

Sandringham Lagoon and Sandringham Creek Restoration

Balberra

Alana O'Brien, Darren Jennings,
Melinda Ferguson, Tim Marsden



Queensland Government
Department of Primary Industries and Fisheries

DRAFT

Sandringham Lagoon and Sandringham Creek Restoration

DRAFT

Balberra

October 2008

Alana O'Brien • Darren Jennings
• Melinda Ferguson • Tim Marsden

Information contained in this publication is provided as general advice only. For application to specific circumstances, professional advice should be sought.

The Queensland Department of Primary Industries and Fisheries has taken all reasonable steps to ensure the information contained in this publication is accurate at the time of publication. Readers should ensure that they make appropriate enquiries to determine whether new information is available on the particular subject matter.

For further information contact:

Tim Marsden
Fisheries Biologist
Queensland Department of Primary Industries and Fisheries
Ph: (07) 49670 724

© The State of Queensland, Department of Primary Industries and Fisheries 2008

Copyright protects this publication. Except for purposes permitted by the Copyright Act, reproduction by whatever means is prohibited without the prior written permission of the Department of Primary Industries and Fisheries, Queensland.

Enquires should be addressed to:

Deputy Director General (Fisheries)
Queensland Department of Primary Industries and Fisheries
GPO Box 46
BRISBANE QLD 4001

Front Cover – A section of Sandringham Lagoon in morning light after restoration has been completed.

Table of Contents

INTRODUCTION.....	1
ENVIRONMENTAL THREATS.....	4
METHODS.....	9
FISH COMMUNITY SAMPLING	9
BIRD OBSERVATIONS	10
WATER QUALITY SAMPLING	10
FISHWAY CONSTRUCTION	11
MECHANICAL REMOVAL OF WEEDS.....	11
WEED SPRAYING	14
SEDIMENT AND FISH REFUGE PONDS	14
REVEGETATION	14
CONSULTATIONS AND PUBLIC EDUCATION.....	15
LANDHOLDER INCENTIVES	15
RESULTS.....	16
FISH COMMUNITY SAMPLING	16
BIRD OBSERVATIONS	21
WATER QUALITY SAMPLING	30
FISHWAY CONSTRUCTION	41
MECHANICAL REMOVAL OF WEEDS.....	42
WEED SPRAYING	44
SEDIMENT AND FISH REFUGE PONDS	45
REVEGETATION	48
CONSULTATIONS AND PUBLIC EDUCATION.....	51
LANDHOLDER INCENTIVES	51
DISCUSSION	51
FISH COMMUNITY SAMPLING AND WATER QUALITY	51
BIRD OBSERVATIONS	54
FISHWAY CONSTRUCTION.....	55
MECHANICAL REMOVAL OF WEEDS.....	55
WEED SPRAYING	58

SEDIMENT AND FISH REFUGE PONDS	58
REVEGETATION	58
CONSULTATIONS AND PUBLIC EDUCATION.....	58
LANDHOLDER INCENTIVES	59
CONCLUSIONS.....	59
REFERENCES	59
ACKNOWLEDGEMENTS.....	60
APPENDIX 1 - FISH SPECIES INFORMATION	61
APPENDIX 2: BIRD SPECIES INFORMATION	81

DRAFT

DRAFT

Introduction

Sandringham Creek and Sandringham Lagoon

Southern Pioneer Floodplain Wetlands lie within the intensively developed Pioneer River floodplain a river basin recognised to pose a relatively high water quality risk to the Great Barrier Reef lagoon in terms of exported contaminant loads. This spring fed system on the Pioneer floodplain is located south of Sandy Creek at Balberra and flows east for 8.6 km's to Sandringham Bay entering the bay at the mouth of Alligator Creek. Sandringham Lagoon is a 2.2 km long wetland located at the headwaters of Sandringham Creek.

The area has been predominately cleared for agriculture (sugar cane farming and cattle grazing), with a number of wetland lagoons embedded within a matrix of farms. Most of the wetland lagoons are less than 50ha in size and form a fragmented network of habitats along drainage lines. High quality riparian and woodland habitat corridors can be found long the length of the larger creeks systems in the floodplain. But do not always contain a width suitable for sustainable bank stabilisation.

Within the context of the highly modified lower Pioneer basin, Sandringham Lagoon has extremely high values both for biodiversity and water quality. The site retains endangered regional ecosystem riparian and floodplain remnant vegetation that provides habitat for waterbirds and migratory fish species. It also retains tenuous connectivity with proximal estuarine wetlands and acts as a retention basin for run off from a sugar cane dominated catchment.

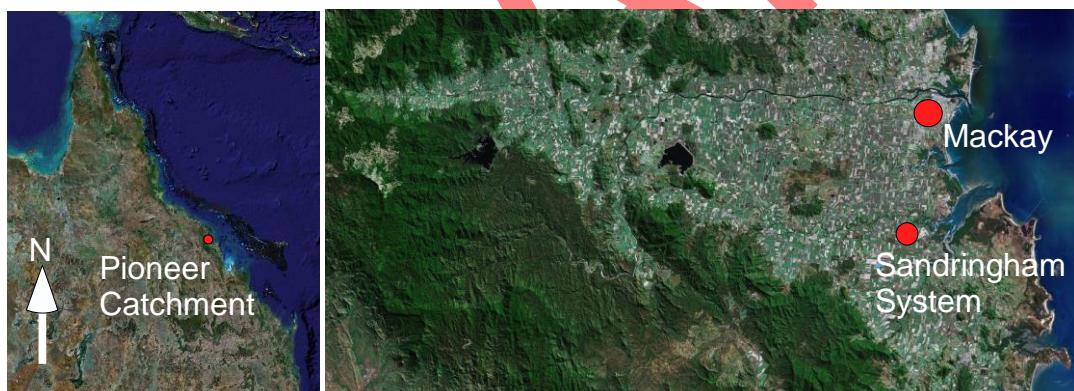


Figure 1. Aerial photos showing the location of the Pioneer River Catchment and the location of the Sandringham System.

