Mary River Threatened (Aquatic) Species Recovery Plan

Author

MRCCC logo
Other logo/s

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The Australian Government facilitates the publication of Recovery Plans to detail the actions needed for the conservation of threatened native wildlife. This plan has been developed with the involvement and cooperation of a range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions.
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Cover photograph/s: top left to bottom left – Mary River turtle (Steve Wilson), Mary River cod (Gunther Schmida), Australian lungfish (Gunther Schmida), freshwater mullet (Gunther Schmida), giant barred frog (Eva Ford).

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Acknowledgements

NOT YET COMPLETE

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In addition to the Recovery Team, Technical Advisory Group and Indigenous working group members, contributors include Dale Watson, Peter McAdam, MRCCC general committee, community members who attended the Caring for Mary forums and completed the online survey.

Abbreviations and acronyms

NOT YET COMPLETE

AMTD	Adopted Middle Thread Distance
ATSI	Aboriginal and Torres Strait Islander
BMRG	Burnett Mary Regional Group
BoT	Queensland Back on Track species prioritisation framework
EHP	Department of Environment and Heritage Protection (Queensland)
FA	*Fisheries Act 1994* (Queensland)
DAFF	Department of Agriculture, Fisheries and Forestry (Queensland)
DNRM	Department of Natural Resources and Mines (Queensland)
DSITIA	Department of Science, Information Technology, Information and the Arts (Queensland)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (Australian Government)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
IUCN	International Union for the Conservation of Nature
MRCCC	Mary River Catchment Coordination Committee
NCA	Queensland *Nature Conservation Act 1992*
TAG	Technical Advisory Group
TOWG	Traditional Owners Working Group
WQIPs	Water Quality Improvement Plans

Glossary of terms

Adopted Middle Thread Distance: The distance in kilometres, measured along the middle of a watercourse, from the mouth or junction (eWater CRC).

Beneficial Large Wood: define *(formally known as Large Woody Debris (LWD))*

Demonstration reach: Large scale river reaches or wetlands where a number of management interventions are applied and closely monitored to showcase the cumulative benefits of river/wetland rehabilitation on native aquatic fauna populations (Jackson 2008).

First order stream: define

Foliage projective cover: define

Non riverine wetlands: Water bodies located outside of the main river channel that are either open water e.g. lake or vegetated e.g. billabong (Queensland Government 2012)

Reach: define

Recruitment: define

Tributary: a stream that flows to a larger stream or other body of water (Dictionary.com).

Water Quality Improvement Plans: Water Quality Improvement Plans (WQIPs), prepared consistent with the Framework for Marine and Estuarine Water Quality Protection, amongst other matters identify the most cost-effective and timely projects for investment by all parties including the Australian Government, State and Local Governments, and community and environment groups. http://www.environment.gov.au/water/policy-programs/nwqms/wqip/index.html

EXECUTIVE SUMMARY

brief (<1 page) To be completed

Peace flows
From the water
To my heart.
Whatever life brings me
I now can face
Because of this,
My sitting down place!

***By Gail Kay**, Indigenous poet, Proserpine, QLD*[1]

1 INTRODUCTION

> *Protection of freshwater biodiversity is perhaps the ultimate conservation challenge because it is influenced by the upstream drainage network, the surrounding land, the riparian zone, and – in the case of migrating aquatic fauna – downstream reaches (Dudgeon et al. 2006).*

1.1 Background

Throughout history Australian rivers have provided pathways for both indigenous and non-indigenous people, access to food sources and resources such as timber and agricultural land. Rivers have nurtured coastal fisheries and ecosystems and sheltered vibrant aquatic and terrestrial biodiversity. At the same time, they have been greatly exploited and transformed since European settlement. Water extraction, infrastructure, de-snagging, logging, agriculture, industry and urban development have changed the way rivers function and the way they interact with the landscape, the groundwater and the sea.

The Mary River, located on the northern fringe of the south east Queensland region, is no exception, having been an important resource and site of cultural significance for indigenous groups and significantly altered since white settlement in the mid 1800s. Changes to the hydrology, fluvial geomorphology and landuse over the last 170 years have resulted in many species to become threatened. Actions within this recovery plan will benefit over 150 rare and threatened species of plants and animals that remain in the Mary River catchment. There are clear and tangible actions that can be taken to facilitate the recovery of these populations and also much willingness within the catchment community to take these actions. This recovery plan has brought together many groups and individuals with expertise and interest in the river and mapped out a plan for the recovery of priority species and overall river health, identifying actions to be taken and mechanisms to be established or supported to achieve this goal.

Today, the river is regarded as the most significant unregulated coastal river in the region from a biodiversity and conservation perspective (Arthington and Bunn 2008) and is considered highly representative of the rivers of the bioregion in which it is located. There are close linkages to the neighbouring Burnett River, so aquatic species share some aspects of hydrology, biology and ecology, although the Burnett is much more highly regulated by dams and weirs.

The catchment covers 9595 km^2 from Maleny to Hervey Bay and contains a population of around 150,000 people in urban areas, rural subdivisions and agricultural properties. The predominant landuse in the catchment is beef cattle grazing, followed by forestry and a

[1] Read more: http://www.creativespirits.info/aboriginalculture/arts/aboriginal-poems/my-sitting-down-place.html#ixzz1p36A65ZB

range of other agricultural and horticulture industries. The Mary River is 310 km long, including over 3000 km of stream length (Johnson 1996) that carries water from the southern most foothills near Maleny, north into the Ramsar listed wetlands of the Great Sandy Strait in the lee of World Heritage Fraser Island (see Figure 1.1) The Great Sandy Strait is home to dugongs, migrating whales and migratory birds and threatened dolphins. In addition to this world recognised ecosystem, significant recreational and commercial fisheries are dependent upon the freshwater flows from the Mary River.

Protection of freshwater biodiversity is perhaps the ultimate conservation challenge because it is influenced by the upstream drainage network, the surrounding land, the riparian zone, and – in the case of migrating aquatic fauna – downstream reaches (Dudgeon et al. 2006). Management of river systems requires consideration of all the various forms of connectivity – between up and downstream, groundwater, surface water, terrestrial, riverine and estuarine elements (Barmuta et al. 2011). The nature of these connections is dynamic in both space and time. Identifying actions to ensure recovery of biodiversity in this kind of system requires a holistic approach that takes into account this connectivity as well as the complex social, cultural and economic roles of river systems.

The Mary River threatened species (aquatic) recovery plan, prepared under the Australian Government *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), is the first regional national recovery plan to focus on a river system.

Much of the coordination and development of this plan and future recovery activities will be undertaken by the Mary River Catchment Coordinating Committee (MRCCC) based in Gympie (http://www.mrccc.org.au/). MRCCC is a dedicated community group and has been instrumental in providing a range of activities that have contributed greatly to the recovery of the Mary River. They are a major contributor to this plan.

1.2 The ecological significance of the Mary River Ecosystem

The Mary River catchment is located in the South East Queensland Bioregion (Interim Biogeographic Regionalisation for Australia) (IBRA Bioregion) and is the southern-most Great Barrier Reef catchment. It is part of the "Eastern Australia Rivers and Streams" ecoregion, which is listed as one of the top 200 ecoregions in the world (Olson and Dinerstein, 2002).

The Mary River threatened species technical advisory group for the recovery plan describes the river as

> "*a high integrity and representative example of a south-east Queensland free flowing riverine ecosystem, rich in unique species of national and international significance."*

The catchment is an area of high biodiversity and at the northern and southern geographical limits of a range of aquatic and terrestrial species. The southern part of the catchment is included in the Macpherson Macleay overlap where tropical and temperate floristic zones overlap (Burbidge 1960). The tributaries of the river are diverse, extending across a range of soil types, annual rainfall totals and vegetation types. These range from wallum[2] type ecosystems in the east to rainforest in the south, eucalypt woodland and pockets of dry rainforest in the west. A large proportion of the catchment has been cleared for grazing purposes or for timber.

The high levels of biodiversity of the catchment are reflected in the large numbers of threatened species (44 EPBC listed species) associated with the Mary River and several

[2]

endemic species (see Table 1, Section 3.1). Five of these are fauna species that live in the freshwater, two are migratory species associated with freshwater, and another 19 are threatened or migratory species associated with the estuary. The remainder are terrestrial species likely to be associated with the riparian zone, including eight fauna species and nine flora species. There are an additional 15 species that are not listed under the EPBC Act, but are listed under the Queensland Government's *Nature Conservation Act 1992* (NCA). These include one estuarine species, five species of terrestrial fauna, seven species of terrestrial flora and two species of aquatic flora.

The estuary supports the largest population of dugong (*Dugong dugon*) on the east coast of Australia south of Torres Strait.

Significant areas of the critically endangered ecological community of the "Lowland Rainforest of Subtropical Australia" are also found in the catchment, often in riparian areas.

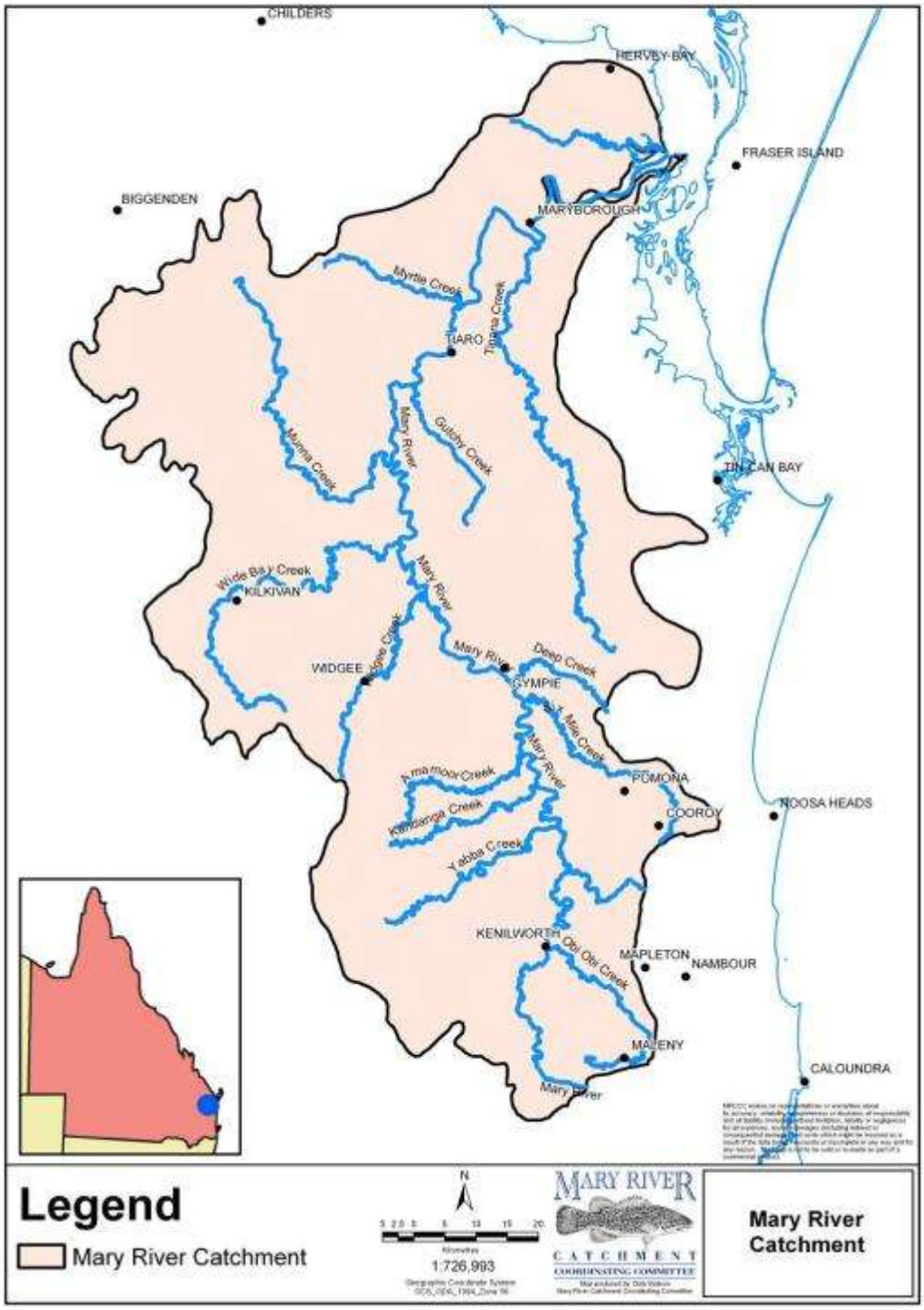


Figure 1.1 Map of the Mary Catchment showing main tributaries

Other Australian Government Matters of National Environmental Significance (MNES) include the Great Sandy Strait Ramsar site (DEH 1999) which includes parts of the Mary River and its estuary, internationally significant populations of migratory birds designated under the Japan Australia Migratory Bird Agreement (JAMBA) and the China Australia Migratory Bird Agreement (CAMBA), and World Heritage listed Fraser Island adjacent to the river mouth.

In addition to a large number of threatened and migratory species being dependent on the Mary River, there are also many other species that are not recognised as threatened

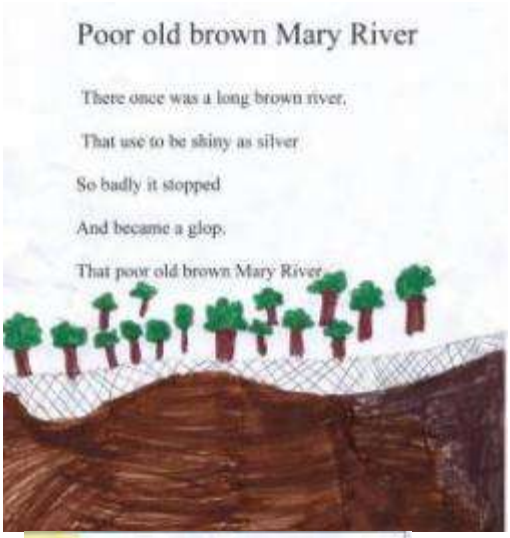
but contribute to the significance of the river system. For example, five species of freshwater mussels have been collected from the Mary River and it is possible there are more (H. Jones pers comm. 2013). This would be one of the most diverse mussel populations in Australia. There are six species of freshwater turtle, which is one of the largest number of turtle species found in any river in Australia (ref). Additionally the dominant invertebrate groups in the lowland reaches are crustaceans and molluscs compared to a more typical invertebrate assemblage of insects.

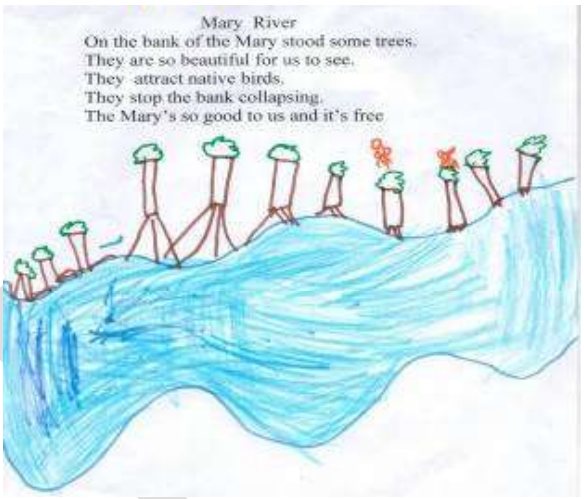
The catchment was classified as having a catchment condition between poorer and moderate in 2002 (National Land and Water Resources Audit 2002). It was recognised as a priority catchment for the National Action Plan for Salinity and Water Quality (ref). Numerous reports including the State of the Rivers report (Johnson 1996), the Mary River Tributaries and Rehabilitation Plan (Stockwell 2001) and the Priority Action Program (MRCCC 2005) have identified that the river now contains areas that range from almost pristine to highly degraded.

1.3 Vision for the recovery plan

The Mary River Threatened (Aquatic) Species Recovery Plan is focused on ensuring a positive future for the Mary River so that in 100 years time, the status of the priority threatened species in the river has improved and the Mary River itself can support healthy populations of these species of national and international significance.

Achieving this vision will require significant improvement in the state of the river. The current perception of the river of young children in the catchment provides a telling indication of how much work is needed. The following limericks and drawings produced by members of Class 4/5MM at Gympie South State School summarise some of the issues that this recovery plan needs to address.





There once was a lungfish called Noo
He didn't know what he could do
The river is a mess
It gives me lots of stress
I wish it would go back to blue

Water Window the Future

In the year 2050, the last evidence of the lungfish is about to disappear. The Mary River is in its' most worse position at the moment. The river is also 100% filled with pollution. Nearly all the people who care about the river have either died or left. Some of the people who care about the river are trying to get it back to health.

Box 1. Children's insight on the Mary River

More dramatic than most scientific reports, the children's reflections may well describe what would happen if we did nothing. Fortunately, for the last two decades concerted effort has been made to address the mistakes of the past. Although in some ways, the river is forever changed, this recovery plan is an important step in the process of continuing to work toward a healthy river.

To contribute to achieving this future, the recovery plan is underpinned by a set of principles explained in section 5 that guide the core task of recovering populations of threatened species and at the same time recognising the complex and interconnected social, cultural and economic role that the river plays.

1.4 Scope of Plan

This plan focuses on five priority species - the Mary River turtle (*Elusor macrurus*), Mary River cod (*Maccullochella mariensis*), Australian lungfish (*Neoceratodus forsteri*) (also known as the Queensland lungfish), giant barred frog (*Mixophyes iteratus*), and the freshwater mullet (*Trachystoma petardi*) (The species is frequently placed in genus *Myxus (*Australian Museum 2012)). The geographical scope of the plan encompasses a large proportion of the majority of these priority species' distributions, and the entire distribution of the turtle.

Of the five priority species identified, four are listed as threatened under the EPBC Act. However, for the purposes of the EPBC Act, this plan constitutes the (revised) national recovery plan for the Mary River cod only.

While focusing on these five species the plan provides recovery guidance for the high levels of biodiversity of the catchment which are reflected in the numerous species and vegetation communities associated with the river system.

The geographical scope of this plan is based on the catchment of the Mary River and its tributaries (see Figure 1.1). The upstream boundary of the plan is defined by the distribution of the threatened priority species life cycles.

Due to the lack of knowledge about the distribution of juvenile lungfish, Mary River cod and turtle, a rigid definition of the upstream catchment boundary has not been adopted. Consequently stream order one tributaries and non-riverine wetlands (water bodies located outside of the main river channel that are either open water e.g. lake, or vegetated e.g. billabong, or in groundwater systems e.g. aquifers (Queensland Government 2012)) can be included.

The downstream limit of the plan is the Ramsar Site at Beaver Rock north of Maryborough. This is the riverine boundary of the Great Sandy Strait Ramsar site.

The downstream boundary also enables the plan to consider the water quality upstream and downstream of the barrages and movement of freshwater mullet and the numerous other fish species that need to move across the tidal barrages.

The lateral extent (or distance away from the river's edge) that has been adopted for the scope of this plan, aims to align with the buffer requirements of the Queensland legislative requirements in the Environmental Protection (Water) Policy 2009 (State of Queensland 2013), the *Sustainable Planning Act 2009* and the *Vegetation Management Act 1999.* The lateral extent deems relevant those ecological requirements required by the priority species such as riparian zones, floodplains and other habitat used by species such as the giant barred frog.

1.5 Benefits/impacts to biodiversity

By focusing on the priority species the aim of this plan is to identify the recovery actions and management practices necessary to ensure the long-term viability of the threatened and priority species and the overall biodiversity of the Mary River system. No adverse impacts to biodiversity are expected as a result of implementing actions in the Plan.

1.6 Social and economic impacts/benefits

Land through which the Mary River flows is generally fertile and productive and prior to European settlement was home to numerous Indigenous communities who place great cultural significance upon on the river. It now supports well established urban communities, rural residential communities and agricultural enterprises and underpins

much of the economic and social viability of three local government areas located within the catchment.

Implementation of this recovery plan will provide a number of social and economic benefits. Recommended recovery actions are compatible with continuation of existing land uses, with a focus on increased knowledge, adoption of 'best practice' adaptive management, and improved planning and development to minimise impacts to the Mary River and the associated species it supports.

Social and economic benefits include:

- addressing community concerns regarding the continued loss of biodiversity and strengthening community networks;
- addressing landholder concern about weeds and management of remnants of native vegetation;
- providing opportunities for leisure and education in regard to protection and enhancement of this riverine system and its components species;
- maintenance of the visual amenity;
- maintenance of a wild gene pool; and
- seed resource base for regeneration
- addressing the economic impact of environmental weeds
- maintenance of productivity of recreational and commercial fisheries
- productivity benefits of stabilisation and restoration of riverbanks
- improved resilience to floods.

The Plan is focussed on promoting partnerships and voluntary participation in biodiversity management. It is therefore anticipated that there will be no significant adverse social or economic costs associated with the implementation of the Plan and that the overall benefits to society will outweigh any disadvantages.

1.7 Interaction with legislation, planning and management processes

The majority of the Mary River catchment comes under the jurisdiction of three local government areas. These are Gympie, Sunshine Coast and Fraser Coast regional councils. Small portions in the southern part of the catchment are in the Moreton and Somerset regional council areas. At the state level, the catchment overlaps with two Queensland Government planning regions of South East Queensland and Wide Bay-Burnett.

The catchment lies within the Burnett-Mary Natural Resource Management Region, overlaps both the Great Sandy Strait and Noosa UNESCO Biosphere Reserves and lies wholly within the Mary Basin Water Resource Planning Area.

Conservation mechanisms associated with Queensland Government legislation include the *Fisheries Act 1994,* the *Nature Conservation Act 1992* and Back on Track species prioritisation framework. Back on Track prioritises Queensland's native species (marine, terrestrial and aquatic species of flora and fauna) to guide their conservation, management and recovery. Overarching State Government legislation includes:

- *Environmental Protection Act 1994*
- *State Development and Public Works Organisation Act 1971*
- *Sustainable Planning Act 2009*
- *Vegetation Management Act 1999*
- *Water Act 2000*

There are a range of Local Government and community strategies that have informed or guided the development with this plan. These include:

- Mary Valley Community and Economic Plan (Mary Valley Renewal Team 2010)
- Local Government planning schemes, community plans and development codes under the *Sustainable Planning Act 2009*
- Sunshine Coast Waterways and Coast Management Strategy (Sunshine Coast Regional Council 2011)
- Fraser Coast Growth Strategy 2031 (GHD and Buckley Vann Town Planning Consultants 2011) (and similar strategies for Gympie Regional Council and Sunshine Coast Regional Council)
- Mary River Catchment Strategy (MRCCC 1997)
- Mary River Tributaries and Rehabilitation Plan and evaluations of this program (Stockwell 2001; Watson 2003)
- Noosa Biosphere Management Strategy (ref)
- Great Sandy Biosphere Management Strategy (ref)

Relevant State government and regional strategies include:

- Wide Bay Burnett Regional Plan (State of Qld 2011d) (informed by the Wide Bay-Burnett Water Strategy (ref) and Natural Resource Management Plan (Wide Bay Burnett Environment and Natural Resources Working Group 2012))
- South East Queensland Regional Plan (State of Qld 2009a) (informed by the South East Queensland Water Strategy and Natural Resource Management Plan (ref))
- South East Queensland Water Grid Systems Operation Plan (Qld Water Commission 2012)
- Water Resource (Mary Basin) Plan (State of Qld 2006)
- Mary Basin Resource Operations Plan (State of Qld 2011b)
- Back on Track species prioritisation framework for the Burnett Mary Region (Lyons and Williams 2010)
- Queensland Biodiversity Strategy (author 2011)
- State Planning Policy for Great Barrier Reef Wetlands (ref)
- Environment Planning Policy (Water) for Mary River (ref)
- Wide Bay Burnett Aquatic Conservation Assessment (State of Qld 2011c)
- Reef Water Quality Protection Plan (State of Qld 2011)
- Mary Catchment Water Quality Improvement Plan (BMRG 2008)
- Mary Valley Economic Development Strategy (State of Qld 2012)

In addition to identifying recovery actions needed to improve the status of listed threatened species, this recovery plan will also act as a guide when the DSEWPaC is considering referrals of activities that may impact on these species. This plan will replace the Mary River Cod Research and Recovery plan (Simpson and Jackson 1996). It will complement the National Recovery Plan for the Australian lungfish *Neoceratodus forsteri* (DSEWPaC in prep), the National Recovery Plan for Stream Frogs of South East Queensland (Hines 2005) and the Conservation Advice for the Mary River turtle (TSSC 2008b). Other EPBC recovery plans and conservation advices that share common or related recovery actions with this plan include:

- Coxen's Fig-parrot *Cyclopsitta diophthalma coxeni* Recovery Plan (Coxen's Fig-parrot Recovery team 2001)
- Lowland Rainforest of Subtropical Australia Ecological Community Conservation Advice and Listing Advice (TSSC 2011)

- Oxlyean pygmy perch (*Nannoperca oxleyana*) recovery plan (NSW DPI 2005)
- Honey Blue-eye (*Pseudomugil mellis*) Conservation Advice (TSSC 2008)
- Southern Macadamia Species Recovery Plan (Costello et al. 2009)
- National Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus* (OEH in prep)

1.8 International agreements

The following international agreements and conventions are relevant to this Plan:

- Convention on Biological Diversity;
- Ramsar Convention on Wetlands;
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES);
- China-Australia Migratory Bird Agreement (CAMBA);
- Japan-Australia Migratory Bird Agreement (JAMBA);
- Republic of Korea-Australia Migratory Bird Agreement;
- Convention on Migratory Species;
- UNESCO Man in the Biosphere Program and
- UNESCO World Heritage Convention

The recovery plan is consistent with these obligations.

1.9 Plan preparation and consultation

The Mary River Catchment Coordination Committee (MRCCC) has worked closely with the Australian Government on involving the community and stakeholders in development of this plan and laying a strong foundation for implementation. The stakeholder engagement process is discussed in more detail in section X. Preparation of this recovery plan has occurred over a period of two and a half years. Throughout this period input to the plan has been provided by a Technical Advisory Group, the Recovery Team and a range of stakeholder organisations and individuals. Membership of these advisory bodies and terms of reference of these groups are provided in Appendix ?. Details of the consultation with various groups are provided in Appendix ?.

Four main instruments were used in the engagement process. These were an online (and also paper) survey, meetings with individuals and groups, general public awareness raising, a series of public forums and making drafts of the plan available to the public via a website.

2 MARY RIVER CATCHMENT AND ITS PEOPLE

The Mary River has significant cultural, social and economic importance to people within its catchment. For thousands of years the river has been used by indigenous people for hunting and gathering, a meeting place and a pathway for travel. During European settlement, the river became a pathway for new industries and was used to transport cedar logged in the upper catchment to the river mouth. The river was the means by which settlers arrived and freight was exported and imported via the port in Maryborough.

Today the river is used for drinking water for people within and outside of the catchment, provides irrigation water for agriculture, supports recreational and commercial fisheries in the estuary and fuels the ecosystem on which nature based tourism in the region depends. These multiple values are recognised in the designation of the Great Sandy

Biosphere and Noosa Biospheres. These are the only two adjacent biosphere reserves in the world and include significant parts of the Mary River catchment.

2.1 Mary River catchment indigenous culture

In the Mary River catchment there are several indigenous language groups with native title and cultural heritage interests. Broadly speaking, the Mary River catchment is separated between two indigenous groups. These are the Butchulla people, who are associated with the northern part of the catchment and the Kabi Kabi/Gubbi Gubbi people who are associated with the southern part of the catchment. A third group called the Jina burra has a connection with the southern part of the catchment. A number of other groups such as the Wakka Wakka have had historical associations with the river.

The Mary River has cultural and spiritual significance to the traditional owners of the area. Some names for the Mary River include '*Moonambulla*' and '*Numabulla'*. Tribes would travel along the river for significant gatherings such as the Bunya Festival and Diamond Scale Mullet gatherings in and around K'Gari (Fraser Island). Permission was granted at these times for people from outside the area to move in and share the bountiful food of bunya nuts or fish.

The river is associated with numerous sacred sites, watering points, resource areas and cultural landscapes. Before white settlement use of natural resources were tightly controlled to facilitate caring for the land (see Box 1).

2.2 Mary River since European settlement

The first Europeans to visit the Mary River district were Andrew Petrie, of Brisbane, Wrottesley, an English aristocrat, Henry Stuart Russell, of Cecil Plains, Joliffe who had been a "middle" in the Royal Navy, five convicts and two indigenous people. They made a trip to the district in May of 1842 (McKinnon 1933).

The river was accessed over land from the south and by water from the north. Some early accounts of the river in the vicinity of Tiaro/Maryborough refer to the "jungle on the banks of the Mary" (Loyau 1897) – a testament to the vegetation, only remnants of which remain today.

Box 1: Mimburi – the environmental law of the Mary River people

Mimburi means continuous flow in Kabi Kabi language. Prior to white settlement, a form of traditional environmental law operated amongst the aboriginal groups living in or passing through the catchment that preserved this flow. This law included knowledge of the species and periods in these species life cycles that were crucial to their ongoing survival. For example, during Dewfish or eel-tailed catfish (Tandanus Tandanus) nesting season **Mimburi** required that breeding dewfish not be caught. If a person broke this rule they were punished severely. (B Hand pers. comm.? 2012, A Bond pers. comm.? 2011)

The river in the north was known as the Wide Bay River and a port was established at Maryborough in 1847. This provided squatters in the region with supplies and ability to ship their products to market. The location chosen is now known as the Old Maryborough

Town site and coincided with an important fishing spot, water source and crossing point for the Butchulla people in the area (Mathews 1995).

Rich grazing lands in the upper Mary catchment attracted European settlers from the 1850s onward (Johnson and Saunders 2007). In 1867 gold was discovered in Gympie, and the Mary River became heavily polluted due to gold tailings from the mining operation.

Timber getters began harvesting timber in the upper Mary catchment in the 1870s. The Mary River was used as transport for the logs, rafts of which at times covered the entire width of the river. Only thirty years later red cedar (the most sought after tree) was practically wiped out in the area and approximately 30% of the hoop and bunya pine forests were cleared (Johnson and Saunders 2007).

By the 1860s, the life style of the indigenous people associated with the Mary River had also been severely altered as a result of the settlers and the native mounted police (Brown 2000). Indigenous people assisted some of the early explorers, and most notably some escaped convicts, who then went on to reveal the pathways and practices of the local people to the settlers.

2.3 Mary River catchment today

2.3.1 Population

The population within the Mary River catchment has grown steadily over the last couple of decades. Both the population within the catchment and the population outside the catchment who are supplied water from the river are relevant to the river recovery. Based on population by postcode, it is estimated the population within the catchment has grown from 81,000 in 1996 (Pointon and Collins, 2000) to 95,194 in 2011 (ABS, 2012). However these figures underestimate the population by the number of people within the population centre of Hervey Bay (population of 55,298 in 2011) who live within the catchment. Although the population of Hervey Bay is not currently supplied water from the Mary River, a significant proportion of the Sunshine Coast Regional Council area residents are. The population within the Sunshine Coast Regional Council area was 306,909 in 2011.

Projections from Queensland Treasury (2011) suggest that the population in each of these council regions will continue to grow. This growth poses a risk of increased demand for the water resources of the Mary River and additional pressures such as land clearing and effect of increased urbanisation.

In addition, the Northern Pipeline Interconnector enables water to be transferred to North Pine Dam for use by the population of Brisbane. Therefore growth of Queensland's capital and future water management strategies will also have a bearing on the Mary River.

2.3.2 Landuse

The highest landuse activity in the catchment is grazing which occupies 48% of the catchment (Pointon and Collins 2000). Forestry is the second largest land use in the catchment occupying 29% of the land. In 2000, the remaining catchment was occupied by residential area (5.8%), dairying (3%), sugar cane (1.8%), national parks (1%) and horticulture (1%). Figure **X-X** shows the distribution of different land uses throughout the catchment.

The Reef Water Quality Protection Plan (State of Qld 2011) indicates 78.7% of riparian areas in the Mary River catchment remain forested. These data are based on satellite imagery and forest is defined as having at least 11% foliage projective cover. Of the non-forested area, 20.2% was regarded as having high ground cover levels (more than 50% ground cover) and 0.24% of the remainder had low ground cover (less than 50%)[3]. This analysis is based on a 50 m buffer and drainage line data including the 1:100 000 Geoscience Australia Drainage Layers 2009.

Approximately 10% of the stream network is included in National Parks, with additional sections covered by voluntary conservation schemes (such as Land for Wildlife).

Table X. Tenure of Allotments > 50 ha in the Mary River catchment (Source: DNRM 2003)

Tenure	**Area in Hectares**	**Percentage**
Freehold	401 460 ha	42.4%
State Forest	270 350 ha	28.6%
Land Lease (Leasehold)	13 480 ha	1.4%
National Park	5 770 ha	0.6%
USL (Unallocated State Land)	10 960 ha	1.2%
Reserves Parks etc	6 170 ha	0.7%
Timber Reserve	4 110 ha	0.4%

[3] 2.4% of the riparian area could not be assessed due to cloud cover, topographic shadow or water within the riparian area.

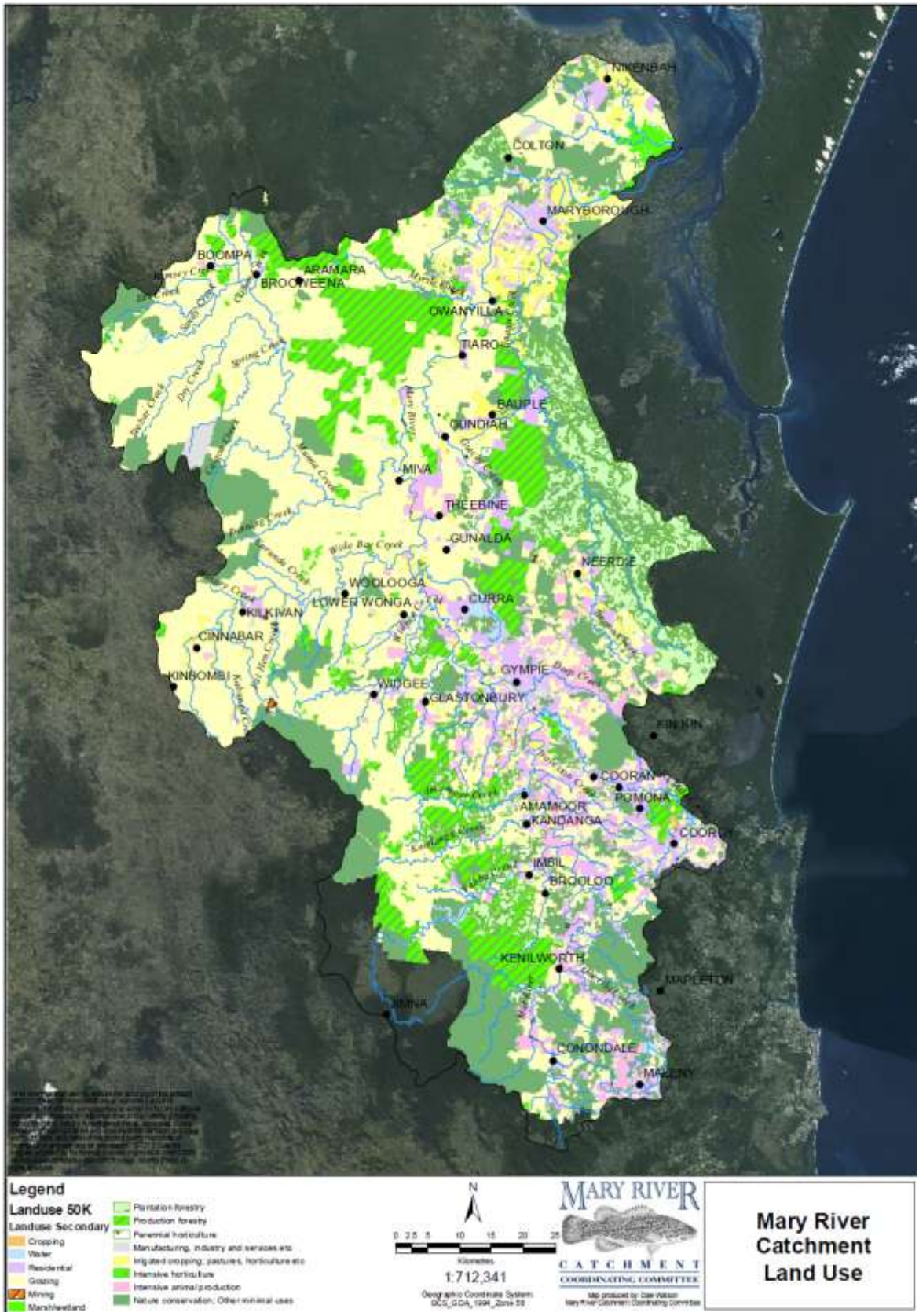


Figure X-X Map showing Landuse in the Mary River Catchment

2.3.3 Water resource use

Water extraction from the Mary River provides for irrigation within the catchment, stock and domestic use and town water supplies. Allocations of approximately 100 000 ML per year is currently available, though not always accessible to users. There are four storages in the catchment, two tidal barrages, three weirs and numerous urban water off-takes.

Groundwater is used extensively in the western part of the catchment. Its use is not regulated and anecdotal reports reveal strong correlations between creek levels and bore drawdown in these areas.

The Mary Basin Water Resource Plan (State of Qld 2006) and Resource Operations Plan (State of Qld 2011b) stipulates how much water can be extracted, though it does not currently regulate groundwater use. Actions identified in this recovery plan will help improve future water planning in the catchment.

2.4 Catchment Description

On a monthly basis, average maximum temperatures vary from the low 20s – low 30s (ºC) while minimum temperatures vary from 5 - 20ºC (Pointon and Collins 2000). In winter temperatures fall low enough to suppress the growth of most tropical plants and frost-sensitive species may be damaged or killed by frost (Bridges et al. 1990).

The Mary River catchment contains several large subcatchments that differ in geological history, geology and rainfall. Different habitats are created as a result of different flow regimes, connectivity, instream structures and predominate geomorphologic processes.

The main trunk of the Mary River and its major western tributaries north of Gympie, such as Munna Creek (15% of catchment area) and Wide Bay Creek (8% of catchment area) are classified as moderate to high energy sand- and gravel-bed streams although they are geologically complex and diverse catchments, which include substantial areas of granitic rocks (Mary Basin Technical Advisory Panel, 2004). Generally these sub-catchments are hilly or undulating through the upper reaches with some mountainous areas. Floodplains and river terraces are also evident in places where the river valley widens. The catchment of the western tributaries and the lower catchment of the main river trunk are on average significantly drier than the other parts of the catchment. This means that in times of low flow, deep pools become crucial habitat areas for the priority species. There are also significant but poorly understood groundwater resources in the Wide Bay Creek area in particular. Coal bearing seams are also found in this part of the Mary River catchment.

