
BM Alliance Coal Operations Pty Ltd
Hay Point Coal Terminal Expansion (HPX)
Marine Plants Restoration Project Plan
Hay Point, Queensland



BHP Billiton Mitsubishi Alliance



DOCUMENT TRACKING

ITEM	DETAIL
Project Name	HPX – Marine Plants Restoration Project Plan
Project Number	09CANPLA-0036
File location	Z:\Synergy\Projects\09CANPLA36
Prepared by	Tom Kaveney
Status	Final
Version Number	1
Last saved on	27 November 2010

Acknowledgements

This Plan has been prepared with the considerable input and assistance of Derek Ball from *Reef Catchments Mackay Whitsunday Inc.* Eco Logical Australia would like to acknowledge and thank Derek for his assistance in this work.

Disclaimer

This document may only be used for the purpose for which it was commissioned and in accordance with the contract between Eco Logical Australia Pty Ltd and the client. The scope of services was defined in consultation with the client, and the availability of reports and other data on the subject area. Changes to available information, legislation and schedules are made on an ongoing basis and readers should obtain up to date information.

Eco Logical Australia Pty Ltd accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report and its supporting material by any third party. Information provided is not intended to be a substitute for site specific assessment or legal advice in relation to any matter. Unauthorised use of this report in any form is prohibited.

Contents

1.	Purpose	4
2.	Background	4
2.1.	EPBC Act (Commonwealth).....	6
2.2.	Fisheries Act (Queensland).....	6
2.3.	Queensland Fish Habitat Management Operational Policy (FHMOP0051)	7
2.4.	Draft Policy Statement 4.1: Use of Environmental offsets under the Environment Protection and Biodiversity Conservation Act 1999	7
3.	Compliance of the Plan	8
3.1.	Impacts on marine fish habitat	9
4.	Restoration site	10
4.1.	Sandringham Bay Conservation Park	10
4.2.	Site selection and Justification	11
4.3.	Benefits of the proposed restoration site	11
4.4.	Remediation and Management.....	13
4.5.	Management and Monitoring strategies.....	15
4.6.	Project Management	15
4.7.	Reporting.....	16
	References	16
	Appendix 1	17

1. Purpose

The purpose of this Marine Plants Restoration Project Plan is to detail the objectives, actions and performance of proposed marine fish habitat offsets works that are to be undertaken to compensate for impacts on mangrove and intertidal habitat areas associated with the proposed Hay Point Coal Terminal Expansion (HPX).

This Plan identifies actions and commitments to be followed by the BMA Project Development Group and *Reef Catchments Mackay Whitsunday Inc*, who will be funded to undertake the works specified within this plan.

Reef Catchments Mackay Whitsunday Inc is the Natural Resource Management (NRM) organisation for the Mackay Whitsunday region. The organisation's focus is on the sustainable management of the regions natural resources (land, water, biodiversity, coasts and marine assets) while maintaining a viable regional community. Reef Catchments receives its funding through federal, state and private institutions to create viable environmental projects that improve the regions natural resource condition.

2. Background

BHP Billiton Mitsubishi Alliance Coal Operations Pty Ltd (BMA) operates nine coal mines in the Bowen Basin of Central Queensland, and owns and operates the Hay Point Coal Terminal (HPCT), one of Australia's largest and most efficient coal export facilities. This facility has the capacity to handle and despatch around 44 million tonnes of coal per year. HPCT consists of two berths and is one of two coal terminals located at the Port of Hay Point. HPCT is located 38 km south of Mackay (S21° 16.38', E149° 17.83'), on the central Queensland coast.

In response to predicted increased demand for coking coal, BMA has commenced works to increase export capacity through a proposed terminal expansion. The Hay Point Coal Terminal expansion includes two stages of reclamation, these being:

1. Reclamation of approximately 9.4 ha of land to the northeast of the existing stockyard area for the construction of the new onshore out-loading systems (see Figure 1 & Figure 1.2); and
2. Reclamation of approximately 32 ha of land along the western shore of the existing stockyard area to accommodate up to three additional stockpiles, associated conveyor systems, barge off-loader facilities and other port related infrastructure (see Figures 1 & Figure 1.2).

Stage 1 of the Hay Point Coal Terminal Expansion will remove a small area of marine fish habitat in what is currently intertidal habitat (mangroves and other intertidal biota) adjacent to existing infrastructure (Figure 1). The development of a marine fish habitat offset measure (the offset), has been proposed as a suitable way in which to avoid a net impact on marine fish habitat.

BMA is yet to fully commit to implementation of Stage 2 of the expansion at the time of writing. This project may proceed in the future following further option and viability analysis.



Figure 1: Hay Point Coal Terminal presently (left) and with proposed reclamation (right).



Figure 2 : Hay Point Coal Terminal showing mangrove communities and scattered individual distribution (yellow dots) in the proposed reclamation zone.

The provision of a marine plants restoration project needs to be in accordance with the approval conditions issued by the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA) and the Queensland Department of Employment, Economic Development and Innovation (DEEDI), as listed below.

2.1. EPBC Act (Commonwealth)

The approval conditions issued under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) states that:

“In conjunction with relevant organisations the person taking the action must develop and implement a program for rehabilitation of mangrove communities in the Hay Point area. The program must be provided for the Minister’s approval prior to the removal of the mangroves. Removal of the mangroves must not commence until the Minister has approved the rehabilitation program. “

2.2. Fisheries Act (Queensland)

The Queensland *Fisheries Act 1994* development approval contains the following conditions:

That, within two (2) months of the granting of this permit, a Marine Plants Restoration Project Plan must be submitted to DEEDI (Fisheries Queensland) for approval.

