestrial
Jim Wallace	CSIRO	Terrestrial connectivity	Terrestrial
John Platten	DERM	Terrestrial ecology	Terrestrial
Mal Lorimer	DERM	Soils	Terrestrial
Sandy Pollock	DERM	Herbarium	Terrestrial
Dan Metcalfe	CSIRO	Rainforest ecosystems	Terrestrial
John Armour	DERM	Groundwater	Terrestrial
Annika Pattrick	GBRMPA		

APPENDIX C – CATEGORIES FOR ECOLOGICAL FUNCTION

Disturbance regulation

The capacity of soil and vegetation to buffer the effects of wind, water and waves through water and energy storage capacity and surface resistance.

Water is stored in the soil profile and runoff is reduced. Vegetation enhances filtration and provides surface resistance. Degraded soils and landscapes have a reduced capacity. Soil properties (e.g. depth, surface texture) and vegetation structure are important.

e.g. marine open coastal, beaches, estuaries, freshwater wetlands, forests

[Millennium assessment Regulating function no. 3]

Disturbance regulation

Capacity	Description
HIGH	This Service Providing Area buffers sub-catchment scale (or greater) from the effects of wind, water and waves, delivering apparent water quality benefits to downstream ecosystems and the Reef
MED	This Service Providing Area provides some buffering at a sub- catchment scale from the effects of wind, water and waves, delivering likely water quality benefits to downstream ecosystems and the Reef
LOW	This Service Providing Area provides very limited buffering at a sub-catchment or at a very small scale catchments scale, from the effects of wind, water and waves, providing very limited impact on water delivered to downstream ecosystems and the Reef
NONE	This Service Providing Area does not provide buffering from the effects of wind, water and waves and therefore provides no likely water quality benefits to downstream ecosystems and the Reef

Food webs

The role of ecosystems in providing sites for primary and secondary production, and a source of food for the Reef and species with connections to the Reef.

e.g. marine open coastal, estuaries, beaches, freshwater wetlands

Food webs

Capacity	Description
HIGH	This Service Providing Area provides, at a sub-catchment scale (or greater) sites or capacity for food production and/or food provision, delivering benefits to the Reef and to species *with connections* to the Reef
MED	This Service Providing Area provides at a sub- catchment scale, some sites for food production and/or food provision, delivering likely benefits to the Reef and to species *with connections* to the Reef
LOW	This Service Providing Area provides, at a sub-catchment level, very limited sites or capacity for food production and/or food provision, delivering very limited benefits to the Reef and to species *with connections* to the Reef
NONE	This Service Providing Area does not provide sites for food production for the Reef or species *with connections* to the Reef

Hydrological processes

The role of ecosystems in providing (*and regulating flows of*) water (*to the Reef*) through sediment trapping, infiltration, dissolution, precipitation, diffusion (and *recharge*).

e.g. marine open coastal, estuaries, freshwater wetlands

[Millennium assessment Provisioning function no. 15]

Hydrological processes

Capacity	Description
HIGH	This Service Providing Area slows or detains sub-catchment scale (or greater) run off and retains water delivering apparent water quality benefits to downstream ecosystems and the Reef
MED	This Service Providing Area provides some detention of sub- catchment scale runoff and retains water delivering likely water quality benefits to downstream ecosystems and the Reef
LOW	This Service Providing Area provides very limited detention of sub-catchment scale run off from very small scale catchments providing very limited impact on water delivered to downstream ecosystems and the Reef
NONE	This Service Providing Area does not detain catchment runoff and the Reef

Physical (Supporting) habitats

Preservation of natural and semi-natural ecosystems as suitable living space for wild biotic communities and individual species *(with connections to the Reef)*.

Natural ecosystems are a storehouse of genetic information generated through evolutionary process. This function also includes the provision of suitable breeding, reproduction, nursery and refugia and corridors (connectivity) for species that *have connections to the Reef*. *Habitat for ecologically important organisms.*

e.g. marine open coastal, beaches, estuaries, freshwater wetlands

[Millennium assessment Supporting function no. 11]

Physical (Supporting) habitats

Capacity	Description
HIGH	This Service Providing Area represents a significant area of high quality habitat permanently or seasonally populated by important species with connections to the Reef
MED	This Service Providing Area contains important areas of habitat permanently or seasonally populated by important species with connections to the Reef
LOW	This habitat has impacts affecting the quality of habitat values or contains only limited areas of suitable habitat permanently or seasonally populated by important species with connections to the Reef
NONE	This habitat does not contain habitat suitable for species with connections to the Reef

Nutrient regulation

The role of ecosystems in the transport, storage and recycling of nutrients.

e.g. marine open coastal, beaches, estuaries, freshwater wetlands, forests, native grasslands, heath and shrublands

[Millennium assessment Regulating function no. 6]