The Obi Obi creek in the south has been dammed to form Baroon Pocket dam. The native vegetation in this area is rainforest. Another major tributary which enters the Mary River from the east is Six Mile Creek. This creek has also been dammed to create Lake MacDonald. This is a low-energy rainforest stream, with a sandy substrate and extensive deposits of beneficial large wood (formally referred to as large woody debris (LWD)).

The other major eastern subcatchment is Tinana Creek, constituting 14% of the total catchment area. The upper reaches of this subcatchment also experience high rainfall. The catchment topography is generally undulating to hilly, except in headwater reaches in the Tagigan Range.

The Mary River and its south western tributaries upstream of Gympie (Little Yabba Creek, Yabba Creek, Kandanga Creek and Amamoor Creek) rise in mountainous terrain in the Conondale and Blackall ranges.

2.5 Stream flow

The Mary River rises in the Conondale Ranges near Maleny and discharges approximately 300 km away into the Great Sandy Strait at River Heads, west of Fraser Island (see Figure X.X). The catchment is approximately 9400 km^2 in area and includes almost 3000 km of major streams (Johnson 1996).

The Mary River catchment is classified as a subtropical area and the natural flow regime has been classified as unpredictable and intermittent by Kennard et al. (2010). Rainfall typically occurs in the late summer and early autumn, although significant rainfall totals have been recorded in all months of the year and their occurrence is highly unreliable (Bridges et al. 1990). Mean annual rainfall varies considerably from 2000 mm near Maleny in the south, to less than 800 mm in the western parts of the catchments (Pointon and Collins 2000).

In general the upper catchment of the Mary River is wetter than the north western and lower catchment. The wettest parts of the catchment receive approximately twice the rainfall of the driest areas. In terms of stream-flow, the difference between the wet and dry areas can be much more accentuated particularly in dry seasons.

Mean net inflows in the upper catchment contribute considerably more stream flow to the river per square kilometre of catchment than the lower catchment. This holds true even when major flooding events such as 1999 flood are considered.

In the 'wet' upper catchment, rainfall greatly exceeds evaporation. However, downstream as far as Gympie (situated midcatchment), annual evaporation exceeds rainfall. In most years this causes water flows in the Mary River to be extremely variable particularly in the months from July to November. Most of the major low flow stresses in the river are experienced in the low flow July to November months. During these times, the amount of water flowing in the river often decreases as water progresses downstream. For example in August 2002 the Mary River, downstream of the Gympie town water the river ceased to flow.

Low flow months often coincide with the peak demand for river water throughout the middle part of the catchment. Sometimes within the catchment area, a particular reach in the river removes more water from the river than what it contributes. This may be a short term situation, but in some years this effect is evident based on the total flow figures for the entire period between July and November. This was the case in the lower and mid Mary River for the years 1996, 1997, 2002 and 2006 (4 years out of 10).

During these low flow periods, all connection between the river and the sea is broken by the two barrages located in the lower river. No fresh water flows over the barrages and often the fishways that are located on these barrages, are inoperable.

Low flow periods can cause serious infestations of aquatic weeds. These infestations may disrupt the dissolved oxygen regime in the river, block out available sunlight, inhibit fish and animal movement and greatly increase evaporative losses. This has adverse impacts on nearly all other aquatic life in the river.

Low flow periods in the Mary River have been noted since at least the 1930s. Low flow years in the 1930s, the mid 1950s, 1990s and early 2000s have been experienced. Low flow periods are exacerbated by the water extraction from the river. In a usual year, the expected impact of water demand for irrigation, agricultural and municipal use accounts for over 60% of the total flow of the Mary River. An increase in the severity and frequency of these low-flow events is detrimental to the survival of populations and ecosystems in

the river that are already recognised as threatened. In addition, these years of low flow have not accounted for any impacts of predicted climate change trends on further reduced stream flows.

3 ECOLOGY OF THE MARY RIVER CATCHMENT

Ecosystems of the catchment include river corridors encompassing active and abandoned channels, the aquatic margins of these channels, the riparian zones along the channel banks and any floodplains, as well as wetlands. In their natural states, river margins consist of a complex mosaic of patches of different type, size and age. The dynamic geomorphology of riverine ecosystems creates a diverse range of meso and micro scale habitats which feature high levels of biodiversity (Treadwell 2003). The main trunk of the Mary River is virtually devoid of threatened riparian plant species. However, tributaries in the Mary catchments contain numerous threatened riparian plant species such as *Cossinia australiana, Alyxia magnifolia* and *Choricarpa subargentea* (Stockwell et al. 2004). The Mary River catchment is also regarded as an important area for the recovery of *Macadamia integrifolia* (Macadamia Recovery Plan) as the Mary River is a strong hold for this species and it mainly occurs in the riparian zone.

3.1 Species: fauna and flora

The five priority species which are the focus of this plan - Mary River turtle (*Elusor macrurus*), Mary River cod (*Maccullochella mariensis*), Australian lungfish (*Neoceratodus forsteri*) (also known as the Queensland lungfish), giant barred frog (*Mixophyes iteratus*), and the freshwater mullet (*Trachystoma petardi*) are considered 'umbrella species' in the Mary River. Umbrella species are those "whose conservation will also conserve other species" (Zacharias and Roff 2001, p. 60).

The plan provides recovery actions that will benefit the high levels of biodiversity of the catchment which are reflected in the 44 EPBC listed species and several endemic species (Tables 1, 2).

Table 1: National and State listed species recorded in the Mary River Catchment

Species	**Common name**	**National *Environment Protection and Biodiversity* (EPBC) *Act 1999***	**Queensland *Nature Conservation Act 1992***	**Queensland *Fisheries Act 1994***
Fauna (re-order these by taxa or alpha)				
Elusor macrurus	Mary River turtle^	E	E	
*Maccullochella mariensis*is	Mary River cod^	E	-	No take
Nannoperca oxleyana	Oxleyan pygmy perch	E	V	
Neoceratodus forsteri	Australian lungfish	V	-	No take
Pseudomugilmellis	Honey blue-eye	V	V	
Haliaeetus leucogaster	White-bellied Sea-Eagle*	M		
Nettapus cormandelianus albipennis	Australian Cotton Pygmy-goose	M	NT	
Cyclopsitta diophthalma coxeni	Coxen's fig-parrot	E, M	E	
Erythrotriorchis radiatus	Red goshawk	V	E	
Mixophyes iteratus	Giant Barred frog	E	E	
Monarcha trivirgatus	Spectacled Monarch	M	LC	
Rhipidura rufifrons	Rufous fantail	M	LC	
Turnix melanogaster	Black-breasted button-quail	V	V	
Phascolarctos cinereus	Koala (Sth East Qld only)	V	V	
Pteropus poliocephalus	Grey-headed flying-fox	V	LC	
Adelotus brevis	Tusked frog	-	V	
Calyptorhynchus lathami lathami	Glossy black-cockatoo (eastern)	-	V	
Litoria pearsoniana	Cascade Tree frog	-	E	
Ninox strenua	Powerful owl	-	V	
Ornithoptera richmondia	Richmond birdwing	-	V	

	butterfly			
Eutacus hystorica	Giant Spiny crayfish	-	-	No take
Flora				
Cossinia australiana		E	E	
Fontainea rostrata		V	V	
Phaius australis		E	E	
Quassia bidwillii		V	V	
Romnalda strobilacea		V	V	
Syzygium hodgkinsoniae	red lilly pilly	V	V	
Xanthostemon oppositifolius	penda	V	V	
Macadamia integrifolia		V	V	
Macadamia ternifolia		V	V	
Alyxia magnifolia	Large leaf chain fruit	-	NT	
Choricarpia subargentea	giant ironwood	-	NT	
Floydia praealta	ball nut	-	V	
Paristolochia praevenosa	Richmond birdwing vine	-	NT	
Symplocos harroldii	hairy hazelwood	-	NT	
Thisma rodwayi		-	NT	
CE – Critically endangered, E – Endangered, V – Vulnerable, M – Migratory, NT – Near Threatened, LC – Least Concern , * also associated with estuarine and marine environments (Table 2) ^ Endemic				

Table 2: National and State listed species found in estuarine and marine environments

Species	**Common name**	**National *Environment Protection and Biodiversity* (EPBC) *Act 1999***	**Queensland *Nature Conservation Act 1992***
Fauna			
Ardea alba	Great Egret	M	
Charadrius mongolus	Lesser Sand Plover	M	
Esacus neglectus	Beach stone-curlew	M	V
Gallinago hardwickii	Latham's Snipe	M	

Haliaeetus leucogaster	White-bellied Sea-Eagle*	M	
Heteroscelus brevipes	Grey-tailed Tattler	M	
Limosa lapponica	Bar-tailed Godwit	M	
Merops ornatus	Rainbow Bee-eater	M	
Numenius madagascariensis	Eastern Curlew	M	NT
Numenius phaeopus	Whimbrel	M	
Pluvialis squatarola	Grey Plover	M	
Rostratula benghalensis s.	Painted Snipe	M	
Tringa nebularia	Greenshank	M	
Xenus cinereus	Terek Sandpiper	M	
Xeromys myoides	Water mouse	V	V
Natator depressus	Flatback turtle	V, M	V
Chelonia mydas	Green turtle	V, M	V
Dermochelys coriacea	Leatherback turtle	E, M	V
Dugong dugon	Dugong	M	V
Sousa chinensis	Indo-Pacific humpback dolphin	M	NT
Caretta caretta	Loggerhead turtle	E, M	E
Megaptera novaeangliae	Humpback whale	V, C, M	V
CE – Critically Endangered, E – Endangered, V – Vulnerable, M – Migratory, NT – Near Threatened, LC – Least Concern, * also associated with catchment (Table 1)			

3.2 Ecological communities/regional ecosystems

Approximately 11 000 ha of critically endangered EPBC Act listed ecological community of the "Lowland Rainforest of Subtropical Australia" is found within the Mary River catchment.

Regional Ecosystems (REs) are defined in Queensland based on region, geology and landform as well as vegetation type. The threatened regional ecosystems that occur in the Mary River catchment are identified below (table 3) listed. It should be noted that this listing applies to these REs at altitudes below 300m.

Table 3: Threatened riparian Regional Ecosystems/ ecological communities

Regional Ecosystem	Short Description	Included in "Lowland Rainforest of Subtropical Aus" EC
Endangered		
12.3.1	Gallery rainforest (notophyll vine forest) on alluvial plains	Yes
12.3.3	*Eucalyptus tereticornis* woodland to open forest on alluvial plains	No
12.5.13	Microphyll to notophyll vine forest±*Araucaria cunninghamii*	Yes
12.9/10.16	Araucarian microphyll/notophyll vine forest on sedimentaries	No
Of Concern		
12.3.11	*Eucalyptus siderophloia, E. tereticornis, Corymbia intermedia* open forest on alluvial plains near coast	No
12.9/10.3	*E. moluccana* open forest on sedimentaries	No
12.11.1	Simple notophyll vine forest often with abundant *Archontophoenix cunninghamiana* ("gully vine forest") on metamorphics ±interbedded volcanic	Yes
12.11.14	*Eucalyptus crebra, E. tereticornis* woodland on metamorphic±interbedded volcanic	No
12.12.1	Simple notophyll vine forest often with abundant *Archontophoenix cunninghamiana* ("gully vine forest") on Mesozoic to Proterozoic igneous rocks	Yes
12.12.12	Araucarian complex microphyll vine forest on metamorphics ±interbedded volcanics, northern half of bioregion	No

3.3 Priority Species

Table 4 lists the five priority species, identifies their current conservation status, percentage of naturally occurring populations within the catchment, and describes how this plan relates to other recovery plans. Two of the five species (Mary River turtle and Australian lungfish) are of worldwide scientific interest due to their unusual biology as is described in section 3.3.2 and 3.3.3 respectively.

Five criteria were developed to select the five priority species. Each priority species satisfies at least four of the five criteria.

- the species is threatened
- a new or revised recovery plan is needed for the species
- their populations in the Mary River are significant relative to the entire population and are in decline or under significant threat
- through considering the habitat needs and/or life cycle requirements of the species, all key functions of the river ecosystem are accounted for (i.e. lateral connectivity, longitudinal connectivity, riparian habitat quality, instream habitat quality (including water quality) and flow regime), and
- the species have community appeal (either through their iconic status or indigenous/cultural value).

Table 4: Priority species, their current conservation status, percentage of population in the catchment and relationship of this plan to an existing recovery plan.

Priority Species	Conservation status			% of natural population in the Mary Catchment	Relationship to existing recovery plans and conservation advices
	Queensland Government		Australian Government		
	Back on Track	NCA/ FA	EPBC Act		
Mary River cod (*Maccullochella mariensis*)	Critical	No take	Endangered	100% Populations elsewhere are entirely captive bred.	This plan to replace Mary River Cod Research and Recovery plan (Simpson and Jackson 1996)
Mary River turtle (*Elusor macrurus*)	Critical	E	Endangered	100%	Recovery plan is required. Existing Conservation Advice
Australian lungfish (*Neoceratodus forsteri*)	Critical	No take	Vulnerable	? % of population in the Mary River?	Complement the National Lungfish Recovery Plan (DSEWPaC in prep)
Giant Barred frog (*Mixophyes iteratus*)	High	E	Endangered	? % of population in the Mary River	Expands on Mary River specific aspects of the Stream Frogs Recovery Plan (Hines et al. 2002)
Freshwater mullet (*Trachystoma petardi*)	Not listed	Not listed	Not listed	? % of population in the Mary River	No existing conservation advice or recovery plan.

3.3.1 Mary River cod (Maccullochella mariensis)

The Mary River cod *(Maccullochella mariensis)* is closely related to the Murray cod (*Maccullochella peelii*) and Eastern freshwater cod (*Maccullochella ikei*) (Nock et al. 2010). Mary River cod are endemic to the Mary River though they do represent a type of fish which is believed to have occurred throughout many waterways in south east Queensland.

Mary River cod were once so common in the catchment that they were caught and used as pig food by settlers. A combination of overfishing and habitat deterioration has contributed to major population declines (Simpson 1994). Based on anecdotal reports, their sharp decline occurred sometime between 1930s and 1960s (Simpson and Jackson 1996).

A captive breeding and release program operated from around the 1970s to 2000s. Although the program began because of recreational anglers' love of the species, it has included an explicit conservation component since the late 1990s.

There are currently limited data regarding the distribution, abundance and population structure and dynamics of Mary River cod (Jackson 2008).

3.3.1.1 Population status

The status of the population is currently unknown though it is believed to reside in only 30% of its original range (Simpson and Jackson 1996). The last population survey of the cod took place in 1994 (Jackson 2008), and a study of the distribution of cod habitat was also conducted in 1998 (Pickersgill 1998). Simpson and Jackson (1996) provided an estimate of the population of less than 600 individuals in the Tinana, Six mile and Obi Obi Creek systems and an unknown number in the remainder of the river system.

As a result of the captive breeding program, fingerlings have been released in 85 – 90 % of their former range since 1998 (Jackson 2008). There are no data available to determine whether the fingerling releases have resulted in any self-sustaining populations. However there are anecdotal reports of cod returning to areas where they have previously been absent.

3.3.1.2 Distribution

Figure **X-X** (Appendix **XX**) depicts the confirmed and possible distribution of the Mary River cod in the Mary River catchment by subcatchment (as defined by the Aquatic Conservation Assessment (State of Qld 2011c)).

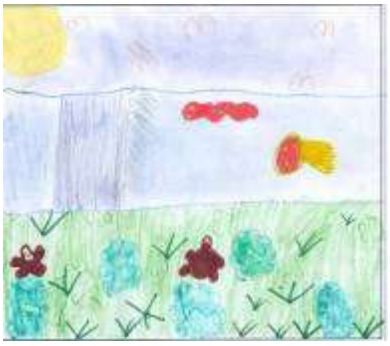
Compared with information in the 1996 recovery plan, known distribution has expanded to include the lower reaches of Yabba and Kandanga Creek, the upper reaches of Six Mile creek and sections of Widgee Creek. Probable occurrence is based on the locations of the DNRMs Aquatic Ecology Group study sites and findings of the 1998 cod mapping project (Pickersgill 1998).

3.3.1.3 Habitat critical

The Mary River cod occurs mainly in pools within relatively undisturbed tributaries (Wager and Jackson 1993). Cod prefer relatively large and deep (0.8 to 3.2 m) shaded pools with abundant, slowly flowing water (Simpson and Jackson 2000). Submerged logs and branches (snags) are a very important component of their habitat. The species also utilises undercut banks, rock outcrop and riffle, run, glide habitats for feeding and breeding. Table **X** details habitat critical for all the species and section 3.4 further explains the importance of habitat critical.

More detail about the ecology and biology of the Mary River cod is provided in the species profile in Appendix **XX**.

3.3.2 Mary River turtle (Elusor macrurus)



The Mary River turtle *(Elusor macrurus)* was formally described 1994. It occurs only in the Mary River and is regarded as the most specialised "river turtle" in the Chelidae family. It has a unique characteristic shared by only a handful of turtles in the world in that it has the ability to breath while underwater through gill like structures within its cloaca. The males of this species are the largest turtles in the Mary River (Queensland Water Infrastructure 2007), and can be identified by their massive tail. The tail of the female Mary River turtle is much smaller than the tail of the male. The turtle is an icon of community engagement and awareness as a result of the work of Tiaro and District Landcare.

3.3.2.1 Population status

The Mary River turtle has experienced major population declines in the last 50 years. Nest surveys (Flakus 2003) indicate that the population has declined by 95% since 1974, with the majority of this decline occurring in the lower catchment.

Current population levels are difficult to estimate and predictions vary significantly. The population is generally thought of in terms of two distinct areas – the lower to middle Mary around Tiaro (where the majority of historical nest robbing occurred) and the stretch of the river between Gympie and Kenilworth. Kuchling (2008) estimated the population in the Kenilworth to Gympie stretch to be five times higher than in the lower and middle Mary and to contain a much higher proportion of juveniles.

Based on estimates of the population in the Traveston Crossing dam footprint of between 895 and 3580 individuals (Queensland Water Infrastructure 2007) and Kuchling's (2008) estimate, the population size could be between approximately 1000 and 4000 individuals. Numbers of animals of breeding age is not known.

3.3.2.2 Distribution

The Mary River turtle is found from Kenilworth to the Mary River Barrage on the main trunk of the Mary in Yabba Creek downstream of Borumba dam. There has also been one sighting on Tinana Creek (Queensland Water Infrastructure 2007).

Appendix xx depicts the distribution of the Mary River turtle.

3.3.2.3 Habitat critical

All freshwater sections of the Mary River are potential habitat. Important features include flowing, well-oxygenated sections of streams, riffles (particularly productive parts of a river that are shallow with fast-flowing, aerated water) and shallow stretches alternating with deeper, flowing pools. Adults are usually found in areas with underwater shelter, such as sparse to dense macrophyte cover, submerged logs and rock crevices. They bask on logs and rocks (Flakus 2002; S. Flakus pers comm. 2003). Some turtles have also been captured at sites with little aquatic vegetation or submerged logs (Cann 1998). The species can occur in depths ranging from less than a metre to more than 5 m (S. Flakus pers comm. 2003). Micheli-Campbell (2012) found that juvenile turtles have very specialised habitats, which are limited in occurrence in the Mary River. In her study, juveniles were predominately located immediately upstream or downstream of riffle zones and near the rivers edge. In these locations the water is not deep and is flowing slowly. Sand banks are required for nesting. Table X details habitat critical for all the species and section 3.4 further explains the importance of habitat critical.

More detailed information about the Mary River turtle is available in the species profile in Appendix XX.

3.3.3 Australian lungfish (Neoceratodus forsteri)

The Australian lungfish *(Neoceratodus forsteri)* is a prehistoric fish, which occurs in a limited number of river systems in South East Queensland. It is regarded as a living fossil, a predecessor to all land vertebrates, which has not changed for the last 200 million years (Joss 2004). When it first became known to the scientific world in the late 1800s, it aroused tremendous curiosity, as explained in Box 1. In the past, the lungfish is believed to have been much more widespread throughout Australia. Researchers have speculated that their survival in the Mary River and other nearby catchments may be a result of a combination of lack of large predators and an ability to out compete ray-finned fish during Queensland's long hot summers when water quality declines (Joss 2004). The ability of the lungfish to breath air through its single lung provides it with an adaptation to low dissolved oxygen.

The lungfish also has particular significance to the Gubbi Gubbi people and is known to them as Dala (Box 2).

3.3.3.1 Population status

In 2003, it was estimated that breeding habitat had been reduced by about 26% in the two main rivers in which it resides (the Mary River and the Burnett) (Environment Australia 2003). Since 2003, the Paradise Dam has been built on the Burnett and habitat for the lungfish further reduced.

The population of lungfish is unknown across its range however the Mary River population is considered relatively healthy compared to other catchments.

Box 1: Mystery of the lungfish

From the earliest times (1870) when Ceratodus (Epiceratodus forsteris Krefft) became know to the scientific world and was described by Gerhard Krefft of the Australian Museum, no one, not even the aborigines, was able to find the very young fish: individuals even six pounds in weight were scarce and only very rarely indeed were specimens two or three pounds in weight taken.

From "On the life history of Ceratodus", Thos Bancroft (1928)

3.3.3.2 Distribution in the Mary River catchment

Surveys conducted by the Queensland Department of Primary Industries and Fisheries (DPI&F) and other records indicate that lungfish are widely distributed throughout the Mary River and its tributaries.

Box 2: Dala the lungfish

She is the artery pulsing life through the veins of Gubbi Gubbi [indiscernible Aboriginal word], touching our birthplaces, the sacred pools, our spiritual places as she flows. She gives sucker to rainforest and special trees that cradle bones of our past generations. In her womb she bares Dala, who, like a whisper from a long forgotten past, symbolises the wisdom of our elders, directed by the ancestral spirits to bring life from the sea to the vertebrae creatures on the land. Flowing through time our duty is to care for Mumabulla and to care for Dala, and it is your duty too. She is the symbol of our past, our present, and our future. She is Mumabulla, mother of the sacred. (poem by Dr Eve Fesl, Gubbi Gubbi elder - should be able to get original, but this is from DeRijke 2011)

Appendix xx shows the confirmed and possible distribution of the lungfish in the Mary River catchment by subcatchment (as defined by the Aquatic Conservation Assessment (State of Qld 2011c)). The known distribution is based on records provided from the Wildnet database in July 2012, and the studies conducted as part of the assessment process for the proposed Traveston Crossing dam.

3.3.3.3 Habitat critical

Structural complexity is an important habitat characteristic for both juvenile and adult lifestages (Brooks and Kind 2002, Kind 2002). Submerged aquatic plants are an important habitat feature for breeding grounds, nursery areas and adult foraging zones (Kind 2002). Woody debris are also believed to be important to Australian lungfish, particularly sub-adult individuals (Kind 2002), though are not utilized as extensively as macrophytes habitats. Lungfish also require open water free of macrophytes and contiguous fringing riparian vegetation. Deep pools >1.5 m are utilized as well as permanent water holes and riffle, run and glide habitats which connect reaches. Table X details habitat critical for all the species and section 3.4 further explains the importance of habitat critical.

Further information about the lungfish is available in the species profile at Appendix xx.

3.3.4 Giant barred frog (Mixophyes iteratus)

The giant barred frog *(Mixophyes iteratus)* is found in the upper Mary River catchment which is the northern limit of the species' distribution. Elsewhere in Queensland, it is found along the Maroochy River, the Stanley River downstream to Kilcoy, the Caboolture River, Burpengary Creek, Coomera River and Nerang River (Hines et al. 2002) as well as in an isolated population in the Burrum catchment. The frog is also found in northern New South Wales.

As a stream dependent frog it is part of a group of frog species which have experienced rapid and, as yet, unexplained declines in population, sometimes leading to extinction (Hines et al. 2002).

Being one of the largest frogs in Australia, and beautifully patterned, the giant barred frog is a charismatic animal that has inspired stakeholders and community involvement in conservation activities.

3.3.4.1 Population status

Declines in this species were noticed, along with several other rainforest dependent frogs between the 1970s and 1980s (Hines et al. 2002). The exact cause of this decline is not known. Possible contributing factors include chytrid fungus, increased UV rays, climate change, chemical pollution as well as a range of localised threats such as habitat clearing (Hines et al. 2002).

In the areas were the MRCCC has been undertaking frog surveys for the last 10 years, populations appear to be relatively stable, however numbers of frogs sighted are low. There is no population estimate for the giant barred frog either within the Mary River or throughout its range.

3.3.4.2 Distribution in the Mary River catchment

Appendix XX shows the known subcatchment distribution of the giant barred frog in the Mary River catchment together with the likely or possible distribution of the frog. The known distribution is based on official records from Wildnet from July 2012. Likely

distribution is based on confirmed records in the MRCCC database which have also been entered into Wildnet and the presence of suitable habitat. This representation of the distribution is not exhaustive because there are significant areas within the catchment that have not been surveyed and there are also likely to be other areas with suitable habitat. The giant barred frog also occurs outside of the Mary River catchment with its full distribution described as from Belli Creek near Eumundi, south-east Queensland, south to Warrimoo, mid-eastern NSW (Hines et al. 1999). The Southern Barred Frog is currently known from mid to low altitudes below 610 m asl (Hines et al. 2004).

3.3.4.3 Habitat critical

The giant barred frog occurs in uplands and lowlands in rainforest and wet sclerophyll forest, including farmland (Ingram and McDonald 1993). Populations have been found in disturbed areas with vegetated riparian strips on cattle farms and in regenerated logged areas (Hero and Shoo n.d. cited in Hines et al. 2004). Many sites where the giant barred frog is known to occur are the lower reaches of streams which have been affected by major disturbances such as clearing, timber harvesting and urban development in their headwaters (Hines et al. 1999). Table **X** details habitat critical for all the species and section 3.4 further explains the importance of habitat critical.

More detailed information about the Giant barred frog is available in the species profile in Appendix **xx**.

3.3.5 Freshwater mullet (Trachystoma petardi)

The freshwater mullet *(Trachystoma petardi)* is endemic to select east coast rivers and is significant because it is in decline (Stockwell et al 2004) and because of its dependence on connectivity between fresh water and estuarine reaches (Riede 2004) and sensitivity to the presence of long-term barriers. Also known as the Pinkeye, Richmond or River mullet, the Mary River is close to the northern limit of its distribution which extends from the Georges River in New South Wales to the Burnett River in Queensland (Allen et al. 2002).

In the Mary River system and adjacent estuarine and coastal waters several mullet species can be found however the Sea mullet is most similar to freshwater mullet in its form and habitat use. Both are found in the river and tributaries, extending as far upstream as the downstream side of Baroon Pocket Dam on Obi Obi Creek. Freshwater mullet are less common in the Mary River system than the Sea mullet (Hutchison 2012). Ways of distinguishing freshwater mullet and sea mullet from each other are discussed in the species profile.

It is a species that is readily identified by the local community even if identification may not always be definitive. The freshwater mullet is also an important species in indigenous culture, particularly in the middle and upper catchment. It is a totem species for around the Gympie area (Bargo 2012) and much traditional knowledge of the mullet is held by elders.

3.3.5.1 Population status

The population is in decline in many rivers, and appears to have almost vanished from the Burnett, Kolan, Gregory, Burrum and Isis Rivers (Kind and Brooks 2003) which are to the north of the Mary River. The populations in the Mary have not experienced the same declines as in other rivers, though they may be locally extinct above the weir on Tinana Creek (Hutchison 2012).

As the freshwater mullet does not utilise ocean waters to a great extent, the opportunity for replenishment from adjacent waterways is minimised once numbers have declined in

a river system. This phenomena has been observed on the Mary and the Burnett Rivers following the removal of some barriers and the installation of fishways, and the subsequent rapid increase in numbers of Sea mullet *Mugil cephalus*, which utilise ocean waters, compared with the slower recovery of freshwater mullet (Hutchison 2012). There is no population estimate for the freshwater mullet either within the Mary River or throughout its range.

All populations in the Mary River should be considered important populations necessary to the long term recovery and survival of the species due to the relative health of the population in the Mary River and decline of the species in other river systems.

3.3.5.2 Distribution in the Mary River catchment

Appendix xx shows the confirmed and possible distribution of the freshwater mullet in the Mary River catchment by subcatchment (as defined by the Aquatic Conservation Assessment (State of Qld 2011c)). The known distribution is based on records provided from the Wildnet database in July 2012. There are limited records, potentially because, despite the population declines, mullet are not typically targeted in monitoring programs. Possible occurrence is based on where they are likely to be found because of the habitat.

3.3.5.3 Habitat critical

Within the riverine habitat this species favour deep pools where stream flow is slow (Gomon 2011). Schools of feeding mullets (mullet runs) are very noticeable at the water surface. They are often caught during electrofishing research activities around submerged structures where it is believed they feed on the biofilm (M. Hutchinson pers comm. 2012). Juveniles are frequently associated with riffle habitats (Kind and Brooks 2003) where protection and a food source is available.

Studies in the Hawkesbury-Nepean River have shown freshwater mullet to be more abundant near well vegetated banks than grassy slopes (Growns et al. 2003). This, combined with observations by researchers of mullet being more abundant in proximity to in-stream woody debris (M. Hutchinson pers comm. 2012) shows a possible reliance on riparian vegetation that is not presently well understood.

Mature adults move downstream to spawn in estuaries and the sea from summer to autumn. Table X details habitat critical for all the species and section 3.4 further explains the importance of habitat critical.

More detail about the freshwater mullet is provided in the species profile in Appendix xx.

3.4 Habitat critical to survival

Because of the importance of connectivity in aquatic ecosystems, habitat critical relates to both the physical characteristics of the habitat in which the species forage, breed and escape predators as well as the broader habitat characteristics required to provide connectivity.

Habitat critical for each priority species is described in table x. Habitat critical will change through the different life stages of each priority species. There is considerable overlap between the important habitat components for the lungfish, cod, mullet and turtle. The frog is more specialised in its requirements.

Due to the fluctuating nature of a river system (flood/drought cycles and associated erosion and deposition changes) the location of habitat critical to survival of the species can fluctuate considerably. Therefore spatial information cannot be provided as the

natural changing systems in play in a river system constantly changes the location of habitat critical to survival.

Table X Habitat critical characteristics

Species	"Habitat critical" characteristics for survival, breeding and connectivity
All species	• Riparian zone providing diverse terrestrial and aquatic habitat features and healthy river processes
All species (except Giant barred frog)	• Open water (free of macrophytes[4]) and complex in stream structure including, beneficial large wood (various sizes of individual logs or log piles), undercut (riparian tree root stabilised) banks, rock outcrop, contiguous fringing riparian vegetation providing shade etc • Deep pools, seasonal and perennial, riffle, run and glide habitats connecting perennial pools and allowing movement between reaches within distribution
Mary River cod *(Maccullochella mariensis)*	• Deep pools (>1.5m) permanent waterholes • Shallower water (often found near riffles – feeding, may also spawn there) • Non turbid in-stream water quality during the spawning period • Natural base flows to inundate riffles and facilitate movement between deep pools. (Movement is generally downstream in Winter and upstream in Spring and associated with location of mates and spawning sites). • Shading of water by fringing riparian vegetation • Spring increases in stream water temperature to >20°C to initiate spawning behaviour • Water temperatures less than ~ 28°C for health and survival • Connectivity (fish passage) throughout entire reach network
Mary River turtle *(Elusor macrurus)*	• Flowing, well oxygenated sections of streams • Relatively deep (~1 – 5 m) river pools with high dissolved oxygen concentrations, alternating with riffles and shallow stretches • Native macrophytes, underwater shelter, submerged logs • Instream basking logs and rocks • Non submerged/available sand banks during the nesting season • Nest bank temperature <30°C
Australian lungfish *(Neoceratodus forsteri)*	• Deep pools (>1.5 m) permanent waterholes • Shallow, flowing stream sections with dense beds of submerged native macrophytes • Non turbid in-stream water quality during egg development (in macrophyte beds) • Natural base flow regime and prevention of rapid inundation/water level drawdown which can lead to egg/juvenile exposure /desiccation or alternatively egg /juvenile habitat scouring /inundation and associated stresses i.e. lower

[4] While macrophytes are an important part of a healthy river system, at times, exotic macrophytes in particular, can grow prolifically and limit open water habitat. Habitat free of macrophytes is needed by these species.

	dissolved oxygen at depth. • naturally timed elevated in-stream flows to facilitate fish movements between pools
Giant barred frog *(Mixophyes iteratus)*	• Stream order 3 to 5 (primarily) and 6 • Shallow, rocky freshwater streams to deep, slow moving streams • Permanent pools with undercut banks and other instream structures (for egg laying and tadpole survival) • Riparian rainforest with stable banks, canopy cover and leaf litter and associated wet schlerophyll forest • Low vegetation and grass • Connectivity of vegetation along river between sub-catchments, and/or connectivity between upper reaches of sub-catchments
Freshwater mullet *(Trachystoma petardi)*	• Deep slow flowing pools • Connectivity between estuary and the upper reaches of the river, requiring both passage and sufficient flow to connect reaches • Seasonal flow pulses to enable movement of adults to spawn in the estuary and the sea and to return to the river

4 THREATS

4.1 Overview

The current status of the priority species and the overall health of the river can be attributed to a range of historical and current activities that have contributed to population declines. The threats are presented in order of their rating based on criteria of scope, severity and irreversibility.

- **Scope:** "The proportion of the species that can reasonably be expected to be affected by the threat within ten years or three generations".
- **Severity:** "Within the scope, the level of damage to the target from the threat that can reasonably be expected given the continuation of current circumstances and trends. Usually measured as the degree of reduction of the target population within the scope".
- **Irreversibility:** "The degree to which the effects of a threat can be reversed and how quickly the target affected by the threat can be restored".

Current known threats were considered in the prioritisation process (Appendix xx). The significance of threats is ranked across the five priority species collectively. As more information becomes available, the threat prioritisation process will be revisited regularly to incorporate new threats and revise the impact of existing threats.

The majority of the threats operate across the entire range of all the species in the plan. The location of threats can fluctuate considerably because of the dynamic nature of the system.

4.2 System wide threats

The threats listed in this section are threats that need to be addressed on a river basin or system wide level because they operate at this scale.

4.2.1 Poor integrity of riparian zone

Overall Threat Ranking: High

MR cod	MR turtle	lungfish	f'water mullet	giant barred frog
high	medium	medium	low	high

The riparian zone plays a crucial role in shaping the structure and function of the river ecosystem. If these structural and functional attributes are not present, there is a range of impacts to specific species and to overall river health.

Features of this threat are listed below along with a summary of the relevance of each feature to the priority species:

- **Stability of the riparian zone** has a direct impact on water quality. Bank slumping has been estimated to account for 87% of sediment entering the Mary River (De Rose et al. 2002).

- **Lack of shading/water temperature impacts** – shade is particularly important for giant barred frog and impacts on water temperature are particularly significant for Mary River cod and Mary River turtle. The Mary River cod is tolerant of a narrow range of temperatures and the proliferation of aquatic plants and low dissolved oxygen that can be associated with high light levels are detrimental to the species. Freshwater mullet are also susceptible to low dissolved oxygen.

Box 8: A healthy riparian zone around Tiaro….

"Lots of maidenhair fern – used to see it on the banks, near the water level. It's a healthy sign according to the elders. Occurs where there is not too much disturbance, not too much traffic."

Aunty Maree,
Butchulla Elder (ref)

- **Lack of ground layer habitat/leaf litter** – leaf litter is essential habitat for both juvenile and adult giant barred frogs. Instream, leaf litter is also believed to provide important habitat for juvenile lungfish.
- **Lack of leaf litter inputs to food chain** – leaf litter is an important source of organic carbon that helps fuel the entire food web of the river ecosystem, particularly the forested streams where light is limited (Bunn et al. 1999). Invertebrates that depend on leaf litter are a food resource for Mary River cod. Microinvertebrates are also suspected to be a food source for larval and juvenile lungfish (Bunn et al. 1999b).
- **Lack of provision/renewal of beneficial large wood** – particularly important for Mary River cod. Tracking studies have found Mary River cod within 1 m of beneficial large wood 90% of the time (Simpson and Jackson 2006). The Mary River cod also uses beneficial large wood as egg laying substrate, although breeding in the wild has not been observed, captive breeding methods indicate hollows logs greater than 30 cm in diameter would be important breeding sites. Beneficial large wood are also important refuges for juvenile lungfish and juvenile Mary River turtle and may provide surfaces for giant barred frogs to lay their eggs. Beneficial large wood also provides surfaces for colonisation by algae, which are believed to play an important role in food webs in large stream systems (Bunn et al. 1999b). Algae are also a common food for freshwater mullet.
- **Reduced availability of undercut root banks** – bank undercuts provide breeding sites for giant barred frogs, which throw their eggs onto the roof of the undercut. Undercuts are also believed to be an important shelter for juvenile Mary River cod, turtle and lungfish. Clearing of riparian vegetation and bank slumping can destroy these undercuts.
- **Reduced width of riparian zone** – narrower riparian zones have less capacity to filter sediments and nutrients entering streams via the land. The giant barred frog also has a requirement of a riparian zone width of approximately 40 m (Lemckert and Bassil 2000; Koch and Hero 2007). Established trees in riparian zones also provide a seedbank for future generations of riparian trees, and if they are removed growth of new seedlings is constrained. Goannas are significant predators of Mary River turtle nests, and there is speculation that narrowing the riparian zone may concentrate goanna populations and increase nest predation (M. Connell pers comm. 2012).
- **Loss of mosaic of micro-habitats** – the need for sandy banks for nesting by the Mary River turtle highlights the importance of a mosaic of habitats.

- **Introduced vine weeds** (e.g. Cats claw creeper (*Macfadyena unguis-cati*), madeira vine (*Anredera cordifolia*)) – these vine weeds can have physical impacts by impeding growth of new trees and weighing down the canopies of established trees to such an extent that limbs break. They also smother the groundcover and inhibit growth of seedlings. Therefore there is potential impact on bank stability, as new trees are not replacing old trees that die and also rob the riparian zone of the old trees that are so crucial for the seedbank.
- **Lack of continuity of riparian vegetation** – for giant barred frog gaps in the riparian zone are believed to be barriers to movement. These gaps also have impacts on water quality and instream habitat which may create barriers that constrain movement of aquatic species.