Project Background

The Sandringham Lagoon and Sandringham Creek Project has been undertaken with funding from a range of sources;

- Conservation Volunteers Australia (CVA) under the GBR Coastal Wetlands Protection Program – Pilot Program - \$84,200,
- Mackay Whitsunday Natural Resource Management Group Inc under the Queensland Wetland Program - \$101,420,
- Pioneer Intergrated Catchment Landcare Group - \$7,700 and

- Inkind contributions from Queensland Department of Primary Industries and Fisheries, Mackay City Council, Conservation Volunteers Australia, Greencorps, LG & KA Bonaventura, S Herman and Landholders along the lagoon and creek.

The project commenced in July 2006 and was completed in August 2008. The tasks undertaken were;

- Water quality sampling
- Fish community sampling,
- Observations of bird communities
- Consultation with landholders and stakeholders,
- Public education,
- Spraying of weeds
- Mechanical removal of weeds,
- Construction of lagoons to act as fish refuge and sediment traps
- Construction of a fishway
- Revegetation of banks and
- Provision of incentives for landholders to control weeds after project completion.

DPI & F were contracted to be the local project drivers due to previous experiences in successful engagement with local project stakeholders.



Figure 11

- Fish Sampling Sites
- Bird Observation Sites
- Water Quality Sampling Sites
- Revegetation Sites
- Removal of Weeds
 - Excavator
 - Weed Harvester
 - Spraying

Sandringham Works Locations

Arial Pictures taken prior to work commencement

Figure 12



Values

The key wetland values of the Sandringham Lagoon and Creek system include:

- nursery habitat for key recreational and commercial fish species (particularly Barramundi);
- rare and endangered plant and animal species (i.e. False Water Rat, Grass Owl, Queensland Lace Plant) and threatened regional ecosystems;
- the water quality function it provides to the adjoining GBR Lagoon in terms of slowed floodwater velocities and the retention of sediment and nutrient loads; and
- Habitat for large populations of resident waterfowl, waterbirds, migratory waders and other bird species.

Sandringham Lagoon/Creek system represent many of the systems within the Mackay Whitsunday bioregion that have become degraded due to agricultural activities. The high value flora and fauna are needed to be preserved and enhanced to demonstrate that sustainable farming and aquatic habitats can co-exist.

Environmental Threats

There were a number of environmental threats impacting on the values of the Sandringham Lagoon and Creek system that were identified as warranting action in the short-term. These included fish passage barriers, invasive weeds and riparian vegetation condition.

Fish Passage and Habitat Degradation

Intensive agricultural development and urban encroachment into wetland areas has led to extensive fish habitat degradation across the Southern Pioneer Floodplain particularly in the Sandringham system. Floodplain development impacts also affect the ability of the system to work effectively as a nutrient sink and filtering system, and also limit the remaining sections of the wetland as fish habitat and nursery areas. Even where better quality floodplain wetland habitats remained, connectivity between the fresh and saltwater interfaces has been either lost or severely impacted by manmade structures and practices causing habitat degradation.

Some sections along the Sandringham Lagoon drainage system had been reduced to depression between sugarcane paddocks (figure 2). These areas were shallow and choked with Hymenachne, offering little (if any) chance of passage in all but major flow conditions. Fish habitat was poor with increased water temperatures due to lack of a riparian canopy, and low oxygen content due to the mass of weeds within the system.



Figure 2. A section of the cane drain which forms the link between Sandringham Lagoon and Sandringham Creek choked with *Hymenachne*.

Degradation of the riparian vegetation zone (figure 3) had led to the loss of good riparian and instream fish habitat, including undercut banks, in stream snags and suitable pool depths. This loss if not rectified could have lead to detrimental fish community numbers and eventually lead to the complete absence of some species of fish and other associated wildlife.



Figure 3. Section of Sandringham Lagoon bank with limited riparian vegetation.

While the road and railway crossings across the floodplain allowed fish passage under most flow regimes, the crossing on Campbell's Ridge Road presented a barrier to migrating fish due to a drop on the downstream side of the culverts and the potential high velocities through the culvert barrels (figure 4).



Figure 4. The culvert crossing on Campbell's Ridge Road at the exit of Sandringham Lagoon.

Invasive Weeds

Terrestrial

Elevated nutrient loads and hot fire regimes had led to a major problem with infestation of exotic weeds species, such as Guinea and Para Grass, along paddock headlands and riparian zones. The elevated fuel loads generated by this infestation has allowed fires to gain greater intensity than what natural species can tolerate. Such fires have the ability to kill off saplings and possibly mature trees, affecting natural recruitment. Although the practice of burning sugarcane in the Sandringham System had all but ceased, the effects of previous hot fire regimes was evident in terms of dead riparian trees, reduced canopy cover and reduced natural tree recruitment.

The density at which the Para and Guinea Grass grow (figure 5) out compete germination of seedlings along the riparian zones, significantly reducing natural recruitment and diversity. With the absence of any substantial grazing in the area, exotic pasture species had become the dominant ground cover within the riparian zone of the creek and wetland.



Figure 5. Paragras on the northern bank of Sandringham Lagoon.

Instream

Hymenachne had invaded the Sandringham System, (figure 6), in particular deeper water habitats. The extent of the Hymenachne had caused:-

- choked shallow water bodies and degraded high instream ecological values (including Barramundi nursery areas) through organic loading and oxygen depletion,
- displaced the native submerged and emergent aquatic macrophyte communities which provide important waterfowl and fish habitats,
- formed a raft for terrestrial plants to gain a foothold which led to the formation of an interwoven weed raft (figure 8) on which melaluca species had established themselves and were growing up to 9 metres in height (figure 9) and
- lead to the infilling of shallow surface waters (important ephemeral wetland habitats) through increased sediment deposition (figure 10).

The dramatic effect the Hymenachne had on the water quality meant oxygen levels in the lagoon dropped below 1 mg per litre of water. Most fish species can not tolerate such a low level of oxygen.

In the top section of the Lagoon, Water Lettuce and Water Hyacinth had created a large raft which again caused a major reduction in dissolved oxygen levels.

The Hymenachne infestation reflected the difficulties associated with the control of this Class 2 Weed of National Significance (WONS), including the lack of interest and engagement by landholders to expend resources to eradicate this species, as well as the limited development of integrated control measures to suit local conditions.



Figure 6. Hymenachne in Sandringham Lagoon.



Figure 8. The two gentlemen standing on the weed raft were not able to touch bottom with a 3 metre stick.



Figure 9. Melaluca's growing on the weed mat hydroponically.