The plan must:

- *Address the restoration of degraded tidal parts of the Sandringham Bay Conservation Park (described as part of Lot 540 on NPW885, on the south - western side of the village of Dunrock);*
- *Be developed in accordance with the Code for Self-Assessable Development- Minor impact works in a declared fish habitat area or involving the removal, destruction or damage of marine plants MP06; and*
- *Include a description of the works required to meet the outcomes of restricting uncontrolled vehicle access to the tidal wetlands, and for the restoration of the microtopography within the restoration area (the vehicle tracks and areas of erosion on and adjacent to vehicle tracks within the tidal parts of the Sandringham Bay Conservation Park);*

Within six (6) months of the completion of reclamation works undertaken in association with the development authorised under this approval, the following works detailed in the Marine Plants Restoration Project Plan must be completed:

- *Restriction of uncontrolled vehicle access to the tidal parts of the Sandringham Bay Conservation Park; and*
- *Restoration of micro-topography within the restoration area (including existing wheel ruts and erosion scours) to allow re-establishment of marine plants.*

Please note, that the current development approval under the *Fisheries Act 1994* only relates to the initial (stage 1) reclamation action with impacts on approximately 9.4 ha of fish habitat. Any subsequent stages will require separate development approval and potentially separate offsets.

In addition, the proposed offset has been identified as an appropriate compensation in accordance with the relevant Queensland Government and Australian Government policies, as detailed below.

2.3. Queensland Fish Habitat Management Operational Policy (FHMOP0051)

Under this policy, marine fish habitat offsets are required when impacts cannot be avoided, minimised or mitigated. Offset measures should seek to:

- Maintain fisheries values, including fish habitat values;
- Match ecosystem costs associated with fish habitat losses with offsets appropriate to the loss;
- Promote the importance of fish habitats during implementation;
- Recognise the natural capital of fish habitats; and
- Create public awareness of the value of fish habitats.

Offsets may include various actions including: fish habitat enhancement, restoration, rehabilitation or creation; exchanging and securing similar fish habitat, or a financial contribution to achieve the former and/or applied research, education, training or extension.

Advice received from DEEDI is that the offset does not necessarily need to be 'onsite' but would ideally be local and in addition 'like for like'. That is, a removal of marine plants would require an offset that improves the situation for the ongoing conservation of such habitat.

2.4. Draft Policy Statement 4.1: Use of Environmental offsets under the Environment Protection and Biodiversity Conservation Act 1999

Environmental offsets can be used under the EPBC Act to maintain or enhance the health, diversity and productivity of the environment as it relates to matters protected by the EPBC Act.

The Australian Government has identified eight principles for the use of environmental offsets under the EPBC Act. These eight principles will be used to assess any proposed environmental offsets to ensure consistency, transparency and equity under the EPBC Act.

The Australian Government's position is that:

- Environmental offsets should be targeted to the matter protected by the EPBC Act that is being impacted.
- A flexible approach should be taken to the design and use of environmental offsets to achieve long-term and certain conservation outcomes which are cost effective for proponents.
- Environmental offsets should deliver a real conservation outcome.
- Environmental offsets should be developed as a package of actions - which may include both direct and indirect offsets.
- Environmental offsets should, as a minimum, be commensurate with the magnitude of the impacts of the development and ideally deliver outcomes that are 'like for like'.
- Environmental offsets should be located within the same general area as the development activity.
- Environmental offsets should be delivered in a timely manner and be long lasting.
- Environmental offsets should be enforceable, monitored and audited.

3. Compliance of the Plan

To meet the needs of the above two policies, this Plan has been prepared as a result of initial discussions between Reef Catchments and the BHP Billiton Mitsubishi Alliance (BMA), with advice from the Department of Employment, Economic Development and Innovation (DEEDI, formerly the Department of Primary Industries & Fisheries). The proposed offsets plan addresses each principle as outlined in Table 1.

Table 1: How proposed offsets will meet Commonwealth and State offset principles.

QUEENSLAND FISH HABITAT PRINCIPLE	PROJECT COMPLIANCE
Maintain fisheries values, including fish habitat values	Mangrove protection and restoration will improve fish feeding- and nursery-habitat, and water quality
Match ecosystem costs associated with fish habitat losses with offsets appropriate to the loss	Proposed offset area at least equal to impact area and comprised of similar habitat values
Promote the importance of fish habitats during implementation	Mangrove protection and restoration will improve fish feeding- and nursery-habitat, and water quality
Recognise the natural capital of fish habitats	Mangrove protection and restoration will improve fish feeding- and nursery-habitat, and water quality
Create public awareness of the value of fish habitats	Funding of community initiatives including the recently established Mangrove Watch
EPBC ACT OFFSET PRINCIPLE	PROJECT COMPLIANCE
Environmental offsets should be targeted to the matter protected by the EPBC Act that is being impacted	Mangrove protection and restoration will match mangrove loss in the Great Barrier Reef World Heritage Area.
A flexible approach should be taken to the design and use of environmental offsets to achieve long-term and certain conservation outcomes which are cost effective for proponents	Mangrove protection and restoration will ensure long-term viability of the mangrove community and future habitat values
Environmental offsets should deliver a real conservation outcome	Mangrove protection and restoration will improve fish feeding- and nursery-habitat, and water quality and habitat for the Mangrove Mouse.
Environmental offsets should be developed as a package of actions	In addition to mangrove improvement, funding towards relevant research and support to community initiatives will be provided
Environmental offsets should, as a minimum, be commensurate with the magnitude of the impacts of the development and ideally deliver outcomes that are 'like for like'	Proposed offset area at least equal to impact area and comprised of similar habitat values
Environmental offsets should be located within the same general area as the development activity.	Impact area is adjacent to offset area (<10 km)
Environmental offsets should be delivered in a timely manner and be long lasting	Mangrove protection and restoration will be carried out in the near future and will ensure long-term viability of the mangrove community and future habitat values
Environmental offsets should be enforceable, monitored	Mangrove protection and restoration will be visually

and audited

apparent; thus can be monitored and audited

3.1. Impacts on marine fish habitat

The shoreline within the reclamation footprint is predominantly bare rock, with a mangrove community scattered across the intertidal zone. The mangrove community is comprised of five species. A sargassum-dominated macroalgal community is also present in the sub-tidal rocky reef that fringes the northern coastline. A rocky reef, referred to as Hay Reef, is located on the inside of the HPCT trestle and approximately 300 m offshore from the northern shoreline.

The intertidal shoreline of Hay Point is designated to be within the construction footprint of HPX. As such, floral communities within the footprint and any associated fauna will be lost. Given that the lower intertidal zone is almost entirely comprised of bare rock devoid of obvious biota, the principal area of biological loss will be the mangrove community located in the mid to upper intertidal zone.