4.2.2 Poor water quality

Overall Threat Ranking: Medium

MR cod	MR turtle	lungfish	f'water mullet	giant barred frog
medium	high	low	medium	low

Water quality is affected by geology, land management techniques, point and non-point source pollution, in stream structures, gravel and sand extraction, changes to the riparian zone structure and function and changes to energy, nutrient and water flows throughout the catchment. The impacts on water quality may be short or long term, localised or widespread depending on the causal factor.

Ecologically the most important characteristics of water quality include temperature, dissolved oxygen, salinity (i.e. electrical conductivity), pH, nutrients, pesticides and herbicides and sediment levels (i.e. turbidity). The impacts of these aspects of water quality for each priority species are described below. Importantly, the impacts may differ at different stages of the life cycle of the species.

- **Turbidity** – sediment is a naturally occurring feature of river systems, however human modification has led to changes in the way that sediment is supplied to the Mary River, the way it moves through the system, and ultimately the amount and timing of sediment flowing into the Great Sandy Strait and Hervey Bay.

  Anecdotal reports identify numerous swimming holes in the river that were once deep and clear, and have now filled with sand and are covered in turbid water.

  Sediment suspended in the river, which then settles to the riverbed, can smother eggs of both the Mary River cod and lungfish. This may directly kill the eggs by depriving them of oxygen, or in the case of lungfish, make the eggs more vulnerable to disease. Sediment can also smother spawning areas of lungfish, which are found in shallow beds of aquatic plants. If sediment is sufficient to smother this aquatic vegetation, this may also impact on Mary River turtles that eat these plants. Sediment may also smother biofilms and algae on which freshwater mullet feed. The impact on giant barred frogs is unknown.

- **Temperature** – Mary River cod have a narrow temperature range that they can tolerate. Mary River turtle are also affected by temperature. Research has shown that juvenile turtles surface more often when water temperature is high as oxygen

levels in the water are lower (Clark et al. 2008). This increases their vulnerability to predators both within the water column (e.g. predatory fish) and at the surface (e.g. birds of prey).

- **Dissolved oxygen** – In addition to the research by Clark et al (2008) Kuchling (2008) has suggested that this aspect of water quality is extremely important for Mary River turtles. Dissolved oxygen levels are closely related to temperature. Very low levels of dissolved oxygen can lead to fish kills of Mary River cod and may also impact on the eggs and larvae of lungfish. Freshwater mullet are also susceptible to low dissolved oxygen levels. The impacts on giant barred frog tadpoles are unknown.
- **Salinity** (often measured by electrical conductivity) – Salinity can occur naturally in streams; it may also become elevated as a result of land management practices. The Mary River catchment has been identified in the National Action Plan for Salinity (Perry and Bay 2003) as a high risk catchment. Some streams within the catchment have naturally high levels of salinity as a result of the local geology. The impacts of salinity on Mary River cod and tadpoles of giant barred frog are unknown. Lungfish are known to be intolerant to salinity (Kind et al. 2008) which may also impact on survival and/or development of lungfish eggs. Mary River turtle are also not tolerant of high salinity levels, as evidenced by the difficulty they experience when they are washed over the barrages into the estuary.
- **pH** – the Mary River Catchment is identified (Perry and Bay 2003) as having high potential for soil acidification which could lead to changes in the pH of streams. There is little known about the impact of pH on the priority species. The Mary River cod, giant barred frog and lungfish are well established within the Tinana Coondoo system, which has a lower ambient level of pH than the main river system, where these species are also found.
- **Nutrients** – elevated levels of nutrients can result in proliferation of aquatic weeds. Excessive growth of aquatic weeds can lead to declines in water quality and decrease the availability of breeding sites for both lungfish and Mary River cod. Based on observations in other frog species, the giant barred frog tadpoles may be directly affected by high levels of nitrate (a mobile and soluble form of nitrogen generated by fertilisers and manures of all types).
- **Pesticides / herbicides** – there is limited evidence regarding the direct impacts of pesticides and herbicides on the priority species. However veterinary chemicals and termite control chemicals have been linked directly with fish kills of Mary River cod. It is likely that these and other chemicals are detrimental to lungfish and giant barred frogs.

4.2.3 Modification of geomorphology

Overall Threat Ranking: Medium

MR cod	MR turtle	lungfish	f'water mullet	giant barred frog
high	medium	medium	medium	medium

Changes to the distribution and movement of sand and gravel in the Mary River and resultant change in riverbed and riverbank stability include:

- **Reduced replenishment of downstream sand banks** - this has an impact on nesting of Mary River turtles, which unlike other turtles in the river are entirely dependent on sandy banks for nesting sites.

- **Loss of deep water habitat and undercuts** – alterations to the riverbed and river banks can lead to changes in sediment movements that result in deep pools being filled with sediment and undercuts lost. The deep pools are important habitat for the Mary River cod, Mary River turtle, lungfish and freshwater mullet. Loss of these pools is believed to increase predation of freshwater mullet. The undercuts also provide breeding sites for giant barred frog and refuge for lungfish, Mary River cod and turtle.
- **Instability of the riverbed** - as a result of past activities (e.g. extraction of gravel and/or sand from the riverbed, construction of infrastructure that destabilises the river bed) this continues to be an issue throughout many areas of the catchment. Where it is occurring, erosion of the streambed in an upstream direction puts existing riparian vegetation, future revegetation projects, and infrastructure such as roads and bridges at risk.
- **Destabilising of riffle and glide zones**[5] - riffles play an important role of oxygenating water and providing habitat for a large number of algae and macroinvertebrates that fuel the food chain of the river. Macrophyte beds that provide breeding grounds for lungfish are often located upstream of riffles and can be destroyed by changes to geomorphology.

4.2.4 Fishing and recreation

Overall Threat Ranking: Medium

MR cod	MR turtle	lungfish	f'water mullet	giant barred frog
high	low	low	low	-

Both legal and illegal fishing, as well as boat movements associated with fishing or other recreational activities (e.g. water skiing) can have detrimental impacts on the species associated with the river.

With the exception of freshwater mullet, none of the priority species can be taken legally (Mary River cod can be caught in stocked dams but not in the Mary River). However they are captured accidentally. In these instances they must be handled in order to remove hooks, which can lead to increased mortality or injury particularly in the case of Mary River cod and turtle. During the breeding season the stress of being captured and released may cause female cod to reabsorb eggs, while males may abandon nests resulting in the eggs being predated upon.

Freshwater mullet are caught both recreationally and commercially. However mullet species are not differentiated in the records of commercial fishers, so the levels of capture are not currently known. Intentional kills of Mary River turtles and illegal take of Mary River cod and lungfish are suspected to occur, however the extent of these activities are unknown.

Activities that concentrate fishing effort in a particular area have the potential to increase accidental catch. In the case of the Tiaro Fishing competition there have been no known catches of Mary River cod (because they are not present), only occasional catches of lungfish and in the past few years two Mary River turtles have been captured (M. Connell pers comm. 2011). Given the number of Mary River turtles believed to be in the area

[5] Glides are the smooth, fast-moving area that often separates pools from riffles (http://www.ecy.wa.gov/programs/wq/plants/management/joysmanual/streams.html)

where the fishing competition occurs it has seems they are not attracted to taking fishing bait.

Discarded fishing equipment such as hooks, fishing line and traps also pose a risk.

Boat movements, particularly at high speed, causing boat strike, are a threat to both lungfish and Mary River turtle. Adult lungfish spend considerable time in open water unlike the cod, which are typically in close proximity to beneficial large wood. The risk is greatest in impoundments and big waterholes.

4.2.5 Invasive aquatic species

Overall Threat Ranking: Medium

MR cod	MR turtle	lungfish	f'water mullet	giant barred frog
medium	medium	medium	medium	low

Invasive aquatic species include both native and non-native plants and animals.

Plants
Weeds can be submerged, floating or emergent. Examples include water hyacinth (*Eichhornia crassipes*), salvinia (*Salvinia molesta*), hymenachne (*Hymenachne amplexicaulis*) and cabomba (*Cabomba caroliniana*). During times of low flow, these species can have profound impacts on water quality by dominating the water column or water surface, limiting light and reducing oxygen levels. Aquatic weeds also reduce the area of open water habitat and contribute to loss of the organisms living in the sediment, which are an important component of the foodweb. Aquatic weeds have the ability to grow in extensive mats or 'rafts' across the surface of the water. These rafts of weeds create a barrier to movement, which is a particular issue for the freshwater mullet. Aquatic weeds can also cause a decline in quality of the breeding ground of lungfish and reduce access to Mary River turtle nesting banks.

Animals
Fish that have been introduced either accidentally or deliberately have an impact on threatened species through competition for food and habitat resources, predation or habitat deterioration. These include aggressive, carnivorous fish such as Yellowbelly (*Macquaria ambigua*), Southern saratoga (*Scleropages leichardti*) (Indigenous name: *Guluibirr*) and Sooty grunter (*Hephaestus fuliginosus*), which have been stocked for recreational fishing purposes, are likely to predate on young turtles, lungfish, giant barred frog, mullet and cod. These fish also compete with cod and turtle for food. They also pose a risk of introducing novel diseases.

There are a number of invasive species that could predate young of the priority species. These include gambusia (mosquito fish) (*Gambusia holbrooki*), Mozambique tilapia or Mozambique mouth-brooder tilapia (*Oreochromis mossambicus*), carp (*Cyprinus carpio*) and red claw crayfish (*Cherax quadricarinatus*). Gambusia are well established in the catchment. Tilapia is not yet established though have been confirmed in one location in Yabba Creek in the Mary River catchment in 2012 (P. Kind pers comm. 2012), though the extent of the population is unknown. Carp and red claw crayfish are yet to be confirmed as present in the catchment. Tilapia and red claw crayfish also cause direct habitat degradation through their behaviour (modification of the riverbed floor for nesting). Overall the significance of the threat posed by these species is not well understood.

4.2.6 Terrestrial weeds

Overall Threat Ranking: Medium

MR cod	MR turtle	lungfish	f'water mullet	giant barred frog
medium	low	low	medium	medium

Direct and immediate impacts of terrestrial weeds include direct mortality (by entrapment) of young frogs e.g. understorey weeds such as silver leaf desmodium (*Desmodium uncinatum*) (also known as Velcro weed). Other weeds such as pasture grasses and various burrs can invade turtle nesting areas, physically restricting the ability of turtles to dig nests. Roots can grow directly through turtle eggs, killing the embryos. Vine weeds such as Cats claw creeper (*Macfadyena unguis-cati*), madeira vine *(Anredera cordifolia*), balloon vine (*Cardiospermum grandiflorum)*, coastal morning glory (*Ipomea cairica*), blue morning glory (*Ipomea indica*) and pasture legumes can reduce the integrity of the riparian zone through damage to canopy trees and preventing growth of seedlings. Weeds add to the fuel load, increasing the risk and severity of fire. Cats claw creeper and madeira vine are classed as Weeds of National Significance (WoNS).

4.2.7 Barriers including dams, weirs, road crossings, culverts, instream "farm dams",reaches with poor water quality

Overall Threat Ranking: Medium

MR cod	MR turtle	lungfish	f'water mullet	giant barred frog
medium	medium	medium	medium	-

In most cases barriers are physical structures in the river, but they can also include reaches which have water quality that is so poor that it acts as a barrier. In the case of the physical structures they may be legal (i.e. approved by local or state government), or they may be illegal (e.g. unapproved instream farm dams, causeways and culverts).

Reduced access to mates and associated gene pool isolation can occur where barriers prevent movement of species up and down the river system. Both the Mary River cod and lungfish are known to move considerable distances to breed. The importance of long distance movement for Mary River turtle is less understood, but the presence of two primary nesting areas within the catchment leads to questions about the importance of movement between the these two areas (located near Tiaro between Traveston-Kenilworth). Kuchling (2008) proposed that this turtle movement occurs and is significant for the species.

Barriers can interrupt the breeding cycle of the freshwater mullet which needs to move between fresh and estuarine waters to breed. Adult mullet will not breed in freshwater and must have access to the estuary for this purpose. Young mullet born in the estuary move up the river system and may be prevented from reaching upper tributaries by impassable barriers. Stranding of mullet in saline water leads to reduced growth, reduced feeding opportunity and possible increase in predation.

Marine stranding at the barrages may occur if a fish is too large to pass through the slots on the existing fishways on the two barrages. Slots on the Mary River and Tinana barrage are 200 mm. This slot size was included in the fishway upgrade in 2001 and 2000 respectively to better accommodate large lungfish and cod (Berghuis and Piltz 2005, Sunwater 2010) however some fish will be too large to fit.

Dams can cause direct mortality or injury of cod, lungfish and turtle either through being passed through a spillway or over a dam wall. Mortalities have been recorded at Paradise Dam on the Burnett River. During a monitoring period of 22 days 152 lungfish were killed after travelling over the spillway and 13 were killed in the downstream fish transfer device (DEEDI Fisheries Queensland 2012). The extent of injury to priority species by existing, smaller impoundments in the Mary River is unknown. However if large numbers of fish were injured or killed anecdotal evidence would be likely to be available.

Little is known about use of fish passage devices by Mary River turtle, however evidence from large pieces of infrastructure in other catchments (Burnett and Fitzroy/Dawson) indicates that water infrastructure is associated with mortalities of other turtle species (Latta 2007, Limpus et al. 2006).

Another effect of dams, barrages etc is that they pond water, creating habitats for bloom-forming algae and invasive plants.

4.2.8 Altered hydrology

Overall Threat Ranking: Medium

MR cod	MR turtle	lungfish	f'water mullet	giant barred frog
medium	medium	medium	high	low

Altered hydrology includes flow regulation as a result of impoundments (see Table X), extraction from the river for irrigation, urban water and other purposes, and the altered habitat found in parts of the river currently impounded. Groundwater/surface water interaction is an important consideration, about which, little is currently known in the Mary River catchment.

Altering hydrology can have detrimental impacts on water quality, causing changes to the temperature regime, reducing the habitat extent thereby contributing to increased crowding and competition and in the worst case fish strandings. Concentration of individuals in pools can also lead to increased predation by raptors as well as aquatic predators. Changes to the habitat, particularly the sequence of pools riffles and glides can also occur. This can cause subsequent changes in the ecosystem (e.g. macrophyte beds that provided breeding ground for lungfish become exposed banks, or pools containing giant barred frog tadpoles are drained). Extraction or regulation that prevents freshwater flow pulses interferes with triggers for movement used by species such as freshwater mullet and jeopardise connectivity throughout the river. Conversely, artificial pulses pose a risk of inundating macrophyte beds used by lungfish for breeding.

4.2.9 Altered catchment runoff regime / changed pattern of water flow

Overall Threat Ranking: Medium

MR cod	MR turtle	lungfish	f'water mullet	giant barred frog
medium	medium	medium	high	low

This threat differs from altered hydrology and barriers in that it refers to the way in which changes in land use, ground cover and aquifer behaviour lead to changes in the regime

and pattern of runoff. These changes include lower rates of infiltration, increased runoff speeds and different patterns of flow that occur through changes to ground cover and landforms associated with urban and in some cases agricultural areas.

Such changes can have impacts such as declines in water quality, reduction in base flow and changes to the persistence of pools, loss of movement triggers, loss of connectivity and increased strandings.

4.3 Species level threats

4.3.1 Terrestrial predators, trampling of eggs and habitat

Overall Threat Ranking: High

MR cod	MR turtle	lungfish	f'water mullet	giant barred frog
-	very high	low	-	medium

Predators may include dogs, cats and foxes; and native animals such as goannas, water rats and possibly ravens (Thompson 1983). Any activities that damage nesting sites such as vehicles driving on nesting banks or stock grazing in these areas can also destroy Mary River turtle nests. Without intervention to protect nests it is suspected that mortality of the nests may be as high as 100% (Limpus, 2008).

The location of nesting banks may change as a result of distribution of sand during floods. However, there are also known permanent nesting banks. These are currently protected by Tiaro and District Landcare and associated individuals around Tiaro, Traveston Crossing bridge and Kenilworth. The river has also been surveyed at various times to determine the location of potential nesting banks. Female Mary River turtles have been found to show strong site fidelity and be highly selective regarding nesting sites though the reasons why they choose particular nest banks are not well understood (Micheli-Campbell 2012).

Trampling and grazing of the riparian zone by stock is also a threat to the giant barred frog, particularly the tadpoles. Tadpoles require permanent pools for their long period of development which are very vulnerable to stock damage. Feral pigs are also known to eat frogs and destroy habitat. Cats and foxes may also eat frogs.

When stock have access to the river at watering points or crossings, this can also lead to macrophyte bed destruction and high incidences of lungfish egg destruction in that localised area. Turtles may also be trampled at these crossing points.

4.3.2 Chytrid fungus

The chytrid fungus is a threat to all frog species.

Chytrid fungus is rated as **medium** threat to giant barred. Chytrid fungus may be vectored by crayfish (McMahon et al. 2012).

4.3.3 Misidentification with cane toads

Because of its size and markings, at a distance, the giant barred frog can appear to resemble a cane toad. Consequently it is threatened by pest control activities targeting cane toads and has been killed accidentally. This threat is rated as **low** due to the limited incidence of this occurring.

4.3.4 Illegal aquarium collection

Illegal take of Mary River turtles by human beings for the pet trade is still believed to occur. Historically, robbing of nests by humans has had a great impact on the population.

Mary River turtles are available for purchase both in legal and illegal (black) markets. Illegal collection for these purposes poses a threat to the species, the extent of which is unknown. The Mary River turtle is available for purchase on the internet for a similar price to other species in the Mary River that are not endangered. This could be because its' nests may be easier to locate than those of other species. For this reason the exact location of nesting banks is not widely publicised. This threat is rated as low.

4.3.5 Low gene pool variability

Overall Risk Ranking: Medium

MR cod	MR turtle	lungfish	f'water mullet	giant barred frog
high	medium	low	low	n/a

In species that have been reduced to small populations or have populations that have been permanently separated, a reduced gene pool can lead to decreased fitness.

Captive breeding of Mary River cod has occurred since the 1970s and may have either reduced or increased this threat depending on the design of the stocking program. The only assessment of genetic variation in the Mary River cod was completed in 2012 (Huey et al. 2013). Results indicate that the two sub-populations in the Mary River and Tinana-Coondoo system are genetically distinct and both have low genetic variability. The level of genetic variability is such that theory would suggest that both genetic drift and inbreeding depression are a threat to the viability of the populations. However there is currently no evidence that the fitness of the population has been affected by the levels of genetic variability. Inbreeding depression may still occur and the low genetic variability may affect the adaptability of the species (J. Huey pers comm. 2012).

4.4 Universal threats

4.4.1 Climate change

Overall Threat Ranking: High

MR cod	MR turtle	lungfish	f'water mullet	giant barred frog
high	high	high	high	medium

The consequences of climate change for the Mary River bring a range of threats for the species considered in this plan that can be lessened through action at the river basin or specific location scale.

The latest predictions from the CSIRO (2007) suggest a range of climatic changes in the vicinity of the Mary River catchment between now and 2030[6]. In very broad terms, these changes may include average annual temperature increase of about 1ºC, a decrease in annual rainfall that is experienced mainly through decreases in spring and winter rain, an increase in the number of days without rain and an increase in the intensity of precipitation. These changes are likely to intensify beyond 2030. The trends regarding frequency and intensity of east coast tropical cyclones, which are often the source of major rain events and floods in the catchment, are currently inconclusive. All of these estimates should be refined in future as the International Panel of Climate Change and the CSIRO undertake more analysis and long term changes will be affected by the level of global emissions,

Overall, these changes in climate will exacerbate many existing threats to the priority species. In particular we are likely to see more prolonged low flow periods during winter, spring, and early summer which would contribute to promotion of aquatic weeds, and higher water and nesting bank temperatures. If flood events do occur more frequently this will also have a major impact on habitat quality and water quality.

The Mary River cod is vulnerable to all of these changes, particularly higher water temperatures because of its sensitivity to temperature extremes. Recent research has shown that Mary River turtles incubated at higher temperatures tend to be less fit and are therefore likely to be more vulnerable to predation and be less healthy in the wild (Micheli-Campbell et al. 2011). Giant barred frog breeding is dependent on semi-permanent pools which, with longer dry periods, may dry up.

Increasing drought severity will extend the periods of low flow in the river and increase the incidence of cease-to-flow events. Increasing flood severity will contribute to erosion and scouring of instream habitat features. The floods of 2011, 2012 and 2013 have illustrated that macrophyte beds can be almost completely obliterated in the main trunk of the river.

Further research is needed to understand the role of refugia and other specific adaptation requirements for the priority species. In addition, climate change has implications for techniques and methods used to restore riparian zones, for water resource planning and land use planning.

4.5 Potential threats

These are considered likely to become current threats in the near future and will be assessed accordingly through the implementation phase of this plan.

4.5.1 Mining for coal and coal seam gas

Mining impacts may further exacerbate the existing threats.

As of 2012 approvals had been granted for exploration for both coal and coal seam gas across an area of approximately 390 000 ha[7] or 42% of the catchment.

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[6] CSIRO (2007) made predictions out to 2070 but these are not discussed here because they are less certain due to the influence that contemporary global emissions trends will have. These predictions are also well outside the timeframe of this plan.

[7] Approximately 20 000 ha is for coal seam gas only, and another 61 000 ha is subject to applications for both coal and coal seam gas. The remainder is for coal only. About 40% of the Exploration Permits for Coal have been granted. These estimates are based on GIS analysis of area covered by exploration according to the Geoscience and Resource Information Service, Queensland Government.

Changes to water quality and hydrology would be likely to be associated with mining. The impact of such activities may be significant, particularly during times of drought when refugia for the threatened species are so crucial for their survival, and during floods when mining operations must manage large volumes of often highly contaminated water.

These exploration activities currently include areas that are regarded as prime habitat for the Mary River cod and lungfish within the Tinana Creek catchment. The interactions between groundwater and the Mary River and tributaries are not well understood. However, the wallum country to the north and east of the catchment is recognised as a groundwater dependent ecosystem and close interactions between the tributaries and the surrounding landscape are presumed to exist. Other significant areas of groundwater river interaction include the Maleny Plateau in the Upper catchment and the area around Wide Bay Creek and potentially Tinyalba Creek. Linkages between the river and the groundwater are observed in Wide Bay Creek particularly during drought. Therefore, in addition to the direct impact of vegetation clearing associated with open cut coal mining and coal seam gas drilling, both practices pose a threat to the hydrology of the catchment.

Burnett Mary Bioregional Assessment (Bennet 2012) on the impacts of coal and coal seam gas mining found that all surface and groundwater systems considered within the catchment are vulnerable to the impacts from these industries. This Assessment is overseen by the Australian Government's Interim Independent Expert Scientific Committee on Coal Seam Gas and Coal Mining and coordinated by the Burnett Mary Regional Group.

4.5.2 Increased demand for water extraction

Based on predicted human population growth (section 2.3.2) within the catchment, future demand for water could potentially come from Hervey Bay to the north and the Sunshine Coast to the south. The Mary River is also connected to the SEQ Water Grid at two points via the Northern Pipeline Interconnector Stage 1 and 2, so growth in South East Queensland could also place increasing demand on water resources within the catchment.

Impacts could arise from both the method of extraction of additional water (e.g. new infrastructure), as well as the volume and timing of extraction.

4.6 Impediments to Recovery

Capacity and Management
There are many significant organisational-related impediments to threatened species recovery. Essentially they revolve around themes of capacity and funding, knowledge management systems and community engagement. Impediment issues do not operate independently, that is, many are closely inter-related. Many important impediments are associated with much wider organisational issues and fully addressing these will be beyond the scope of this plan's implementation. Relevant management objectives for impediments to recovery are presented in Section 5.5.1.

Resources and Capacity

- There is a general lack of resource capacity for:
    - Government management agencies, NGOs and community groups to address the recovery needs of all priority species,
    - Recovery programs to fully engage and utilise community groups to contribute to recovery needs of all priority species, and

- Comprehensive monitoring and evaluation of threatened species recovery management performance.

- Issues involving funding arrangements include:
  - Lack of adequate funding to address the recovery needs of all priority species,
  - Inadequate funding structures for securing long-term sustainability for recovery programs (also affecting project staff satisfaction and staff continuity), and
  - Lack of consistency and coordination of project funding sources, leading to difficulties in integrating management priorities across program.

Knowledge-base systems

- Inadequate systems to assess long-term trends in regional conservation status (hence monitoring baselines are unknown and population decline is not detected in a timely way).
- Inadequate 'knowledge management' by conservation agencies. Knowledge is poorly captured and stored in management agency documentation, databases, monitoring and reporting systems. Consequently there is a great deal of uncertainty in relation to the status of most threatened species. This poor institutional knowledge also leads to poor project planning, information dissemination, sharing of knowledge and continuity in program management. Note, the term 'knowledge' refers to both descriptive and database forms of knowledge.
- Inadequate mapping and condition assessment.
- Current database systems and content are lacking for effective threatened species recovery planning. Issues include:
  - Poor integration of corporate and non-corporate databases
  - Poor systems structures
  - Incomplete minimum dataset information

Community engagement and coordination

- Insufficient community engagement, inter-agency engagement and coordination in recovery programs to address all recovery priorities.
- Insufficient engagement with Aboriginal stakeholders in recovery programs.
- The awareness levels concerning threatened species and recovery programs are generally low amongst the urban and rural resident population.

Other

- Insufficient applied research to inform management and planning
- State and local government policy and planning conflicts (e.g. economic development and population policies versus conservation policies), driving numerous direct threats to threatened species populations.

Knowledge Gaps

A major gap for the majority of species included in this plan is the lack of knowledge concerning population status. There is also uncertainty in many species juvenile behaviour and habitat. Recovery planning and management is impeded by the significant ecological knowledge gaps for the range of species included in this plan. The primary research needs that should be addressed during the life of this plan are included in the management actions in Section 5.5.2.

4.6.1 Lack of riverine habitat managed for conservation

Approximately 10% of the stream network is within National Parks, additional sections are covered by voluntary conservation schemes (such as Land for Wildlife) and various projects have occurred to improve riverine habitat (e.g. Beneficial Large Wood installation, removal of barriers to biopassage, riparian restoration). However, outside these areas, there are currently no mechanisms that allow certainty for long term management of key habitat areas or protection from key threats.

4.6.2 Lack of knowledge

The most important gaps in knowledge relate to current population status of the species, aspects of the life cycle, particularly the juvenile stage, use of habitat and impact of particular threats. These gaps create challenges for identifying the best recovery actions and appropriate management actions.

5 BIODIVERSITY MANAGEMENT PROGRAM

5.1 Guiding principles

The recovery plan is underpinned by a set of principles that guide the core task of recovering populations of threatened species and at the same time recognising the complex and interconnected social, cultural and economic role that the river plays. These principles define the plans as being interconnected, strategic, aligned, adaptive, relevant, inviting, encouraging and coordinated. Each principle is described in more detail below:

Interconnected: An aboriginal perspective on the river recognises that everything is connected. Within the constraints of the scope of the plan, this principle recognises that the priority species are connected with one another, with other species, to human culture and ultimately with a healthy river system. A complex set of factors influence river health, endangered species population status and the relationship between people and the river. This plan embraces that complexity. As suggested during one of the community forums about the plan, an interconnected approach urges people to "think catchmentally", which involves thinking in terms of the whole catchment and being mindful of the connections within the catchment.

Strategic: Communication about the recovery plan is linked to a clear set of goals and carefully targeted to the specific audiences. Opportunities are sought to piggy-back on existing activities and work with existing trends and interests among stakeholders. Actions have been prioritised strategically and are linked to subcatchments.

Aligned: Information presented in the recovery plan and associated documents are closely aligned with other plans and regulations.

Adaptive: As new information comes to light and progress is made on recovery actions, adjustments to this recovery plan will be needed. Additional detail regarding actions and species status is provided in appendices which can be revised / updated faster than the plan itself.

Relevant: The Plan is linked to other plans and landholder relevant information on a subcatchment scale. Locally iconic species are used to help people identify with the recovery actions.

Inviting: The plan invites contributions and involvement from all stakeholder groups and encourages people to learn about and value their part of the river.

Encouraging*:* The Plan recognises the existing activities that have been undertaken by landholders and numerous groups in the catchment and supports these existing activities as well as encouraging involvement of new groups and individuals.

Coordinated: Close cooperation between participants in the recovery process and all organisations with a stake in the outcomes of the plan forms the basis of a coordinated approach to recovery.

5.2 Recovery goal

The overall long-term goal of the recovery program is to ensure the long-term survival of healthy populations of the Mary River turtle, Mary River cod, Australian lungfish, giant barred frog and freshwater mullet in the Mary River ecosystem, and achieve improvements on the overall health of the Mary River that benefit a wide range of other species.

5.3 Strategy for recovery

The strategy for recovery is based on a view that the priority species form an important part of an integrated system, in which numerous other species and the catchment community live, and in which agriculture and various other industries operate. Collaboration across groups and inclusion of the community are keys to the success of this recovery program. Actions taken to assist in the recovery of the priority species will also assist in the recovery of the overall health of the Mary River.

> *If we wish to maintain a truly Australian river character, with naturally adapted flora and fauna, our target conditions for river management must replicate the natural variability in river structure and flow inherent in the Australian landscape. Hence, effective management is contingent on improving our knowledge of geomorphological interactions with ecological functioning in aquatic ecosystems"* (Brierley 1999).

This plan supports the involvement of the catchment community in the recovery process and aims to build capacity within and foster social and economic opportunities for this community.

Devising measurable recovery objectives with performance criteria to meet the recovery plan aim is the means by which both short and long-term recovery management success can be determined. However, considering the broad scope of this plan, development of comprehensive and quantitative recovery targets to achieve recovery outcomes is constrained by a range of factors. These include:

1. Extensive loss of riparian vegetation and destabilisation of the river bed. The ecological systems in the Mary River have been fundamentally modified by changes occurring in the last 170 years.
2. There are significant knowledge gaps of species ecological status.
3. Coordination and integration of prioritised recovery management is challenging as current on-ground management activities are undertaken by a diverse range of government and non-government stakeholders (planning and policy responsibilities are similarly varied).
4. Currently there are limited resources and capacity to achieve even modest conservation targets.
5. The intended duration of this plan is only ten years.

6. The complexity of the recovery requirements and lack of baseline data at the whole of catchment scale (both with regard to species status and indicators of river health) for use in quantitative comparisons.

There are many “no regrets” actions that can be taken. The validity of these actions is based on river science, past experience and local knowledge of the social context. Closing critical gaps in knowledge is an important part of the recovery process, and as these gaps are closed, and actions are taken and evaluated, the recovery process will adapt. It is recognised that one ten year plan, cannot claim to address all the complex ecological and management issues involved in recovering all the threatened species and ecological communities associated with the Mary River. However, the development of this plan has been mindful of avoiding actions that may have perverse outcomes for species recovery and has placed a high priority on actions that benefit overall river health. It both builds on past planning activities and provides a strong foundation for future planning.

Further, due to the size of the catchment, the diversity of current conservation management, its decentralised nature throughout the catchment and the strong preference people have for working within localised social networks, further adoption of sub-catchment based planning and action would be beneficial. To this end, the main purpose of this plan is, through mainly a species-based analysis, to inform threat abatement implementation by proposing both catchment and sub-catchment priorities according to transparent analyses of the best available information and data. This plan only presents a summary of this work. More detailed analysis results will be presented elsewhere by the recovery team for implementation use.

5.4 Previous and current conservation activities

The recovery of the species and river system considered in this plan could not occur without ongoing support and commitment from the people who rely upon and use the Mary River. Decisions regarding recovery of Mary River threatened species will benefit from recognition that this recovery plan is a recent phase in the long history of interaction between the Mary River ecosystem and humans. Much information is to be learned from the past impacts that have occurred on the Mary River. This may include ways to better manage the river, ways to better engage people and provide reminders of the resilient and dynamic nature of the ecosystem.

5.4.1 Existing management and conservation action

The early 1990s saw a consolidation of prevailing attitudes in the catchment toward greater awareness of and concern for the river. Some landholders changed their management practices accordingly. There was a focus on riparian zones and the research conducted by Thomson and Pepperdine (2003) found that in the early 1990s the perception of the importance of riparian restoration was already high and in the decade following knowledge of what to do in relation to riparian restoration and participation in restoration activities increased.

Since then, through the activities of the Mary River Catchment Coordination Committee (MRCCC), over 650 rivercare and catchment care projects have led to the fencing off of approximately 400 km of stream length (out of approximately 3000 km of major streams) and approximately 20 000 ha is being managed in more sustainable ways. The Mary River Catchment Coordinating Committee is a dedicated community group with a strong connection to the river that has been and continues to be, responsible for driving much of the river restoration projects in the region. Other groups have also contributed to hundreds of other projects involving revegetation, improved practices and rivercare activities. All of these activities are likely to have made a significant contribution to

improving the overall health of the river. As an indication, the first riparian restoration project, the Voluntary River Restoration Grants scheme involved 225 landholders and was estimated to have reduced faecal contamination and nutrients entering the river by the equivalent of removing a sewage treatment plant servicing 50 000 people (Kelly 1998). The Mary River Tributaries and Rehabilitation Plan (Stockwell 2001) prioritised reaches in the river for rehabilitation. This plan was updated further in 2005 (MRCCC 2005) and the results of this prioritisation of sections of the river is shown on Figure X along with the location of projects undertaken by the MRCCC and Lake Baroon Catchment Care Group. There are numerous other projects not shown on this map. These include projects undertaken directly by the Burnett Mary Regional Group and by local Landcare groups (e.g. Noosa and District, Barung, Gympie and Tiaro) and the Lower Mary Coast and Catchment Care group.

These Rivercare projects, as they have become known, have also facilitated and benefited from high levels of community involvement. Community organisations have played major roles in driving Landcare initiatives, protecting threatened species, revegetating areas and undertaking community awareness activities and many of these are listed in the community engagement strategy (Appendix X). There is also a history of using iconic species to engage the community. Examples include the Mary River Cod Network and Mary River Turtle Project of Tiaro and District Landcare (see Box X). The Mary River cod became a significant focal point of community engagement and landholder activities after its recovery plan was completed in 1996 and the Mary River Cod Community Network was created. The Codline (formerly the Cod Catch Up), a Mary River catchment newsletter, has been produced since 1998 with the 24th edition sent out in May 2013. The Mary River cod recovery plan (Simpson and Jackson 1996) was reviewed in 2008 (Jackson 2008). The outcomes of the review indicated that although some objectives had been achieved none of the criteria to assess the success of the recovery plan can be judged to have been fully met. A summary of the review is at Appendix X.

The Waterwatch program has been another important dimension of community involvement in the catchment. Commencing in 2003, in 2013 the program supports seven networks involving monitoring of water quality at over 100 sites involving 80 volunteers.

A proposal to build a dam at Traveston Crossing on the Mary River fuelled community concern about the river. Subsequent assessment of the proposal resulted in rejection of the proposal by the Australian Government Minister Peter Garrett in December 2009. Resultant activities undertaken by the community have informed actions within this plan.

The levels of engagement in river restoration and sustainable land management practices currently exceed existing capacity to provide advice and incentive funding. Continuing to support these activities is essential for the effective implementation of the recovery plan. These activities also need to be seen in a broad context of the societal benefit that private landholders create when they take action to restore and protect riverbanks adjoining their property.

Information gained from these on-going programs, evaluation of the previous recovery plan for the Mary River cod (Appendix X) and other research has been used to inform the development of this recovery plan.

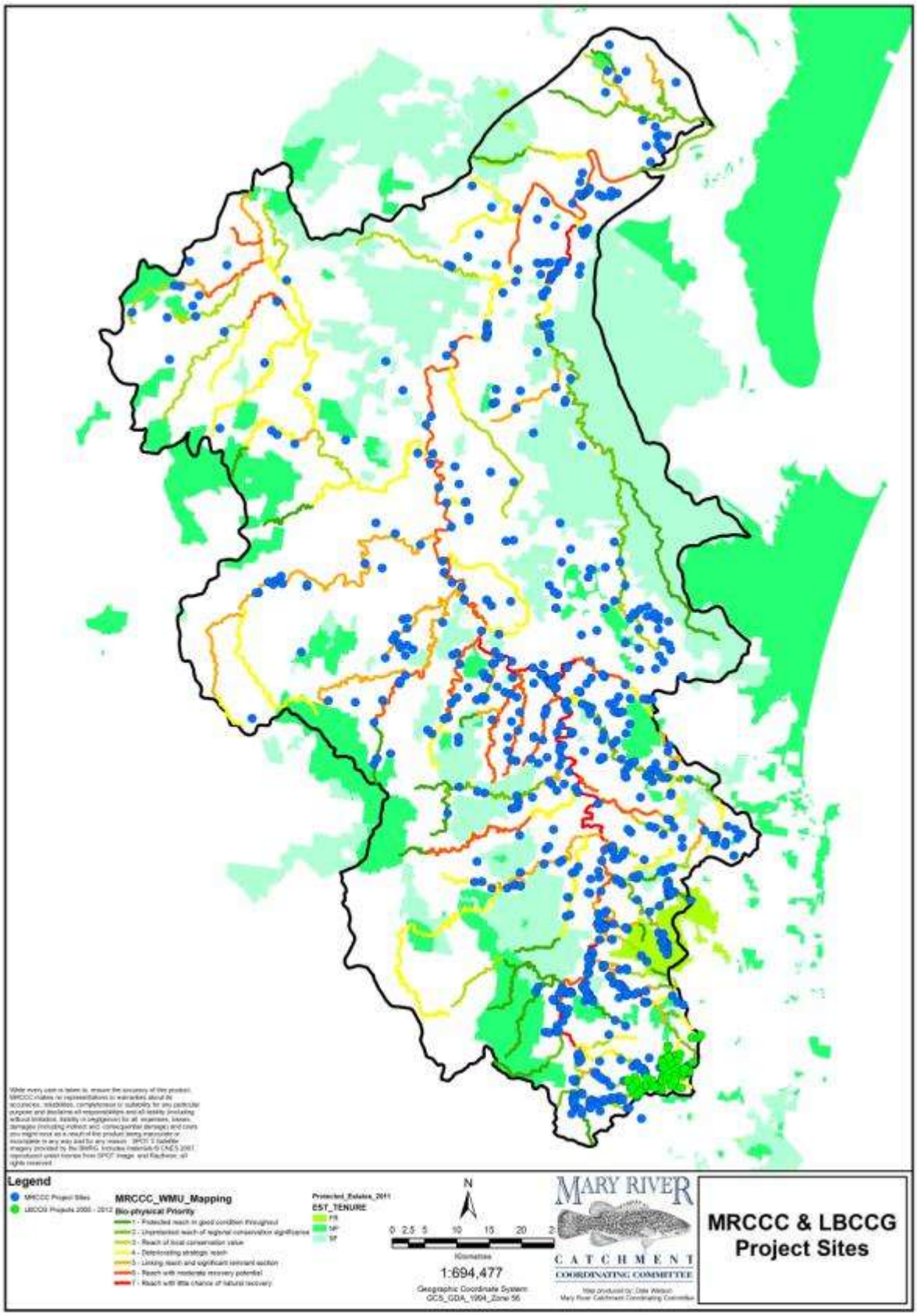


Figure X Location of MRCCC and LBCCG projects relative to the 2005 reach prioritisation

Box 5: A bright future: Tiaro and District Landcare Group

This Landcare group has fallen in love with the Mary River turtle over the last decade and has focussed on nest protection, funding research scholarships and raising public awareness of the turtle. These activities are funded in large part by sale of 250,000 chocolate Mary River turtles made by Landcare volunteers. The Fraser Coast Regional Council, Ergon Energy, Department of Environment and Resource Management (DERM) and the Mohammed Bin Zayed Species Conservation Fund have also supported the group.
An art exhibition is the latest in the growing list of innovative activities undertaken by this world renowned community organisation.