Riparian Vegetation Degradation

The loss of riparian vegetation had led to a number of factors affecting the biodiversity of the Sandringham System. In particular, the fish community had suffered a large impact from these changes. Increased erosion due to bank destabilisation led to channel infilling and the loss of fish habitat (such as undercut banks) and the lack of large trees reduced the availability of instream habitat (in the form of snags). Loss of canopy cover shading the wetland system affected water temperatures, dissolved oxygen, macrophyte growth and consequently the diversity and abundance of species including key prey species such as Freshwater Herring and recreationally important species such as Barramundi.

Methods

Fish Community Sampling

Electrofishing was conducted on a 3.7 m vessel (Hypnos II) equipped with a Smith-Root 2.55 GPP electrofisher unit, two boom arms with 4 dropper anode arrays and hull cathode. At one site, unsuitable for vessel electrofishing, the use of a backpack electrofishing unit was required. The unit utilised was a Smith-Root Model-12B-POW Backpack Electrofisher operating a 500-volt Pulsed-DC current and a standard pulse setting of 1ms. An operator and single dip-netter were employed during all sampling activities.

Boat sampling was conducted in shallow water to a depth of 5 meters and encompassed all habitat types for optimum species representation. Sampling was conducted during daylight hours and was standardised by fishing time.

A maximum of six 300 second 'shots' at each of the chosen sites, a 'shot' included two passes mid stream along a 50 m section of bank consisting of a multiple of 12 seconds power-on followed by 12 seconds power-off, then ten runs into the bank at 5 m intervals along the that 50 m section were complete. A run into the bank consisted of a total of 24 seconds power-on including 8 seconds motoring into the bank, holding for 8 seconds at the bank then 8 seconds reversing away from the bank. In areas where a 50 m stretch of bank was not available a 'shot' consisted of multiples

of power-on, power-off for a total of 300 seconds. These techniques allow the thorough sampling of an area whilst preventing fish herding effects of boat electrofishing.

A 'shot' conducted by a backpack unit consisted of the operator walking in a straight line across the width of the stream from one bank to the other using a side to side sweeping motion covering an area of 2m. The dip-netter is located approximately 1m behind the operator on the downstream side at all times. Power on is applied from one side of the stream bank to the other. Once the operator has reached the far bank they then works their way back across the width of the stream, 2m upstream and parallel to the area just electrofished. This method is repeated for a total of 300 seconds power-on.

Bird Observations

Bird count surveys were completed at two sites along the lagoon, one at the top of the Lagoon and the other at the bottom end of the lagoon. These observational surveys were conducted by Ms Marge Andrews of BOCA (Bird Observers Club of Australia) and were completed from November 2006 through to September 2008 although not every month was surveyed. These surveys were conducted to ascertain information on the general health of the system, including changes in bird diversity and composition.

Water Quality Sampling

Water Quality was conducted by a Reef Catchment's Officer (local NRM Group). This process was undertaken at three sites along the main lagoon and the following parameters were tested;

- Temperature,
- pH,
- Conductivity,
- Dissolved Oxygen,
- Phosphates and
- Water clarity.

These parameters were recorded on four different machines. The Temperature and Dissolved Oxygen were tested using a Merck Oxi 330i handheld metre with a CellOx 325 probe. The pH was tested using a Merck pH 330i handheld metre with Sentix 41 electrode, the Conductivity was tested using a Merck Cond 330i handheld metre with a TetraCon 325 probe and the Turbidity (water clarity) was tested using a Merck Turbi-quant 1000 IR handheld metre.

These samples were collected from the middle of the water body (except at site 2) using a bucket to collect the water samples, the water was separated into different containers for each test (to avoid contamination). Prior to sampling the water, each probe was rinsed, calibrated and re-rinsed at the site to ensure accurate readings were taken. Sampling the pH involved simply immersing the probe in the water sample and a reading taken. Dissolved Oxygen required the probe to be submerged

in the water sample, the probe then required stirring in a slow circular motion. This probe also recorded the water temperature at the same time.

The Conductivity was recorded, by first sampling the air temperature, then immersing the probe into the water sample and recording the data. The Phosphate test required a sample of water being collected in a 10mL sterile plastic vial, this sample was then sealed in a plastic bag, then frozen and sent off to Australian Centre for Tropical Freshwater Research Laboratory Services in Townsville for processing.

Fishway Construction

A full width rock-ramp fishway was constructed on the downstream side of the causeway on Campbell's Ridge Road joining the lagoon to the cane drain (which then links to Sandringham Creek). Rock-ramp fishways are a common design in Australia as they permit passage of a wide range of species and size classes and are relatively cost effective to build in comparison to the more highly engineered vertical slot and lock fishways. They are constructed on barriers up to 2m high and consist of a series of rock ridges within the waterway channel to create a succession of pools and falls that fish are able to negotiate.

The Sandringham Lagoon fishway consists of a 6 ridges, 2 metres wide and 30 metres in length. The ridges were designed to create small 100mm falls between the pools with the topmost ridge acting as a control point to back up 100mm of water through the culverts which slow down the flow velocity and provide enough depth for fish passage.

The construction of the fishway took 2 days to complete, using 40m³ of 300 - 600mm rock and a 21 tonne excavator utilised for the entire period. For further information on rock-ramp fishways please refer to:- Clay 1995, Thorncraft and Harris 1996, Harris et. al. 1996, Thorncraft and Marsden 2000, Thorncraft and Harris 2000, McGill and Marsden 2001, Baumgartner and Lay 2002, Zampatti et. al. 2003.

Mechanical Removal of Weeds

A 21 tonne excavator (with a specially designed extension arm and weed rake attachment) and a specialised aquatic weed harvester were used in the removal of the weed mat in the lagoon and cane drains. The specially designed extension arm gave the excavator a reach of 14 meters (figure 15). The arm with weed rake attachment was extended out and then lowered so as only the tines entered the weed mat. The arm was then brought back to the bank ensuring that only tines stayed inserted into the weed mat. This section of the weed then separated from the where the tines were inserted and this section could then be raked up on to the bank, where it could dry out and then be transferred to trucks for complete removal. In most cases the excavator could reach to the opposite bank to remove the weed mat, where this was not possible the excavator was placed on the opposite bank and the procedure repeated.



Figure 15. The excavator extension arm and weed rake attachment were specifically built for the weed removal at Sandringham Lagoon. This picture shows the arm at its full reach (14 meters).