The mangrove community of Hay Point exists predominantly as isolated individual recruits across the project footprint, with the exception of two continuous mangrove communities of approximately 0.5 ha each, one located to the northeast of the site and another located to the southwest.

All five species of mangrove occurring at Hay Point are widely distributed in tropical northern Australia, with southern geographical distribution limits on east and west coasts varying with the species. None of these species are listed in the Queensland Herbarium Plant Census (Queensland Department of Environment and Resource Management) as endangered, vulnerable, near threatened or rare species (Bostock and Holland 2007).

Given the sparseness and low species diversity of the habitat to be lost at Hay Point, its relative size with respect to the regional mangrove community (0.028% of the total mangrove area), and the likely importance of adjacent subtidal turf and foliose algae in the support of local Green turtles and fishes, it is not expected that the loss of mangroves within the reclamation footprint will measurably impinge upon regional productivity or the values of the Great Barrier Reef World Heritage Area (GBRWHA) or the Great Barrier Reef Marine Park (GBRMP).

Northern mangrove community

The reclamation will extend over the rocky intertidal zone on the northern shoreline of Hay Point but will not extend into the subtidal area at this location, with the exception of the proposed trestle suspended on piles. Given that the intertidal zone consists of mangrove colonisation in the upper intertidal zone, but only bare rock in the mid to lower intertidal zone, it is expected that direct impacts on marine habitats from construction in this area will be slight to negligible.

Western mangrove community

The reclamation will extend past the intertidal zone and into shallow subtidal seabed on the western shoreline of Hay Point (Figure 1 & 2). All benthic fauna and flora within the reclamation footprint will be lost.

4. Restoration site

Ten important wetlands sites have been identified in the Wetland Plan for the Mackay-Whitsunday region which aligns with the objective and goals of the Reef Water Quality Protection Plan and the Coastal Wetland Protection Program.

Many of the sites are experiencing impacts upon water quality associated with invasive exotic pasture grasses, nutrient loading and through agricultural and urban runoff. In many sites wetland biodiversity remains compromised due to past and present land management practices, sedimentation, and impacts associated with stock grazing and land use intensification. However, wetland restoration projects identified for on-ground rehabilitation activities in the Wetland Plan have been extremely successful in reducing sediments and nutrients and improving water quality entering the Great Barrier Reef Lagoon. It is also a requirement of the Wetland Plan that these projects integrate with or build upon future remediation priorities and that Land Managers and the wider community participate in wetland rehabilitation and Natural Resource Management activities.

In line with these objectives, recent fisheries habitat restoration and rehabilitation projects have been undertaken within the Hay Point/Mackay region. These are expected to result in significant improvements to the condition of mangrove and saltmarsh habitats. Details of two of these projects are included in Appendix 1 and could be considered as indicative of what the proposed offset(s) may be able to achieve.

4.1. Sandringham Bay Conservation Park

Encompassing an area of 7,367 hectares, the Sandringham Bay-Bakers Creek Aggregation situated north of the HTPC is listed on the Directory of Important Wetlands of Australia. Sandringham Bay is a good example of marine and estuarine wetlands of the Central Queensland Coast bioregion. It is significant because of the very extensive expanse of intertidal and shallow water habitat, the diversity of the shoreline and extent of the mangroves. It is recognised as a nationally important area for shorebirds (DEWHA 2010).

The Conservation Park is composed of several disjunct sections of estuarine habitat including mangroves, saltmarsh, saltwater couch grasslands, brackish wetlands and associated supralittoral vegetation bordering on lowland eucalypt and melaleuca woodlands. The tidal wetlands, including intertidal flats and channels, sandbars, river banks and claypans, contribute to ecosystem complexity, which enables fisheries resources to feed, grow and reproduce to complete their life cycles. These areas are important habitat for a number of notable species including barramundi, grey mackerel, sea mullet, school mackerel, whiting, mud crab and tiger prawns. The saline flats of the bay are highly productive habitats for adult marine animals, and are critical habitat for juveniles of many marine species.

Most notably, the terrestrial wetlands of the area, which include mangroves and freshwater swamps, are critical habitat for a suite of rare and/or threatened species including the mangrove mouse (*Xeromys myoides*). These wetlands are also considered to be of national importance for shorebirds. The Mackay region has been ranked sixth out of 13 regions in Queensland in terms of the total number of shorebirds present.

Prior to gazettal the restoration area within the Conservation Park (Figure 3) was unallocated State land and has suffered multiple impacts as a result of off road vehicle use that has caused considerable damage to marine plants, rutting of the substratum and consequent changes to the micro-topography of the system. Areas of the Park are in need of restoration and rehabilitation works

to improve their ecosystem function. The upper catchment of the Park is highly disturbed and contributes to high nutrient loads through sediment runoff from agricultural land use.

4.2. Site selection and Justification

The proposed offset site is located within one section of Sandringham Bay Conservation Park.