Marilyn Connell, Tiaro and District Landcare and Professor Craig Franklin, University of Queensland at the "Exclusive and Elusive" Art Exhibition. They are standing with "Mr T", the newly unveiled bronze Mary River Turtle Sculpture at Gatakers Art Space in Maryborough (2 Dec 2011).

Find out more about the group at: http://www.maryriverturtle.com

5.4.2 Indigenous involvement in the river recovery

Identifying opportunities for indigenous leadership and involvement in river recovery has been a high priority in the recovery planning process. Several dedicated meetings have been held with indigenous groups and individuals throughout the catchment to discuss both the content of the recovery plan and the actions that the recovery plan would recommend. Based on these meetings it became apparent that it would not be possible for this recovery plan to do justice to the vast knowledge and systems of understanding the Mary River and associated ecosystems held by indigenous elders in the catchment. After all, this knowledge

"These species are endangered, but so is our culture. Our culture is endangered. We need to protect these species and we need to maintain our culture."
Kabi Kabi Knowledge holder commenting on recovery plan (double check this with Alex)

belongs to the indigenous people. A small number of anecdotes and stories have been quoted in this recovery plan to serve as a reminder that indigenous people have a very important contribution to make to the future of the Mary River. These snippets by no means attempt to encompass the breadth and depth of knowledge.

The role of the recovery plan with respect to indigenous people is to facilitate indigenous aspirations regarding river recovery. This is closely intertwined with social, cultural and economic aspirations, just as it is for the whole catchment community. Indigenous leaders in the catchment have expressed a strong desire to be involved in river recovery and see an opportunity for this process to create opportunities for local indigenous people and to strengthen the cultural awareness and connection of both indigenous and non-indigenous people. Consequently, one of the six objectives of the recovery plan is devoted to identifying and acting on these opportunities.

5.5 Recovery objectives and performance criteria

Objective 1	**Maintain or increase population of priority species**
Objective 1 some text to describe	
Performance Criteria	
Objective 1	
1. Baseline understanding of recruitment levels of priority species established. 2. Population health and distribution is documented for priority species by year 5.	
Objective 2	**Reduce threats to priority species and to overall river health**
Objective 3	**Increase the quality, extent and connectivity of the priority species habitat**
Objectives 2 and 3 recognise that without reduction of threats and provision of quality, connected habitat, recovery of the priority species will be severely inhibited. However the catchment will only be managed, and effort and resources invested toward these objectives if there is overarching coordination of the implementation process as well as understanding, capacity and motivation to work toward these objectives among the various stakeholders.	
Performance Criteria	
Objective 2	
3. No large scale actions (e.g. new dams, change in large infrastructure, mining, forestry, clearing) undertaken that significantly[2] reduces habitat quality[3] and/or extent[4]. 4. Extent (kms) of connected river network (e.g. free of new barriers i.e. dams, retrofit of existing barriers) is maintained by year 5 and increased by year 10. 5. No new high risk invasive weed or animal species (e.g. tilapia, Catsclaw) become established in areas where they were previously not present. 6. Mary River Aquatic Weed Strategy implementation has been monitored and evaluated by year 5 and actions adjusted accordingly by year 10. . 7. Feral terrestrial species or incidentally translocated invasive aquatic species density/diversity/range has not increased by year 5 and has decreased by year 10. 8. Water quality has been maintained at priority sites by year 5 and improved by year 10. 9. Environmental flow requirements of the priority species have been incorporated into water resource planning processes by year 5 and flow delivered by year 10.	
Objective 3	

10. Extent[1] (kms) of vegetated riparian zone maintained by year 5 and increased across all subcatchments by year 10 (including across multiple water management units[2])

11. Instream and riparian habitat quality has been assessed at priority sites using the Habitat Quality Guide developed in Action 3: Task a, sub-task **26.2?** by year 5 and habitat quality improved at these sites by year 10 (to interpret broad-scale impact of changes in extent).

Objective 4	**Undertake research and monitoring to close gaps in knowledge related to species recovery**

Objective 4 aims to address crucial knowledge gaps associated with the life cycles, behaviours and specific ecological needs of the priority species as well as gaps in ecological health data that currently limit the certainty regarding aspects of the recovery process.

Performance Criteria

Objective 4

12. Significant research and monitoring projects have commenced by year 5 and informed identification of critical physical and hydraulic habitat of priority species by year 10.

13. Catchment monitoring and reporting system established by year 4.

14. Mary River cod captive breeding genetic goals/objectives as outlined in outcomes from the Mary River cod Forum have been met by year 10.

15. Knowledge from research on flow and biopassage has been incorporated into existing and new infrastructure modifications.

Objective 5	**Ensure effective adaptive implementation of the plan**

Objective 5 encompasses the need for coordination of implementation of the recovery plan and ongoing operation of the recovery team, in collaboration with regional councils, and state and federal government. If such coordination does not occur, the remaining actions in the recovery plan are unlikely to be implemented in a comprehensive and coordinated fashion.

Performance Criteria

Objective 5

16. Recovery team has met at least annually and continues to oversee implementation of the recovery plan.

17. All relevant universities, NGOs and other groups involved in data sharing arrangements for priority species, water quality, habitat quality and hydrology by year 2.

18. Regional councils have established and are enacting a process for cooperating on issues related to the Plan by year 2.

Objective 6	**Strengthen the sense of connectedness to the river and increase the capacity and motivation of society to contribute to recovery of priority species and river health**
Objective 7	**Create opportunities for indigenous involvement and leadership in the recovery process and strengthen cultural connections as part of the recovery program**

Objective 6 focuses on the role that the society, which includes the broader community as well as local organisations and institutions, would like to play in the recovery process. Indigenous involvement and leadership in the recovery process has been recognised

explicitly in Objective 7 because of the unique role indigenous people can and would like to play in building a multidimensional recovery process.
Performance Criteria
Objective 6
19. Capacity of community organisations to implement recovery actions has increased. 20. Knowledge of the Mary River and its ecosystems requirements has increased and is evident in how people, including children, interact with the river.
Objective 6/7
21. Economic and employment opportunities associated with conservation actions have been developed including for Indigenous people.
Objective 7
22. A framework for addressing cultural, economic and environmental aspirations of indigenous people has been established by Yr 2 and plays an integral role in implementation of the recovery plan.

5.6 Actions

The recovery actions and management practices of this Plan will be implemented within an adaptive management framework, with monitoring and research results being used to assess the success of, and improve, the objectives.

The following actions provide for the management and research necessary to support the recovery of the threatened species and ecological communities in the Mary River catchment over the next 10 years. Although these actions/activities have a priority species focus, all the actions have been developed to also support the conservation of the catchment's biodiversity.

Multiple actions are needed to achieve each objective. Below, each objective is listed with the major actions. Each major action is broken down into tasks and some into sub-tasks which are provided in Appendix **X**.

The action list is extensive, in recognition of the fact that the priorities of future sources of funding and other resources are difficult to predict. However, the action list is prioritised in a way that attempts to find a balance between urgent issues that need to be addressed, and actions that support the long term foundation for the recovery process. A high priority is allocated based on the assumption that the actions will be revised annually and that the high priority actions would be achieved (or commenced in the case of ongoing actions) within the first two years. The approach to prioritisation is based on ranking of each action against three criteria. These criteria were:

> ***Criterion 1: Urgency*** - that this action needs to happen in the short term i.e. in the first two years of implementation of the plan e.g. because there is a window of opportunity that exists in that time frame and/or because of a threat that needs to be addressed as soon as possible.
>
> ***Criterion 2: Significance*** - that this action will have a significant impact on the recovery of the species considered in the plan.
>
> ***Criterion 3: Foundational*** - that this action underpins the ability of the plan to be implemented effectively and to achieve its objectives. Actions that rank highly under this criterion are ones that are essential to other actions; if they do not happen, the recovery process would be undermined.

Actions in the medium and high priority categories initially will shift up the priority scale as progress with the recovery plan is reviewed by the Recovery Team. Very high priority actions are to be achieved in years 1–3 of implementation, high priority actions in years 1-5 and medium priority in years 1–10. Commencement of all actions in year one is in recognition of the fact that the recovery team will need to review the entire list of actions each year. Also if opportunity and energy to take any action on this list emerges from within an interest group this recovery plan would support that regardless of the priority, as all actions are deemed important for recovery.

Action 1. Manage direct threats to the priority species **High Priority**

Informed by current knowledge and refined by new information as it becomes available, manage direct threats to the priority species. Sub-actions incorporated into this action are:

1.1 Undertake integrated feral animal control programs at sites priority species use for breeding, nesting and feeding (High priority)
1.2 Respond to the threat of feral aquatic animals as required (Very High priority)
1.3 Undertake Mary River turtle nest protection (Very High priority)
1.4 Continue Mary River cod stocking program to reduce threat of low population (High priority)
1.5 Undertake precautions to prevent chytrid fungus introduction (Very high priority)
1.6 Manage the impacts of unanticipated direct threats to survival as required (Medium priority)
1.7 Improve design of development proposals and existing infrastructure to avoid and remove biopassage barriers (High priority)

Gather information required to refine management of direct threats. Sub-actions include
1.8 Monitor the genetic fitness of Mary River cod (including Tinana Ck) populations and manage threat if the risk increases (High priority)
1.9 Monitor biopassage and manage threats if the risk rating warrants action (Medium priority).

Monitoring and reporting of this action will include the following sub-action:
1.10 Collect, collate and report the outcomes of implementation to the MRTSRT annually (Very high priority).

Notes

1.1 Feral terrestrial animals:
Terrestrial feral animals are a direct threat to giant barred frog and Mary River turtle in particular, and sub-sub-actions listed in Appendix ? (Action 1.1) seek to minimise this threat and build on work that is already happening. Coordination is needed to enable improvement and adaptive management of this issue.

1.2 Feral aquatic animals:
Currently the Mary River doesn't contain noxious aquatic pests that are present in surrounding catchments. Appendix ? (Action 1.2) lists activities that should be taken to help prevent their introduction, to ensure early detection and to manage populations that have established.

This is an action that the recovery team would need to oversee in the long term and be ready to respond if new species are detected.

1.3 Mary River turtle nest protection:
This is a very high priority as it addresses the threat of terrestrial predators which is regarded to be very high. The action involves continuing and expanding the nest protection activities currently undertaken, primarily by Tiaro and District Landcare and associates.

1.4 Mary River cod stocking program:
Draft recommendations from the Mary River cod Forum (Kind 2012) will inform this action. This is a high priority.

Relationship to objectives and performance criteria
Addresses objective 2.

Action 2. Manage threats to and improve habitat quality	**High Priority**

Informed by current knowledge and refined by new information as it becomes available, manage habitat to: maintain the extent of habitat critical to survival, improve the extent of preferred habitat, and increase the distribution and diversity of suitable aged-class habitat. Sub-actions incorporated into this action are:
2.1 Identify and prioritise priority areas for instream and riparian rehabilitation (Very high priority)
2.2 Undertake riparian rehabilitation in priority sites (high priority)
2.3 Manage the threat of invasive weeds at priority sites (High priority)
2.4 Improve stream bed stability in priority sites (based on retention of key habitat and protection of assets) (High priority)
2.5 Undertake activities that improve water quality (High priority)
2.6 Improve environmental flow provision and compliance (Very high priority)
2.7 Improve biopassage throughout the catchment (High priority)
2.8 Establish demonstration reaches that have overlapping habitat for priority species and that integrate community, cultural and ecological significance (High priority)
2.9 Assess, and manage if required, the threat of unanticipated disturbance from human activities (High priority)
2.10 Integrate strategies to improve habitat into voluntary management agreements and agency land and water management procedures and plans (Medium priority)
2.11 Secure conservation agreements, covenants or inclusion in reserve tenure on priority sites and continue to implement voluntary management agreements, and agency land and water management procedures and plans (High priority)

Monitoring and reporting for this action will include the following tasks:
2.12 Collect, collate and report the outcomes of implementation to the MRTSRT annually (Very high priority).

Notes
Management of threats to habitat quality should aim to avoid further reductions in habitat quality and to actively improve habitat at priority sites. Descriptions of quality habitat, and habitat restoration techniques (Stockwell, 1999) and guidelines (O'Donnell, 1998), are available. Priority sites for management to be determined in consultation with the MRTSRT, with reference to the likely current and future importance of the site to the priority species.

2.1 and 2.2 Rehabilitation:
This sub-action builds on previous prioritisation frameworks (Mary River Tributaries and Rehabilitation Plan (Stockwell 2001), Mary River Priority Action Plans (Watson et al. 2005a, Watson et al. 2005b, MRCCC 2005) and existing assessments of the catchment (Aquatic Conservation Assessment (State of Queensland 2011c) and adds an additional layer to the prioritisation process based on the definition of habitat critical provided in section **x**. Appendix **?** includes a range of sub-sub-actions to prioritise instream and riparian habitat for rehabilitation and pinpoints particular opportunities to undertake these activities that exist at the time of completing writing this plan. An example of one of these opportunities is the Biodiversity Fund grant received by the MRCCC which will target rehabilitation of habitat for the priority species. This sub-action also encompasses replanting of macrophytes after scouring (to maintain macrophyte seed beds) and the re-introduction of beneficial large wood. It is noted that this sub-action also incorporates activities specific to giant barred frog habitat quality and connectivity improvement, as this species has requirements that need to be considered independently of the other four priority species. This information is based on the review of actions in the National recovery plan for Stream Frogs of South-east Queensland (Hines et al. 2002) related to the giant barred frog.

2.3 Invasive weeds:
Aquatic and terrestrial weeds have the potential to devastate habitat if not addressed. Aquatic weeds are of significant concern during low flow periods and drought. Terrestrial weeds, particularly viny weeds can destroy riparian vegetation. There is an existing aquatic weed management strategy, the implementation of which forms an important part of this task. Individual landholders and Landcare groups exert considerable effort to address this major issue but weeds are still a significant threat within the catchment. The recent listing of two of the most significant riparian weeds, Cats claw creeper and Madeira Vine, as Weeds of National Significance in 2012 creates opportunities to be explored as part of this task. This sub-action links to Action 3.1 about assessing current levels of weed infestation.

This is a task that the recovery team would need to oversee in the long term.

2.4 Stream bed stability:
Returning stability to the river bed requires intervention, which can be costly. However there are opportunities to combine addressing this issue with asset maintenance and construction activities as well as undertaking projects to protect habitat critical. This sub-action links to actions ?, ? and ?.

2.5 Water quality:
Activities to improve water quality revolve around reducing sediment, salt, nutrient and pesticide loads entering the river and tributaries. Loads from the broader landscape as well as point sources from particular industries (e.g. farming and agriculture) or sewage treatment plants have been taken into consideration. These activities involve working to improve practices of landowners which have been a strong point of historical activities in the catchment.

2.6 Environmental flow:
A significant opportunity to improve environmental flow provision and compliance is approaching with the scheduled revision of The Mary Basin Water Resource Plan (State of Qld 2006) in 2016. It is crucial that knowledge gaps regarding environmental flow requirements (see action ??) and current inconsistencies in the environmental flow schedules for the Mary Basin are addressed in the review.

2.7 Biopassage:
The Burnett Mary Biopassage strategy (Stockwell et al. 2008) sets priorities for removing barriers to biopassage in the catchment and recommends linking barrier removal projects to demonstrations reaches (see action ?).

This is an action that the recovery team would need to oversee in the long term.

2.8 Demonstration reaches:
As the name suggests provide an opportunity to demonstrate the practical actions necessary to improve habitat quality, extent and connectivity and to engage landholders and the broader community in learning about the river (Lovett 1999). Demonstration reaches should be established in each regional council (Sunshine Coast, Gympie and Fraser Coast), to increase local ownership of the river and provide evidence of what can be done. Establishment of demonstration reaches will provide quality habitat in the local reach and encourage repetition of similar actions to be undertaken on other parts of the river.

Funding obtained from the Biodiversity Fund by the MRCCC can assist in achieving this sub-action in Gympie and Sunshine Coast council areas in particular.

<u>Relationship to objectives and performance criteria</u>
Addresses objectives 2, 3, 5 and 6.

Action 3. Conduct research essential for future management	**High Priority**
Undertake investigations to inform future management and recovery planning. Sub-actions incorporated into this action are: 3.1 Establish a baseline for river health and habitat quality (High priority) 3.2 Establish integrated and ongoing monitoring programs regarding river health (Very high priority) 3.3 Undertake research to determine the distribution, population status and address ecological knowledge gaps associated with the priority species (High priority) 3.4 Undertake research to determine best practice Environmental Flow releases and include findings in Water Resource Plan revision (Very high priority) 3.5 Undertake research and monitoring regarding improved biopassage and connectivity (Medium priority) 3.6 Assess future risks to the Mary River and priority species from increased water extraction, coal and coal seam gas mining proposals and unforseen threats (Very high priority) 3.7 Identify and map all habitat critical for survival (Very high priority) 3.8 Identify likely impacts of climate change on the extent and distribution of priority species habitat (Medium priority) 3.9 Undertake research to improve knowledge of the impact of native and feral predators (both terrestrial and aquatic) on the priority species (Medium priority) 3.10 Increase understanding of the secrets of success for increasing community and	

stakeholder participation in river recovery (Medium priority)
3.11 Undertake other investigations as needed to serve future requirements (Medium priority)

Monitoring and reporting of this action will include the following task:
3.12 Collect, collate and report the outcomes of implementation to the MRTSRT annually (Very high priority)

Notes

3.1 Baseline for river health and habitat quality:
Monitoring of various aspects of river health is already undertaken, but there are some gaps in this knowledge and also a need for more comprehensive integration of this information into a holistic picture of the catchment health. However, without collation and synthesis of existing data as well as collection of information regarding key knowledge gaps, the ability to assess progress with the recovery plan will be limited. Therefore, this sub-action is a high priority that needs to be acted upon in years 1-5. A complete freshwater and estuarine monitoring program for the catchment was proposed by Watson et al. (2005a). Costs for this sub-action are based on cost estimates for this project.

3.2 Monitoring programs:
Because of the difficulty of establishing the status of the species, river health (which incorporates habitat quality) is an important proxy for assessing the recovery process. There are opportunities to collaborate and partner with other organisations to monitor river health. As the decade long Waterwatch program illustrates, community involvement in monitoring can make a major contribution to our understanding of catchment health. Several opportunities for involving the community in other aspects of the monitoring processes have been identified by the Technical Advisory Group and can be explored during the implementation of this sub-action.

3.3 Distribution, population status and ecological knowledge of the priority species:
As the distribution maps for the five species shown in section ?.? indicate, for each species, there are gaps in knowledge regarding their distribution. In addition, the status of the populations of each of the species is unknown (aside from anecdotal reports of increases or decreases in population. Though these anecdotes can form an important part of the picture, in combination with various forms of scientific data). This sub-action is based on identification of the key knowledge gaps for each species. It also links closely with the performance criteria and monitoring and evaluation of the plan.

3.4 Environmental Flow:
The review of the Water Resource Plan (State of Queensland 2006) due in 2016 provides an opportunity to improve environmental flow releases for ecological purposes within the Mary River (link to Action 2.5). For this reason it is a high priority. In particular, environmental flow requirements for freshwater mullet, lungfish and cod are not well understood, though research undertaken in the Burnett (for lungfish) and in the Mary (for cod and lungfish) is increasing knowledge in this area. Another important dimension of this sub-action is access to low flow data to enable monitoring and modelling of cease to flow events and other critical low flow parameters that relate to habitat quality and connectivity. A reciprocal science project about freshwater mullet would also contribute to addressing this knowledge gap (link to Action 21).

3.5 Biopassage and connectivity:
The Burnett Mary Region Biopassage Strategy (Stockwell et al. 2008) provides a framework for targeting barriers to biopassage. This sub-action addresses a gap in knowledge about the biopassage requirements for turtles and fish. It involves working with researchers, governmental staff and key stakeholders who manage, maintain or construct cross river infrastructure (rail, roads, powerlines, pipelines) and instream infrastructure (weirs and barrages) to gather data about the effectiveness of biopassage improvements and impacts of biopassage barriers. The improvements currently being considered for Gympie Weir provide an excellent opportunity to

monitor the impact of this improvement. Acting on this opportunity is urgent. Therefore Gympie Weir activity is regarded as a high priority, whereas other activities in this sub-action are rated as a medium priority.

3.6 Future risks:
As explained in section 4.5 on potential threats, as of 2012, approvals had been granted to explore across approximately 40% of the catchment for both coal and coal seam gas. Any one mining operation can pose a threat to the recovery of threatened species in the Mary River and the significance of this threat requires assessment. Increased water extraction is another threat that is likely to feature in the future of this recovery plan. These activities will influence existing threats such as water quality, and can be evaluated within the framework already provided by this plan.

3.9 Native and feral predators:
The impact that predators are having on the recovery of threatened species is currently unknown. In the case of the Mary River turtle, there is clear evidence of predation of nests, but there is little known about the survival of juvenile turtles that do make it to the water and the impact that aquatic predators have on turtles and other priority species. The food web, and the way nutrient and carbon dynamics have changed as a result of human influence is not well understood, nor are the impacts of introduced recreational fish species and the changes to river processes caused by various human and natural influences on the river. There is a view among some experts that predation by introduced recreational fishing species may have significantly altered energy and nutrient flows in the river, but further research is required.

3.10 Community and stakeholder participation:
Improving methods of engagement of stakeholders and the broader community is crucial aspect of being able to deliver on the recovery plan. If involvement of these groups can be increased, the delivery of recovery actions is also likely to increase. There has already been some work of this kind undertaken, most recently two separate projects by Lake Baroon Catchment Care Group and the University of Sunshine Coast. Disseminating the results of these studies throughout the organisations in the catchment is likely to contribute to more effective stakeholder engagement.

Relationship to objectives and performance criteria
Addresses objectives 2, 3, 4, 5 and 6

Action 4. Coordinate implementation	**Very High Priority**

Coordinate implementation to achieve objectives through adaptive management and cost-effective delivery. Sub-actions include:
4.1 Maintain the operation of the recovery team to track progress, enable adaptive management and advocate for improved policy and regulation to help achieve objectives 1-5
4.2 Operate functional sub-groups of the Recovery Team, as necessary, and in accordance with an agreed Terms of Reference
4.3 Secure the services of a Recovery Program Coordinator to facilitate operations of the Recovery Team, and resolution of multi-jurisdictional issues
4.4 Integrate results of monitoring activities into the adaptive management process
4.5 Prepare and implement two-year implementation plans to outline priority tasks, detail recovery plan implementation and document any changes to priorities or tasks in response to monitoring data and other new information
4.6 Review implementation plans annually in light of recent monitoring data and any other new information
4.7 Prepare annual reports to outline progress against implementation plans and recovery plan objectives and criteria, and to identify any changes in recovery priorities
4.8 Develop mechanisms for sharing information, including development of new and utilisation of existing databases, to facilitate swift and informed decision-making
4.9 Review the recovery plan in year 5

Notes
Responsibility for implementation of this and other actions lies with the agencies with a statutory responsibility for the recovery of threatened species and protection of native habitats. The Recovery Team, supported by a Recovery Program Coordinator, provides an effective delivery platform for this multi-jurisdictional recovery program (see section x.x) and it is anticipated that this will be the vehicle by which the responsible agencies coordinate implementation.

Relationship to objectives and performance criteria
Addresses objectives 2, 3, 4, 5 and 6.

Action 5. Secure resources for implementation	**Very High Priority**

Secure sufficient resources for implementation of very high and high priority actions, and seek additional resources for all other recovery actions. Sub-actions are likely to include:
5.1 Identify and secure funding to support implementation of two-year implementation plans (see Action **X.X**) and support a paid Recovery Program Coordinator (links to Action 5.3)
5.2 Identify requirements for new partnerships for effective delivery, and make targeted approaches to develop these relationships
5.3 Maintain relationships with existing key delivery partners
5.4 Continue to involve volunteers in as many aspects of implementation as possible, providing safe, supported and engaging opportunities to participate
5.6 Involve Indigenous groups in as many aspects of implementation as possible, providing opportunities for local Indigenous community engagement in biodiversity conservation

Notes
Full implementation of the highest priority actions in this recovery program is likely to require a commitment of resources from Recovery Team organisations, as well as the development of new partners and new funding sources. A coordinated approach to seeking additional resources will be beneficial to many current and potential future partners.

Relationship to objectives and performance criteria
Addresses objectives 2, 3, 4, 5 and 6.

Action 6. Communicate effectively with partners and engage stakeholders and the community	**High Priority**

Communicate effectively with partners, stakeholders and the community to develop and maintain support for implementation. Sub-actions include:
6.1 Provide high quality communication products to funding bodies to foster productive partnerships (Medium priority)
6.2 Develop and implement a communications plan to service the information requirements of a range of partners and stakeholders with coordinated communications products (Medium priority)
6.3 Develop a strategic, creative and coordinated approach to obtaining funding to support on-ground activities (Very High priority)
6.4 Support and reward involvement of stakeholders in implementing the recovery actions (High priority)
6.5 Increase awareness of the general public of the links between general river health, riverbed stability, river restoration, priority species (at multiple life cycle stages) and community values (High priority)
6.6 Encourage responsible recreation that also creates opportunity to touch, experience, and love the river (Medium priority)
6.7 Provide extension services such as on farm advice, incentives, field days and workshops on an ongoing basis (High priority)
6.8 Increase capacity and effectiveness of local organisations involved in activities that affect the river and threatened species recovery (High priority)
6.9 Strengthen involvement of schools (at all levels) in river recovery and incorporate information about the catchment and priority species into classroom activities (High priority)

Notes
Implementation will rely on the support of many partners and stakeholders, including the broader community. Effective communication will develop and maintain this support. The efficiency and effectiveness of the Codline newsletter will be considered in the communication planning process.

6.3 Funding:
This sub-action aligns closely with Action 5.1 and 5.3 in that one role of a coordination body could be to help obtain funding to support on-ground activities. This task identifies the need to be strategic and creative and to seek new opportunities for funding such as through philanthropic sources. This task also aims to facilitate networking and coordination between groups to enable more effective lobbying for funds. This could include sharing resources, partnering on project applications and numerous other possibilities. Although considerable work is done via in-kind contributions and volunteering, funding is crucial to the long term ability to implement the actions in the plan. This is particularly the case for coordination, incentives, training workshops, field days and large projects.

6.4 Support and reward stakeholders:
This sub-action is about recognising the role that a range of stakeholders currently play in implementing recovery actions and the ongoing support that is needed to maintain and enhance this important role. There are several activities that are listed under this task (see Appendix ?, Action 7.4). Availability of labour to undertake on-ground works is lacking. One of the key proposals under this task is development of a volunteer recruitment strategy to generate more capacity to undertake low cost on-ground work. Another important dimension of this sub-action is recognising the important role that community festivals and events play in creating a sense of community, sense of connection to the river and in maintaining and increasing levels of volunteering. Cultural awareness training for NRM groups and stakeholders is another important activity that should be undertaken as part of this sub-action.

Overall, this sub-action is rated as high because of the need to maintain participation of people

already involved and to facilitate a deepening of their involvement. This is consistent with the principles of engagement described in section ?.?.

6.5 Increase awareness:
Following on closely from Action x, this sub-action is focussed on the general public. There are a large number of activities (see Appendix ?, Action 7.5) that can be undertaken as part of this sub-action. These activities are critical for maintaining the interest of people and organisations who are already involved and also for reaching new groups and individuals. It is recognised that activities related to this sub-action need to occur on an ongoing basis.

6.6 Responsible recreation:
Access to the river is consistently described as a constraint on the ability of people to gain knowledge and love of the river. This sub-action is focussed on access, and the sub-sub-tasks (see Appendix ?, Action 6.6.) that are needed to ensure and encourage responsible recreation. Other sub-sub-actions include informative and engaging signage and information for recreational fishers that enables them to minimise risks of their activities to the priority species.

6.7 Extension services:
Experience within the catchment, most recently with the Mary River Restoration Stories Project (MRCCC) and Healthy Habitats program (BMRG/MRCCC) illustrates the important role that field days and workshops play in encouraging best practice and helping maintain motivation and encouragement for individuals who are already improving their practices. Feedback received from a community survey in 2011 undertaken as part of community consultation during the development of this plan, indicated that approximately 90% of respondents regarded site visits and field trips as “very useful” or “likely to be useful” in terms of being involved with the recovery plan. This was second only to “emails distributed through your network” as a preferred way of engaging with the recovery plan.

6.8 Capacity and effectiveness of local organisations:
Investing in the capacity of local organisations will help ensure that momentum is maintained and that there continues to be healthy and active groups in the catchment. Although no official estimate has ever been made, the volunteer contribution to the recovery of the Mary River to date has been significant. Current indications are that there will continue to be reliance on volunteers to undertake considerable river recovery activities. It is therefore crucial that they are supported and appreciated. Through the various conversations that have taken place with the community, several low cost opportunities to build capacity have been identified. They do however require support and coordination.

A high priority has been placed on this sub-action because of the need to maintain continuity and capacity within community organisations.

6.9 School involvement:
Increasing the involvement of schools in the recovery process was a strong priority for participants in the public forums undertaken as part of the community consultation during development of this plan. There is an opportunity now, with the development of the Australian National Curriculum, to influence the 20% of local content that can be included in units in the curriculum. Because of the timing of this opportunity, the priority for this sub-action is high and the timeframe of years 1 – 5 is proposed.

<u>Relationship to objectives and performance criteria</u>
Addresses objective 5.

Action 7. Involve and engage Indigenous people	**High Priority**

Sub-actions include:
7.1 Foster indigenous engagement, training and employment opportunities associated with river recovery (Very high priority)
7.2 Reciprocal science – sharing culture and sharing knowledge, closing the gap (Very high priority)
7.3 Raise cultural awareness of non-indigenous NRM organisations and staff (High priority)
7.4 Knowledge recording according to cultural protocols – Secret, Sacred and Significant (High priority)
7.5 Hold a Mary River day that is run and designed by indigenous groups (Medium priority)
7.6 Explore ways of formalising the process of consultation (Medium priority)

Notes

7.1 Indigenous involvement:
Fostering employment and training opportunities for indigenous people associated with recovery actions also provides a situation in which people can reconnect to country and learn from elders. It is essential that any such programs occur in close consultation with elders and involve mentoring of indigenous people working in the catchment. Therefore this sub-action is about integrating cultural and economic opportunities. The Cultural Connections model (Department of Environment Climate Change and Water NSW 2010) developed in Northern NSW was discussed as a potential model for achieving this. The Indigenous Work Crew project already underway through collaboration between BMRG/Flora and Fauna International and Kahwun Wooga Aboriginal Corporation is a concept that people would like to see duplicated elsewhere in the catchment.

7.2 Reciprocal science:
Participants in the Indigenous Working Group meeting coined this phrase of Reciprocal Science to imply an exchange of ideas and knowledge between university based river science and indigenous knowledge of the river. Both knowledges are to be treated with respect and regarded as equal. Walking the country and participating in Back to Country field trips are part of this task.

7.3 Cultural awareness:
In some ways this sub-action is a precursor to other sub-actions under this action because it is necessary to increase understanding of NRM organisation when working with indigenous groups on the other actions listed in this recovery plan. For this reason it is a very high priority that should be acted on in the first year of implementation and then on an ongoing basis. It is proposed that cultural awareness training be provided to all current staff in NRM organisations and in the induction process for new staff. Volunteers would also be included. Training of this nature was provided in 2012 from a Kabi Kabi perspective. Ideally such training would also encompass a Butchulla perspective and potentially the perspectives of other groups as well. Materials created for the Fraser Coast campus of the University of Southern Queensland could be useful in this respect. This awareness could be formalised in the form of organisational policy, reconciliation actions plans, memorandums of understanding or other formal mechanisms.

7.4 Knowledge recording:
Recording knowledge for future generations is of great concern to the indigenous representatives consulted about the recovery plan. The way in which this knowledge is recorded needs to provide different levels of access to the information so that control can be exercised by those with responsibility for and authority over this knowledge. The Burnett Mary Regional Group does have an existing knowledge recording database, but there was a view expressed that this database should be independent to ensure indigenous protocol is followed. However, this database and gaining understanding of the way in which it operates provides a potential starting point for implementing this sub-action. Protocols also need to be established to ensure the authenticity of knowledge incorporated in the database.

7.5 Mary River Day:

This sub-action would provide an opportunity for young indigenous people to be involved in an event that is run by their elders and provide opportunity for sharing culture and knowledge across the generations.

7.6 Formalising consultation:
Memorandums of Understanding have been drafted with the regional councils. Formal recognition of the way in which council will engage with indigenous groups was seen as important. There may be opportunity to include the cultural and ecological significance of the Mary River in these formal documents. This task needs to be explored further to determine whether it is a viable approach for incorporating concerns related to the recovery of the river into the relationship between indigenous groups, local councils and other organisations.

Relationship to objectives and performance criteria
Addresses objective 6.

5.7 Implementation Schedule and Costs

It is the responsibility of organisations implementing actions to report on implementation annually to the Recovery Team for inclusion in annual reports and assessments against the performance criteria of this recovery plan.

Where resources are limiting, responsible organisations will prioritise those actions likely to provide the most cost-effective benefits to the recovery program. Estimated costs are summarised in Table X, with more detailed information in section X.X.

This plan is intended for use by natural resource managers, planners and funding partners to guide catchment wide investment of threatened species projects. For the most part, implementation of the plan will rely on additional funding sources from both within and outside of the catchment. Possible potential contributors include SunWater, Wide Bay Water, various Queensland departments, Regional Councils, BMRG and Caring for Our Country.

For some species a number of the actions included in this plan are already being undertaken in various forms by numerous agencies and individuals. Also, several species included within this recovery plan, are the subject of a national single or multi-species recovery plan. Cost estimates for some actions which are also to be undertaken as part of these national recovery plans are therefore potentially an overestimate. However, in general it is more likely that costs have been underestimated due to the difficulty in comprehensively costing site-specific management requirements for the numerous species included in this plan.

It will primarily be the responsibility of the Recovery Team to facilitate recovery coordination and integration. The total funding required to support implementation over five years is estimated to be $????. The priorities for funding are indicated in the actions above. The estimated costs of undertaking the actions are presented below.

Table X Recovery action implementation

This table needs filling in timing, performance criteria, links to actions and costs.

Summary of implementation costs for actions in this recovery plan. Action priority rankings were determined following the method described in section X.X, and detailed annual cost estimates are provided in section X.X. Cost estimates including "+tbd" are for actions that could not be fully costed at the start of the planning cycle due to their reliance on the outcomes of pending assessments or opportunistic nature.

	Priority	Timing	Relevant Performance Criteria	Links to other actions (A)	Costs (in thousands of dollars)				
					Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Objective 1 – Maintain or increase population of priority species			1,2						
Action 1: Manage direct threats to priority species and to overall river health	High	ongoing			40	14	14	14	14
Objective 2: Reduce threats to priority species and to overall river health			3,4,5,6,7,8,9						
Objective 3: Increase the quality, extent and connectivity of the priority species habitat			10, 11						
Action 2: Manage threats to and improve habitat quality	High	ongoing			394	253.3	253.5	228	228
Objective 4: Undertake research and monitoring to close gaps in knowledge related to species recovery			12, 13, 14,15						
Action 3: Conduct research essential for future management	High				312	312	312	252	252
Objective 5: Ensure effective adaptive implementation of the plan			16,17, 18						
Action 4: Coordinate implementation	Very High				122.5	0.5	0.5	?	?

	Action 5: Secure resources for implementation	Very High				363	363	418	363	353
Objective 6: Strengthen the sense of connectedness to the river and increase the capacity and motivation of society to contribute to recovery of priority species and river health				19, 20, 21						
Objective 7: To create opportunities for indigenous involvement and leadership in the recovery process and strengthen cultural connections as part of the recovery program				21, 22						
	Action 6: Communicate effectively with partners, and engage stakeholders and the community	High	ongoing	Need to break down cost to reflect new action list		Inc	inc	inc	inc	inc
	Action 7: Involve and engage indigenous people	High	ongoing			inc	inc	inc	inc	inc

6 MONITORING, EVALUATION, REPORTING AND IMPROVEMENT

It is recommended that the recovery team be reconvened to review performance annually, with a large audit five years after adoption of the plan, and a complete review at 10 years. A ten year plan is considered appropriate in this instance because the species are long-lived and measurable improvements may not be noticeable after the standard 5 year review period. The purpose of a five year review will be to assess performance of implemented actions, and review relevance of performance criteria in light of progress and developments.

6.1 Monitoring

The performance criteria play a strong role in monitoring the effectiveness of whether actions are meeting objectives and should be used to indicate achievement of specific individual tasks. A generalised monitoring program is discussed below incorporating general trends which should be monitored.

6.1.1 Logic behind proposed monitoring program

The monitoring program has been split into two categories;

- existing monitoring activities that should be continued and expanded, and
- new monitoring activities that are required.

This approach takes into account the monitoring which will be able to be undertaken in the foreseeable future and where the opportunity arises, monitoring that should be undertaken. A priority of the recovery team should be to attract funding to support data sharing agreements associated with any new monitoring activities. Activities that are listed as 'New' activities will be shifted to 'Existing' activities once they are being undertaken, with the ultimate intention that all the monitoring activities listed are taking place.