Figure 16. Removing the weed mat with the use of the extention arm on the excavator.



Figure 17. Loading sections of the weed mat into 10 tonne trucks for transport to dump sites.

The specialised aquatic weed harvester is a paddle wheel powered vessel with a set of cutting teeth at the front of the vessel and a conveyer belt that runs through the length of the vessel to move cut weed material from the front to the back (figure 18). This harvester is able to cut "tracks" 2 metres wide. The machine is only capable of handling small amounts of material at any given time however it is able to operate on the water where the excavator could not reach and was therefore able to cut "tracks" around sections of the weed mat and then push these sections into a position that could be reached by the extension arm on the excavator. The aquatic weed harvester was able to remove all of the water lettuce and water hyacinth at the top end of the lagoon. Any material collected by the weed harvester was then dumped onto the banks for draining and later collection.

This weed (once dry) was removed via 10 tonne dump trucks to a nearby landholders gully, (this gully had eroded away and required filling). BioActive Roundup was then sprayed over the weeds and the landholder was supplied with a 20L drum to ensure the weed did not re-shoot. The mechanical removal took 100 working days to complete.



Figure 18. The aquatic weed harvester cutting a section of weed mat in the middle reaches of Sandringham Lagoon.

Weed Spraying

Spraying of the weeds on the banks and in Sandringham Lagoon, Sandringham Creek and the “cane drain” was undertaken using 15 litre backpack spray units, 5 litre hand held spray units and a 200 litre electric spray unit. The 15 litre and 5 litre units were all individually operated working in team between 2 and 10 along designated sections. These operations were spraying terrestrial weeds along the banks.

The 200 litre unit was mounted in either the tray of vehicle or in the hull of a 3.85 metre boat. The unit has a 30 metre hose and is operated using an electric pump capable of spraying up to 10 metres from the nozzle. The unit was operated by a sprayer and a driver. The spraying program included a number of days spraying the banks, drain, creek and lagoon with Roundup bioactive which contains glyphosate and was used at a rate of XXX/litre of water and XXX litres per Ha. This chemical is authorised for use in water courses and has been formulated specifically to reduce the toxicity of the product to certain aquatic organisms including frogs and is the preferred formulation for use around dams, waterways and other aquatic situations. The product is absorbed by plant foliage and green stems. It is inactivated immediately in the soil and does not provide residual weed control. The areas targeted by this unit were large terrestrial infestations and shallow areas of the lagoon not reachable with the excavator. Spraying was undertaken by Department of Primary Industries and Fisheries personnel and Conservation Volunteers Australia volunteers and took 15 working days.

Sediment and Fish Refuge Ponds

Three ponds were constructed downstream of Sandringham Lagoon below the fishway in the cane drain section. Land was made available after consultation with landholders in area's where the construction would have minimal impact on productive land. The ponds were designed at 2+ metres deep and situated in such a way to encourage water based sediment would drop out of the water column by creating an eddying effect. The placement of revegetation would in high flows create slower water velocities and further eddying. The ponds were constructed using the same 21 tonne excavator and the removed soil was transported by the same trucks to adjacent paddocks to assist the landholder in raising the lower areas of his cane paddocks. The three ponds were constructed in 15 working days.

Revegetation

Selection of plant species required for the revegetation of Sandringham Lagoon was undertaken in two parts. Firstly the Pioneer Integrated Catchment Management Association (PICMA) donated approximately 1400 local native plants to the project. These species were selected by a local botanist (Mrs Irene Champion) who has specialist knowledge of plants of the Mackay region. These plants were then maintained at the Mackay Regional Council Nursery (Swayne Street) until the sites were ready for revegetation.

Another 2200 plants were required to complete the revegetation of the lagoon and detention ponds. These plants were selected by utilising a Regional Ecosystem Map (Regional Ecosystems 8.3.5 and 8.3.3) to identify potential species. Mrs Irene Champion (botanist) was again consulted to define the list. Although it was preferred that the plants be sourced from local suppliers, the majority of these plants could

only be sourced from suppliers in Brisbane and Townsville (local suppliers could not provide numbers or species).

Revegetation labour was supplied by a local landscape company (Mackay Green Solutions) as well as a GreenCorp Team from Conservation Volunteers Australia. This team undertook the planting, staking, watering and mulching of approximately 3600 plants around the lagoon and the detention ponds.



Figure XX. The Green Corp team watering a section of revegetation on the banks of Sandringham Lagoon.

Consultations and Public Education

Landholders were initially consulted by way of letter and a public meeting held locally to discuss the project and to seek their support. Individual meetings with landholders were held regularly over the course of the project and a second public meeting was held to provide and update on the progress and to seek further support for the ongoing spraying of weeds.

Consultations were made with local council, Department of Natural Resources and Water, Biosecurity Queensland and other local experts in weed management to obtain advice on the best practice methods of weed clearing.

Landholder Incentives

As part of the plan to ensure ongoing works to continue to maintain the reduction of weeds, incentives were made available to all landholders along Sandringham Lagoon, Sandringham Creek and cane drain. The incentives consisted of chemical for use over a 6 month period and funds to pay for the labour component of spraying.

The allocation of these funds was based on the amount of land owned adjacent to the watercourse or land that had been used to dump material from the watercourse. Landholders who took up the incentive were asked to sign a letter of agreement outlining that the chemical was for use in spraying weeds on Sandringham Lagoon banks, in the water body, within the cane drain, Sandringham Creek or on the weed dump sites and that spraying was required monthly for a period of 6 months.

Results

Fish Community Sampling

The fish community sampling undertaken at Sandringham lagoon was completed at 10 different sites both in and around the lagoon. From this survey a total of 4639 freshwater fish comprising of 16 species were sampled (before, during and after rehabilitation of the lagoon). 10 potamodromous, 1 catadromous, 2 amphidromous and 3 introduced species were identified from the 16 different species sampled.

The most abundant species found throughout the survey was the Empire Gudgeon, (see Table 1), totalling 2307 individuals identified. The next most abundant species was the Fly-Speckled Hardy-Head, totalling 1092 individual fish identified. The Eastern Rainbow Fish was also fairly abundant with 899 individual fish identified. The three introduced species identified were found in two of the three rounds of fish community sampling. Gambusia was the most abundant of these species, with 141 fish identified, then the Platy with 11 individuals and the Guppy with 1 individual sampled.