Nutrient regulation

Capacity	Description
HIGH	This Service Providing Area detains sub-catchment scale (or greater) run off and retains nutrient loads delivering apparent water quality benefits to downstream ecosystems and the Reef
MED	This Service Providing Area provides some detention of sub- catchment scale runoff and retains nutrient loads delivering likely water quality benefits to downstream ecosystems and the Reef
LOW	This Service Providing Area provides very limited detention of sub-catchment scale run off from very small scale catchments providing very limited impact on nutrient loads delivered to downstream ecosystems and the Reef
NONE	This Service Providing Area does not detain catchment runoff and/or retained nutrient loads are too insignificant to deliver measurable water quality benefits to downstream ecosystems and the Reef

Sediment trapping and stabilisation

Soil formation processes including chemical weathering of rocks and the transportation and accumulation of inorganic and organic matter.

Minimising soil loss through having adequate vegetation cover, root biomass and soil biota.

e.g. estuarine wetlands, freshwater wetlands, forests, grasslands, heath and shrublands

Sediment trapping and stabilisation

Capacity	Description
HIGH	This Service Providing Area detains sub-catchment scale (or greater) run off and retains sediment loads delivering apparent water quality benefits to downstream ecosystems and the Reef
MED	This Service Providing Area provides some detention of sub- catchment scale runoff and retains sediment loads delivering likely water quality benefits to downstream ecosystems and the Reef
LOW	This Service Providing Area provides very limited detention of sub- catchment scale run off from very small scale catchments providing very limited impact on sediment loads delivered to downstream ecosystems and the Reef
NONE	This Service Providing Area does not detain catchment runoff and/or retained sediment loads are too insignificant to deliver measurable water quality benefits to downstream ecosystems and the Reef

APPENDIX D – Summary table of coastal ecosystems and their ecological function for the GBRWHA

Process	Ecological Service	Coral Reefs	Lagoon floor	Open water	Seagrass	Coastline	Estuaries	Freshwater wetlands	Forest floodplain	Heath and shrublands	Grass and sedgelands	Woodlands	Forests	Rainforests
Physical processes- transport and mobilisation														
Recharge/Discharge	Detains water						MH	H	✓					
	Flood mitigation						M	✓	H		L			
	Connects ecosystems						✓	H	H					
	Regulates water flow (groundwater, overland flows)	H	L		✓	✓	MH	H	✓		L	MH	MH	H
Sedimentation/ erosion	Traps sediment	M	MH	ML	M		H	H			L	MH	MH	MH
	Stabilises sediment from erosion		✓		M	H	✓	✓	✓	✓	L	MH	MH	M
	Assimilates sediment					✓	✓	H				MH	MH	H
	Is a source of sediment							M				MH	MH	
Deposition & mobilisation processes	Particulate deposition & transport (sed/nutr/chem. etc)							H						
	Material deposition & transport (debris, DOM, rock etc)							H						
	Transports material for coastal processes							H						
Biogeochemical Processes – energy and nutrient dynamics														
Production	Primary production	✓	✓	H	H	✓	H	H				M	M	H
	Secondary production				H	✓	H	✓						
Nutrient cycling (N, P)	Detains water, regulates flow of nutrients							H						
	Source of (N,P)				M	L	H					M	M	H
	Cycles and uptakes nutrients	L	H	H	M	L	H	MH		✓	✓			

	Regulates nutrient supply to the reef				M	L	H	M	H			M	M	H
Carbon cycling	Carbon source				M	L	H	H						H
	Sequesters carbon	✓	H	L	M	L	H	H	✓					
	Cycles carbon	L	H	H	M	L	H					H	H	H
Decomposition	Source of Dissolved Organic Matter						H	H						H
Oxidation-reduction	Biochar source											H	H	
	Oxygenates water		H	H		L	✓							
	Oxygenates sediments		✓		M	L	✓							
Regulation processes	pH regulation				M			H						
	PASS management						H	H						
	Salinity regulation													
	Hardness regulation							H						
	Regulates temperature					✓	✓	✓	✓					ML
Chemicals/heavy metal modification	Biogeochemically modifies chemicals/heavy metals	L			M		✓	H						
	Flocculates heavy metals						✓	H						
Biological processes (processes that maintain animal/plant populations)														
Survival/reproduction	Habitat/refugia for aquatic species with reef connections	H	M	L	✓	H	H	H		✓				
	Habitat for terrestrial spp with connections to the reef	H						H						
	Food source		✓		H	✓	✓	✓		H				
	Habitat for ecologically important animals	H	✓		H	L	H			✓	✓			
Dispersal/ migration/ regeneration	Replenishment of ecosystems – colonisation (source/sink)	H			H	M	H	H						
	Pathway for migratory fish							H						
Pollination														
Recruitment	Habitat contributes significantly to recruitment	H			H	H	H	H		H				