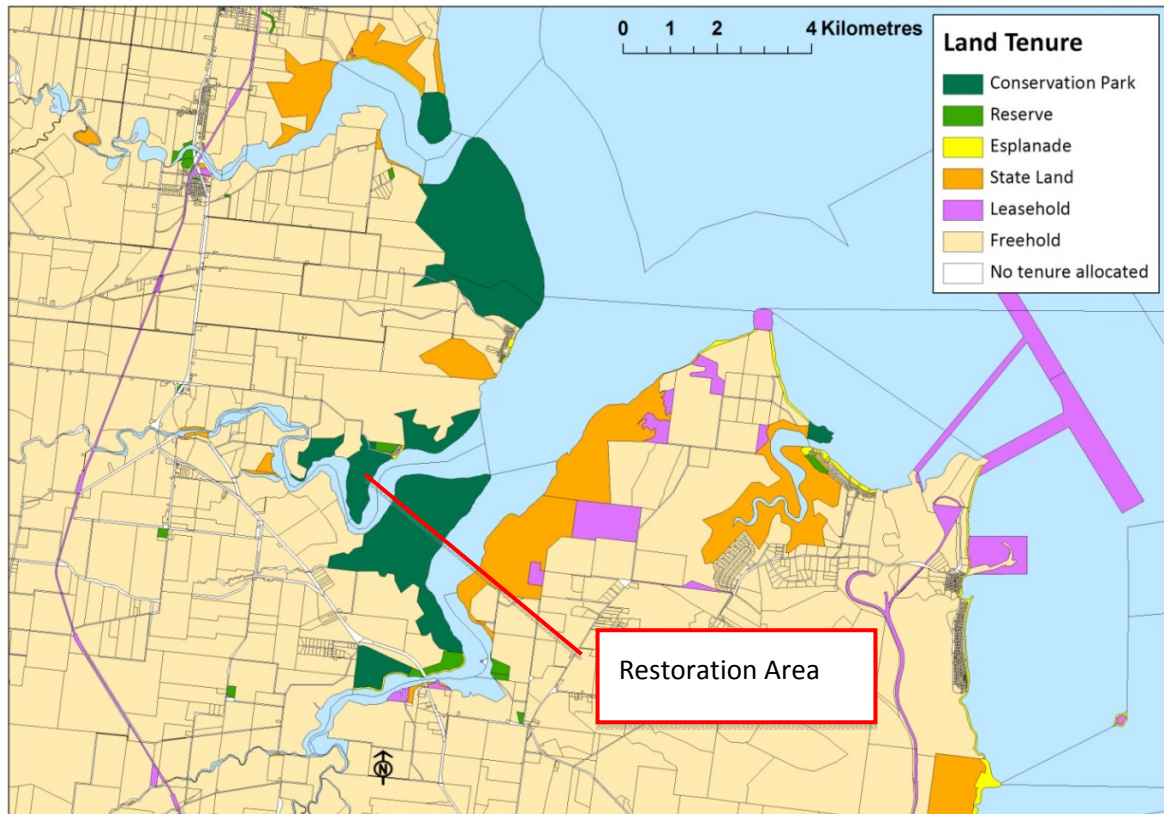


Figure 3 Location of proposed restoration site

4.3. Benefits of the proposed restoration site

The proposed restoration site is located within a protected area gazetted under the *Nature Conservation Act*. In addition to providing the required fisheries habitat offset, the proposed works will also have a range of public benefits including improved recreational amenity.

The environmental benefits of the proposed restoration include:

- Direct rehabilitation of approximately 10ha of salt-marsh habitat through filling and re-contouring vehicle tracks to re-establish the micro-topography and thus hydrology of the salt flat (figure 4).
- Benefits to mangrove habitat through a reduction in erosion of the salt flat caused by storm-water run-off along vehicle tracks.
- The proposed work is complimentary to existing initiatives within the Sandy Creek catchment aimed at improving estuarine water quality by improved farm management practices.
- A reduction in storm-water run-off into mangrove habitats is expected to improve habitat quality for the vulnerable (EPBC listed) mangrove mouse (*Xeromys myoides*).
- Improved amenity of the area for nature based visitation.

- Improved habitat quality for a suite of threatened and rare species.



Figure 4 Erosion and Scalding of Saltmarsh habitat as a result of past vehicle use