Table 1. Total Fish Caught at Sandringham Lagoon (including catch rates) Before, During and After Rehabilitation.

Species	Before	Catch rate	During (Lagoon)	Catch rate	During (Dam & Stream)	Catch Rate	After	Catch rate
Eastern Rainbow fish	18	1.1	6	0.191	15	0.7759	860	28.667
Swamp Eel			2	0.03181			3	0.1
Long Finned Eel	4	0.25	6	0.0636	1	0.0518	1	0.3334
Oxeye Herring	1	0.06	3	0.0955				
Empire Gudgeon			284	9.035	60	3.1035	1963	35.434
Purple Spotted Gudgeon			19	0.6045	61	1.6035	22	0.7334
Midgley's Carp Gudgeon			3	0.0955			12	0.4
Spangled Perch			1	0.03181	1	0.0518	12	0.4

Fly-Speckled Hardy-Head			30	1.5517	1062	35.4	
Bony Bream			1	0.0518	20	0.6667	
Sleepy Cod			3	0.0518			
Chanda's Perchlet			2	0.1035	1	0.3334	
Western Carp Gudgeon					9	0.3	
Gambusia		65	2.0679	54	2.7931	22	0.7334
Platy		6	191			5	0.1667
Guppy		1	0.03181				

Prior to rehabilitation of Sandringham Lagoon, there difficulty in accessing the majority of the lagoon, due to the extensiveness of the weed mat, only one site was able to be sampled, (figure xx). From this site, three different species and 23 individual freshwater fish were identified. The most abundant species was the Eastern Rainbow Fish with 18 individual fish identified at a catch rate of 1.1 fish per minute, (figure #). The other two species identified at this site was the Long Finned Eel and the Oxeye Herron (Tarpon).

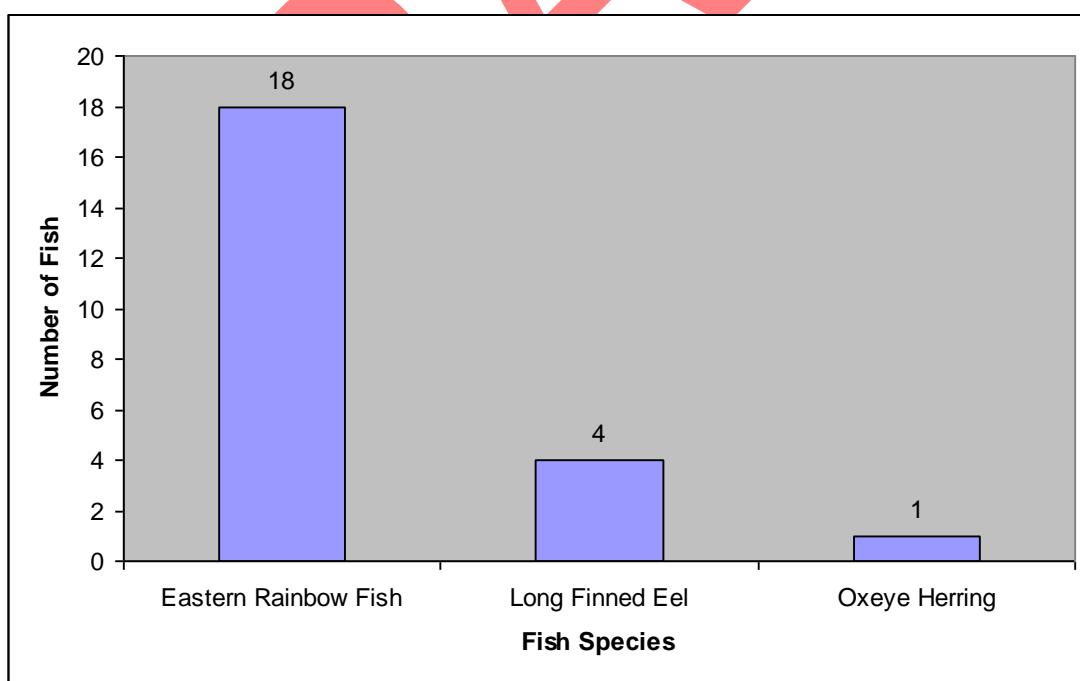


Figure #. Number of fish caught prior to the rehabilitation of Sandringham lagoon

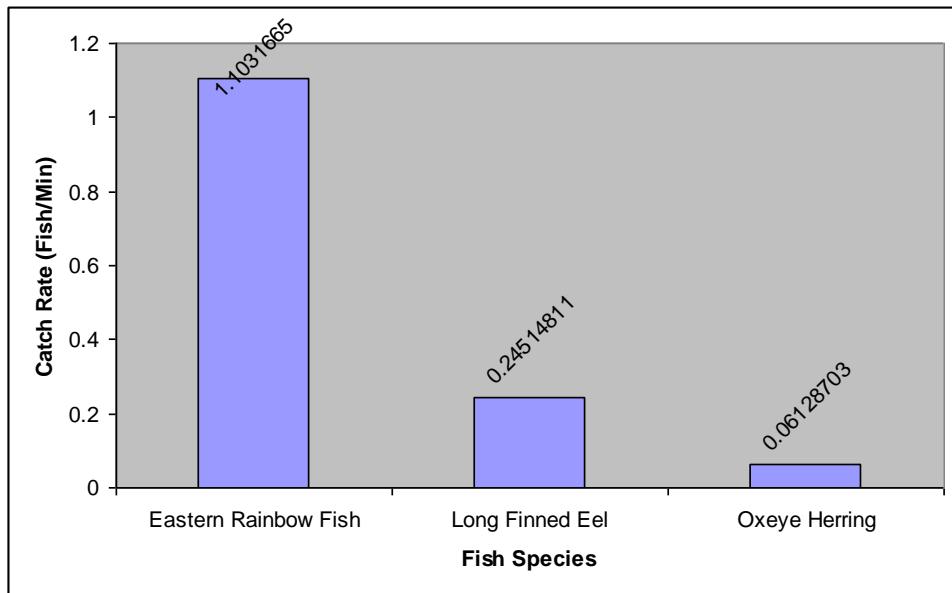


Figure #. Catch rates of the fish species caught prior to the rehabilitation of Sandringham lagoon.