Research is also a component that has an important role to play to improve understanding. The research has been separated out to distinguish that once the research has been undertaken it can be used to inform better monitoring processes.

6.1.2 Current Monitoring Programs

Current monitoring programs include:

Mary River turtle nests
First monitored in 1997 by Flakus. The Tiaro and District Landcare Group have been protecting and monitoring nesting banks since 2001.

Giant barred frog
MRCCC have been monitoring populations of the frog at one site since 2005. In 2007 an additional site was included in the monitoring program. In December 2008 another two sites were added. A new monitoring program, under the direction of Barung Landcare, commenced in 2012 on Obi Obi Creek in Maleny. This program has expanded the known distribution range of the species through confirmed sightings of several frogs in this section of waterway.

The Department of Transport and Main Roads (Qld) have monitored 14 sites between 2010 and 2013.

Mary River cod
Department of Natural Resources and Mines (DNRM) Environmental Flows Assessment Program for the cod started in 2009. Outcomes of the program will include mapping of persistence of waterholes, flow patterns, water and habitat quality, size and movement patterns of the cod. Genetics and ageing studies will also be undertaken.

Australian lungfish and Mary River cod
Fish that are caught by recreational fishers have been tagged and a reporting system established to report tagged fish that are recaptured.

Water quality
Data is routinely collected by Waterwatch. Currently it is not collated and evaluated across the catchment. Actions in this plan will seek to collate and use this information to inform recovery activities.

Instream
Index of Stream Condition (ISC) assessments are routinely undertaken by MRCCC. The ISC assessments measure a variety of parameters including beneficial large wood (large woody debris), stability of stream banks and macro invertebrates (which indicate health of the system). These assessments should continue to be undertaken and data collected should be collated and evaluated. This information will contribute greatly to the overall Mary River recovery plan management.

Riparian vegetation
Riparian vegetation data is collected by MRCCC using a standard method (MRCCC Riparian Condition Assessments).

Wildnet – this is Queensland government's wildlife database which contains records of flora and fauna throughout Queensland. This database has potential to be a single repository for monitoring data but it is not currently utilised for this purpose. Using Wildnet will assist in collation of data and evaluation purposes to help inform Mary River recovery plan management.

6.1.3 New Monitoring

Recovery Team meetings
During the implementation phase an aim of the recovery team would be to oversee the implementation of actions. Evidence that the Recovery Team is meeting can be used as a monitoring indicator as it will demonstrate that there is active implementation of a suite of actions including community consultation.

Biopassage
Records of removal of barriers to fish and turtle movement could be used as an indicator of increased biopassage. Data collected from Passive Integrated Transponders (PIT) tag readers recording mullet presence and any increased distribution of this species could also be used as a monitoring indicator of improved biopassage.

Species population survey

Currently there is no population estimate for the priority species i.e. the Giant barred frog, lungfish, freshwater mullet and Mary River cod and turtle. Baseline and subsequent population estimates would inform whether actions implemented are increasing population sizes. The current limitation on collection of this data is establishing an efficient, effective, appropriate and affordable method for obtaining this data.

Mapping

Mapping of habitat critical would provide a baseline for areas that are critical for the survival of the priority species. Overtime, as the mapping is updated, this would indicate progress on increasing available and suitable habitat. Limitation to producing mapping involves lack of habitat critical identified at this stage and resources required to produce maps.

Riparian vegetation assessment

A consistent method (e.g. MRCCC Riparian Condition Assessments) of monitoring riparian vegetation should be used across all on-ground riparian projects associated with the Mary River to ensure consistent monitoring and evaluation.

Use of high definition landscape scale imagery (LIDAR) would be able to efficiently assess the presence, density and species composition of riparian vegetation. This could then inform priorities for revegetation and weed removal projects. As projects were undertaken further LIDAR imagery could inform progress. The current limitation on use of this monitoring technique is that LIDAR imagery is very expensive.

Societal capacity, attitudinal change and awareness

The number of field days and training delivered can be used as a monitoring indicator. The approximate number of groups operating on projects linked to the river, the number of members, including indigenous people, employed or number of new positions in conservation could be used for monitoring. In parallel to this, feedback sessions, unstructured interviews or similar social research methods can be used to add robustness to monitoring and evaluation of societal capacity, attitudinal changes to conservation practices and awareness of these.

Societal survey

A large scale survey of affected communities conducted 5 years after implementation of actions could be used as a monitoring indicator to assess achievement of changing attitudes and the level that awareness rose. Coordination and evaluation of such a survey would require a dedicated and suitably qualified person and supporting resources.

6.2 Research

The following gaps in information have been identified as being important to fill to inform recovery of those species.

- Time lapse photography of turtle basking rocks (presence/absence to determine distribution / relative abundance / individuals entering breeding population)
- Movement behaviour and connectivity requirements of priority species
- Key physical and hydraulic habitat parameters for Mary River cod (riparian and instream e.g. spawning habitat)
- Lungfish, Mary River cod and turtle:
    - aging
    - population structure

- level of recruitment needed to sustain population
- juvenile habitat
- role of tributaries/wetlands as flood refugia and breeding sites
- identify what size lungfish are when they enter breeding population
- identify what the key habitat characteristics are for lungfish to survive to breeding age

- Riparian Rehabilitation – research tools used to monitor rehabilitation

6.3 Data Storage

Each agency is responsible for collecting, collating, evaluating and storing their monitoring data as determined by their respective requirements for the data. Where data is applicable to be included in Qld DEHP's Wildnet database and Recovery Action Database, agencies responsible for collecting the data are required to provide this data to the Wildnet database. As part of the implementation phase of this plan, data sharing agreements will be formed with agencies that collect data which is of benefit to informing recovery.

6.4 Evaluation

The Recovery Team is responsible for evaluating the actions, achievements, learning and improvement of the plan as a whole. Evaluation of the information provided in reports and available data will be undertaken to assess progress towards objectives and to adjust process and actions where necessary, through:

- reviewing action implementation to assess whether actions implemented are progressing towards achievement of objectives
- review actions that have not been implemented to assess whether their priority for implementation should be varied or whether the action is still appropriate, or new actions are required
- investment review such as change in investment approach and investment scope
- review of process

An interim assessment will be conducted by the Recovery Team after 3 years to assess progress towards recovery. This will include an evaluation of the overall progress as well as progress made on individual actions. A comprehensive evaluation and review of the recovery plan will be undertaken after five years and in accordance with the Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) guidelines.

6.5 Reporting

The Recovery Team is responsible for producing an interim report after 3 years. At five years the recovery team will conduct a review of the plan and publish a report detailing progress to date. These reports should be published on appropriate websites (Qld Government DEHP, MRCCC, BMRG, local councils etc) and provided to appropriate agencies, industries and interest groups.

6.6 Linking the Objectives, Performance Criteria and Monitoring

Objective	PC	Performance Criteria	Monitoring
1 Maintain or increase population of priority	**1**	Baseline understanding of recruitment levels of priority species established.	Mary River turtle nest monitoring (Existing) Australian lungfish and Mary River cod data collection (Existing) Giant Barred frog survey (Existing) DNRM's EFAP monitoring (Existing) Griffith/UQ research projects (Existing and New) Species population survey (New)
	2	Population health and distribution is documented for priority species by year 5.	
2 Reduce threats to priority species and to overall river health	**3**	No large scale actions (e.g. new dams, change in large infrastructure, mining, forestry, clearing) undertaken that significantly2 reduces habitat quality3 and/or extent4.	Riparian vegetation data collection (Riparian Condition Assessments etc).(Existing) Instream (Index of Stream Condition (ISC) assessments etc).(Existing) DNRM's EFAP monitoring (Existing)
	4	Extent (kms) of connected river network (e.g. free of new barriers i.e. dams, retrofit of existing barriers) is maintained by year 5 and increased by year 10.	DNRM's EFAP monitoring (Existing) Biopassage (New)
	5	No new high risk invasive weed or animal species (e.g. tilapia, catsclaw) become established in areas where they were previously not present.	Riparian vegetation data collection (Riparian Condition Assessments etc).(Existing) Instream (Index of Stream Condition (ISC) assessments etc).(Existing)
	6	Mary River Aquatic Weed Strategy implementation has been monitored and evaluated by year 5 and actions adjusted accordingly by year 10.	
	7	Feral terrestrial species or incidentally translocated invasive aquatic species density/diversity/range has not increased by year 5 and has decreased by year 10.	
	8	Water quality has been maintained at priority sites by year 5 and improved by year 10.	Water quality (Waterwatch etc).(Existing)
	9	Environmental flow requirements of the priority species have been incorporated into water resource	DNRM's EFAP monitoring (Existing)

		planning processes by year 5 and flow delivered by year 10.	Biopassage (New)
3 Increase the quality, extent and connectivity of the priority species habitat	10	Extent[1] (kms) of vegetated riparian zone maintained by year 5 and increased across subcatchments by year 10 (including across multiple water management units[2]) (with the long term aim of self sustaining riparian vegetation extent increasing).	Riparian vegetation data collection (Riparian Condition Assessments etc).(Existing) Instream (Index of Stream Condition (ISC) assessments etc). (Existing) DNRM's EFAP monitoring (Existing) Riparian vegetation assessments (LIDAR etc).(New) Mapping (New)
	11	Instream and riparian habitat quality has been assessed at priority sites using the Habitat Quality Guide developed in Action **24.2?** by year 5 and habitat quality improved at these sites by year 10 (to interpret broad-scale impact of changes in extent).	
4 Undertake research and monitoring to close gaps in knowledge related to species recovery	12	Significant research and monitoring projects have commenced by year 5 and informed identification of critical physical and hydraulic habitat of priority species by year 10.	DNRM's EFAP monitoring (Existing) Research (New)
	13	Catchment monitoring and reporting system established by year 4.	Mary River turtle nest monitoring (Existing) Australian lungfish and Mary River cod data collection (Existing) Giant Barred frog survey (Existing) DNRM's EFAP monitoring (Existing) Species population survey (New)
	14	Mary River cod captive breeding genetic goals/objectives as outlined in outcomes from the Mary River cod Forum have been met by year 10	
	15	Knowledge from research on flow and biopassage has been incorporated into existing and new infrastructure modifications.	DNRM's EFAP monitoring (Existing) Research (New)
5 Ensure effective adaptive implementation of the plan	16	Recovery team has met at least annually and continues to oversee implementation of the recovery plan.	Recovery Team is meeting (Existing)
	17	All relevant universities, NGOs and other groups involved in data sharing arrangements for priority species, water quality, habitat quality and hydrology by year 2.	

	18	Regional councils have established and are enacting a process for cooperating on issues related to the Plan by year 2.	
6 **Increase society capacity, sense of connectedness and motivation to contribute to recovery of priority species and river health**	19	Capacity of community organisations to implement recovery actions has increased.	Societal capacity (Existing) Societal survey (New)
	20	Knowledge of the Mary River and its ecosystems requirements has increased and is evident in how people, including children, interact with the river.	
6/7	21	Economic and employment opportunities associated with conservation actions have been developed including for Indigenous people.	??
7 **Create opportunities for indigenous input to the recovery process and opportunities for cultural connections as an integral part of the recovery of the priority species**	22	A framework for addressing cultural, economic and environmental aspirations of indigenous people has been established by Yr 2 and plays an integral role in implementation of the recovery plan.	??

7 NEW HEADING?

7.1 Affected interests and potential contributors

The stakeholders and other affected interests in the recovery program include:

Australian Government
Department of Environment
Department of Agriculture Forestry and Fisheries
Department of

Queensland and local government
Department of Environment and Heritage Protection
Department of Natural Resources and Mines
Department of Science Information Technology Industry and the Arts
Department of Agriculture Forestry and Fisheries
Department of Energy and Water Supply
Department of Infrastructure and Planning
Queensland Parks and Wildlife Service
Fraser Coast Regional Council
Gympie Regional Council
Sunshine Coast Regional Council

Industry organisations and private companies
Queensland Water Infrastructure
SEQ Water
Sun Water
Wide Bay Water

Primary Industry Sector groups
Queensland Dairy Farmers
Macadamia Association
Growcom
Agforce

Non-government organisations
Mary River Catchment Coordinating Committee
Burnett Mary River Group
Tiaro & District Landcare Group
Barung Landcare
Noosa and District Landcare
Lower Mary Coast and Catchment Care
Lake Baroon Catchment Care Group
Traditional owners working group
Wide Bay Burnett Environment and Natural Resources Working Group
Wide Bay Burnett Environment Council
Save the Mary River Coordinating Group
The Greater Mary Association Inc.
And other Landcare organisations and neighbourhood networks that arise during implementation of the plan

Noosa and Great Sandy Biospheres and the associated management groups.

Natural Resource Management (NRM) regional bodies

Universities / Research Organisations
University of Queensland
Griffith University
Australian Rivers Institute
James Cook University
University of Sunshine Coast

Other
Landowners

7.2 Guide for management

Subject to assessment and approval processes under the EPBC Act, actions, activities and management practices should be adopted to avoid, reduce or mitigate impacts on species.

Before undertaking recovery activities there are a number of general principles which need to be considered. These include that:

The Mary River system is in a state of continuous change.
Some areas of the Mary River system are relatively physically stable and some are very unstable. Some of this instability is the result of recent disturbance, some from disturbances many decades ago, and some as part of the natural long-term geological process. Unstable areas often undergo rapid changes during flood events. The Mary River system also experiences an extraordinarily wide range of stream flows, which can rise sharply within hours, vary greatly throughout the year, and vary greatly from decade to decade. These considerations need to be taken into account in any management decisions within the river system: recovery actions which may be appropriate for a stable section of the river may be totally unsuitable for another location, and decisions made during low-flow conditions need to take account of the implications during flood events (and vice versa).

Management practices need to be designed around extreme conditions and events
Most of the adverse impacts which threaten the priority species in the Mary River occur during times of extreme conditions: during extended periods of low flows, extreme floods, extreme low and high temperatures, extreme pollution loads or extreme weed infestations. Management actions which mitigate the impacts of these extreme conditions will be generally beneficial, and management actions which place any additional stress on the system during these extreme conditions will be damaging.

The priority species can only exist within the fragile connected network of in-stream and riparian habitat, which occupies a very small part of the general landscape
The linear geometry of a stream network and the generally thin band of riparian vegetation in much of the Mary River system is such that a relatively small area of disturbance can easily fragment the habitat required for the recovery of the priority species. The total area of habitat that these species can inhabit covers a very small area of the overall landscape, and maintaining connectivity within this habitat requires

management attitudes which recognise how fragile and important this connectivity is. Stream junctions are particularly important habitat locations within the stream network.

Rivers and streams are flowing connected systems, and management actions in one location may have significant implications for other parts of the system a long way away, upstream and downstream
A simple illustration of this management principle is the way that aquatic and riparian weeds, pests, disease organisms or pollutants introduced in one location can rapidly be distributed for hundreds of kilometres downstream during floods by river flows. Another example is the way that one poorly designed road culvert can block the upstream movement of fish for many tens of kilometres upstream during periods of low flow.

A comprehensive set of State and local government laws and codes apply to the management of riparian zones, terrestrial vegetation, fish habitat, water quality, construction work in streams and water flows
Any significant management intervention in the stream network will be subject to a State or local government regulation or code. It is important to recognise this and take heed of these management guidelines and requirements, which will generally enhance river health and the recovery of the priority species in this plan. Within the Mary River system, Queensland laws and policies which apply include the *Fisheries Act 1994*, the *Water Act 2000*, the *Environmental Protection Act 1994*, the *Sustainable Planning Act 2009*, the *Vegetation Management Act 1999*, the Environmental Protection (Water) Policy 2009 (State of Queensland 2013) and the Wetland Protection Policy for Great Barrier Reef Wetlands (ref). In addition, there may be additional local government policies and codes which apply to development proposals which impact on the stream network.

There is a considerable depth of knowledge and assistance available in the Mary River catchment regarding best practice land management and rehabilitation actions within the Mary River and its tributaries.
In addition to government agencies, local industry, catchment management and landcare groups can provide site specific best practice management advice, based on local expertise. There may be opportunities to access technical and financial assistance for implementing management practices which enhance stream health and implement recovery actions for the priority species in the plan. The Mary River and Tributaries Rehabilitation plan (Stockwell 2001) has provided a systematic planning framework for coordinating and prioritising on-ground river rehabilitation actions within the Mary River Catchment since 2000, and this framework will continue to be used by the Mary River Catchment Coordinating Committee to support recovery actions for the priority species in this recovery plan.

7.3 Management Actions Checklist
The systematic five point checklist below demonstrates how particular management activities support or oppose the recovery objectives of this plan (table X).

Table x: Management actions checklist

Integrity of Riparian Zone includes considerations of the riparian zone's width, longitudinal continuity, structural intactness, cover of exotic vegetation and regeneration	Management practices which improve the integrity and function of the riparian zone, such as native vegetation management and enhancement, ongoing weed control, appropriate fencing and control of stock access, will aid the recovery of the priority species in this plan. Management practices which should be avoided include those which fragment riparian habitat or disturb the streamside zone.
Water Quality	Practices which protect stream water quality, such as maintaining effective vegetation buffers around streams and diversion and treatment of waste water into streams will contribute to the objectives of this plan. Activities which cause a decline in water quality, such as discharges of sediment, nutrients or toxicants from point or diffuse sources or disturbances which alter the salinity, acidity or temperature of surface waters should be avoided.
Physical river features and habitats includes bed banks, instream bars, erosion sedimentation, instream habitat and longitudinal continuity (presence of barriers).	Management practices which recognise and work with the dynamic geomorphic processes operating within the stream and floodplain, maintain connectivity between natural pool, riffle and sandbar sequences and maintain or enhance instream habitat diversity (including wood debris and undercut banks) will support the recovery objectives of this plan. Activities which should be avoided include those which induce new bed or bank instability, break connectivity within the stream or floodplain, disrupt pool and riffle sequences or reduce important instream habitat structures such as undercut banks and beneficial wood.
Hydrological connectivity	The recovery objectives are supported by management practices which aim to preserve and mimic natural flow regimes (where possible). In areas where flows are altered by existing water supply schemes and infrastructure, management actions should endeavour to preserve or recreate the critical aspects of the flow regime that are required for the life cycles of the priority species. Practices which significantly alter the timing, quantity and velocity of natural stream flows, such as over-extraction in dry seasons, reduction of flushing flows, changing the timing of seasonal flow events, extreme drawdown of pools and impounded reaches, temporary or permanent stream diversions and barriers should be avoided.
Aquatic Life and Ecosystem	Practices which actively enhance reproduction, recruitment and survival of individuals, such as turtle nest protection, hygiene protocols for reducing the risk of transfer of diseases, pest and weed species, education of recreational fishers, appropriate infrastructure design support the recovery objectives of this plan. Activities to be avoided include those which reduce reproduction, recruitment or survival of individuals within populations of the priority species, such as recreational fishing disrupting cod nesting behaviour, fish traps which

Table x: Management actions checklist

	drown turtles, transfer of chytrid fungus into frog habitat areas, spillway structures which cause fish and turtle injury when overtopping, the illegal take of eggs and adults or the transfer of pest species such as tilapia or water weeds.

8 REFERENCES

All references throughout need checking

These need to be fixed up in the document…

- Noosa Biosphere Management Strategy (ref)
- Great Sandy Biosphere Management Strategy (ref)
- Wide Bay Burnett Regional Plan (State of Qld 2011d) (informed by the Wide Bay-Burnett Water Strategy (ref) and Natural Resource Management Plan (Wide Bay Burnett Environment and Natural Resources Working Group 2012))
- South East Queensland Regional Plan (State of Qld 2009a) (informed by the South East Queensland Water Strategy and Natural Resource Management Plan (ref))
- Queensland Biodiversity Strategy (author 2011)
- State Planning Policy for Great Barrier Reef Wetlands (ref)
- Environment Planning Policy (Water) for Mary River (ref)
- Mary Basin Water Resource Plan (State of Qld 2006)
- Mary Basin Resource Operations Plan (State of Qld 2011b)
- B Hand pers. comm.? 2012, A Bond pers. comm.? 2011

Allen, G. R., Midgley, S. H., & Allen, M. (2002). *Field Guide to the Freshwater Fishes of Australia*. Perth: Western Australian Museum.

Arthington, A., & Bunn, S. E. (2008). Submission on Traveston Dam EIS for the Mary River region.

Australian Bureau of Statistics. (2012). 2011 Census Community Profile QuickStats (LATEST ISSUE Released at 11:30 AM (AEST) 21/6/2012 ed.).

Australian Museum. (2012). Pinkeye Mullet, *Trachystoma petardi* (Castelnau, 1875). Retrieved from http://australianmuseum.net.au/Pinkeye-Mullet-Trachystoma-petardi/

Bancroft, T. L. (1928). On the life-history of Ceratodus. *Proceedings of The Linnean Society of New South Wales, 53*, 315-317.

Bargo, E. (2012). [Mullet totem]. rest of ref

Barmuta, L. A., Linke, S., & Turak, E. (2011). Bridging the gap between 'planning' and 'doing' for biodiversity conservation in freshwaters. *Freshwater Biology, 56*(1), 180-195. doi: 10.1111/j.1365-2427.2010.02514.x

Berghuis, A. P., & Piltz, S. A. (2005). Assessment of the upgraded fishway on the Mary River Barrage. Brisbane.

BMRG. (2008). Mary Catchment Water Quality Improvement Plan Draft Version 1.2 (pp. 85-116).

Bond ?.? (2011). Personal communication by telephone/email?, 2011, Agency.

EM Bridges, E.M., Ross, D.J. and CH Thompson. (1990). Soils of the Mary River Alluvia Near Gympie, Queensland, CSIRO, Division of Soils Divisional Report No. 109

Brown, E. (2000). Cooloola Coast: Noosa to Fraser Island *The Aboriginal and Settler Histories of a Unique Environment* Retrieved from http://books.google.com.au/books?hl=en&lr=&id=itrYMD80OmEC&oi=fnd&pg=PP10&dq=%22mary+river%22+mullet+totem&ots=u82h5XMNaQ&sig=bQHfXF0k7S4AYwzOs9ap5twYDsM#v=onepage&q&f=false

Brooks, S.G. and Kind, P.K. (2002). Ecology and demography of the Queensland Lungfish (*Neoceratodus forsteri*) in the Burnett River, Queensland with reference to the impacts of Walla Weir and future water infrastructure development. Final Report, prepared for the Queensland Department of Natural Resources and Mines.

Bunn, S. E., Davies, P. M., and Mosisch, T. D. (1999). Ecosystem measures of river health and their response to riparian and catchment degradation. *Freshwater Biology, 41*(2), 333-345. doi: 10.1046/j.1365-2427.1999.00434.x

Burbidge, N. T. (1960). Phytogeography of the Australian Region. *Australian Journal of Botany, 8*(2), 75-211. doi: 10.1038/188544a0

Burghuis, A. (2012). [Freshwater mullet]. Personal communication?

Burnett Mary Regional Group, L. (2011). The Great Sandy Biosphere Links Project - A Long Term Plan to Maintain Ecological Function within the Great Sandy Biosphere. Bundaberg, Queensland.

Cann, J. (1998). *Australian Freshwater Turtles*. Beaumont Publishers, Singapore.

Carpenter, K. E., and Niem, V. H. (1999). *FAO Species Identification Guide for Fishery Purposes - The living marine resources of the Western central pacific,* (Vol. 4). Rome: Food and Agriculture Organization of The United Nations.

Chessman, B. (1999). PBH (pressure, biota, habitat): an assessment method for stressed river ecosystems: Draft Outline of Method: NSW Department of Land and Water Conservation.

Clark, N. J. (2008). *The Diving Physiological Ecology of Australian Freshwater Turtle Hatchlings.* PhD Thesis, School of Biological Sciences, University of Queensland.

Clark, N. J., and Gordos, M. A. F. C. E. (2008). Thermal plasticity of diving behaviour, aquatic respiration and locomotor performance in the Mary River turtle Elusor macrurus. *Physiological and Biochemical Zoology, 81*(3), 301-309.

Clark, N. J. G. M. A. F. C. E. (2008). Diving behaviour, aquatic respiration and blood respiratory properties: a comparison of hatchling and juvenile Australian turtles. *Journal of Zoology*(275), 399-406.

Cooloola Shire Library Service. (2001). Cooloola Shire - a golden past part II.

Connell, M. (2012) Personal communication - feedback on draft plan. with Tanzi Smith, MRCCC. Tiaro and District Landcare.

Connell, M. (2011). Personal communication - phone discussion regarding Tiaro Fishing Competition records. With Tanzi Smith, MRCCC. Tiaro and District Landcare.

CSIRO, 2007. Regional climate change projections. In Climate Change in Australia: Technical Report. CSIRO and Australian Bureau of Meteorology, pp. 49–107. Available at: http://www.climatechangeinaustralia.gov.au/technical_report.php

De Rose, R., Prosser, I., Wilkinson, L., Hughes, A., and Young, W. (2002). *Regional Patterns of Erosion and Sediment Transport in the Mary River Catchment, Queensland*. Technical Report 37/02. Canberra. Retrieved from http://www.clw.csiro.au/publications/technical2002/tr37-02.pdf

DEEDI Fisheries Queensland. (2012). Paradise Dam Downstream Fishway Monitoring Program Retrieved from http://www.sunwater.com.au/__data/assets/pdf_file/0018/9225/Paradise_Dam_Downstream_Fishway_Monitoring_Program.pdf

file:///Users/shawnjarvey/Dropbox/Mary River Species Recovery Plan/Paradise_Dam_Downstream_Fishway_Monitoring_Program.pdf

Department of Environment Climate Change and Water NSW, 2010. *Cultural Connections: Indigenous communities managing biological and cultural diversity for ecological, cultural and economic benefit*, Biodiversity Assessment and Conservation Section –North East of the Department of Environment, Climate Change and Water NSW. Sydney.

Department of Environment and Heritage. (1999). Information Sheet on Ramsar Wetlands - Great Sandy Strait Brisbane: Department of Environment and Heritage.

DNRM (2003) Land & Water Resources Assessment Report – Mary Basin Draft Water Resource Plan, The State of Queensland, Department of Natural Resources & Mines, Brisbane.

Department of Primary Industries (DPI). (1995). Rest of ref

Dudgeon, D., Arthington, A. H., Gessner, M. O., Kawabata, Z.-I., Knowler, D. J., Lévêque, C. (2006). Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological reviews of the Cambridge Philosophical Society, 81*(2), 163-182. doi: 10.1017/s1464793105006950

Environment Australia (2003). Information Sheet - Australian Lungfish (*Neoceratodus forsteri*). [Online]. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/lungfish.html. [Commonwealth Info Sheet; Status=Final; ID=8730].

Fishbase. FishBase version 06/2012 Retrieved 18 July, 2012, from http://www.fishbase.us

Flakus, S. P. (2002). *Ecology of the Mary River Turtle, Elusor macrurus.* Master of Science (Zoology), University of Queensland.

GHD and Buckley Vann Town Planning Consultants. (2011). Fraser Coast 2031 Sustainable Growth Strategy.

Gomon, M. F. (2011). Pinkeye mullet, Trachystoma petardi from HTTP://fishesofaustralia.net.au/Home/species/4470

Grigg, G. (1965). Spawning behaviour in the Queensland lungfish, Neoceratodus forsteri (Krefft). *Australian Natural History, 30*, 50-50.

Growns, I., Gehrke, P. C., Astles, K. L., and Pollard, D. a. (2003). A comparison of fish assemblages associated with different riparian vegetation types in the Hawkesbury-Nepean River system. *Fisheries Management and Ecology, 10*(4), 209-220. doi: 10.1046/j.1365-2400.2003.00337.x

Hand ?.? (2012) Personal communication by telephone/email?, 2012, Agency?.

Hines, H., Mahony, M. and McDonald, K. 1999. An assessment of frog declines in wet subtropical Australia. pp 44-63 in Campbell, A. (ed) *Declines and Disappearances of Australian Frogs*. Environment Australia, Canberra.

Hines, H. B. and the South-east Queensland Threatened Frogs Recovery Team (2002). Recovery plan for stream frogs of south-east Queensland 2001-2005. Report to Environment Australia, Canberra. Queensland Parks and Wildlife Service, Brisbane.

Hines, H., D. Newell, J. Clarke, J-M. Hero and Meyer, E. (2004). *Mixophyes iteratus*.
IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. [Online]. viewed on 25 January 2010. Available from: http://www.iucnredlist.org/apps/redlist/details/13598/0.

Huey, J.A., Espinoza, T. and Hughes, J. 2013, “Natural and Anthropogenic Drivers of Genetic Structure and Low Genetic Variation in the Endangered Freshwater Cod, Maccullochella Mariensis.” Conserv Genet [online] DOI 10.1007/s10592-013-0490-y

Huey, J.A. 2012. Personal Communication email "Update on Cod Genetics" 30/03/2012, with Tanzi Smith, MRCCC. Griffith University.

Hutchison, M. (2012, 16 July 2012). [Freshwater mullet]. Personal communication with Tanzi Smith, MRCCC.

Hutchison, M. (2012) Personal communication with Eva Ford, MRCCC. July 2012, Queensland Department of Agriculture, Forestry and Fisheries

Johnson, D. P. (1996). State of the Rivers: Mary River and Major Tributaries - An Ecological and Physical Assessment of the Condition of Streams in the Mary River Catchment.

Jackson, P. (2008). Appendix L Mary River Cod Review and Research Priorities, Supplementary Environmental Impact Statement: Traveston Crossing Dam. Brisbane: Queensland Water Infrastructure Pty Ltd.

Johnson, M., and Saunders, K. (2007). Wild Heart Bountiful Land: A Historical Overview of the Mary River Valley.

Jones, H. (2011). [Freshwater Mussels in the Mary]. Email communication with Tanzi Smith.

Jones, H. (2013). Personal communication by email March 2013, This was with Keith Walker wasn't it?

Joss, J. (2004). Fishing with Dinosaurs. *Wildlife Australia Magazine, 41*(2), 18-19.

Kelly, S. (1998). Community Restoration Efforts in the Mary River Catchment. Department of Natural Resources Gympie.

Kennard, M.J. Pusey, B., Olden, J.D., Mackay, S.J., Stein, J.L. and Marsh, N., 2010. Classification of natural flow regimes in Australia to support environmental flow management. Freshwater Biology, 55(1), pp.171–193. Available at: http://doi.wiley.com/10.1111/j.1365-2427.2009.02307.x [Accessed September 17, 2013].

Kind, P., Ramage, A., and Brooks, S. (2008). Survival Strategy for the Australian lungfish Neoceratodus forsteri. (September), 1-34.

Kind, P. K., and Brooks, S. G. (2003). Fish communities in the lower Burnett River Queensland, with reference to Walla Weir and future water infrastructure development *Final report prepared for the Department of Natural resources and Mines* (pp. 49): Department of Primary Industries.

Kind, P.K. (2012). Personal Communication. Email Tilapia Update, 21 March 2012. with Tanzi Smith MRCCC. DEEDI.

Kind, P.K. (2012). Draft Meeting Summary - Evaluating the ongoing role of fish stocking in Mary River cod management(A forum co-hosted by MRCCC and Fisheries Queensland), Tuesday 21st February 2012, Sunshine Coast Regional Council, Pelican St, Tewantin.

Kuchling, G. (2008). INDEPENDENT EXPERT REVIEW OF THE INFORMATION PROVIDED IN THE TRAVESTON CROSSING DAM EIS THAT RELATES TO THE MARY RIVER TURTLE (EPBC Referral 2006 / 3150) by.

Ladson, A. R., and White, L. J. (1999). An Index of Stream Condition: Reference Manual (Second ed.). Melbourne Department of Natural Resources and Environment.

Latta, G. (2007). Effects of Water Infrastructure on Freshwater Turtles (pp. 5). Cooroy: Australian Freshwater Turtle Conservation and Research Association.

Limpus, D. J., Hodge, W. J., and Limpus, C. J. (2006). Impacts of Dams and Weirs on Freshwater Turtles : Fairbairn Dam. *Environmental Sciences, 2006*(7).

Limpus, C., 2008. *Freshwater Turtles in the Mary River*, *Qld*, Review of biological data for turtles in the Mary River , with emphasis on Elusor macrurus and Elseya albagula, Brisbane. Queensland Government.

Lovett, S. (1999). Seeing is believing: The value of demonstration sitse. *RipRap, 15*.

Lowry, B. (2004). Dips and peaks: the life of Australia's freshwater eel. *Widlife Australia Magazine, 41*(2), 33-35.

Loyau, G. (1897). *The history of Maryborough and Wide Bay and Burnett Districts from the year 1850 to 1895*. Brisbane: Pole, Outridge & Co.

Lyons, R., and Williams, R. (2010). Burnett Mary Burnett Mary Natural Resource Management Region Back on Track Actions for Biodiversity.

Mary Valley Renewal Team. (2010). Mary Valley Community and Economic Action Plan. http://www.kenilworth.qld.au/documents/MVactionplan01.pdf

Mangold, C. (2012). [Freshwater mullet]. pers comm?

Mathews, T. (1995). *River of Dreams: A History of Maryborough and District, Volume 2*: Maryborough City Council.

McKinnon, F. (1933). Early Pioneers of the Wide Bay and Burnett. Retrieved from http://espace.library.uq.edu.au/eserv/UQ:207886/s18378366_1940_3_2_90.pdf

Merrick, J. R., & Schmida, G. E. (1984). *Australian Freshwater Fishes: Biology and Management*: Griffin Press Ltd.

Micheli-Campbell, M. A., Campbell, H. a., Cramp, R. L., Booth, D. T., and Franklin, C. E. (2011). Staying cool, keeping strong: incubation temperature affects performance in a freshwater turtle. *Journal of Zoology*, no-no. doi: 10.1111/j.1469-7998.2011.00840.x

Micheli-Campbell, M.A. (2012). Habitat requirements for nesting and early life-stages of the endangered Mary River turtle (*Elusor macrurus*): Insights for conservation. PhD Thesis, School of Biological Sciences, University of Queensland.

Miles, N. G., West, R. J., and Norman, M. D. (2009). Does otolith chemistry indicate diadromous lifecycles for five Australian riverine fishes? *Marine And Freshwater Research, 60*(9), 904-911. doi: http://dx.doi.org/10.1071/MF08252

Moran, P., (2009). Mary River Aquatic Weed Strategy 2010-2014 for the Mary River Pest Management Group, Burnett Mary Regional Group Bundaberg.

MRCCC ,(2005). Mary River Catchment Rivercare Initiatives Recommendations Report (Priority Action Project 2.2).Mary River Catchment Coordination Committee, Gympie.

MRCCC (2008). Riffle/pool/sandbank community of the Mary River (Queensland) floodplain - Threatened Ecological Community EPBC nomination. Available from: http://mrccc.org.au/downloads/publications/MRCCC%20Mary%20Threatened%20Ecological%20Community%20EPBC%20nomination%20Apr%2008%20(13%20mb).pdf

MRCCC (2011). Rest of ref.... Results of community survey??

National Land and Water Resources Audit. (2002). Catchment, River and Estuary Condition in Australia.

New South Wales Department of Primary Industries. (2005). Oxleyan Pygmy Perch (*Nannoperca oxleyana*) Recovery Plan and Background Paper. [Online]. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/n-oxleyana.html

Nock, C. J., Elphinstone, M. S., Rowland, S. J., and Baverstock, P. R. (2010). Phylogenetics and revised taxonomy of the Australian freshwater cod genus , Maccullochella (Percichthyidae). *Marine and Freshwater Research, 61*, 980-991.

O'Donnell, S. (1998). Management of River and Creek Bank Plantings in Sub-tropical Coastal Riparian Rainforest. Department of Natural Resources and Mary River Catchment Coordination Committee, Gympie.

Olson, D. M., and Dinerstein, E. (2002). The Global 200: Priority Ecoregions for Global Conservation. *Annals of the Missouri Botanical Garden, 89*, 199-224.

Perry, M., and Bay, H. (2003). National Action Plan for Salinity and Water Quality Burnett Mary and Western Catchments of South East Queensland BURNETT MARY Salinity Hazard (Potential for Salt Mobilisation). (February), 506653-506653.

Pointon, S. M., and Collins, A. W. (2000). Mary River Catchment Resource Atlas.

Queensland Government. (2012). Wetland Definitions Retrieved 29 April, 2012, from http://wetlandinfo.derm.qld.gov.au/wetlands/WetlandDefinitionstart/WetlandDefinitions/Systemdefinitions.html)

Queensland Treasury. (2011). *Queensland Government population projections to 2031: local government areas, 2011 edition*.

Riede, K. (2004). Global register of migratory species - from global to regional scales *Final Report of the R&D-Project 808 05 081*. Bonn, Germany: Federal Agency for Nature Conservation.

Simpson, R. (1994). An investigation into the habitat preferences and population status of the endangered Mary River Cod (Maccullochella peelii mariensis) in the Mary River System, south-eastern. Queensland. Department of Primary Industries: Brisbane.

Simpson, R. and Jackson, P. (1996). The Mary River Cod Research and Recovery Plan - 1996-2001. [Online]. QLD DPI. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/recovery/mary-river-cod/index.html.

Simpson, R and Mapleston, AJ (2002) 'Movements and habitat use by the endangered Australian freshwater Mary River Cod Maccullochella peelii mariensis', Environmental Biology of Fishes, vol. 65, pp. 401-10.

Sunwater. (2010). Fishways (pp. 26-26).rest of ref?

State of Queensland. (2006). Water Resource (Mary Basin) Plan 2006. Water Act 2000.

State of Queensland. (2009). South East Queensland Regional Plan 2009–2031. Department of Infrastructure and Planning, Brisbane, Qld.

State of Queensland. (2011). Reef Water Quality Protection Plan: First Report 2009 Baseline. Reef Water Quality Protection Plan Secretariat, Brisbane, Qld.

State of Queensland. (2011b). Mary Basin Resource Operations Plan. Department of Environment and Resource Management.

State of Queensland. (2011c). An Aquatic Conservation Assessment for the non-riverine and riverine wetlands of the Wide Bay-Burnett region. The Department of Environment and Resource Management, Brisbane.

State of Queensland. (2011d). Wide Bay Burnett Regional Plan. Department of Local Government and Planning. Brisbane

State of Queensland. (2012). Mary Valley Economic Development Strategy. Department of State Development, Infrastructure and Planning, Brisbane, Qld.

State of Queensland. (2013). Environment Protection (Water) Policy 2009 reprint.

Stockwell, B.R. (1999). Riparian Projects Demonstration and Evaluation in the Mary River Catchment, final report November 1999, Mary River Catchment Coordination Committee and Land and Water Resources Development Corporation.