Figure 5 Indicative area of erosion and scalding to be repaired

4.4. Remediation and Management

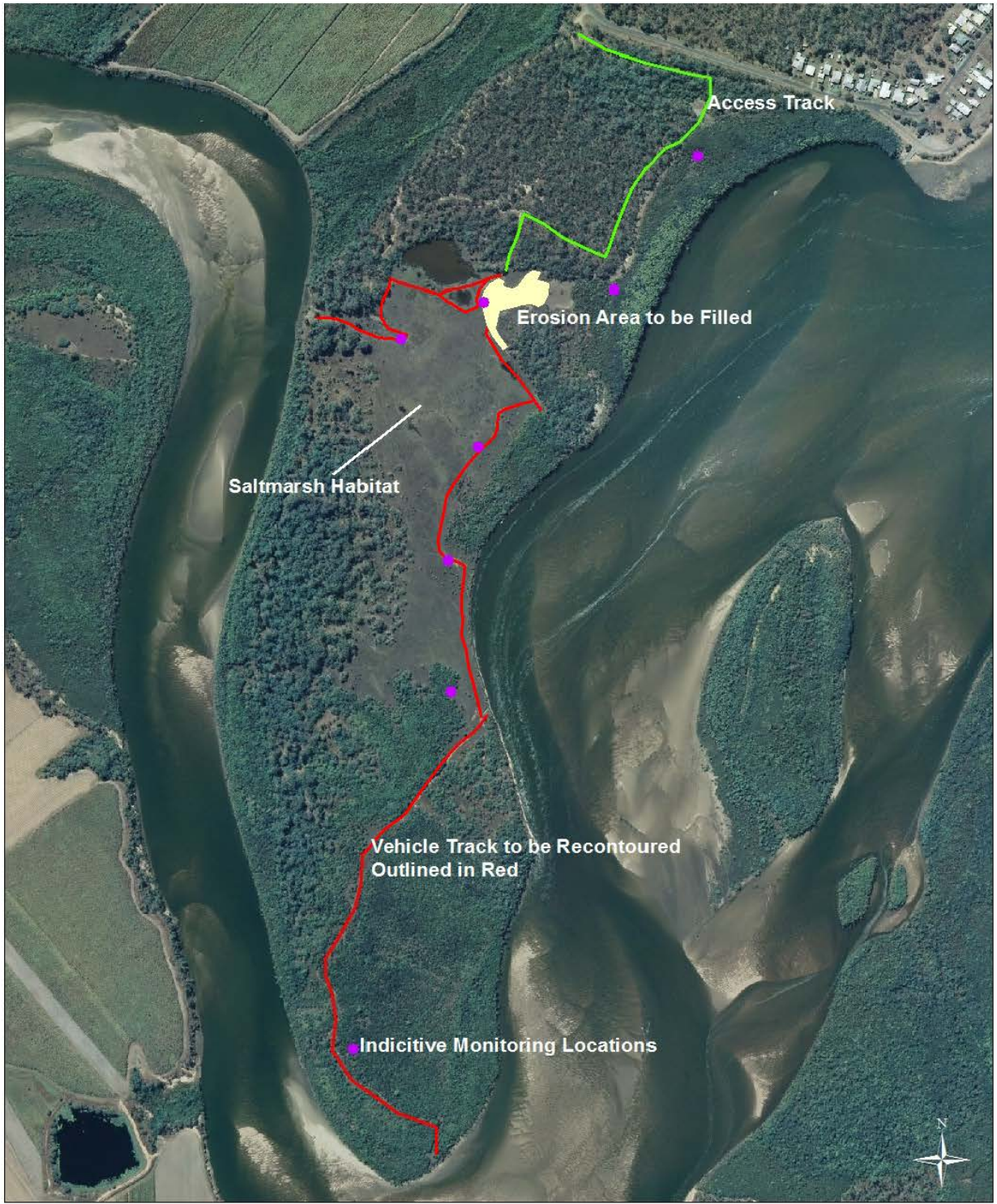
Proposed Remediation Activities

Listed below are the on-ground works that will be undertaken at the Sandringham Bay Conservation Park site. They comprise a mix of remediation works and on-going restoration actions (refer Figure 6).

- Provide public awareness of the project and its benefits as a fisheries habitat offset (and ancillary benefits).
- Securing the project area from public access for safety reasons.
- Remedial work to an access track to facilitate heavy vehicle access to the project site.
- Control of weeds along access points and tracks to reduce the potential for further spread.
- Establishment of baselines for ongoing monitoring (i.e. existing type and distribution of salt-marsh vegetation) and to ensure that evidence can be provided to demonstrate that no unintended impacts on salt-marsh or mangrove vegetation will occur (i.e. mangrove vegetation characteristics, soil core water salinity and pH, grassid crab density, mangrove mouse presence).
- Fill and re-contour approximately 1600m of vehicle track to restore the natural hydrology and micro-topography of the salt-marsh, reducing scalding and allowing re-establishment of salt-marsh vegetation.
- Fill areas of major erosion at track heads including construction of a small rock revetment to hold imported fill.
- Restore access track to original condition to avoid attracting further vehicle track including re-establishing bollards and fencing as required.
- Undertake follow-up pest control.
- Undertake back-up earthworks (additional filling and contouring) after compaction and wearing of the major works.
- Undertake on-going monitoring over a 12 month period.

Given the sensitive nature of the project site a number of conditions will need to be satisfied:

- All fill to be introduced to the area will need to be clean and free from weed seeds.
- All machinery accessing the site will need to be washed down prior to entry to ensure that no new weeds are introduced to the area.
- Supervision of all works will be required by QPWS including ensuring that the public is not present during operations for safety reasons.



0 100 200 400 Meters

This project is supported by Reef Catchments Mackay Whitsunday Inc. Through funding from the Australian Government's Caring for our Country. IMAGE: The above image includes rectified aerial photo imagery (c) Mackay Sugar Cooperative Associated Limited, reproduced by Reef Catchments Mackay Whitsunday Inc. under license from Aerial Photography 2005 - 2007, all rights reserved.

PROPERTY BOUNDARIES: The property boundary is based upon Digital Cadastral Data Base (DCDB) data provided by the Department of Environment and Resource Management (C) DERM (2009). The DCDB provides an approximate location of your property boundary and should only be used as a guide.

DISCLAIMER: (C) Reef Catchments Mackay Whitsunday Inc.

In consideration of the Reef Catchments Mackay Whitsunday Inc. permitting use of the licensed data, I acknowledge and agree that Reef Catchments Mackay Whitsunday Inc. gives no warranty in relation to the data (including accuracy, reliability, completeness or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data.



CARING FOR OUR COUNTRY



Figure 6 Offset site location and proposed works

4.5. Management and Monitoring strategies

A range of management and monitoring activities will be undertaken throughout the life of the project and for 2 years after completion (3 years in total). Monitoring will include:

- Monitoring transects will be established to determine the distribution and composition of salt-marsh vegetation. This will allow tracking of recovery of this habitat as a result of the re-contouring works.
- Baselines will be established for mangrove vegetation, soil core water salinity and pH, sedimentation, and grapsid crab density/ distribution. This will facilitate ongoing monitoring of key features of the mangrove habitat.
- Pre and post surveys for the mangrove mouse.
- Ongoing monitoring of the compaction of filled areas will facilitate design of any secondary works, ensuring that re-contouring is satisfactorily maintained.
- Ongoing monitoring of weeds for a 12 month period to ensure that no new species or infestations are inadvertently introduced; or are able to permanently establish within the Conservation Park.

In addition, the area will be managed in the long-term by the Queensland Parks and Wildlife Service (QPWS) to secure long-term improvements through maintenance of management effort.

4.6. Project Management

A timeline breakdown of the remediation activities to be undertaken is provided below.

Task	Timing
Remedial work to access track (app 750m), public awareness of project, securing the site from public access, provision of appropriate signs and information at the project site.	Week 1
Weed control along access points and tracks prior to commencement of other works, tests required to ensure that fill introduced to the site is free of weed seeds.	Week 2
Establishment of monitoring baselines across the project site.	Week 2
Fill, compact and re-contour 1600m of vehicle track (app 640 cubic meters).	Weeks 3-6
Fill areas of major erosion at track heads including installation of rock revetment to hold introduced fill (app 300 cubic meters).	Weeks 3-6
Supervision of earthworks by QPWS staff	Weeks 3-6
Pest control post earthworks	Weeks 6, 12, 18
Post works monitoring (over 12 months)	Months 3, 6 & 12
Secondary earthworks to be conducted after 6 months allowing compaction and consolidation of fill.	Month 6
Project management	Months 1-12

Suitable periods for conducting the works are available in October and November 2010. Fifteen day work windows in each month are available in between periods of spring high tides that would inundate the project site and make access to machinery inappropriate. Alternative times could be identified post-wet season in 2011.

4.7. Reporting

A reporting procedure has been included as a component of the on-going management of the project

The report will act to keep all stakeholders informed of the progress of the works and identify issues so that they can be addressed. It is proposed that the report cover a twelve month period and be submitted in February each year for three years.

The report will be prepared annually by Reef Catchments and endorsed by BMA. The report will include details regarding: work undertaken and timing; ecological monitoring, weed monitoring and maintenance and any site specific incidents or observations (eg unauthorised vehicle access and damage).