With the partial removal of the weed mat from the lagoon, more areas became accessible and three sites in the lagoon were sampled, plus two sites off the lagoon in a dam and its adjoining stream that both overflow into the lagoon in periods of high flow. Eleven species and 396 individuals were identified (figure #). The most abundant species was the Empire gudgeon, 284 individuals were caught at a rate of 9.035 fish per minute. The next most abundant species was an introduced Mosquito fish (Gambusia) with 65 individuals at a rate of 2.0679 fish per minute, (Figure #).

There were two other introduced species identified in this round of sampling, the Guppy (1 individual) and the Platy (6 individuals).

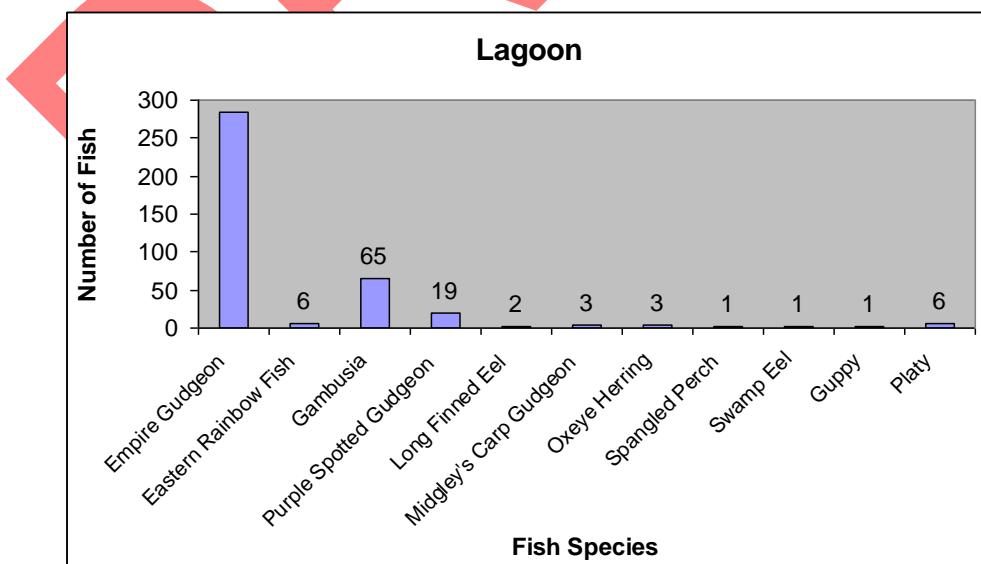


Figure #. Number and type of fish caught during the rehabilitation of Sandringham Lagoon.

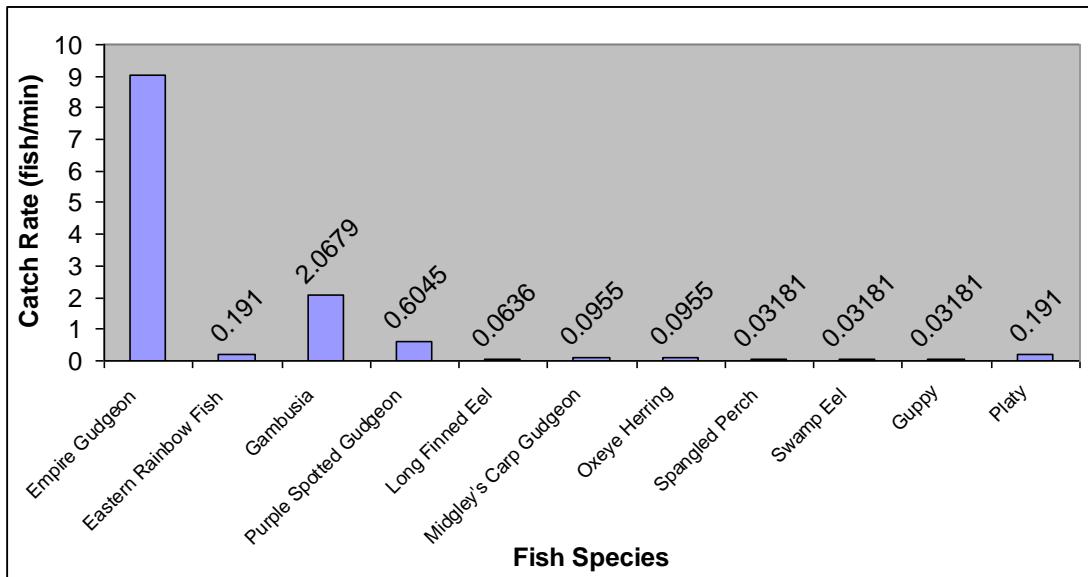


Figure #. Catch rate and species abundance during the rehabilitation of Sandringham Lagoon.

An off site dam and stream adjacent to Sandringham Lagoon was sampled and was found to contain 10 different species and 228 individual fish. The most abundant species caught was the Empire Gudgeon, 60 individuals were caught at a rate of 3.1035 fish per minute, (figure # & #). The next most abundant species was an introduced Mosquito fish (Gambusia) with 54 individuals caught at a rate of 2.7931 fish per minute in the dam/stream area. No other introduced species were noted in the dam or the stream.