Stockwell, B.R. (2001). Mary River and Tributaries Rehabilitation Plan Implementation Edition. Mary River Catchment Coordination Committee, Gympie.

Stockwell, B., Hutchison, M., Wedlock, B., Ford, E., Anderson, T., Thomson, C. (2004). Draft Freshwater aquatic biodiversity in the Burnett Mary region peer review version (Vol. 2004).

Stockwell, B., Johnston, B., and Hutchison, M. (2008). Burnett Mary regional biopass strategy Reconnecting the Dreamtime's Rainbow Serpent.

Sunshine Coast Regional Council. (2011). Sunshine Coast Waterways and Coast Management Strategy 2011-2021. Sunshine Coast, Qld.

Threatened Species Scientific Committee (TSSC) (2008). *Commonwealth Conservation Advice on* Pseudomugil mellis. [Online]. Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/26180-conservation-advice.pdf.

Threatened Species Scientific Committee (TSSC) (2008b). *Commonwealth Conservation Advice on Elusor macrurus*. [Online]. Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/-conservation-advice.pdf.

Threatened Species Scientific Committee (TSSC) (2011). Commonwealth Conservation and Listing Advice on Lowland Rainforest of Subtropical Australia. [Online]. Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/cgi-bin/sprat/publicshowcommunity.pl?id=101.

Thomson, D., and Pepperdine, S. (2003). Assessing community capacity for riparian restoration.

Tutt, S. (1994). Trees went, sand came: days gone by. Sunshine Coast Sunday

Magazine, February 27, p. 14.

Watson, D. (2003). Implementing the Mary River and tributaries rehabilitation plan monitoring and evaluation report.

Watson, D., Wedlock, B. and Skrokov, L., 2005a. Mary River Catchment Water Quality Monitoring Recommendations Report (Priority Action Project 2.1), Mary River Catchment Coordination Committee, Gympie.

Watson, D. Wedlock, B. Skrokov, L and Collins, A., 2005b. Great Sandy Strait Water Quality Monitoring Recommendations Report (Priority Action Project 2.1), Mary River Catchment Coordination Committee, Gympie.

Wide Bay Burnett Environment and Natural Resources Working Group. (2012). Wide Bay Burnett Environment and Natural Resource Management Plan 2012-2031. Burnett Mary Regional Group for Natural Resource Management, Bundaberg, Qld.

Wikipedia. (2013). Wallum definition. [Online]. Available from: http://en.wikipedia.org/wiki/Wallum

Zacharias, M. A., and Roff, J. C. (2001). Use of focal species in marine conservation and management : a review and critique. *Aquatic conservation: Marine and Freshwater Ecosystems, 76* (April 2000), 59-76.

Appendix 2 Biodiversity of the Mary River

Have not checked any appendices. Some appendices might be able to be published separately on website.

Species and ecological communities of conservation significance associated with the Mary River are listed below according to four main ecosystems types: Aquatic, Terrestrial, Estuarine and Marine.

Aquatic Ecosystem

Nationally listed aquatic species

Species	Common name	National status (EPBC Act)	Qld status (Fisheries & NC Acts)
Elusor macrurus	Mary River turtle	E	E
*Maccullochella mariensis*is	Mary River cod	E	No take
Nannoperca oxleyana	Oxleyan pygmy perch	E	V
Neoceratodus forsteri	Australian lungfish	V	No take
Pseudomugilmellis	Honey blue-eye	V	V
Haliaeetus leucogaster	White-bellied Sea-Eagle	M	NL
Nettapus cormandelianus albipennis	Australian Cotton Pygmy-goose	M	NT
E – Endangered, V – Vulnerable, M – Migratory, NL – Not Listed, NT – Near Threatened			

Other significant threatened aquatic species which are not listed nationally, but have conservation significance

Species	Common name	Qld status (Fisheries & NC Acts)
Aponogeton queenslandicus	No common name (this is an aquatic plant)	LC
Elseya albagula	White-throated snapping turtle	LC
Rhadinocentrus ornatus	Ornate rainbowfish	
Vallisneria nana	Ribbonweed	LC
LC – Least concern		

Aquatic ecological community:

An assessment for a new ecological community, the “Long Lowland Rivers of South East Queensland and North East New South Wales ecological community” was considered for listing under the EPBC Act. The Mary River was included in this proposed listing. Despite the result that the proposed listing was ineligible for listing, conservation advice was published which will assist to avoid deterioration and consequent eligibility for listing in the future.

The distinctive features include perennial shallow riffle zone providing oxygenation, a sandy/gravelly stream bed, deep pool habitat with snags, beneficial large wood and submerged macrophytes and sandy loam banks extending to the water’s edge. Found in the perennial flowing floodplain reaches of the Mary River and tributaries upstream of the tidal influence and downstream of the confined headwater system.

Terrestrial Ecosystems

These ecosystems include river corridors encompassing active and abandoned channels, the aquatic margins of these channels, the riparian zones along the channel banks and any floodplains, as well as wetlands. In their natural states, river margins consist of a complex mosaic of patches of different type, size and age. The dynamic geomorphology of riverine ecosystems create a diverse range of meso and micro scale habitats which feature high levels of biodiversity (Treadwell 2003). The main trunk of the Mary River is virtually devoid of threatened riparian plant species. However, tributaries in the Mary and Burnett River catchments contain numerous threatened riparian plant species such as *Cossinia australiana*, *Alyxia magnifolia* and *Choricarpa subargentea* (Stockwell et al. 2004). The Mary River catchment is also regarded as an important area for the recovery of *Macadamia integrifolia* (ref).

Nationally listed species found in terrestrial ecosystems

Species	**Common name**	**National status (EPBC Act)**	**Qld status (Fishers & NC Act)**
Flora			
Cossinia australiana		E	E
Fontainea rostrata		V	V
Phaius australis		E	E
Quassia bidwillii		V	V
Romnalda strobilacea		V	V
Syzygium hodgkinsoniae	red lilly pilly	V	V
Xanthostemon oppositifolius	penda	V	V
Macadamia integrifolia		V	V
Macadamia ternifolia		V	V
Fauna			
Cyclopsitta diophthalma coxeni	Coxen's fig-parrot	E, M	E
Erythrotriorchis radiatus	Red goshawk	V	E
Mixophyes iteratus	Giant Barred frog	E	E
Monarcha trivirgatus	Spectacled Monarch	M	LC
Rhipidura rufifrons	Rufous fantail	M	LC
Turnix melanogaster	Black-breasted button-quail	V	V
Phascolarctos cinereus	Koala (SEQ)	V	Special LC
Pteropus poliocephalus	Grey-headed flying-fox	V	LC
CE – Critically endangered, E – Endangered, V – Vulnerable, M – Migratory, LC – Least Concern			

Other significant threatened terrestrial species not listed under the EPBC Act

Species	**Common name**	**Fisheries/ NC Acts**
Flora		
Alyxia magnifolia	Large leaf chain fruit	NT
Choricarpia subargentea	giant ironwood	NT
Floydia praealta	ball nut	V
Paristolochia praevenosa	Richmond birdwing vine	NT
Symplocos harroldii	hairy hazelwood	NT
Thisma rodwayi		NT
Fauna		
Adelotus brevis	Tusked frog	V
Calyptorhynchus lathami lathami	Glossy black-cockatoo (eastern)	V

Litoria pearsoniana	Cascade Tree frog	E
Ninox strenua	Powerful owl	V
Ornithoptera richmondia	Richmond birdwing butterfly	V
Eutacus hystorica	Giant Spiny crayfish	No take
E – Endangered, V – Vulnerable, NT – Near Threatened		

Terrestrial Ecological Community
Approximately 11 000 ha of critically endangered EPBC Act listed ecological community of the "Lowland Rainforest of Subtropical Australia" is found within the Mary River catchment.

Regional Ecosystems are defined in Queensland based on region, geology and landform as well as vegetation type. Below, the threatened regional ecosystems that occur in the Mary River catchment are listed. The right hand column indicates whether the particular RE is also protected through the Lowland Rainforest of Subtropical Australia listing. It should be noted that this listing applies to these Regional Ecosystems at altitudes below 300m.

Threatened riparian RE communities

Regional Ecosystem	**Short Description**	**"Lowland Rainforest of Subtropical Aus" Ecological Community (TSSC 2011)**
Endangered		
12.3.1	Gallery rainforest (notophyll vine forest) on alluvial plains	Yes
12.3.3	Eucalyptus tereticornis woodland to open forest on alluvial plains	No
12.5.13	Microphyll to notophyll vine forest±Araucaria cunninghamii	Yes
12.9/10.16	Araucarian microphyll/notophyll vine forest on sedimentaries	No
Of Concern		
12.3.11	Eucalyptus siderophloia, E. tereticornis, Corymbia intermedia open forest on alluvial plains near coast	No
12.9/10.3	E. moluccana open forest on sedimentaries	No
12.11.1	Simple notophyll vine forest often with abundant Archontophoenix cunninghamiana ("gully vine forest") on metamorphics ±interbedded volcanics	Yes
12.11.14	Eucalyptus crebra, E. tereticornis woodland on metamorphic±interbedded volcanics	No
12.12.1	Simple notophyll vine forest often with abundant Archontophoenix cunninghamiana ("gully vine forest") on Mesozoic to Proterozoic igneous rocks	Yes
12.12.12	Araucarian complex microphyll vine forest on metamorphics ±interbedded volcanics, northern half of bioregion	No

Estuarine/Marine Ecosystem

Nationally listed species found in estuarine and marine environments in proximity to the Mary River catchment

Species	Common name	National status (EPBC Act)	Qld status (Fishers & NC Act)
Fauna			
Ardea alba	Great Egret	M	
Charadrius mongolus	Lesser Sand Plover	M	
Esacus neglectus	Beach stone-curlew	O	V
Gallinago hardwickii	Latham's Snipe	M	
Haliaeetus leucogaster	White-bellied Sea-Eagle	M	
Heteroscelus brevipes	Grey-tailed Tattler	M	
Limosa lapponica	Bar-tailed Godwit	M	
Merops ornatus	Rainbow Bee-eater	M	
Numenius madagascariensis	Eastern Curlew	M	NT
Numenius phaeopus	Whimbrel	M	
Pluvialis squatarola	Grey Plover	M	
Rostratula benghalensis s.	Painted Snipe	M	
Tringa nebularia	Greenshank	M	
Xenus cinereus	Terek Sandpiper	M	
Xeromys myoides	Water mouse	V	V
Natator depressus	Flatback turtle	V, M, O	V
Chelonia mydas	Green turtle	V, M, O	V
Dermochelys coriacea	Leatherback turtle	E, M, O	V
Dugong dugon	Dugong	M, O	V
Sousa chinensis	Indo-Pacific hump-backed dolphin	C, M	NT
Caretta caretta	Loggerhead turtle	E, M	E
Megaptera novaeangliae	Humpback whale	V, C, M	V
E – Endangered, V – Vulnerable, M – Migratory, O – Marine, C – Cetacean, NT – near threatened, LC – Least Concern			

Other significant threatened fauna listed under the NCA and not the EPBC Act

Species	Common name	Qld status (Fishers & NC Act)
Acrodipsas illidgei	Illidge's ant blue	V
V – Vulnerable		

Wetland of International Importance/Ramsar Site:

The Great Sandy Strait

The Ramsar site includes the tidal waters of the Great Sandy Strait, Mary River, Susan River, Kauri Creek, Tin Can Bay and Tin Can Inlet and the freshwater swamps and patterned fens contiguous with the mangroves on Fraser Island and southwest of Rainbow Beach. The Mary River flows into the Great Sandy Strait at its northern end.

World Heritage Area
Fraser Island

A wide range of species will benefit from action 3 and 4. Particular consideration can be made to inclusion of Macadamia species in the subcatchments known to contain these species (see Macadamia Recovery Plan), to the habitat requirements of the white throated snapping turtle and the Giant Spiny Crayfish within their respective ranges.

Appendix 3 Discussion regarding selection of priority species

WORK IN PROGRESS

Key decisions:
Explain selection of Freshwater Mullet
Jungle Perch was a potential candidate. It also requires longitudinal connectivity throughout the entire river system and is in decline. The Mary River is near its southern limit. It is not representative of the SEQ bioregion and is more representative of coastal waters in the tropics. See Hutchinson et al (Hutchinson, Simpson, Elizur, Willett, & Collins, 2002) and Lewis and Hogan (1987) for more information about the species.

The Freshwater Mullet has a narrower distribution from Northern NSW to The Burnett (G. R. Allen et al., 2002). The population is in decline regionally, with Freshwater Aquatic Biodiversity in the Burnett Mary Region Peer Review Technical Paper (Stockwell, Hutchison, Wedlock, Ford, Anderson, Thomson, & Stephens, 2004b)(p3) referring to research which has found that the freshwater mullet has "virtually disappeared from the Burnett, Kolan, Gregory, Burrum and Isis Rivers".

– mullet may be an important food of Mary River cod (Stockwell, Hutchison, Wedlock, Ford, Anderson, Thomson, & Stephens, 2004b). Actions designed at maintaining population have benefits for other species.

The Freshwater Mullet is also representative of the SEQ bioregion (J. Tait pers comm.? year), and given that the Mary River is a characteristic river of inland waters in the SEQ bioregion. For rivers in the SEQ bioregion the Freshwater mullet (Trachystoma petardi) is an iconic and representative fish species. The Mary River being one of the rivers in the SEQ bioregion that is still in a reasonable state in terms of its biodiversity, the status of the freshwater mullet population in this river is of particular conservation significance.

The mullet is also primarily a herbivore, feeding mainly on algae but also eating detritus and benthic invertebrates (G. R. Allen et al., 2002). The diet of the algal diet of the mullet has a strong association with the spawning areas of the lungfish where algae grow in submerged macrophytes such as vallisenaria sp.

Freshwater Mullet also plays a significant role in the indigenous culture of the upper catchment and mullet runs are noted as significant events in folklore of the catchment. (Diamond Scale Mullet are very significant to the Butchulla people in the lower catchment (but I am yet to confirm the scientific name of this species – I think it might be Liza viagiensis and they are also distributed worldwide). Historical gatherings of tribes from throughout the region occurred during mullet runs at the river mouth and are often discussed in association with Bunya Festival that occurs in Bunya mountains)

The freshwater mullet is also known as the pinkeye mullet.

Note: There are several mullet species that utilize the Mary River. According to the BMRG Country to Coast Aquatic Biodiversity survey (Burnett Mary Regional Group, 2005) these include the Bully Mullet (*Mugil cephalus*) (also called sea mullet (G. R. Allen et al., 2002)), flat-tailed mullet, (*Liza dussmieri*) and green back mullet (*Liza subviridis*) (the flat-tailed and green back have not been recorded in the freshwater section since the barrages were constructed) . The Bully or Sea Mullet occurs worldwide (G. R. Allen et al., 2002).
Giant Barred Frog White Throated Snapping Turtle

Jungle Perch (Kuhlia rupestris)	Not listed	Not listed	A flagship species for connectivity between fresh and salt – population is in decline (Stockwell, Hutchison, Wedlock, Ford, Anderson, Thomson, & Stephens, 2004b). Mary River provides an opportunity for localised recovery of the population. Mullet could potentially represent this category. Mary River estuary was classified as Priority 2 in the BMR biopass strategy ie. capacity to return habitat and connectivity to pre disturbance condition should be explored pg. 20 (Stockwell et al., 2008.)	Nothing
Secondary Focus				
White Throated Snapping Turtle	High	Not listed	It is likely to be listed soon. It is not in the category of primary species because its issues are similar to the Mary River turtle. Main differences from the Mary River Turtle from a conservation point of view are the length and timing of the breeding season and difference in nesting location.	Management plans in Burnett and Fitzroy??
Oxlyean Pygmy perch	Critical	Endangered	Existing recovery plan. Occurs in specific habitat that is already targeted?? (not sure if this is correct)	Recovery Plan (NSW Department of Primary Industries, 2005)
Honey Blue eye	Critical	Vulnerable	Existing conservation advice	Conservation Advice (Federal Environment Minister, 2008)
Eel-tailed catfish	Not listed	?	Population is in decline elsewhere (ref). Mary River population appears relatively healthy and actions designed at maintaining population have benefits for other species. Juveniles of this species are associated with riffles and runs (Stockwell, Hutchison, Wedlock, Ford, Anderson, Thomson, & Stephens, 2004b)	??
Vallisneria nana beds	Not listed	?	Key to lungfish breeding (ref) and actions aimed at protecting this ecological feature have benefits for other species.	Listed as rare under

Or “flow dependent macrophyte communities”			Their presence reflects flow regimes and absence of aquatic regimes. (see study of EF effects in Daly River (Rea, Dostine, Cook, Webster, & Williams, 2002) and water level fluctuation in the Burnett river (Duivenvoorden, 2008) Are listed in the nomination for the riffle pool sandbar sequence.	the Nature Conservation Act. No mentioned in EPBC listing, though part of Nomination for Riffle Pool Bar ecological community (Burgess, 2008)
Riffle pool sandbar sequence	Not listed	Nomination under consideration	Loss of riffle habitat could also potentially impact on long-finned eels, juvenile Mary River cod, Marjories hardyhead, Australian smelt, juvenile Tandanus tandanus freshwater mullet and jungle perch, all species which are associated with riffles or runs.(Stockwell, Hutchison, Wedlock, Ford, Anderson, Thomson, & Stephens, 2004b)	
Lowland Rainforest of SEQ	Not listed	Nomination under consideration		
Freshwater mussel	Not listed	Not listed	There are no formal assessments yet the Mary /Burnett River area is probably an important biogeographic limit as many fish and mussels have their range limits here. You will find Cucumerunio novaehollandiae (fast waters). Hyridella drapeta, H. australis and H. depressa are at their northern limit and you may not find all three. You will also get Velesunio ambiguus, V. wilsonii and Alathyria pertexta here. The last three tend to be waterhole species but A. pertexta will occur in flowing watrers. A. pertexta and V. wilsonii look superficially similar but can be readily distinguished with practice. Seven species is possibly the highest mussel diversity you are likely to find anywhere in Australia. (H. Jones pers comm. year?) According to the Mussel project, species in the Mary include Cucumerunio novaehollandiae, Alathyria pertexta, Hyridella depressa, Velesunio angasi http://mussel-project.ua.edu/db/db.php?view=valid&h=s&c=Mary+River&l=spec&button=Submit	Nothing

			Suspected to be an indicator of river health and are affected by barriers as well as water quality If fish (hosts) are prevented from movement due to barriers, this would impact on mussel dispersal (Ponder and Walker 2003).	
Cascade Tree Frog	Not listed	Not listed in EPBC Endangered in NCA	Narrow distribution in Queensland, (Kandanga State Forest is northern limit). Populations appear to have declined greatly in Connondale and Blackall ranges. Inhabitat streams in rainforest and adjacent wet sclerophyll forest at elevations of 200-1000m.	Part of Stream Frogs of Australia recovery plan
Spiny crayfish Euastacus hystricosus	Not listed	IUCN endangered	The region also contains two crayfish entered on the IUCN's red list of endangered fauna (Euastacus hystricosus and Euastacus urospinosus). The giant spiny crayfish (Euastacus hystricosus) is restricted to upland streams located in wet sclerophyll forests and rainforests throughout the Conondale and Blackall Ranges. Adults of this species grow up to more than 30 centimetres in length and weigh over two kilograms. Little is known about the giant spiny crayfish, despite being regarded as excellent indicators of ecological health. Occurrence above 475m – stream order??	
Euastacus urospinosus	Not listed	IUCN Red List Endangered	Endemic. It is restricted to a tributary of Obi Obi Creek, between Maleny and Mapleton in the Blackall Ranges, and other sites in the Conondale Ranges. Requires cool clear headwater streams and two remaining populations are current separated by fragmented vegetation.	
Macadamia ternifolia and M. integrifolia	Not listed	vulnerable	Occur in association with riparian zones	Recovery plan for southern macadamias
Listed and non listed species that Benefit				
Red Goshawk	High	Vulnerable	red goshawk nests in tall trees usually within 1 km of a river.(Brizga 2006)	
Coxen's Fig Parrot	Critical	Endangered	Fig Parrot relies on fruit	Recovery Plan (Coxen's Fig-parrot Recovery team, 2001)
Grey headed	Critical	Vulnerable	Riparian zones are believe to provide important roosting sites for Grey headed	Recovery

flying fox			Flying fox (In NSW at least) and rainforest plants which occurs as part of the riparian zone provide a food source.	Plan
Dugong	Critical	Migratory Marine Vulnerable (NCA)	Seagrass health is important for survival of dugong population in the Great Sandy Strait. The Great Sandy Strait is a Dugong Protection Area. Impacts of past floods on the seagrass beds and also the association between the river and seagrass recovery indicate the importance of the link. Actions to improve water quality and provide environmental flow to the estuary are likely to benefit dugong.	Threat abatement plan for the impacts of marine debris on vertebrate marine life
Loggerhead	Critical	Endangered	Loggerheads eat benthic organisms, and water quality and flow regime in the Mary River provide an important component of the benthic food web through inputs of organic matter(ref). Excess sediment (what about salinity) can also cause damage to this foodweb through smothering of benthic communities.	
Green turtle	Critical	Vulnerable	Green turtle eat seagrass, and would therefore be affected by similar factors to dugong.	
Leartherback turtle	Critical	Vulnerable (endangered under NCA)		
Flatback turtle (Natator depressus)	Critical	Vulnerable		
Illidges ant blue butterfly	Critical	Vulnerable (NCA)	Would benefit from environmental flows to estuary as their life cycle depends on mangrove flowering which in turn is triggered by flow events.	
Richmond Birdwing Butterfly Ornithoptera richmondia (Gray)	High	Low risk (rehabilitated)	Rainforest where *Parastilochia* vines occur. A species around which a lot of community interest has been generated and successful Richmond Birdwing Butterfly Network has operated.	
Indo-pacific humpback dolphin	Critical	Migratory (rare under NCA)	Environmental flow to the estuary impacts on food chain from benthic organisms up to fish.	
Quassia	High	vulnerable	Endemic??	

bidwilli				
Cossinia australis	High	Endangered	Located in Teddington Weir (narrow distribution)	
Deep Ck Fontainea Fontainea rostrata	Not listed	Vulnerable	(narrow distribution – need to confirm details)	
Kin Kin Penda (Xanthestemon oppositifolius)	Not listed	Vulnerable	(narrow distribution - need to confirm details)	

Appendix 3: Summary of the chronological order of activities undertaken by the Recovery Team, the Technical Advisory Group and the broader community

A stakeholder analysis and prioritisation was completed at the commencement of the engagement period. Stakeholders were engaged through a series of iterations that have focussed on two areas; 1) introducing the plan and seeking feedback on the vision, and 2) introducing and seeking feedback on proposed actions in the plan. Figure **X** summarises the planning process, the main activities undertaken involving the Recovery Team, Technical Advisory Group and the broader community. The words in bold print in Figure **X** summarise the focus of decision making at the time and the placement of the oval around these words shows which group/s influenced this aspect of the plan. For example, all three groups contributed significantly to the vision and action prioritisation. Defining 'habitat critical' (see section **X.X**) was undertaken entirely by the Technical Advisory Group, whereas the threat prioritisation involved some input from all three groups.

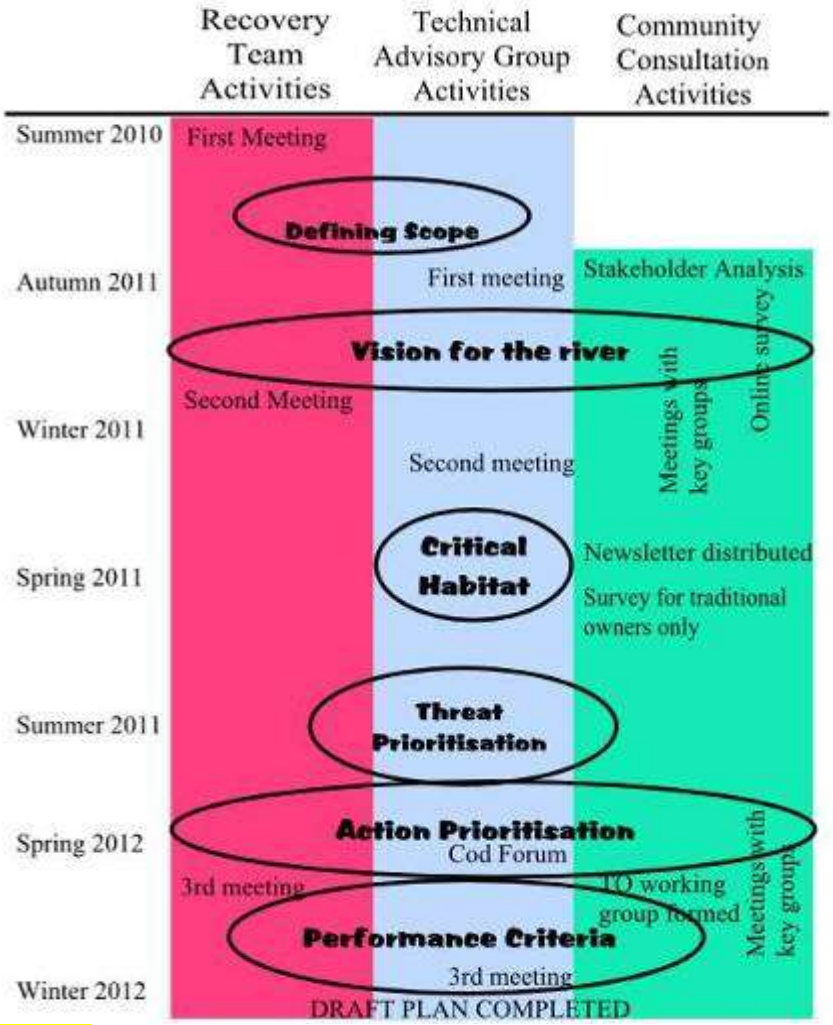


Figure x-x Summary of the chronological order of activities undertaken by the Recovery Team, the Technical Advisory Group and the broader community (revise)

Appendix 4: Stakeholder engagement

x.x.x The approach to community engagement

Involvement of interest groups serves two major purposes in the recovery plan. Firstly, the knowledge and expertise of members of the community shared during engagement activities has provided direct inputs to the recovery plan regarding the vision for the plan, recovery actions, species status and threats. Secondly, involving the community is essential for building a strong foundation for implementation of the plan. Where possible, the strategy has sort to fulfil the following characteristics which Barmuta et al (2011, p. 186) have identified as being important for successful implementation:

- early stakeholder involvement,
- openness and humility in negotiations,
- building capacity and trust,
- making and maintaining explicit links with institutions and community groups, and, of course,
- sufficient resources and time to foster and maintain the collaboration.

A list of all the stakeholder groups involved in the recovery plan and the nature of their participation is provided in Appendix 5.

From the outset, certain principles and approaches guided stakeholder, community and indigenous engagement in the development of the recovery plan. These principles are in addition to the guiding principles of the plan (section **Error! Reference source not found.**), and are as follows:

- Create resources and opportunities for people already involved in Rivercare
- Inspire new people and groups to be involved in Rivercare
- Use familiarity with the district/sub-catchment to generate local interest
- Achieve multiple outcomes i.e. benefits to river health and species recovery, benefits to this project and partner projects
- Build on the past and continue to strengthen relationships and connections with other organisations
- Take a long term view

In summary, the process involved the following interconnected stages:

1. Stakeholder Analysis and Prioritisation - stakeholder groups were divided into 3 categories based on their level of influence and interest. This was done to enable targeted use of the limited time and resources available.

2. Online survey was sent to priority groups. The survey focussed on their perspective on the vision regarding the future of the river and the actions they believe the recovery plan should include. The survey also asked questions about their preferred way of being involved in the development of the plan. Approximately 300 hundred people would have received the survey, primarily by email, but also in hard copy at events or by request. Fifty responses were received. The proposed actions were incorporated into the action prioritisation process and the ongoing engagement process was designed according to the preferences expressed. Comments on the vision have influenced the way the plan was approached. The results of the survey are documented in MRCCC (2011).

3. Meetings with and presentations to key groups and individuals who are influential and interested – A focussed effort was made to reach these groups early in the project to discuss vision and actions.

4. Public engagement activities including use of social media and public forums - These aimed to reach both “new and old faces”, inform and provide the opportunity to give input. Effort in this area was concentrated on two periods. The first period was from March-June 2011 when the vision for the plan was the focus. Between May-June 2012 the draft action

list was the focus of a second period of community engagement. A website and facebook page were used to provide the general public with access to information and updates in 2012. A third period of engagement centred on the action prioritisation. This took place in early 2013 an occurred predominately online through another action prioritisation survey.

All of these processes were designed to seek feedback that would enable improvement of the recovery plan and build a platform for implementing the plan by encouraging ownership of the actions and outcomes identified in the document. This task was made more possible by the role Mary River Catchment Coordinating committee played in the development of this plan.

x.x.x Overview of the outcomes of the engagement process

Engagement of the General Public

The views and aspirations expressed during the engagement process echoed those expressed in previous engagement activities, such as the extensive rounds of public consultation conducted in the early years of MRCCC. At that time, a vision for the future of the catchment was developed (see Box ?). This vision recognises the value of the river for agriculture, fishing and recreation as well as the changes that are needed to enable the river to be healthier and continue to support a "myriad of life forms".

Similar sentiments were expressed during the two intensive periods of community engagement conducted during the development of the recovery plan.

As is explained further in section ?, two of the six objectives for the plan relate directly to the involvement of the community in the recovery process and the actions that needed to facilitate a strong community role in the future. One objective covers the entire community and the other is specific to indigenous involvement in the recovery process.

During June 2012, four Caring for Mary Forums were held throughout the catchment in addition to a workshop at the General Committee meeting of the MRCCC. In total 109 people participated in these five events. The focus of these events was on developing the actions needed to facilitate community involvement in the recovery process. As part of this process, people were asked why they care about the Mary River. They were then asked to think of the activities they would like to undertake to care for the river and what they needed more of to facilitate these activities. Figure x and Figure X summarise the themes that were raised in response to these two questions.

Box 6: Community vision from the mid 1990s

"In our lifetime the community will be enjoying the natural bounty of sustainable agricultural, fishing and recreational activities flowing from a healthy river system. Native forests growing on stable stream-banks will shade the length of the river and all its creeks, where pools, riffles and snags interplay, to create diverse habitat for a myriad of life forms (Source ..xxx)

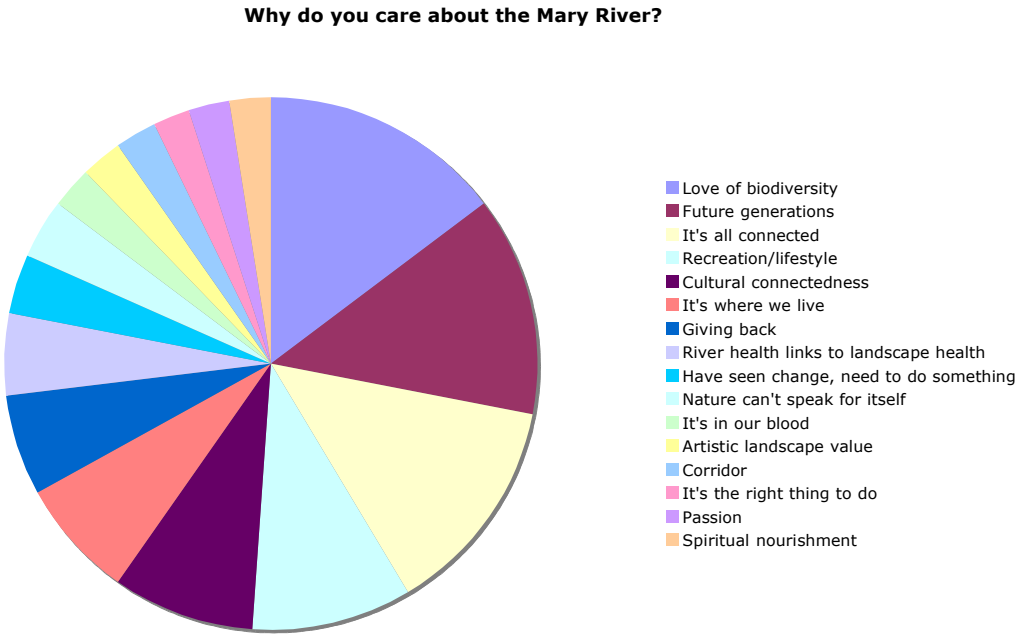


Figure 8-1 Results of the Caring for Mary public forums – Why do you care?

In addition to those shown Figure 8-1 additional reason to care, were: the river is “a resource”, “water security”, “nutrients to fish nurseries”, “sustains life”, “The stuff of legends” and to “create an example” (these received one response and were not shown in the graph).

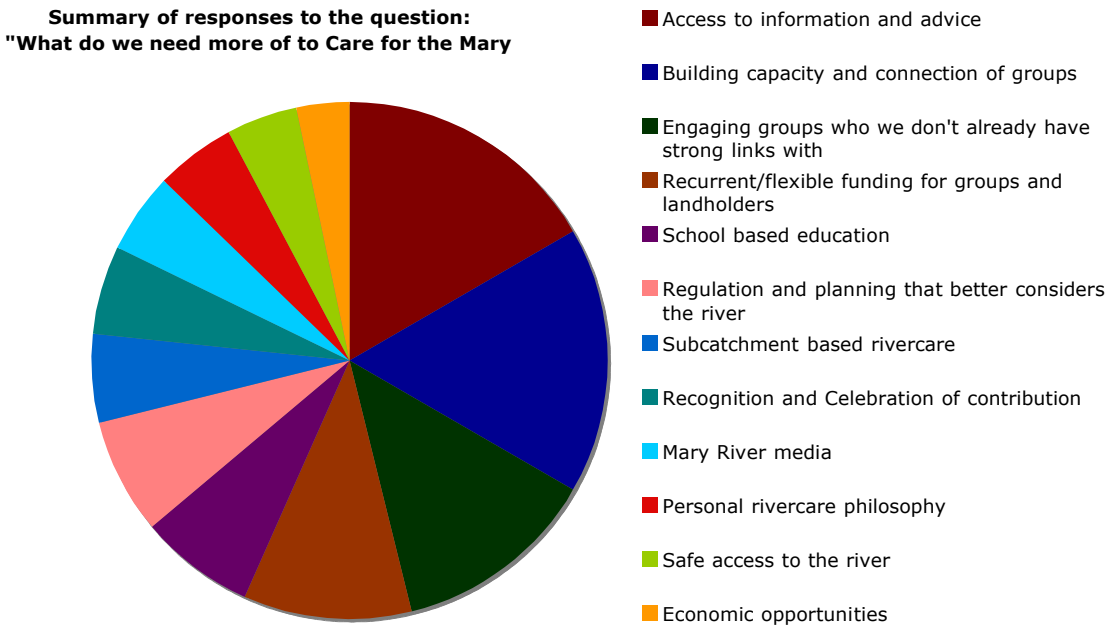


Figure 8-2 Results of the Caring for Mary public forums – What do we need more of?

The Caring for Mary public forums culminated in a discussion of actions that should be included under objective 4. The themes listed in the above figures are reflected in the final list of actions which are detailed in section ?.

Indigenous engagement

Indigenous involvement and leadership in the recovery process was the focus of a dedicated series of meetings with key groups and individuals. The details of this process are described in

Appendix 5. The contributions made in this process were in addition to the contribution several individual indigenous people made during general community engagement opportunities.

The discussion with the indigenous groups initially focussed on the species of cultural significance, the potential use of language in the plan and location of sites of cultural significance. However, it became apparent during the course of the discussion that the assumptions underpinning the initial consultation were incorrect.

Box 7: Endangered culture
"These species are endangered, but so is our culture. Our culture is endangered. We need to protect these species and we need to maintain our culture."
Kabi Kabi Knowledge holder commenting on recovery plan scope (double check this with Alex)

Species of cultural significance are numerous, and the significance depends on the individual person and their spiritual and cultural connection to particular species. There are relationships between different species that operate via a different system of understanding than that typically used in conservation. For example, flowering of particular trees relates to behaviour of particular fish species. There is great potential for the recovery process to engage with this different system of knowledge and a suite of recovery actions aim to facilitate this.

Language has not been used in the plan, unless as part of a story, because of the contested nature of the language and possibility of alienating people by choosing one term over another.

Sites of cultural significance have not been listed because of the sacred nature of many of the locations. Rather, it is proposed that whenever a major project is undertaken, the custodians of that area are consulted with regard to potential sacred sites.

Following on from the quote in Box 7, this recovery plan can play a role in the recovery of traditional culture and connection to country by incorporating actions that recognise the value of traditional knowledge for species recovery, the ownership of this knowledge by indigenous people and their right to seek economic opportunities to share and apply this knowledge.

An important dimension of this aspect of the plan is the need for greater cultural awareness among Natural Resource Management Groups and organisations within the catchment.

Actions that the indigenous representatives recommended be included in the recovery plan are detailed in section ?.

Engagement of other key stakeholders

Key stakeholder groups have been listed in Appendix 5. The ways in which these groups were given opportunity to provided feedback to the recovery plan process are also listed. These included having a representative on the recovery team, being given briefings on the project and being invited to provide feedback to the online survey, the draft recovery plan or draft action list.

Appendix 5: Evaluation of performance of previous Mary River cod recovery plan

The 1996 Mary River Cod Research and Recovery Plan (Simpson and Jackson 1996) nominated three recovery criteria against which to judge the success of the recovery plan. None of those three criteria can be judged to have been fully met (Table 1).

Table 1: Assessment of recovery criteria in 1996 Mary River Cod Research and Recovery Plan.

Self-sustaining populations established outside the present range by 2010.	Not achieved
Conservation status of cod downlisted from 'endangered' to 'vulnerable' by 2010.	Not achieved
Distribution of cod in the Mary River system increased to encompass at least 60% of their former known range by 2010.	Not achieved

The poor outcome of these recovery criteria is due to one or a combination of the following:

- the criteria operate on a time scale beyond the life of the recovery plan;
- lack of infrastructure and associated complications in captive breeding program; and
- lack of funds, resources and support to undertake actions

A comprehensive review of the Mary River Cod Research and Recovery Plan 1996 (http://www.savethemaryriver.com/downloads/COMPLETE%20REPORT%20QWI%20RESPONSE%2006102009.pdf) was undertaken in 2008. This review had a number of recommendations which are summarised below. These recommendations have been taken into consideration in development of the Mary River Threatened (Aquatic) Species Recovery Plan.

The results for the specific objectives are summarised in Table 5.

Table 5: Evaluation of achievement against criterion of 2001 Recovery Plan.