The report will highlight successes and draw attention to potential problems, including results of on-going monitoring programs.

References

Bostock, P.D. and Holland, A.E. 2007. *Census of the Queensland Flora 2007*. Queensland Herbarium, Environment Protection Agency, Queensland Government; Brisbane.

Connolly R.M., Hindell J.S. and Gorman D. 2005. Seagrass and epiphytic algae support nutrition of a fisheries species, *Sillago schomburgkii*, in adjacent intertidal habitats. *Marine Ecology – Progress Series*. 286: 69-79.

Department of Environment, Water, Heritage and the Arts 2010. *A Directory of Important Wetlands in Australia*. http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW&doiw_refcodelist=QLD052 (cited 19th July 2010).

Melville A.J. and Connolly R.M. 2005. Food webs supporting fish over subtropical mudflats are based on transported organic matter not in situ microalgae. *Marine Biology*. 148: 363-371.

NAILSMA 2006. *Dugong and Marine Turtle Knowledge Handbook*. 137pp.

Saintilin N. 2004. Relationship between estuarine geomorphology, wetland extent and fish landings in New South Wales estuaries. *Estuarine, Coastal and Shelf Science* 61(4): 591 – 601.

Appendix 1

Previous wetland restoration projects

McEwans Wetlands Project

Background

The project seeks to implement priority rehabilitation actions as discussions are continuing to convert the area into a Conservation Park managed by EPA (Queensland Parks and Wildlife). This also allows the opportunity to engage adjacent landholders in the sustainable management of the wetlands, and seeks to engage the council in a coordinated management regime.

Management priorities included:

- Excluding stock in adjacent freehold wetland areas
- Control and management of feral pigs and weeds
- Eliminating the dumping of rubbish and garden waste in adjoining wetland areas
- Reducing motor bikes, off road vehicles in wetland areas, and
- Allowing access for bush walkers and bird observers.

Negotiations with adjacent landholders are continuing in an attempt to establish a coordinated approach to controlling feral pig populations in the area. Land holders have been provided with pig traps and pest officers at EPA, Mackay Regional Council and Bioscience Queensland (DPI&F) have been notified. Adjacent wetland buffers have been fenced however some neighbours were reluctant to do so. Fencing of the wetland fringe along the edge of the road and internal recreational vehicle exclusion fencing have been completed. This required the submission of a plan showing the proximity of the fence to the road, identifying and mapping Telstra and water infrastructure and the production of a traffic management plan. All this has required significant effort and time however the project is now complete.

The weed control component has been progressing well. Much of the buffer has been treated, however much of the wetland is still inaccessible and negotiations are progressing with the Mackay Regional Council and EPA to provide in-kind assistance. Some activities from the original proposal will be provided as in-kind support from EPA (e.g. fire planning, feral animal surveys).

There is also a good deal of interest in the area by the general public, and it is anticipated that we will continue to work with interested residents and the local Progress Association on other pressing wetland management needs into the future.

Outcomes and Objectives

To reduce incoming sediment and nutrient loads we will need the support and agreement from adjacent landholders to fence off buffers. This has been accomplished in some areas (Figure 17) however other landholders have indicated an unwillingness to participate.

The main fence along the road adjacent to the wetland is completed (Figure 18) as is the removal of the original barbed wire fence. Two internal post and rail fences have been erected to exclude motorbikes from entering the wetlands from adjoining residential areas. Discussions are progressing with the EPA and Mackay Regional Council to erect signage at the key access points to limit this behaviour.

Weed control has been undertaken along the roadside and will require further follow up work beyond the timeframe of this project. We are still in the process of gaining assurances from council and QPWS that follow up spraying will be regularly undertaken.

Feral animal surveys and fire management planning are ongoing and are currently being undertaken by EPA including adequate resourcing to ensure appropriate management is implemented. At certain times during the year feral pigs damage many hectares of wetland fringe (Figure 19), adjoining canelands and grazing land. Baiting programs are inappropriate due to the close proximity of the

residential areas. Trapping programs (Figure 20) are only partly effective (8 animals to date) due to shyness towards the take up of pre-feed. Further research is continuing in conjunction with EPA and adjoining land holders to monitor pig movements using radio tracking collars and to examine stomach contents to determine the food source. This may help in developing an appropriate attractant / bait for use in traps.

Wetland inventory data capture has been undertaken (Appendix 9) and the reports have been submitted to the EPA Wetland Info system for incorporation into their database. Nine sites were selected covering all of the ecosystems across the wetlands and data collected included flora, fauna, hydrology and geology. Water quality was not measured due to the tidal influence and hydrology of the area.



Figure 19: Feral pig damage to wetlands.



Figure 20: Pig Trap

Appropriateness

The full suite of activities has been appropriate for this site. Prior to this project, there was little to no management of the wetlands and thus simple priority measures like fencing and weed control were required. We are linking with Council and EPA to ensure that on-going work is prioritised at McEwans. It has taken some time to obtain approvals which has hampered our efforts in negotiating with landholders to some degree. Follow up discussions with adjoining landholders resulted in one property owner agreeing to fence some wetland buffers while the other landholders declined.

Some of these activities are long term in scope and probably beyond the ability of what we can achieve in a short time frame. For example, pigs are a significant problem seasonally in this area, however we cannot ensure that the pig traps we are providing through this project will result in reduced pig density in the area. Similarly we cannot maintain fences if they are damaged etc.

Therefore short time frame projects are difficult to maintain momentum if there is no one to continue to build links with land managers and residents in the area.

Effectiveness

The roadside and internal exclusion fencing adjoining the wetland has initially proved effective in reducing off road vehicle activity however recent vandalism (Figure 21) has allowed vehicles to once again access these areas. Access was also gained by cutting through the mangroves at the end of the fence (Figure 22). It has been realised that short term projects of this nature are ineffective due to the limited timeframe for the project and for the public consultation process. Public education programs are required prior to commencement of the project and that this continues after the project has been finalised. There is also a need for a provision in the budget for future repairs to vandalised infrastructure.



Figure 21: Damage to internal fences.



Figure 22: Vehicle access through mangroves.