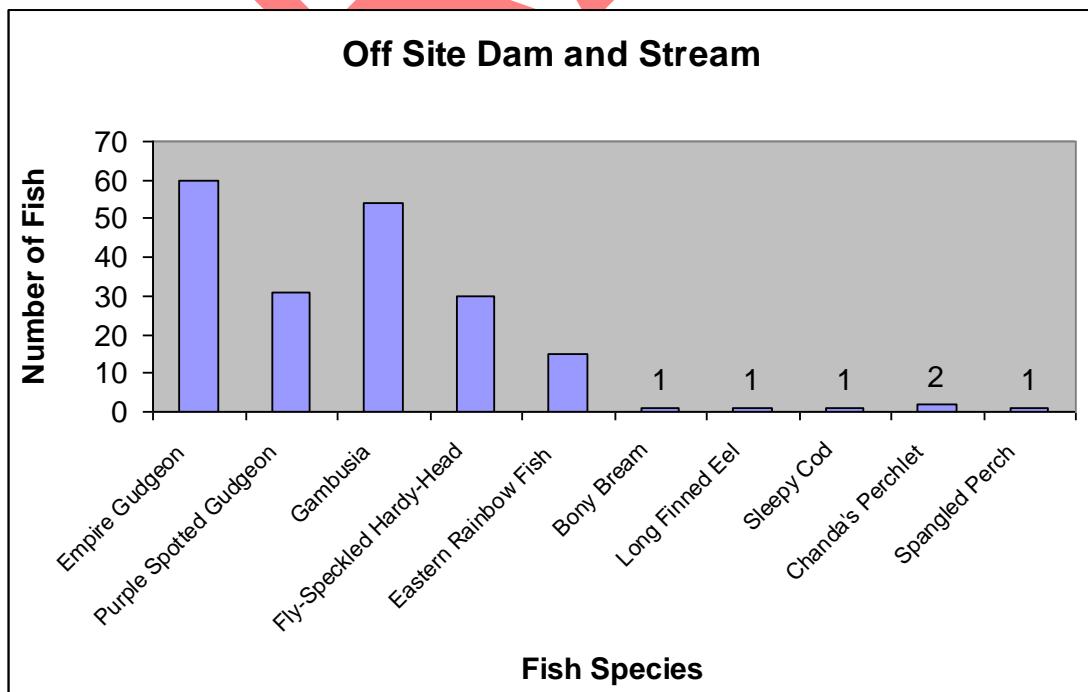


Figure #. Fish species and number identified during the rehabilitation of Sandringham Lagoon in the off site Dam and Adjoining Stream.

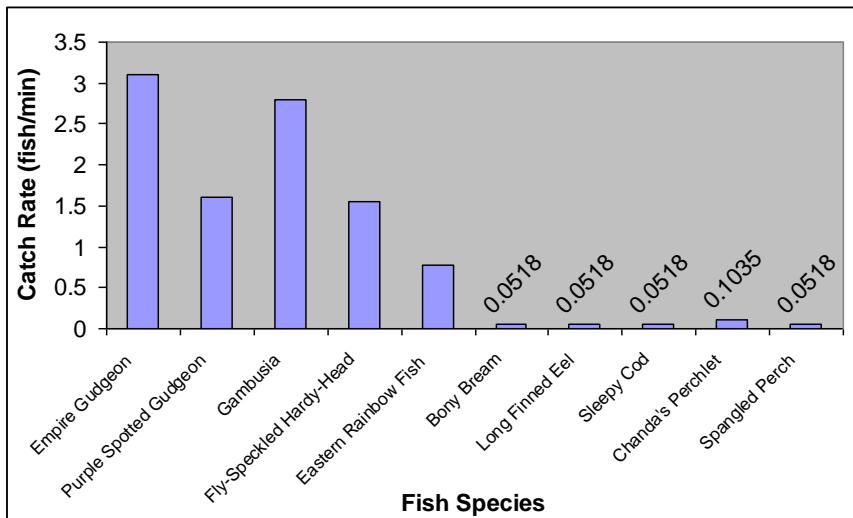


Figure #. Catch rate and species abundance during the rehabilitation of Sandringham Lagoon in the off site Dam and Stream.

With complete removal of the weed mat from the lagoon, the species diversity increased to 13 species and a total number of 3992 individual fish caught, (figure #). The most abundant species within the lagoon was the Empire Gudgeon, with 1963 individual fish caught at a rate of 65.434 fish per minute. The next most abundant species was the Fly-speckled hardy-head, with a total of 1062 individuals caught at a rate of 35.4 fish per minute. And then the Eastern Rainbow Fish, 860 fish were identified with a catch rate of 28.667 fish per minute, (Figure #).

Introduced species were found in the lagoon, with 22 Gambusia (caught at 0.7334 fish per minute) and 5 Platys, (caught at 0.1667 fish per minute).

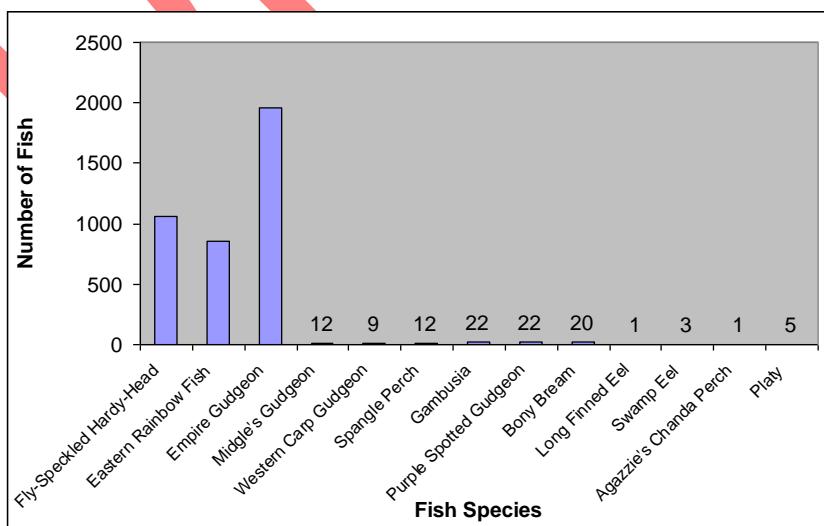


Figure #. Fish number and type identified after rehabilitation of Sandringham Lagoon.

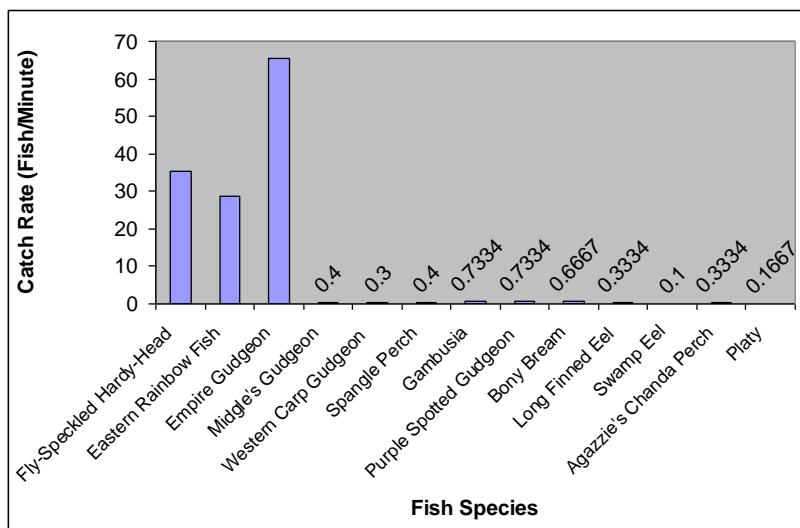


Figure #. Catch rate and species abundance after the rehabilitation of Sandringham Lagoon.