Self-sustaining populations established outside the present range by 2010.	(? Actions) ?% achieved	There has been no monitoring to assess the results of stocking and no evidence that recruitment has occurred as a result of fingerling releases. There has been some limited monitoring of stocked fingerlings that has indicated at least some survival.
Distribution of cod in the Mary River system increased to encompass at least 60% of their former known range by 2010.	(? Actions) ?% achieved	Despite stocking occurring over 85-90% of the former range of the cod there is no data to suggest any additional self-sustaining populations now occur.
Conservation status downlisted from "endangered" to "vulnerable" by 2010.	(?Actions) ?% achieved	There are no data to indicate that the Mary River cod can be downlisted from the endangered category. There are no indications that its status has changed.

A summary of review recommendations:

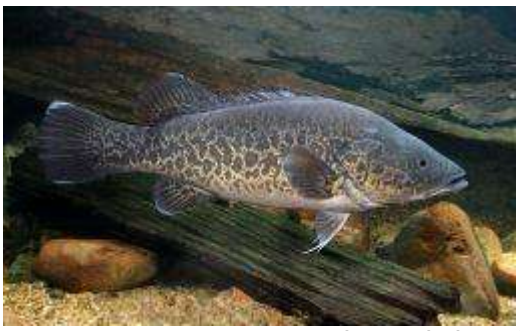
- Develop and implement a long-term monitoring program for cod

- Undertake research on key aspects of cod biology and ecology
- Acknowledge existence of Regional Natural Resource Management Groups and define linkages with regional plans especially in relation to habitat rehabilitation initiatives
- Acknowledge the preparation of a recovery plan for Australian lungfish and recovery actions for the Mary River turtle and identify appropriate linkages and opportunities for collaboration
- A joint Mary River cod/Mary River turtle Recovery Team
- Membership of the Recovery Team should include the Mary Burnett Regional Group
- The Recovery Team should be affiliated to a community group such as the Mary River Catchment Coordinating Committee to further establish community ownership of the recovery process

Additionally, the review acknowledged the partial implementation of actions. These include establishment of the cod recovery network, regulations to protect cod from take but not to protect habitat and captive breeding program and stocking program implemented but not monitored.

Appendix 6: Species Profiles

Maccullochella mariensis Mary River cod



Description

The Mary River cod (*Maccullochella mariensis*) is a yellowish to pale green fish. Formerly, cod as large as 23.5 kg (and anecdotally up to 38 kg) were caught. Today, cod larger than 5 kg and 70 cm are uncommon (Simpson & Jackson 2000). It has dark heavily reticulated mottling on the back and sides, sometimes extending onto the belly. The belly is grey-green to whitish. The fins are clear to dark with grey-green mottling on bases, with whitish margins (McDowall 1996).

Name Information

Maccullochella mariensis (Roland 1993)

Conservation Significance

- EPBC listing: Endangered
- Qld: No take species under Fisheries Act 1994.

Cultural Significance

This species is culturally significant for the Butchella people?

Existing conservation measures

xxxxxxxxxxxx

Previous Recovery Plan:

Simpson and Jackson 1996. xxxx

Distribution

The historical distribution of freshwater cod in southeast Queensland included in the Mary, Brisbane-Stanley, Albert-Logan and Coomera River systems (Wager and Jackson 1993). Cod are now very rare or extinct in all but the Mary system. It is estimated that the species now occurs in less than 30% of its former known range in the Mary River system (Simpson & Jackson 2000).

Populations

The status of the population is currently unknown though it is believed to reside in only 30% of its original range (Simpson and Jackson 1996). The last population survey of the cod took place in 1994 (Jackson 2008), and a study of the distribution of cod habitat was also conducted in 1998 (Pickersgill 1998). Simpson and Jackson (1996) provided an estimate of the population of less than 600 individuals in the Tinana, Six mile and Obi Obi Creek systems and an unknown number in the remainder of the river system.

As a result of the captive breeding program, fingerlings have been released in 85 – 90 % of their former range since 1998 (Jackson 2008). There is no data available to determine whether the fingerling releases have resulted in any self-sustaining populations. However there are anecdotal reports of cod returning to areas where they have previously been absent.

Currently all populations are considered important for the long term survival of the species.

Life cycle and habitat requirements

Mary River cod live to at least 40 years of age and are closely associated with forest streams, beneficial large wood, particularly log piles, and deep pools. Diet consists primarily of shrimp, baby mullet and small bodied fish. To sustain a 20kg fish, a large amount of food is needed in a single pool.

Homing behaviour is common, with the home range consisting of a river section 100 – 1000 m in length which contains up to two to four core areas where the fish will spend most of its time (Simpson and Jackson 1996; Simpson and Mapleston, 2002).

Breeding occurs at 3–4 years of age in freshwater during summer and spring. The exact details of the breeding biology are not known. Based on the behaviour of similar species in the wild and the Mary River cod's behaviour in captivity, it is suspected that they deposit their eggs within submerged hollow logs and caves. The male then guards the eggs from predators until they hatch, which takes four to seven days (Simpson and Jackson, 1996). It is likely that the male cod will stay with the young fish for a week after they hatch. While guarding the nest the male will not feed and therefore immature or underweight males are unlikely to be able to protect the nest for sufficient time. Water temperature is a critical factor during breeding.

Habitat connectivity is also important for breeding. Although cod generally use a small area associated with a deep pool, when they need to disperse for breeding or other purposes, they can travel distances of 50 – 70 km (Simpson and Jackson 1996).

Tracking studies have found that movement often occurs in parallel with increases in flow, but that the direction of movement is unpredictable (Simpson and Mapleston 2002). With reduced population numbers, it is believed that the need to travel to find mates is greater than when the population numbers were higher. Movement at particular times of the year and in response to high flows has also been observed (Simpson and Jackson 1996).

Threats

Threats include degradation of riparian zone, loss of gene pool variability, fishing and recreation, barriers to movement including dams and weirs, introduced species, climate change, poor water quality and altered hydrology.

These threats are widespread and can be considered a threat across the entire river system.

Management Actions

check these against new actions

- Undertake rehabilitation in priority areas to increase quality and extent of habitat
- Implement prevention and control program for aquatic feral animals
- Continue a stocking program in accordance with the forum outcomes
- Close key gaps in knowledge regarding breeding and population status
- Develop and provide information packs/guidelines to recreational fishers about techniques and gear that reduce impacts to threatened species
- Undertake a review of the likely impact of increased recreational use on the Mary River

References

Jackson, xx (2008). xxxxxxxxxxxxxxxxxxxxxxxx

McDowall, R.M. editor (1996). Freshwater Fishes of South-Eastern Australia. Reed Books: Chatswood, Sydney.

Pickersgill, xx (1998) xxxxxxxxxxxxx

Rowland, S.J. (1993). *Maccullochella ikei*, an endangered species of freshwater cod (Pisces: Percichthyidae) from the Clarence River System, NSW, and *M.peelii mariensis*, a new subspecies from the Mary River System, QLD. Records of the Australian Museum 45: 121–145.

Simpson, R. & Jackson, P. (1996). *The Mary River Cod Research and Recovery Plan - 1996-2001*. [Online]. QLD DPI. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/recovery/mary-river-cod/index.html.

Simpson, R. & Jackson, P. (2000). The Mary River Cod Research and Recovery Plan. Environment Australia Endangered Species Program. Environment Australia: Canberra.

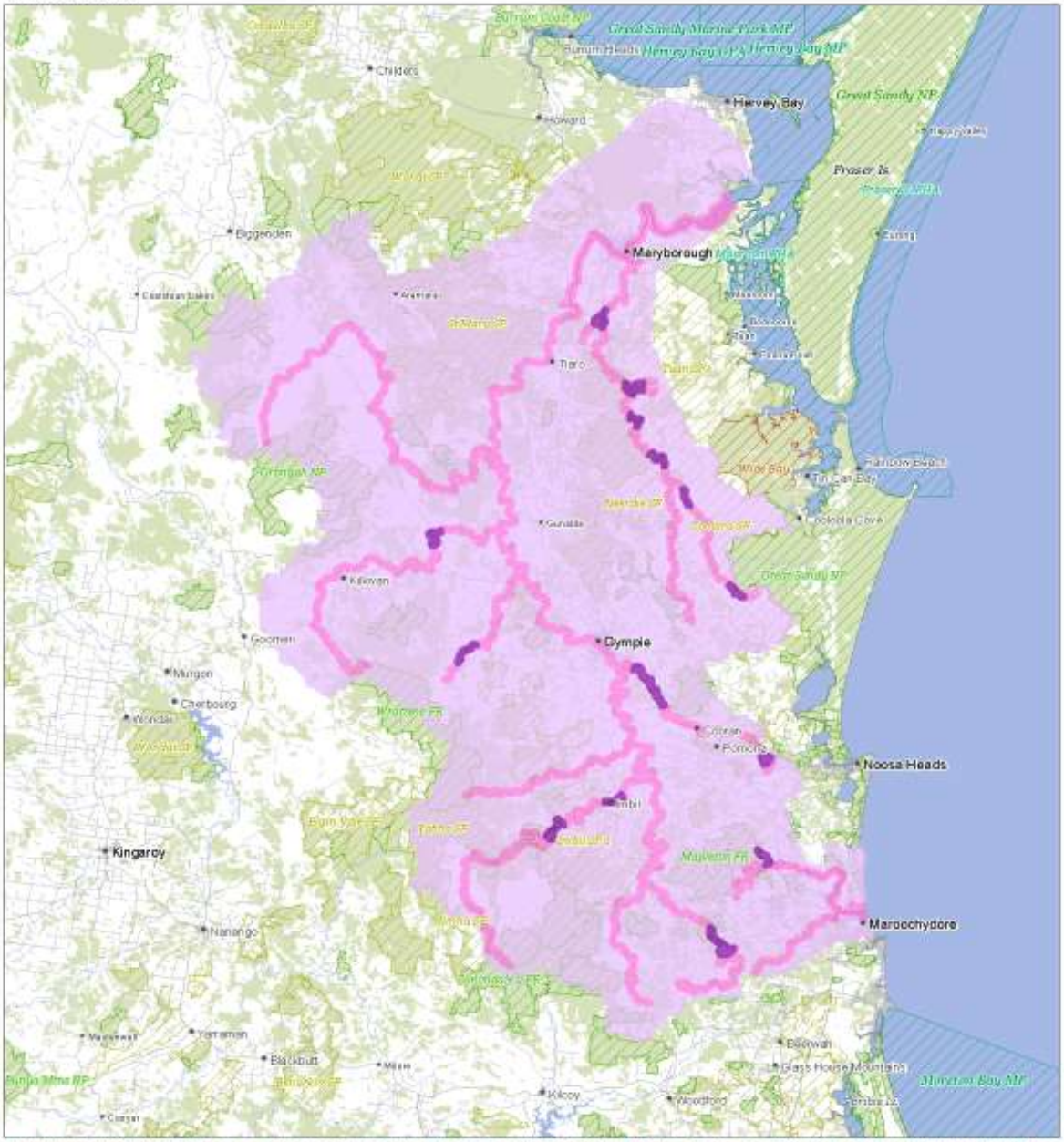
Simpson, R.R. & A.J. Mapleston (2002). Movements and habitat use by the endangered Australian freshwater Mary River Cod *Maccullochella peelii mariensis*. *Environmental Biology of Fishes*. 65:401-410.

Wager, R. & Jackson, P. (1993). The Action Plan for Australian Freshwater Fishes. Australian Nature Conservation Agency, Canberra.

Maccullochella mariensis

Mary River Cod

Sprat ID: 83806



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Distribution Updated: 10/05/2010 Map ID: 64080

- Known to Occur
- Likely to Occur
- May Occur
- Cities & Towns
- State Border
- Roads
- Built Up Areas
- Major Rivers
- Native Vegetation
- Perennial Lake
- Non-perennial Lake
- Conservation Areas
- Defence Reserves
- Forestry/Indigenous Lands
- Aust. Maritime Waters
- Comm. Marine Park
- State Marine Park

* not all features visible at all scales

Map #. Mary River cod distribution.

Elusor macrurus Mary River turtle

Description

The Mary River turtle (*Elusor macrurus*) is dark brown, rusty red-brown to almost black above, with a greyish underbody, a broadly oval shell with a median notch, and a moderately sized plastron (the lower half of the shell) which is about twice as long as broad (Cogger 2000; Thomson et al. 2006). The plastron may be cream to yellow, the skin of the inguinal areas pinkish-white, and the dorsal skin grey, suffused with pink on the transverse lamellae scales (Flakus 2002). The species also has pointed tubercles (small, rounded protuberances on the skin) on the neck. Unlike most Australian freshwater turtles (Berry & Shine 1979), males are larger than females. Females grow to 34 cm long, and males to 42 cm long. The shells of females are wider at the front than at the back, and the shells of males are narrow and straight-sided. Tails of males are very long and laterally compressed (Cogger 2000). The carapace (upper shell) of adult males is generally longer than 35 cm, and the tail is longer than 7 cm. This species displays physiological features that allow for cloacal respiration (it has bursae, which are structures like gills in its cloaca, with which it can obtain some oxygen from the water) (Flakus 2002). It has large hind feet, and is a fast swimmer (Thomson et al. 2006).

Name Information

Elusor macrurus (Cann & Legler 1994)

Conservation Significance

- EPBC listing: Endangered
- NCA listing: Endangered

Cultural Significance

?

Existing conservation measures

- Turtle nest were first monitored in 1997 by Flakus. The Tiaro and District Landcare Group have been protecting and monitoring nesting banks since 2001. This has been ongoing at ? sites, however to date data has been inconclusive of any trends.

Previous Recovery Plan:

This is the first recovery plan for this species.

Distribution

The Mary River turtle is endemic to the Mary River. It occurs from Kenilworth, 262.8 km from the mouth of the river, to the area upstream of the Mary River Tidal Barrage at Tiaro, which is 59.3 km from the mouth of the river (Cogger et al. 1993; Cann & Legler 1994; Cann 1998; Flakus 2002). In 1999, the known range was from 78 to 270 km from the mouth of the Mary River (Tucker et al. 2000). Populations are known to occur in major tributaries and the main channel of the Mary River including Yabba and Tinana Creeks, Gunalda, Miva and Tiaro (Hauser et al. 1992; Cogger et al. 1993; Cann & Legler 1994; Cann 1998; Flakus 2002).

Populations

Based on estimates of the population in the Traveston Crossing dam footprint of between 895 and 3580 individuals (Qld Water Infrastructure 2007) and Kuchling's 2008 estimate, the estimated total

population is between 1000 and 4000 individuals. Numbers of animals of breeding age is not known.

All populations are necessary to the long term recovery and/or survival of the species.

Life cycle and habitat requirements

After the turtles reach approximately 15 – 25 years of age, they commence breeding. They nest on particular north facing, non vegetated sand banks (Micheli-Campbell 2012). Nesting season commences after the first rains in October and concludes in January. Nests contain 15 eggs on average and are incubated for approximately 55 days. Female turtles return to the same nesting sites repeatedly and are highly selective with their choice of sites (Micheli-Campbell 2012). Without nest protection, it is assumed that egg predation is very high. Little is known about the survival rate of juveniles, or about the overall population and age structure.

Being a river specialist, the Mary river turtle prefers flowing, well oxygenated sections of streams. Its principal habitat is relatively deep (~1 – 5 m) river pools with high dissolved oxygen concentrations, alternating with riffles and shallow stretches. The turtle prefers habitat that includes macrophytes, underwater shelter, submerged logs, and basking logs and rocks (Kuchling 2008). Micheli-Campbell (2012) found that juvenile turtles have very specialised habitats, which are limited in occurrence in the Mary River. In this study, juveniles were predominately located immediately upstream or downstream of riffle zones and near the rivers' edge. In these locations the water is not deep and flows slowly.

Dissolved oxygen levels are a key determinant of the ability for the turtle to breathe underwater. This characteristic is regarded as important for predator avoidance particularly for juveniles (Clark & Gordos 2008). Laboratory based research has suggested that the turtles may not be able to adapt to long term exposure to low dissolved oxygen in the water, which suggests that poor water quality may lead to increased predation (Clark 2008).

As juveniles, the turtles are generally carnivorous, and it has been proposed that they shift to a more herbivorous diet as they age (Flakus 2003). While this may be the case, the adult turtles have also been observed opening freshwater mussels (Cann 1998).

Threats

Threats include predators and trampling of eggs, poor water quality, climate change, poor integrity of riparian zone, loss of gene pool variability, barriers to movement including dams and weirs, altered hydrology, introduced species and fishing and recreation.

These threats are widespread and can be considered a threat across the entire river system.

Management Actions check these against new actions.

- Undertake coordinated management of fox, dog and pig control
- Protect turtle nesting banks at priority sites during breeding season
- Continue and increase support for turtle nest protection activities
- Identify and trial methods for using elements of the natural predator-prey hierarchy (e.g. dingo urine) to reduce predation of turtle nests
- Improve understanding of the factors that affect goanna predation of turtle eggs (e.g. distribution of riparian vegetation) and use this information to inform riparian vegetation regeneration projects

References

Berry, J.F. & Shine, R. (1979). Sexual size dimorphism and sexual selection in turtles (Order Testudines). Oecologia 42: 185-191

Cann, J. (1998). Australian freshwater turtles. J. Cann and Beaumont Publishing: Singapore

Cann, J. and Legler, J.M. (1994). The Mary River Tortoise: a new genus and species of short-necked chelid from Queensland, Australia (Testudines; Pleurodira). Chelonian Conservation and Biology 1(2):81-96.

Clark, N. J. (2008). *The Diving Physiological Ecology of Australian Freshwater Turtle Hatchlings.* PhD Thesis, School of Biological Sciences, University of Queensland.

Clark, N. J., & Gordos, M. A. F. C. E. (2008). Thermal plasticity of diving behaviour, aquatic respiration and locomotor performance in the Mary River turtle Elusor macrurus. *Physiological and Biochemical Zoology, 81*(3), 301-309.

Cogger, H. (2000). Reptiles and Amphibians of Australia. 6th edition. Reed Books: Sydney

Cogger, H.G., E.E. Cameron, R.A. Sadlier & P. Eggler (1993). The Action Plan for Australian Reptiles. Australian Nature Conservation Agency: Canberra
Flakus S (2002) The ecology of the Mary River turtle, *Elusor macrurus*. MSc Thesis, University of Queensland.

Flakus, S. (2003). Personal Communication Frazer NB (1992) Sea turtle conservation and halfway technology. Conservation Biology 6, 179. Georges, A. (1995). Mary River Turtle. Nature Australia: Summer 1995/6, 22

Hauser, D. & Members of the Task Force (1992). Our Mary River: a current assessment. Mary River Regional Recreational Study Task Force: Maryborough

Kutchling x (2008) xxxxxxxxxxx

Micheli-Campbell, M.A. (2012). Habitat requirements for nesting and early life-stages of the endangered Mary River turtle (*Elusor macrurus*): Insights for conservation. PhD Thesis, School of Biological Sciences, University of Queensland

Queensland Water Infrastructure (2007) xxxxxxxx

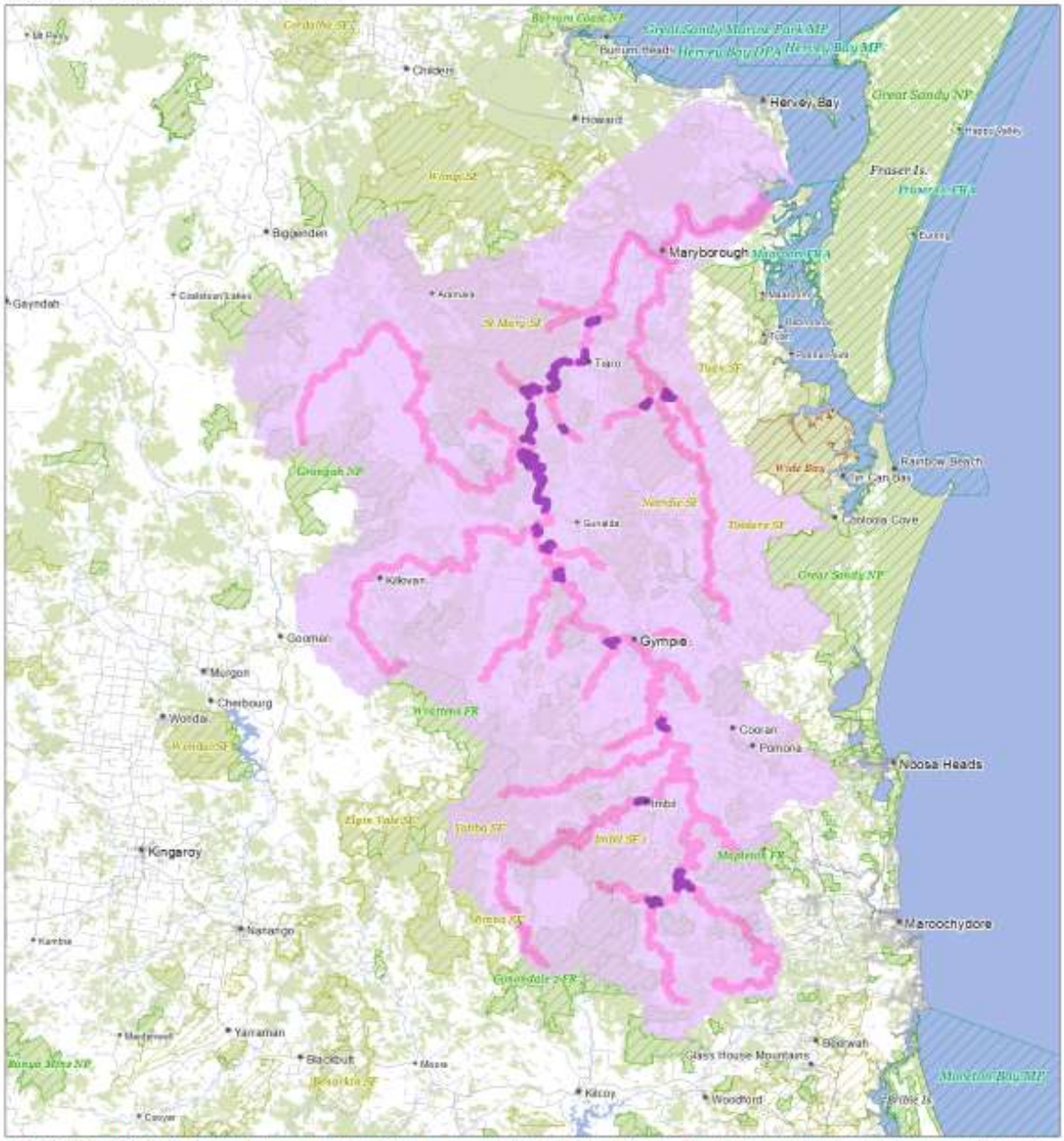
Thomson, S., Hamann, M., Latta, C. & Latta, G. (2006). The environmental impacts of dams on the regionally endemic turtles of the Mary River. http://www.travestonswamp.info/_mgxroot/page_10771.html

Tucker, A.D., Priest, T., Guarino, E. & Couper, P. (2000). Turtle biodiversity in regard to regional conservation planning: additional recommendations for mitigation *in* Cumulative Effects of Dams and Weirs on Freshwater Turtles: Fitzroy, Kolan, Burnett and Mary Catchments. Pages 105-130. Report for Queensland Parks & Wildlife Service, Bundaberg

Elusor macrurus

Mary River Turtle, Mary River Tortoise

Sprat ID: 64389



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Distribution Updated: 11/08/2010

Map ID: 64389

- Known to Occur
- Likely to Occur
- May Occur
- Cities & Towns
- State Border
- Roads
- Built Up Areas
- Major Rivers
- Native Vegetation
- Perennial Lake
- Non-perennial Lake
- Conservation Areas
- Defence Reserves
- Forestry/Indigenous Lands
- Aust. Maritime Waters
- Comm. Marine Park
- State Marine Park

* not all features visible at all scales

Map Extracted: 4/07/2012

Map #. Mary River turtle distribution

Neoceratodus forsteri Australian lungfish

Description

The Australian lungfish (*Neoceratodus forsteri*) is a long, heavy-bodied freshwater fish. The species has five pairs of gills and its fins resemble flippers. Adult lungfish can weigh up to 48 kg and grow to around 2 m (Environment Australia 2003; Grigg 1975), but commonly reach 1.3 m. In the Burnett River, the average length was approximately 900 mm, and average weight 700 – 800 g (Brooks & Kind 2002). Adult lungfish are olive-green or grey-brown above, and yellow-orange below, with some whitish colour on the belly and underside of the head. They have large, overlapping scales and a small mouth with large, crushing teeth on the palate and lower jaw (Allen 1989; Grigg 1975). Juveniles are dark olive, brown or yellow with a mottled pattern above and a dull pink belly (Kemp 1995; Kind 2002).

The species is able to breathe aquatically using its gills, and aerially using its single lung. It usually uses its gills, but surfaces to breathe when it is active and requires more oxygen. For example, it breathes air more often at night while foraging, when swimming in floodwaters, and when spawning (Grigg 1965, 1975; Kemp 1984; Merrick & Schmida 1984).

Name Information

Neoceratodus forsteri (Krefft 1870)

Conservation Significance

- EPBC listing: Vulnerable
- Qld: No take species under Fisheries Act 1994.

Cultural Significance

This speicies is culturally significant for the Gubbi Gubbi people (the Lungfish is known as ‘Dala’).

Existing conservation measures

xxxxxxxxxxx

Previous Recovery Plan:

There is a separate full range species plan (Australian Government in prep).

Distribution

The Australian lungfish is restricted to south-eastern Queensland (Wager 1993). It currently occurs in the Burnett River, the Mary River, the North Pine River (including Lake Samsonvale) the Brisbane River (including Lake Wivenhoe), and Enoggera Reservoir (Brooks & Kind 2002; Johnson 2001; Kemp 1995). Its natural distribution is the Mary and Burnett River systems. It was translocated and persists at a number of other sites, and the Condamine River west of the Great Dividing Range, where it did not persist (O'Connor 1897).

Populations

All populations are necessary to the long term recovery and/or survival of the species. The population of lungfish is unknown across its range however the Mary River population is considered relatively healthy compared to other catchments.

Life cycle and habitat requirements

Australian lungfish complete their life cycle entirely in freshwater. The diet of the juveniles is mainly carnivorous and shifts toward a more omnivorous diet as they age. It is believed that adults mature at approximately 10–15 years of age can live as long as 80–100 years in captivity (Joss

2004) and perhaps 50 years in the wild. Lungfish are primarily nocturnal and recent records show that they grow to a size of 1.5 m, though historical records document larger fish up to 1.7 m.

After a courtship period (between August and November), eggs are laid on submerged aquatic plants in shallow water. Suitable breeding habitat includes protection from predators, appropriate dissolved oxygen levels for developing embryos and abundant food supplies hatchlings.

Breeding grounds, nursery areas and adult foraging areas share similar habitat features. Adults congregate in complex underwater habitat, particularly in submerged macrophyte beds or underneath partially submerged riparian vegetation (Kemp 1995; Kind 2002). Beneficial large wood, bank undercuts and rocks provide alternative shelter sites in heavily populated reaches (Brooks and Kind 2002; Kind 2002). Juveniles exhibit an affinity for complex instream habitat, although those less than 300 mm in length are seldom observed and their behaviour and habitat preferences are unknown.

Kind (2002) found that individuals in flowing riverine systems occupy a distinct home range typically 1 – 1.5 km in length. Joss (2004) suggests that adults return to particular spawning sites to breed. Behaviour of lungfish in impoundments demonstrates their capacity to move long distances to spawn, with recent evidence suggesting individuals in the Burnett River may move distances of tens of kilometres (DEEDI Fisheries Queensland 2012).

Threats

Threats include degradation of riparian zone, introduced species, climate change, poor water quality, altered hydrology, barriers to movement including dams and weirs, fishing and recreation, and loss of gene pool variability.

These threats are widespread and can be considered a threat across the entire river system.

Management Actions check these against new actions.

- Undertake rehabilitation in priority areas to increase quality and extent of habitat
- Identify flow regimes and refugia requirements (timing, volume depths) - that meet recovery requirements (including avoiding mortality on fishways and spillways) and incorporate into Water Resource Plan
- Improve knowledge of the impact of fish stocking

References

Allen, G.R. (1989). *Freshwater Fishes of Australia*. Brookvale, NSW: T.F.H. Publications. [Book; Status=Final; ID=2134].

Brooks, S.G. & P.K. Kind (2002). *Ecology and demography of the Queensland lungfish* (Neoceratodus forsteri) *in the Burnett River, Queensland with reference to the impacts of Walla Weir and future water infrastructure development*. Queensland Department of Primary Industries. Queensland, Queensland Agency for Food and Fibre Services. [Report; Status=Final; ID=9310].

Environment Australia (2003). *Information Sheet - Australian Lungfish* (Neoceratodus forsteri). [Online]. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/lungfish.html. [Commonwealth Info Sheet; Status=Final; ID=8730].

Grigg, G.C. (1965). Studies on the Queensland lungfish, *Neoceratodus forsteri* (Krefft) III. Aerial respiration in relation to habits. *Australian Journal of Zoology*. 13:413-421. [Journal; Status=Final; ID=16853].

Grigg, G.C. (1975). The lungfish- creature from the past. *Koolewong*. 4 (2):11-13. [Journal; Status=Final; ID=16851].

Johnson, J.W. (2001). Review of the draft lungfish report (Ecology and demographics of lungfish (Neoceratodus forsteri) and general fish communities in the Burnett River, Queensland with reference to the impacts of Walla Weir and future water infrastructure developement, by St. *Report for Burnett Water, 4 July 2001*. Queensland: queensland Museum. [Report; Status=Final; ID=16856].

Kemp, A. (1984). Spawning of the Australian lungfish, *Neoceratodus forsteri* (Krefft) in the Brisbane River and Enoggera Reservoir. *Memoirs of the Queensland Museum*. 21:393-399. [Journal; Status=Final; ID=16859].

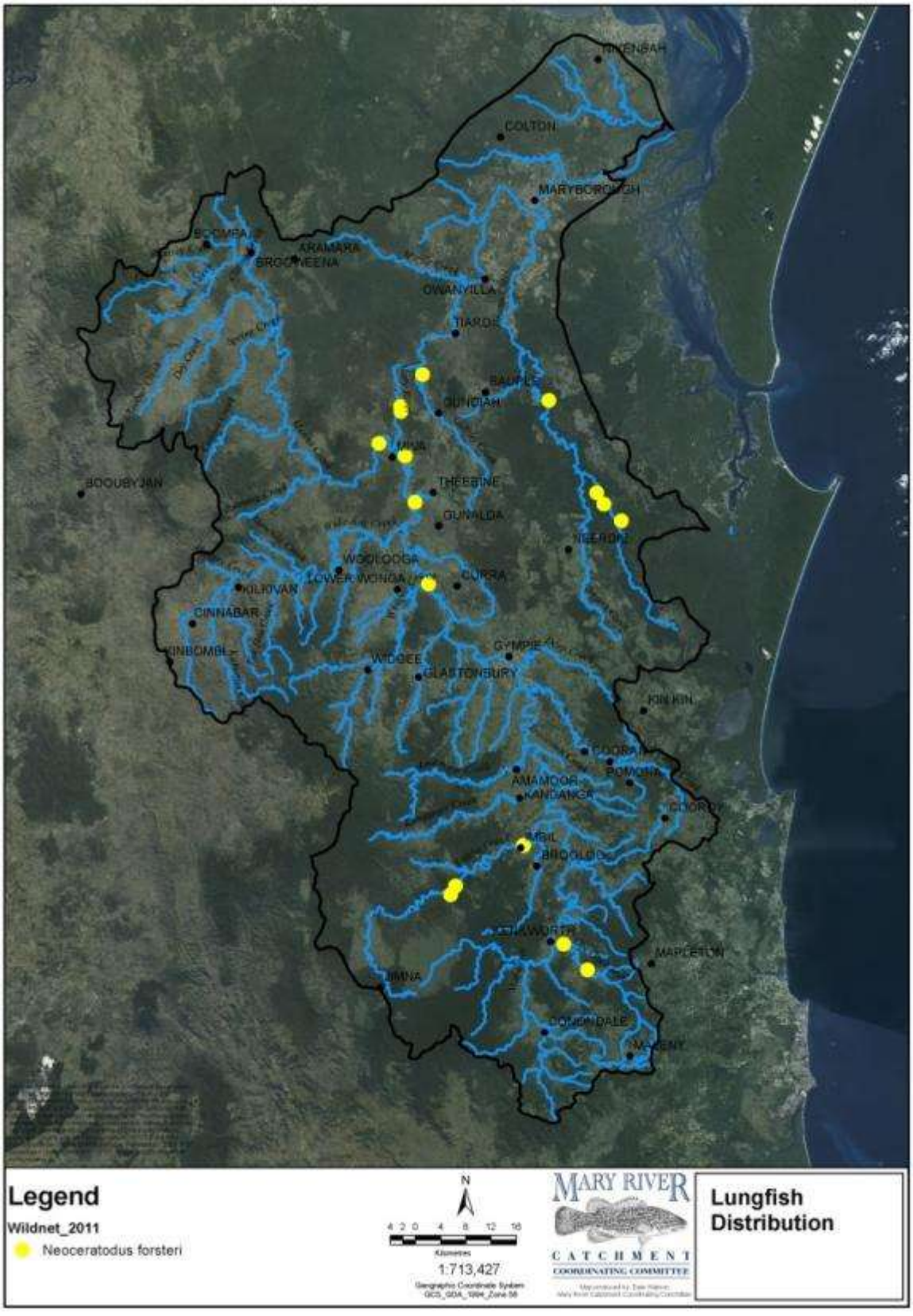
Kemp, A. (1995). Threatened fishes of the world- *Neoceratodus forsteri* (Krefft 1870) (Neoceratodontidae). *Environmental Biology of Fishes*. 43:310. [Journal; Status=Final; ID=16863].

Kind, P.K. (2002). *Movement patterns and habitat use in the Queensland lungfish* Neoceratodus forsteri *(Krefft 1870)*. Ph.D. Thesis. PhD Thesis, University of Queensland. [Ph.D. Thesis; Status=Final; ID=16864].

Merrick, J.R. & G.E. Schmida (1984). *Australian Freshwater Fishes - Biology and Management*. Netley, South Australia: Griffin Press. [Book; Status=Final; ID=2139].

O'Connor, D. (1897). Report on the preservation of *Ceratodus*. *Proceedings of the Royal Society of Queensland*. 11:101-102. [Journal; Status=Final; ID=16868].

Wager, R.N.E. (1993). The distribution and conservation status of Queensland freshwater fishes. *Queensland Department of Primary Industries Information Series No Q193001*. [Report; Status=Final; ID=16875].



Map #. Lungfish distribution in the Mary River catchment

Mixophyes iteratus Giant barred frog

Description

The giant barred frog (*Mixophyes iteratus*) is a large, dark-olive green to black coloured frog that grows to 115 mm. It has a pointed snout and a broad lateral band of dark spots dividing the dark dorsal surface from the white, or pale yellow, ventral surface (underside). The limbs have dark crossbars. The hind side of the thighs are black with large yellow spots. Two joints of the fourth toe are free of web (Cogger 2000). The skin is finely granular above but smooth below (QLD DERM 2005).

The call of the male Giant barred frog is a deep guttural grunt (Barker et al. 1995; Robinson 1993).

Giant barred frog tadpoles are large, growing to over 100 mm in length. They are deep-bodied and ovoid, with a tail length twice that of the body. The tadpole's eyes are dorsolateral. The tadpoles are coloured yellow-brown above with dark spots and a dark patch at the base of tail. The underside is silver-white. The intestinal mass is obscured but the heart and lungs are visible from below (except near metamorphosis). The tail is thick and muscular. Fins are low and opaque with dark flecking (except the anterior half of the ventral fin) (Meyer et al. 2001).

Name Information

Mixophyes iteratus (Straughan 1968)

Conservation Significance

- EPBC listing: Endangered
- NCA listing: Endangered

Cultural Significance

?

Existing conservation measures

- A survey program has been ongoing since 2005 and continues to contribute distribution knowledge.

Previous Recovery Plan:

There is a separate full range species plan (Hines et al. 2002).

Distribution

The giant barred frog is distributed from Belli Creek near Eumundi, south-east Queensland, south to Warrimoo, mid-eastern NSW (Hines et al. 1999). It is currently known from mid to low altitudes below 610 m asl (Hines et al. 2004).

Populations

Declines in this species were noticed, along with several other rainforest dependent frogs between the 1970s and 1980s (Hines 2005).

Numbers are low in the Mary catchment but appear to be stable.

All populations are necessary to the long term recovery and/or survival of the species.

Life cycle and habitat requirements

The frog is regarded as a habitat specialist, relying on riparian rainforest and presence of permanent water for the 9 – 10 months or longer period required for development of the large tadpoles (up to 114 mm (Anstis 2002 in Hughes 2005)). They are nocturnal and will move up to 40 m away from the stream in search of worms, insects and potentially other frogs to eat.

About three years after emerging for the egg as a tadpole they reach breeding age. Females require undercut banks or rocky ledges on which to deposit their eggs. Eggs are flicked up into the air and onto the exposed surface with their hind legs. The eggs develop in the moist air, and on hatching, the tadpoles drop into the water. This may be a strategy to reduce predation of eggs.

The frog is negatively affected by disturbance of the riparian zone with levels of disturbance of habitat to be a good predictor of frog numbers in the nearby Stanley catchment (Hughes 2005).

Threats

Threats include degradation of riparian zone, introduced species, climate change, chytrid fungus, misidentification with cane toads, poor water quality and altered hydrology.

These threats are widespread and can be considered a threat across the entire river system.

Management Actions check these against new actions

- Undertake activities that support rehabilitation of frog habitat on private land, leased land and within the reserve estate and increase public awareness of the species
- Implement weed management plans or strategies
- Undertake coordinated management of fox, dog and pig control
- Implement strategies, onground works and community capacity building to reduce threat of chytrid fungus
- Encourage community participation in frog monitoring projects
- Conduct surveys to determine distribution in the catchment

References

Straughan, I.R. (1968). A taxonomic review of the genus *Mixophyes* (Anura: Leptodactylidae). *Proceedings of the Linnean Society of New South Wales* **93**: 52-59 [54].

Barker, J., G.C. Grigg. & M.J. Tyler (1995). *A Field Guide to Australian Frogs*. Chipping Norton, NSW: Surrey Beatty & Sons.

Cogger, H.G. (2000). *Reptiles and Amphibians of Australia - 6th edition*. Sydney, NSW: Reed New Holland.