Barbed wire was removed from the existing roadside fence adjoining the wetlands before the new fence was erected. Previous to this, there had been incidences where birds, gliders and bats were getting caught on the wires. The new fence consists of timber split posts with four strands of plain wire and has effectively stopped this incidence.

It is expected that the project will be very effective in establishing a good management regime at McEwans. QPWS will assume management responsibility and have shown in-principal support to maintain some of the activities we are currently delivering. There is also a good response by neighbouring landholders to maintain a level of commitment to a coordinated feral animal control program.

Transferability

As this project represented a number of activities, it is difficult to determine how transferable these are to other sites. However, similar issues will be found at many wetland sites both in this and in other coastal regions throughout Australia. Until the community places more value on 'swamps' and identifies management requirements, the cumulative impacts of unauthorised vehicle access, feral animals, inappropriate fire management and grazing regimes will continue. This makes the job of implementing management priorities difficult. One big difficulty with this project, in terms of transferability, is the long process of engagement we have had to have with council to have a roadside fence approved.

This will not help us in the long term as the staff required to give approvals are not the same staff that are responsible for managing the environment. This would be difficult to get around though as we can see the necessity of identifying infrastructure and ensuring our project would also not damage any.

Much of the other work including pig control and weed control is building on processes already being undertaken by state and local government. We see the value of this project in assisting these organisations to undertake works in an area that may not be seen to be a high priority until it is demonstrated that this is the case.

McEwans Project	Item	Sub item	Start Date	Completed Date
McEwans	Wetland Inventory	Complete Inventory of McEwans Wetlands	July 2007	Sept 2007
McEwans	Feral Animal Assessment Surveys	4 x Surveys (1/4 ly)	July / Oct 2007	Jan / April 2008
McEwans	Feral Animal control and Management	Traps and Baiting Program	July 2007	April 2008
McEwans	Assessment and inventory of wetland assets	Inventory	July 2007	August 2007
McEwans	Fire management Plan	Plan	Aug 2007	Jan 2008
McEwans	Exclusion Fencing	4km roadside pedestrian and vehicular exclusion fencing	Aug 2007	April 2008
McEwans	Exclusion Fencing	2km stock exclusion fencing	Aug 2007	April 2008
McEwans	Weed Control	2Ha (4km) Wetlands fringe weed control	Sept 2007	March / April 2008
McEwans	Weed Control	Incentives to Landowners for spraying weeds	Sept 2007	March / April 2008
McEwans	Weed Control	2.5 ha wetland Paragrass control	Nov 2007	March / April 2008
McEwans	Habitat and Biodiversity Signage.	2 x signs installed	Feb 2008	Feb 2008

Sandringham Lagoon Restoration Project

Background

Sandringham Lagoon (Figure 31) is a 2.2km freshwater lagoon located approximately 20km south of Mackay. This lagoon has been part of an ongoing project to fully restore the site which previously was almost completely covered by Para grass, Hymenachne, Water hyacinth and a thick weed mat. This weed mat was so extensive it was supporting numerous Melaleuca species that were growing hydroponically on the mat (these trees were up to 9 metres in height).

The majority of this weed mat had been removed in a previous project, however the remaining weeds were to be removed and/or controlled in this project. This project also took into account the restoration of the lagoon banks as well as the adjoining creek.



Figure 31: Sandringham Lagoon and Creek with monitoring points and detention pond sites. (Adapted from MiMaps 2008)

Outcomes and Objectives:

Complete removal of the Hymenachne mats covering the lagoon (Figure 32). Opening up the lagoon by removing the weed mat has increased water quality. The system was once described as being similar to that of battery acid. The water quality tested on the last round of sampling had dramatically improved. Dissolved oxygen levels had improved from 1.04 mg/L before modification, 3.42 mg/L during modification and then above 5.77 mg/L after this project was completed.

Revegetation of lagoon banks and around detention ponds. Downstream of the lagoon is a cane drain which forms the start of Sandringham Creek in which the sediment/nutrient detention ponds were installed. These ponds were also revegetated and will act as resting ponds for fish during migration periods. The vegetation management plan is involving the landowners of the lagoon & creek into keeping their banks clean of weeds and prevent the weed mat from taking over the lagoon again by spot spraying any new weeds that emerge.

The plant species (Appendix 15) utilised in this project was mainly provided by local suppliers. Revegetation plots were established along the lagoon, around the detention ponds and along the creek. As this report is drafted the success rate of this revegetation is approximately 80%

The original number of plants required was not met by the plants suppliers, a number of suppliers could not provide the number of plants required and one supplier could not supply the plants ordered from them at all. Of the 5000 plants required only 3640 could be sourced and planted.

Excavation of sediment/nutrient detention ponds for improved water quality and to increase fish passage. The total number of fish identified in Sandringham Lagoon increased dramatically once restoration had begun, and then again once restoration had been completed. Originally only 23 fish had been identified in the lagoon before any restoration had begun. After restoration had been completed 3992 fish had been identified (over 13 species). Table 8 shows what fish were identified before during and after restoration of Sandringham Lagoon.



Figure 32: Sandringham Lagoon Site 2 before (5/12/2006) and after (29/07/2008) weed mat removal.

Appropriateness

Much of these objectives look at decreasing the chance of an extensive weed population re-establishing along the lagoon. Revegetating the banks of the lagoon and creek (including the newly opened up areas of the detention ponds) will help reduce any further weed establishment.

Mechanical weed removal (Figure 33) was the most appropriate method of weed control due to the extensive weed mat covering the lagoon. This was also combated with a chemical spray regime to reduce the amount of weeds along the banks.



Figure 33: Removal of weed mat using an extension arm on an excavator. (Photos: A. O'Brien)

Detention ponds (Figure 34) were constructed along Sandringham Creek as a means of reducing sediments and nutrients entering the downstream estuary and to increase fish passage between the creek and lagoon. This section had been previously converted into a narrow drain that reduced connectivity to the downstream section of Sandringham Creek. The detention ponds will also provide

a suitable settling point for sediments and nutrients in runoff from the surrounding sugar cane farms. The ponds were designed to reduce stream velocity during flood events allowing for the assimilation of nutrients and sediments from flows entering Sandringham Bay and the Great Barrier Reef Lagoon.