Hines, H., D. Newell, J. Clarke, J-M. Hero & Meyer, E. (2004). Mixophyes iteratus. *IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2*. [Online]. viewed on 25 January 2010. Available from: http://www.iucnredlist.org/apps/redlist/details/13598/0.

Hines, H., M. Mahony & K. McDonald (1999). An assessment of frog declines in wet subtropical Australia. **In:** Campbell, A., ed. *Declines and Disappearances of Australian Frogs*. Page(s) 44-63. [Online]. Canberra: Environment Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/frogs.html.

Hines, H.B. & South-east Queensland Threatened Frogs Recovery Team (SEQTFRT) (2002). *Recovery plan for Stream Frogs of South-east Queensland 2001–2005*. [Online]. Report to Environment Australia, Canberra. Brisbane, Queensland: Queensland Parks and Wildlife Service. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/recovery/stream-frogs/index.html.

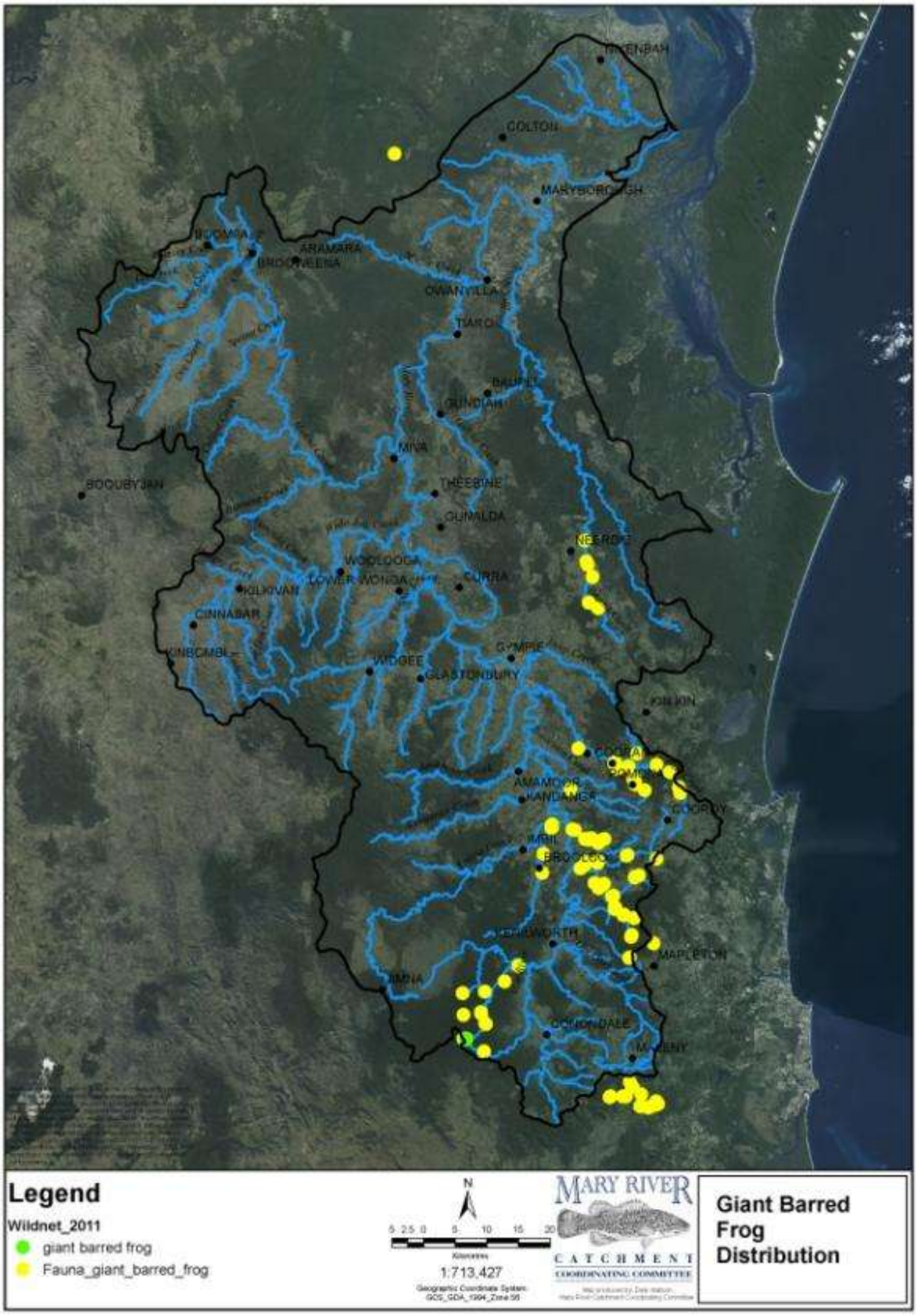
Hughes, xxxxxx (2005). xxxxxxxxxxxx

Ingram, G.J. & K.R. McDonald (1993). An update on the decline of Queenslands frogs. **In:** Lunney, D. & D. Ayers, eds. *Herpetology in Australia: a diverse discipline*. Page(s) 297-303. Sydney, NSW: Royal Zoological Society of NSW.

Meyer, E., H. Hines & J-M. Hero (2001). Giant Barred-Frog, *Mixophyes iteratus*. **In:** *Wet Forest Frogs of South-east Queensland*. Page(s) 30-31. Gold Coast, Queensland: Griffith University.

Queensland Department of Environment and Resource Management (Qld DERM) (2005). *Giant barred frog*. [Online]. Available from: http://www.derm.qld.gov.au/wildlife-ecosystems/wildlife/threatened_plants_and_animals/endangered/giant_barredfrog.html.

Robinson, M. (1993). *A Field Guide to Frogs of Australia*. Chatswood, NSW: Reed.



Map #. Giant barred frog distribution in the Mary River catchment

Trachystoma petardi — Freshwater mullet

Description

The Freshwater mullet (*Trachystoma petardi*) is moderately deep-bodied with a pointed snout that is longer than the diameter of the eye. It has no andipose eye membrane and a very slightly thickened upper lip and thin lower lip. Its tail is deeply forked. The colour is greenish black dorsally, lighter on flanks and silvery white ventrally. The iris is yellow-orange to pink and the fins are pale yellow (Gomon 2011, Kind and Brooks 2003). It can be distinguished from the Sea mullet *Mugil cephalus* by its lack of andipose eyelid and axillary process at the top of the pectoral fins. Its snout is relatively longer and more pointed than that of *M. cephalus*. To the experienced eye the body shape is also different, *M. petardi* being generally stockier in appearance than *M. cephalus* (M. Hutchison pers comm. year? QLD DAFF).

Freshwater mullet reach a maximum length of 810 mm and 7500 g (maximum age 14 years (Allen et al. 2002) but are commonly found to be 350 mm long (Merrick and Schmida 1984). They feed on filamentous algae, microscopic plants and animals, and detritus (Gomon 2011) and they are likely to play an important role in converting plant biomass into other forms that are accessible to other parts of the food chain.

Name Information

Trachystoma petardi (Castelnau 1875). Other common names include Pinkeye, Richmond or River mullet.

Conservation Significance

Although not listed as threatened this species demonstrates the link between the ocean and upper reaches of the catchment. This species has declined in other river systems though is still relatively abundant in the Mary River catchment.

Cultural Significance

This is an important species for indigenous people especially in the middle and upper catchment and also a totem species.

Existing conservation measures

xxxxxxxxxxx

Distribution

The freshwater mullet is endemic to select east coast rivers. The Mary River is close to the northern limit of its distribution which extends from the Georges River in NSW to the Burnett River in Qld (Allen et al. 2002).

Populations

?xxxxxxxxxxx

Life cycle and habitat requirements

Freshwater mullet feed on filamentous algae, microscopic plants and animals, and detritus (Gomon 2011) and they are likely to play an important role in converting plant biomass into other forms that are accessible to other parts of the food chain. They mature after about 4 years (360 – 400 mm) and are believed to spawn in estuaries at low salinities, during late summer and early autumn (Fishbase 2012, Gomon 2011). Young and adults move back upstream to freshwater. Although they do spend some of their life between the shore and the edge of the continental shelf, they are commonly believed to be catadromous (spend most of their lives in fresh water and migrate to the sea to breed) (Gomon 2011). They may migrate between fresh and estuarine waters regardless of flows (Burghuis 2012; Miles et al. 2009) and may make this journey for reasons other than spawning (Miles et al. 2009).

In addition to accessing freshwater as part of their breeding cycle, freshwater mullet require linkage to fresh water to increase survival rates of individuals (Hutchison 2012). In tidal reaches below barriers Freshwater mullet grow more slowly and are likely to be exposed to more predators thereby reducing population levels over a very short period (Hutchison 2012).

Within the riverine habitat this species are active at the surface and midwater zones forming small shoals that favour deep pools where stream flow is slow (Gomon 2011). Schools of feeding mullets (mullet runs) are very noticeable at the water surface. They are often caught during electrofishing research activities around submerged structures where it is believed they feed on the biofilm (Hutchison 2012). However, mullet are considered difficult to catch on lines (Mangold 2012). Juveniles are frequently associated with riffle habitats (Kind and Brooks 2003) where protection and a food source is available.

Observations of mullet (Growns et al. 2003, Hutchison 2012) suggest a possible reliance on riparian vegetation that is not presently well understood.

Threats

Threats include altered hydrology, altered catchment runoff, poor water quality, introduced species, modification of geomorphology and barriers to movement including dams and weirs.

These threats are widespread and can be considered a threat across the entire river system.

Management Actions check these against new actions.

- Implement the strategies and actions proposed in the Mary River Aquatic Weed Strategy (Moran 2009)
- Undertake activities to reduce the impact of point sources on water quality
- Identify flow regimes and refugia requirements (timing, volume, depths) that meet recovery requirements
- Establish monitoring program for Freshwater mullet based on commercial catch
- Establish flow regime to trigger mullet migration and determine how this impacts on other species

References

Allen, G.R., Midgley S.H. and Allen M., (2002). Field guide to the freshwater fishes of Australia. Western Australian Museum.

Burghuis, Andrew (2012). [Freshwater Mullet].xxxxxxxxx pers. comm????

Castelnau F. L. (1875). Researches on the fishes of Australia. Philadelphia Centennial Expedition of 1876. Intercolonial Exhibition Essays, 1875-6. Proceedings of the Academy of Natural Sciences of Philadelphia No. 2: 1-52

Fishbase.). FishBase version 06/2012. Retrieved 18 July, 2012, from http://www.fishbase.us

Growns, I., Gehrke, P.C., Astles, K.L. and Pollard, D.A. (2003). A comparison of fish assemblages associated with different riparian vegetation types in the Hawksbury-Nepean River system, Fisheries Management and Ecology, 10:209–220.

Gomon, M.F. (2011). Pinkeye mullet, Trachystoma petardi, in Fishes of Australia. Available from: http://fishesofaustralia.net.au/Home/species/4470

Hutchison, Michael (2012, 16 July 2012). [Freshwater Mullet]. Xxxxxxxxx pers com??

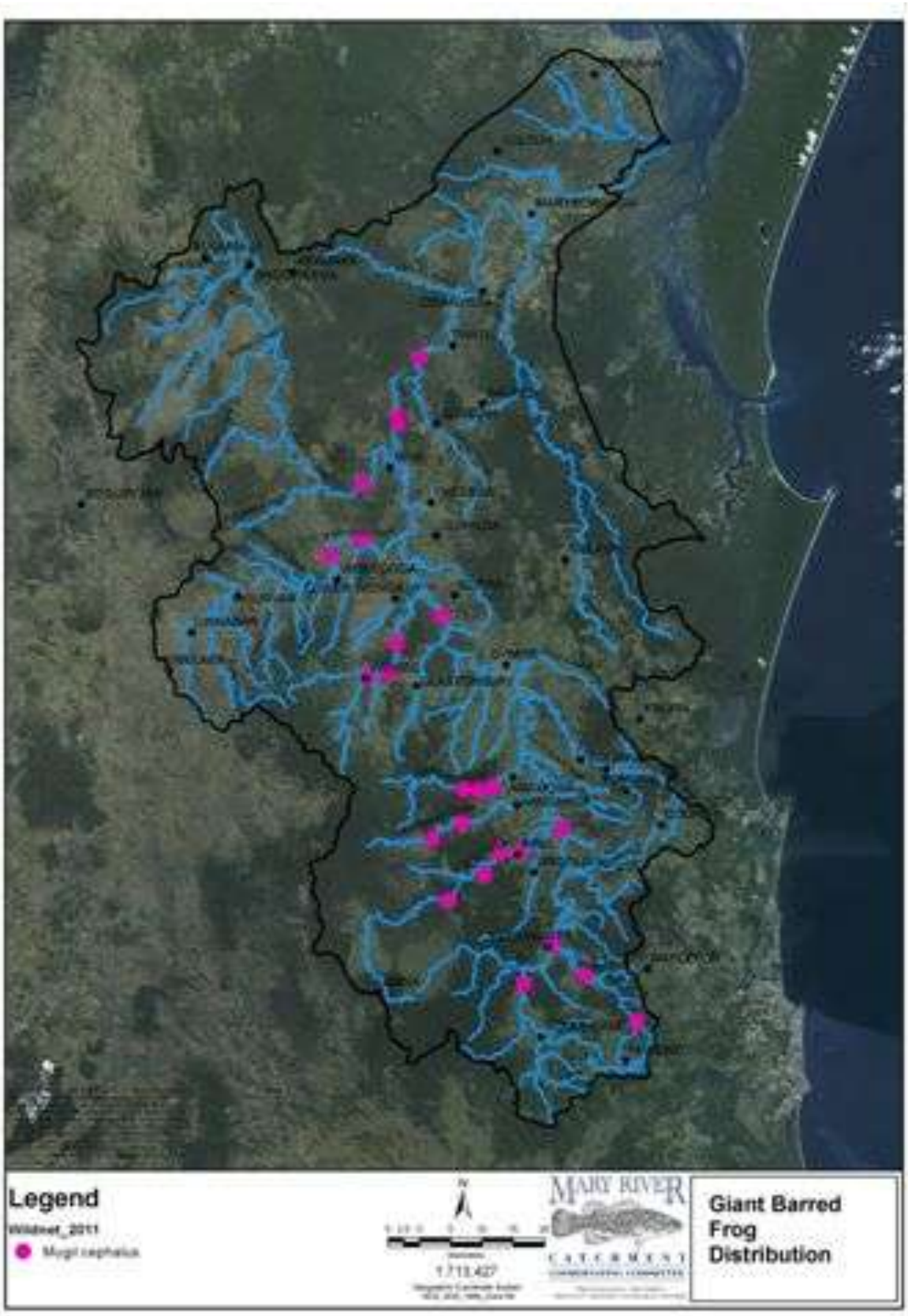
Kind, P. K. and Brooks S. G. (2003). *Fish communities in the lower Burnett River Queensland, with reference to Walla Weir and future water infrastructure development.* Final report prepared for the Department of Natural resources and Mines, Queensland. Department of Primary Industries. 49 pp.

Mangold, Chris (2012). [Freshwater Mullet].xxxxxxx pers comm??

Merrick, J.R. and Schmida, G.E. (1984). Australian Freshwater Fishes: Biology and Management. Griffin Press Ltd.

Miles, N. G., West, R. J., & Norman, M. D. (2009). Does otolith chemistry indicate diadromous lifecycles for five Australian riverine fishes? *Marine And Freshwater Research, 60*(9), 904-911. doi: http://dx.doi.org/10.1071/MF08252

Moran, P. (2009). Mary River Aquatic Weed Strategy 2010-2014. Noosa and District Landcare Group.



Map #. Freshwater mullet distribution in the Mary River catchment

Appendix 7 Recovery Team and Technical Advisory Group membership

Recovery Team Membership

Organisation	Representative
Burnett Mary River Group	Ms Rachel Lyons/Ms Kirsten Wortel
Burnett Mary River Group	Mr James Bulbert
Department of Agriculture, Forestry and Fisheries	Dr Peter Kind
Department of Agriculture, Forestry and Fisheries	Mr Daniel Smith
Department of Agriculture, Forestry and Fisheries	Mr Andrew McDougall
Department of Environment and Heritage Protection	Ms Rebecca Richardson
Department of Infrastructure and Planning	Mr Dale Bell
Department of Sustainability, Environment, Water, Population and Communities	Mr Peter Latch
Department of Sustainability, Environment, Water, Population and Communities	Ms Claire Sim
Fraser Coast Regional Council	Mr Tony van Kampen
Greater Mary Association	Mr Lawrie Wilson
Gympie Regional Council	Ms Amy Gosley
Kabi Kabi representative	Mr Alex Bond
Mary River Catchment Coordinating Committee	Dr Tanzi Smith
Mary River Catchment Coordinating Committee	Mr Steve Burgess
Mimburi Upper Mary Aboriginal Association	Ms Beverly Hand
Queensland Water Commission	Ms Emma Patullo
Queensland Water Commission	Mr Ian Hanks
SEQ Water	Mr Tim Odgers
SEQ Water	Mr Murray Kerr
Sunshine Coast Regional Council	Mr Mick Smith
SunWater	Mr Matthew Barrett
Tiaro Landcare	Ms Marilyn Connell
Wide Bay Burnett Conservation Council	Mr Roger Currie
Wide Bay Burnett Environment and Natural Resources Working Group	Mr Luke Diddams
Wide Bay Water	Mr Mark Vanner
Save the Mary River Coordinating Group	Glenda Pickersgill
?	Peter Jackson

Technical Advisory Group Membership

Organisation	Representative
Australian Rivers Institute	Professor Stuart Bunn
Department of Agriculture, Forestry and Fisheries	Dr Peter Kind
Department of Agriculture, Forestry and Fisheries	Mr Steven Brooks
Department of Agriculture, Forestry and Fisheries	Mr Andrew Berghuis
Department of Environment and Heritage Protection	Ms Rebecca Richardson
Department of Environment and Heritage Protection	Dr Col Limpus
Department of Natural Resources and Mines	Mr Thomas Espinoza
Econcern	Mr Jim Tait
Mary River Catchment Coordinating Committee	Dr Tanzi Smith

Mary River Catchment Coordinating Committee	Mr Steve Burgess
Mary River Catchment Coordinating Committee	Ms Eva Ford
SEQ Water	Mr Dave Roberts
Sunwater	Mr David Scriven
SunWater	Mr David Scriven
University of Queensland	Professor Craig Franklin
University of Queensland	Professor Gordon Grigg

Appendix 8 Threat Prioritisation and Threat Matrix for the Priority Species

Threats \ Targets	Australian lu...	Mary River cod	Giant barred ...	Mary River t...	Freshwater ...	Summary Threat R...
Altered catchment runoff	Low	Medium	Medium		High	Medium
Altered hydrology	Medium	Medium	Low	Medium	High	Medium
Barriers (dams, weirs, road crossings etc))	Medium	Medium		Medium	Medium	Medium
Chytrid fungus			Medium			Low
Climate change	High	High	Medium	High	Low	High
Fishing and recreation	Low	High		Low	Low	Medium
Invasive aquatic species	Medium	Medium	Medium	Medium	Medium	Medium
Lack of knowledge	Low	High	Low	Medium	Low	Medium
Lack of riverine habitat managed for conservation	Medium	High	Medium	Low	Low	Medium
Misidentification with cane toads			Low			Low
Modification of geomorphology	Medium	High		Medium	Medium	Medium
Poor integrity of riparian zone	Medium	High	High	Medium	Low	High
Poor water quality	Low	Medium	Low	High	Medium	Medium
Risk of low gene pool variability	Low	High	Not Specif...	Medium	Low	Medium
Terrestrial predators, trampling of eggs and habitat	Low		Low	Very High		High
Terrestrial weeds	Low	Medium	Medium	Low	Medium	Medium
Summary Target Ratings:	High	Very High	High	Very High	High	**Overall Project Rating** Very High

Appendix 9 Recovery actions list including actions and subactions

Needs updating with new objectives, actions, sub-actions and sub-sub-actions.

Objective 1: Establish or improve mechanisms to deliver actions identified in the recovery plan, support collaboration between stakeholders and address legislative barriers

Action 1: Establish a transparent and accountable mechanism to foster delivery of recovery actions, collaboration and address key regulatory barriers

- A1.1 Obtain funding to support a paid Coordinator Position
- A1.2 Maintain the operation of the recovery team to track progress, enable adaptive management and advocate for improved policy and regulation to help achieve objectives 1-6
- A1.3 Establish framework for accountability and transparency regarding the plan, including regular reporting to the public
- A1.4 Use Queensland government's Recovery Actions Database (RAD) to track progress with implementation
- A1.5 Establish a mechanism for collating and sharing data, disseminating progress and the latest research findings regarding the Mary River and the priority species
- A1.6 Recovery team to work toward improving policy and regulation at the State and Australian Government Level to better support the recovery plan objectives and "thinking catchmentally"
- A1.7 Recovery team to identify and support a mechanism for a more coordinated and catchment oriented approach across the three regional councils with significant area and "thinking catchmentally"

Action 2: Develop a strategic, creative and coordinated approach to obtaining funding to support on-ground activities

- A2.1 Encourage interested parties, including community groups, to apply for funding to implement actions
- A2.2 Pursue non-conventional funding opportunities (i.e. corporate and philanthropy) to provide further funding streams for on-ground management
- A2.3 Create and communicate expectation that water authorities contribute more to catchment management
- A2.4 Use the holistic nature of this plan to access a wide range of funding sources e.g. Queensland Week 2013 - $10,000 to celebrate the community – link to Celebrating the river – think creatively/beyond the square

Objective 2: Increase habitat quality, extent and connectivity

Action 3: Identify and prioritise rehabilitation of areas with habitat critical characteristics

- A3.1 Identify priority areas in each local government area that have the characteristics of habitat critical for the priority species and are also priority areas in the PAP/Rehab Plan (ref)
- A3.2 Undertake rehabilitation in priority areas to increase quality and extent of habitat
- A3.3 Rehabilitate and restore riparian area quality and connectivity
- A3.4 Initiate site specific projects to restore/maintain connectivity and habitat with infrastructure organisations who maintain cross river infrastructure (e.g. Powerlink, Main Roads, Energex, QR??, Regional Councils)
- A3.5 Undertake bed stabilisation works in priority areas

Action 4: Establish demonstration reaches that have overlapping habitat for priority species and that integrate community, cultural and ecological significance

A4.1 Integrate riparian and instream habitat protection through recognising indigenous pathways and sites of community significance

A4.2 Establish demonstration reaches in each local government area and use as a means to raise awareness, community and government capacity

Action 5: Species specific action to increase habitat quality, extent and connectivity

A5.1 Undertake activities that support rehabilitation of giant barred frog habitat on private land, leased land and within the reserve estate and increase public awareness of the species.

A5.2 Replant macrophytes after scouring to maintain macrophyte seed beds and re-introduce beneficial large wood. This action will benefit all species.

Action 6: Improve bed stability in priority sites (based on retention of key habitat and protection of assets)

A6.1 Incorporate threatened species concerns into the management of sand and gravel extraction (reword and ensure sufficient justification in recovery plan)

A6.2 Develop localised guidelines that include threatened species issues for the self-assessable codes for "working in rivers" to guide landholder activities

A6.3 Seek opportunities to link maintenance, construction and protection of new infrastructure (e.g. bridges, roads) with bed stabilisation projects & biopassage

Action 7: Support a coordinated approach to the threat of aquatic and terrestrial weeds

A7.1 Develop and implement a coordinated landscape scale program to reduce the extent and spread of riparian vine weeds in the Mary River catchment (incorporate actions from BoT Burnet Mary ?? BM75.2.1, 75.2.2, 75.2.3, 75.2.4) Note: there are multispecies benefits to these actions as outlined in Back on Track, and this should be considered in the development of this program)

A7.2 Implement the strategies and actions proposed in the Mary River Aquatic Weed Strategy (2009)

A7.3 Establish integrated Aquatic and Riparian Weed Management Plans that are integrated with environmental flow regime and make an explicit link between the control of Weeds of National Significance (WoNS) and threatened species recovery

A7.4 Include weeds that are not WoNS but are a threat to Giant Barred frog in all weed management plans or strategies (i.e. Silver Leaf Desmodium (*Desmodium uncinatum)*)

A7.5 Review progress with aquatic and terrestrial weeds as part of regular meetings of the recovery team

Action 8: Support a coordinated approach to the threat of feral aquatic and terrestrial animals (might need to make this more detailed)

A8.1 Undertake coordinated management of fox, dog and pig control to reduce threats to the Mary River turtle and Giant Barred frog

A8.2 Implement prevention and control program for aquatic feral animals

A8.3 Keep up to date with the latest control measures and monitoring techniques for feral animals (e.g. eDNA, genetic control options)

A8.4 Review progress with aquatic and terrestrial feral animal control as part of regular meetings of the recovery team

Action 9: Undertake activities that improve water quality

A9.1 Undertake activities to reduce the impact of point sources (e.g. ??) on water quality

A9.2 Undertake activities to reduce sediment, nutrient and pesticide loads into water courses according to the analysis of sediment sources (e.g. SedNet sediment network[8], Water Quality Improvement Plans (WQIPs)

A9.3 Undertake prevention and management activities in line with catchment Salinity Hazard mapping and localised salinity issues

A9.4 Identify risk zones for salinity - feedback to planning schemes (not sure this need to be included as action, but need to better understand the significance and get back to Mark)

Action 10: Improve environmental flow provision and compliance

A10.1 Identify flow regimes and refugia requirements (timing, volume depths) - that meet recovery requirements (including avoiding mortality on fishways and spillways) and incorporate into The Mary Basin Water Resource Plan (WRP) (link to BM43.2.1, 43.3.2, 43.3.3)

A10.2 Support compliance monitoring and transparency regarding environmental flow provisions in The Mary Baisn WRP and in EPBC Act controlled actions (e.g. Northern Pipeline Interconnector)

A10.3 Relate environmental flow requirements to cultural flow requirements

Action 11: Improve biopassage throughout the catchment

A11.1 Continue implementing the Burnett Mary Biopassage strategy (ref) and undertake review of progress by 2014?? (check how this strategy is supported on an ongoing basis and incorporate as an action if necessary)

A11.2 Incorporate species recovery needs into location and design of any new instream infrastructure

A11.3 Operate water supply and regulation infrastructure in ways that minimise adverse impacts on river health

Action 12: Species specific actions to reduce threats

A12.1 Continue protection of turtle nesting banks especially between October and January at the Tiaro, Traveston and Kenilworth nesting aggregations and protect new aggregations as they are identified (methods used include fencing (reduction in goanna, fox and dog, cattle access) and in-situ nest protection) (see BM 45.1.1, BM 45.5.2 & BM 31.1.5)

A12.2 Replant macrophytes after scouring and introduce snags to pools

A12.3 Continue a Mary River cod stocking program in accordance with Mary River cod Forum outcomes

A12.4 Implement strategies, on-ground works and community capacity building to reduce threat of chytrid fungus to Giant Barred Frog (as outlined in BM 19.10.1 - 19.5.1)

Objective 4: Increase societal capacity, sense of connectedness and motivation to contribute to recovery of priority species and river health

Action 13: Support and reward involvement of stakeholders in implementing the recovery actions

A13.1 Develop and disseminate specific education material for a targeted sub-catchment approach

A13.2 Support and encourage hands on restoration activities e.g. Wandering Weeders, Roving restorers

A13.3 Continue and increase support for turtle nest protection activities

A13.4 Develop a volunteer recruitment strategy to attract both local and non-local support for

[8] SedNet is a simple, testable, physically-based model of catchment sediment sources and transport which can help to inform catchment management to give healthier catchments and rivers http://www.csiro.au/en/Organisation-Structure/Flagships/Water-for-a-Healthy-Country-Flagship/Ecosystems-and-Contaminants/Ecosystem-response-to-catchment-processes/SedNet-sediment-network-modeling-software.aspx

on-ground work on public and private land

A13.5 Celebrate achievements e.g. completion of community projects

A13.6 Provide training and awareness raising opportunities for staff and decision makers in regional councils about issues that are critical to species recovery

A13.7 Undertake cultural and environmental awareness training programs that could be linked to sites e.g. dreaming pathways

Action 14: Increase awareness of the general public of the links between general river health, priority species (at multiple life cycle stages) and community values

A14.1 Make available for a general audience targeted, high quality and accurate information on priority species life cycles, habitat critical, threats and recovery actions

A14.2 Provide basic information targeted at new residents (renters, owners and leasers) to raise awareness of the catchment and increase connection with local groups (some councils already send some information to residents)

A14.3 Utilise crowd sourcing and social media resources to increase awareness and connectedness to the Mary River

A14.4 Create immersion opportunities that encourage valuing of the river and creating personal philosophies

A14.5 Increase the frequency of Mary River related stories in the Media

A14.6 Continue to produce Codline and seek support to produce multiple editions each year

A14.7 Develop projects that links to the national level – e.g. stamps and coins with local artwork of priority species and/or river

Action 15: Encourage responsible recreation, celebration of the River and River-carers, in ways that also creates opportunity to touch, experience, and love the river

A15.1 Increase access to the river by creating carefully designed and located launch pads/picnic areas, walking tracks. Create opportunities to experience the river and engage decision makers (e.g. Deep Creek Walk, Charles St. River Park Kenilworth, Queens Park Gympie, Maleny/Obi Creek boardwalk)

A15.2 Provide signage about species and things people can do to minimise impact at access points on the river (Kenilworth turtle signs are a good model)

A15.3 Develop and provide information packs/guidelines to recreational fishers about techniques and fishing gear that reduce impacts on threatened species

A15.4 Encourage participation in Waterwatch, frog monitoring and other citizen science projects

A15.5 Celebrate the Mary River through public festivals and events

Action 16: Provide extension services such as on farm advice, incentives, field days and workshops on an ongoing basis

A16.1 Maintain advice and referral services to rural and urban landholders – grants, ecological advice (Back on Track refers to DEEDI Wetland Management Handbook as a resource for many activities for intensive agriculture)

A16.2 Maintain a program of field days and workshops that respond to landholder needs and contemporary issues

A16.3 Ensure information about best management practices and significance of the Mary River's biodiversity is readily available include - best practice demonstration/pilot sites – access/enjoyment + extension services eg Platypus platform

A16.4 Establish a mentoring programs – create means for a knowledge exchange between generations

Action 17: Increase capacity and effectiveness of local organisations involved in activities that affect the river and threatened species recovery

A17.1 Training, networking and mentoring opportunities for community groups that build skills and help make volunteering more attractive

A17.2 Increase networking of groups involved in implementing activities relevant to the recovery plan to facilitate sharing of resources, coordination of events, strategic (SCRC website that has links to all groups – already used a lot for mapping – link this additional

information to the services already used, approach funding applications e.g. a shared website on Fraser Coast has been suggested, (SCRC website that has links to all groups – already used a lot for mapping – link this additional information to the services already used)

A17.3 Encourage acknowledgement and sharing of experience and knowledge across local groups– see different perspectives across catchments

A17.4 Support for neighbourhood groups – technical support, advice on how to start a group, and ways of dealing with issues such as insurance (e.g. can these small groups be auspiced by Landcare groups or MRCCC – if so how/what's the process – get the word out)

Action 18: Creating economic and employment opportunities

Creative industries

Growing the region/caring for resources

Research centre

Create products to make $$ and raise awareness at the same time (e.g. Cats claw turtles/baskets, examples in Tiaro Landcare

Use tourism promotion to recognise local environment entrepreneurs avian tourism, biosphere

Action 19: Strengthen the involvement of schools (at all levels) in river recovery and incorporate information about the catchment and priority species into classroom activities

A19.1 Incorporate awareness of the river in the national curriculum by developing modules relevant to the Mary for local schools and ensure continuity between levels of schooling (ie that the program follows through from prep to high school)

A19.2 Involvement of schools – competitions about healthy rivers, using national curriculum (make it interactive – see festival stall ideas). Involve schools in recovery activities

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Objective 5: Create opportunities for indigenous input and leadership in the recovery process and opportunities for cultural connections as an integral part of the recovery of priority species

Action 20: Foster indigenous engagement, training and employment opportunities associated with river recovery

A20.1 Explore the Cultural connections model for application to the Mary River catchment

A20.2 Develop a cultural and environmental mentor program for young indigenous kids

A20.3 NRM Work Crews in other parts of the catchment e.g. in upper and middle Mary. (sacred sites, sacred trees, mentoring with elders)

A20.4 Caring for Country projects in high schools and for kids on the dole. Link to job networks.

Action 21: Reciprocal science – sharing culture and sharing knowledge, closing the gap

A21.1 Walking the Mary events

A21.2 Back to Country camps and field trips

A21.3 Projects/activities that provide healing for young people through reconnecting to country

A21.4 Establish intellectual property protocols to safe guard knowledge that is inappropriate for the public domain

Action 22: Raise cultural awareness of non-indigenous NRM organisations and staff

A22.1 Employment of cultural advisors (both male and female) for Mary River NRM groups

A22.2 NRM staff to do induction in cultural awareness (best result if induction is over a couple of days over a long period e.g Day 1, then wait a month, Day 2, then wait 3 months, then Day 3)

A22.3 Catchment based internships within NRM Groups for indigenous young people (both male and female) that involve strong mentoring by elders

A22.4 Develop guidelines for cultural awareness that are made available to NRM groups

Action 23: Knowledge recording according to cultural protocols – Secret, Sacred and

Significant

A23.1 Establish an independent database for storing traditional cultural and ecological knowledge

A23.2 Authentic stories of the Mary to be recorded for the future and passed on to youth

Action 24: Hold a Mary River day that is run and designed by indigenous groups

Action 25: Explore ways of formalising the process of consultation

A25.1 MOU with regional councils

A25.2 MOU or something similar with NRM Groups

Objective 6: Undertake research and monitoring to close gaps in knowledge related to species recovery

Action 26: Establish a baseline for river health, habitat quality and species status

A26.1 Establish baseline extent of vegetated riparian zone and sand banks and bars

A26.2 Develop a habitat quality guide to establish a baseline and assist in ongoing monitoring

A26.3 Establish baseline extent of riparian weeds

A26.4 Establish baseline extent of aquatic weeds

A26.5 Assess the current level of bed stabilisation and prioritise areas for action (linked to riparian rehabilitation and habitat critical and assest protection)

Action 27: Establish integrated and ongoing monitoring programs regarding river health

A27.1 Develop and implement a survey and long term monitoring program for Lungfish, Mary River cod, Mary River turtle, Giant Barred frog (platypus also suggested in Freshwater Biodiversity Plan)

A27.2 Ensure that accurate low flow data is available (through data sharing agreements with infrastructure operators, or state government guages)

A27.3 Continue water quality monitoring programs, including event monitoring, and coordinate under the Mary Water Quality Improvement Plan (WQIP) to minimise duplication, improve and standardise parameters and reporting to the stakeholders and wider community (potentially in the form of a report card similar to healthy waterways)

A27.4 Establish monitoring program for Freshwater mullet based on commercial catch

A27.5 Secure funds need to collate and report on the monitoring program

A27.6 Explore role that community organisations and individuals could play in monitoring programs (eg Tag Recapture for Cod (only select anglers permitted), macrophyte bed health (link to waterwatch), stories of mullet runs etc, turtles caught on fishing lines, turtle carapaces and deceased turtles found on banks of waterways etc. animals taken to wildlife carers, or to vets/Australia zoo (method of early detection of diseases eg Marine Turtle)

Action 28: Undertake research to determine the distribution, population status, age class structure and address ecological knowledge gaps associated with the priority species

A28.1 Create population model for each species

A28.2 Close key gaps in knowledge regarding cod breeding and population status

A28.3 Undertake studies to better understand life cycle and age ratio of lungfish

A28.4 Undertake studies to better understand the life cycle, behaviour and population size of Mary River turtle

A28.5 Conduct surveys to determine Giant Barred Frog distribution in the catchment (prioritise surveys based on potential habitat areas (e.g Kandanga Ck, Yabba, Amamoor, Tinana, Glastonbury, upper Widgee/Wide Bay/ Munna - everywhere west and north of Gympie)

A28.6 Ensure that all relevant data regarding species status/distribution is entered into a central database i.e. Wildnet and research findings are collated at a central point i.e. Qld government's Recovery Actions Database (RAD)

Action 29: Undertake research to determine best practice Environmental Flow releases and include findings in WRP revision

A29.1 Revisit IQQM model (ROP) (need clarity on what this aims to achieve

A29.2 Install or obtain access to data from low flow gauges

A29.3 Establish flow regime to trigger freshwater mullet migration and determine how this impacts on other species

A29.4 Establish species specific flow habitat requirements (need to check NWC research and link to Tom et als work)

Action 30: Undertake research and monitoring regarding improved biopassage and connectivity

A30.1 Continue/undertake research as to the use and requirements (engineering, design, burst speeds etc) to improve design of fish transfer devices for the priority species

A30.2 Monitor the improvement in biopassage in response to the retrofit of the Gympie Weir and develop recommendations for future biopassage projects

A30.3 Possilbe method suggested included inserting PIT tags into a cohort of freshwater mullet and installing PIT tag readers on barrage and Gympie Weir

A30.4 Map and assess the impact of cross river infrastructure (bridges, powerlines, railway lines) on connectivity within the riparian zone (particularly in relation to habitat critical)

Action 31: Assess future risks to the Mary River and priority species

A31.1 A strategic conservation and water quality assessment of the implication of Mining in the Mary

A31.2 Undertake a review of the likely impact of increased recreational use of the Mary River (eg. Motorised craft, recreational fishing)

Action 32: Undertake research to improve knowledge of the impact of native and feral predators (both terrestrial and aquatic) on the priority species

A32.1 Undertake research according to BM30.5.1, 30.5.2 and 30.5.5 regarding impact of feral and also natural predators on the Mary River turtle

A32.2 Identify and trial methods for using elements of the natural predator - prey hierarchy (eg dingo urine) to reduce predation of Mary River turtle nests

A32.3 Improve understanding of the factors that affect goanna predation of turtle eggs (eg distribution of riparian vegetation) and develop recommendations for future revegetation projects to help minimise this threat (see BM45.2.1, 45.3.1 and 45.3.2)

A32.4 Improve knowledge of the impact of fish stocking on the priority species (See lungfish recovery plan for actions regarding impact of fish stocking)

Action 33: Increase understanding of the secrets of success for increasing community and stakeholder participation in river recovery

A33.1 Identify the approaches and situations that enable people to make informed choices about their interaction with the river

A33.2 Identify the local triggers that enable organisations and individuals to overcome the knowing/doing gap and implement knowledge in practice