Figure 34: Three excavated detention ponds along the cane drain system.
(Photos: A. O'Brien)

Effectiveness

This project has met all of its objectives, there has been total weed mat removal, sediment/nutrient detention ponds have been excavated, revegetation of the lagoon has been completed and a vegetation management plan has been implemented to landholders.

The weed mat removal was completed by March 2008 and a herbicide spraying regime was introduced shortly after to ensure the weed levels in and around the lagoon are kept to a minimum. Landholders have been allocated incentives to continue the weed control program and to date this has been successful.

The effectiveness of the detention ponds will not be established until after the next wet season when the main lagoon (and the ponds) will be sampled to identify migratory species entering the system. These ponds have already withstood out of season rainfall (over 600mm) and only one of the ponds had minor erosion (which was repaired with a rock retaining wall). With this erosion a small number of plants were lost, however the success rate of the revegetation on a whole is approximately 85%. These trees were planted early in the year and have established themselves so their success rate is expected to stay high.

Transferability

Undertaking such an extensive project was completed successfully due to the use of an extension arm on an excavator and the use of an aquatic weed harvester. These two pieces of machinery enhanced the productivity of removal. Chemical spraying was also utilised in this project to maintain the small areas of weed that could not be collected by the excavator or weed harvester. This method could easily be transferred to different regions with similar situations. Chemical spraying would be the most effective method of weed removal in small areas, however manual removal was most effective in the large areas. Involving the landholders in the chemical spraying regime allows for continual maintenance of the weed population throughout the system.

By construction sediment/nutrient detention ponds along a cane drain has allowed increased habitat for migrating fish without disrupting the surrounding cane farms. They allow for runoff to be slowed and sediments and nutrients time to drop out of the water column, before the water runs out into the Great Barrier Reef Marine Park.

Table 2 shows the fish species identified in Sandringham Lagoon before, during and after rehabilitation. The results show how productive the lagoon has become after removal of the weed mat indicating an improvement in water quality.

Table 2: Fish species identified in Sandringham Lagoon before, during and after restoration

Species	Before Restoration	During Restoration	After Restoration
Eastern Rainbow Fish (<i>Melanotaenia splendida</i>)	18	6	860
Long Finned Eel (<i>Anguilla reinhardtii</i>)	4	6	1
Oxeye Herring (<i>Megalops cyprinoids</i>)	1	3	
Empire Gudgeon (<i>Hypseleotris compressa</i>)		284	1963
Purple Spot Gudgeon (<i>Mogurnda adspersa</i>)		19	22
Midgley's Carp Gudgeon (<i>Hypseleotris sp 1</i>)		3	12
Spangled Perch (<i>Leiopotherapon unicolour</i>)		1	12
Snake Headed Gudgeon (<i>Giurus margaritacea</i>)		2	3
Fly-Speckled Hardy-head (<i>Craterocephalus stercusmuscarum</i>)			1062
Gudgeon Species (<i>Hypseleotris klunzingeri</i>)			9
Bony Bream (<i>Nematalosa erebi</i>)			20
Agassiz Chanda Perch (<i>Ambassi agassizii</i>)			1
Introduced Pest Species			
Mosquito Fish (<i>Gambusia holbrooki</i>)		65	22
Platy (<i>Xiphophorus maculatus</i>)		6	5
Guppy (<i>Poecilia reticulata</i>)		1	

Table 3 indicates water quality data collected at three locations along Sandringham Lagoon (Sites 1, 2 & 3) and at one location (Site 4) on lower Sandringham Creek. Recent analysis of water samples along this system has revealed the following:

- Low levels of herbicides leaching from adjacent farming land.

Elevated nutrients (Nitrogen and Phosphorus) associated with agricultural runoff. Nitrogen and Phosphorus levels are higher further downstream at Sandringham Creek (Site 4).

Moderate Dissolved Oxygen levels throughout the system are sustainable to aquatic life.

Water quality monitoring has been occurring on a monthly basis at three sites along Sandringham Lagoon since December 2006. Site 2 is located mid way along the lagoon and was highly degraded. Water quality data (Appendix 16) and accompanying graphs of this data (Figures 35 & 36) reveal the following improvements in water quality since commencement of the removal of Hymenachne mats in mid 2007:

- Water clarity has improved considerably from 158 NTU's in January 2007 to level out at around 10 to 12 NTU's by November 2007.
- pH has increased from 5.99 in December to 7 (neutral) by February 2008.
- Dissolved Oxygen (DO) was extremely low (0.4mg/L) during December 2006/January 2007 and unresponsive of aquatic life. Removal of the weed mats and flushing of the system in February 2008 has led to considerable improvement in DO to stabilise at levels around 5 to 7 mg/L by July 2008.

Although the Lagoon has only recently been completed and the revegetation has not yet established, early indications suggest a complete rehabilitation of this system and an extremely successful project.

The successes of this project resulted from the perseverance and determination of the project partners and enthusiasm of the land holders, contractors and volunteer organisations.

Sandringham Project	Item	Sub item	Start Date	Completed Date
Sandringham	Weed Control	7.5 Ha Hymenachne and Paragrass and water hyacinth control in wetlands	June to Oct 2007	March 2008
Sandringham	Wetland Inventory	Complete Inventory of Goorganga Wetlands Project area	July 2007	Sept 2007
Sandringham	Water Quality monitoring program	Monthly monitoring + biannual sediment/nutrient analysis including agri-chem analysis + Dissolved Oxygen diurnal monitoring	July 2007	June 2008
Sandringham	Weed Control	Incentives to Landowners for spraying weeds	Aug 2007	May 2008
Sandringham	Revegetation	2ha of fringing lagoon vegetation	Sept 2007	May 2008
Sandringham	Sediment / nutrient detention ponds (constructed wetlands)	Excavation and construction of 3 sediment / nutrient detention ponds (constructed wetlands).	Sept 2007	Nov 2007
Sandringham	Revegetation	Riparian rehabilitation: 2Ha revegetation along Sandringham Lagoon	Dec 2007	March 2008
Sandringham	Revegetation	1 Ha Sandringham Creek adjacent to estuary	Dec 2007	May 2008
Sandringham	Revegetation and vegetation management	1ha Upper Sandringham Creek (contributing catchment)	Dec 2007	May 2008