Bird Observations

The bird data collected between November 2006 and September 2008 varied significantly in both number of species and number of individuals. On a whole there were 110 different species and a total of 2625 individual birds sited at Sandringham Lagoon within the survey period.

The most abundant species of bird was the Pacific Black Duck, with over 185 individual birds sited throughout the 13 surveys. This species was sited in most of the surveys undertaken, all except one, the first August survey of 2008 (see Table #). The next most abundant species was the Little Pied Cormorant, with 134 individual birds sited within the 13 surveys. Again this species was identified in most of the surveys, all except three (February 2007, April 2007 and August 2007). The Yellow Honeyeater and the Willie Wagtail were also quite abundant with 123 and 111 individuals identified respectively.

Of the 110 species sited at Sandringham Lagoon, four of those were sited in every survey, these species (and numbers) include the Peaceful Dove (79), the Red-backed Fairy-Wren (97), the Yellow Honeyeater (123) and the Torresian Crow (80).

Table #, shows a comparison of the bird data of certain months of each year, this table has indicated increases in the number of species and individuals throughout the surveys.

November 2006 and November 2007 however varied greatly, decreasing in numbers of both species and individuals. November 2006 identified 59 and 500 individuals, and November 2007 identified 32 species and 123 individuals.

The increasing trend was indicated between February 2007 and January 2008. February 2007 sited 27 individuals over 17 species identified, and January 2008 sited 177 individuals and a species count of 37. This rise in numbers was also seen in August 2007/2008, 129 individuals and 35 species were sited in 2007 and 286 individuals and 52 species were sited in 2008. The September 2007 and 2008 results shows an increase in species numbers, increasing from 48 to 50, however the number of individuals decreased from 271 to 243.

Although there were 110 different species identified during the 13 bird count surveys, many of those individuals were in small numbers. 71 species were found in groups of 15 or less, and of those, 43 species were found in groups of 5 or less. Of the total 110 species, 20 of those were found to be only 1 single individual.

There were 4 significant species recorded in the bird counts, these include: - The White-Bellied Sea-Eagle, the Little Eagle, the Brahminy Kite and the Lemon Bellied Flycatcher. These species are significant in the Sandringham Lagoon area mostly due to their normal habitat differing from that of the habitat found at the lagoon.

14 species were identified only in the surveys prior to the rehabilitation of Sandringham Lagoon, these include: the Comb-Crested Jacana, the Australasian Grebe, the Magpie Goose, the Swamp Harrier, the Bush-Hen, the Buff-banded Rail, the Pied Imperial Pigeon, Horsefield's bronze cuckoo , Gould's bronze cuckoo, the Shinning Bronze Cuckoo, the Little Bronze Cuckoo, the Fairy Gerygone, the White-Winged Triller and the Little-Shrike Thrush.

12 species were identified only after the rehabilitation of Sandringham Lagoon, these include, Richard's Pipit, the Scarlet Honeyeater, the Restless Honeyeater, Lewin's Honeyeater, Latham's Snipe, the Azure Kingfisher, the Little Eagle, the Brahminy Kite, the Australian Pelican, the Royal Spoonbill and the Black-Necked Stork.

DRAFT

Table #. Complete Bird Data surveyed between November 2006 and September 2008

	26 Nov 2006	09 Feb 2007	03 Mar 2007	14 April 2007	18 May 2007	13 July 2007	17 Aug 2007	28 Sept 2007	24 Nov 2007	12&13 Jan 2008	5,6,7 Aug 2008	17 Aug 2008	15 Sept 2008
	*Prior	Prior	Prior	Prior	Prior	Prior	*During	During	During	During	*After	After	After
Brown Quail	10							2					
Plumed Whistling Duck	49	2	3	15				21		15	16		
Australian Wood Duck								11			107	5	
Pacific Black Duck	27	3	2	4	17	10	24	15	11	4		48	20+
Wandering Whistling Duck										2			
Radjah Shelduck										2			
Australasian Grebe	2												
Magpie Goose	1												
Darter	16		16						2	10	13	1	4
Little Pied Cormorant	30		16		1	1		14	11	20	2	2	3
Little Black Cormorant	25		2		1			8	10		15	24	2
Pied Cormorant										1			
Black Bittern										1			
Cattle Egret	1				1	4		4	1				
Great Egret	1											3	2
Intermediate Egret	4				1								2

Black-necked stork								1				
Straw-necked Ibis					1		1		2	9	2	
Australian White Ibis					1	4			2			
White-faced Herron		1							1	1		
Royal spoonbill										4		
Australian Pelican									1			
Swamp Harrier					1							
Pacific Baza						2				4	2	
Black Kite	3		1		1	3	2	3	2	6	4	2
Whistling Kite	1			2	1		1	1		2	4	1
Brahminy Kite										1		
Brown Goshawk							2					2
Brown Falcon						1	1			1		
White-bellied Sea-eagle												1
Little Eagle											2	
Wedge-tailed Eagle							2					
Bush-hen	1	1	1	1								
Buff-banded rail	3											
Purple Swamphen	8				5		3	6	3	1	1	6
Dusky Moorhen	2		1						1	3		

Bush Stone-curlew								1			1		
Marsked Lapwing	4		2	8	4	2	6	8	9	7	7	5	11
Peaceful Dove	12	2	4	4	7	8	5	6	2	10	4	4	11
Pied Imperia Pigeon	3												
Bar-shouldered Dove		1			1	2	2	2		2	4	1	
Common Kole	3								1				
Brush cuckoo	1		1							1			
Fan-tailed cuckoo	1			1		1							
Horsefield's bronze-cuckoo	1												
gould's bronze cuckoo	2							1					
Shining Bronze-Cuckoo							1						
Little Bronze-Cuckoo							1						
Channel-Billed Cuckoo	2									2			
Rainbow lorikeet	2					8	2					3	5
Pale-headed Rosella						2						8	1
Pheasant Coucal	3	1	4		2			1	2	3	1		
Laughing Kookaburra	1		1				2	4	1	2	6	2	6
Blue-winged Kookaburra			2					2			1	2	2
Forest Kingfisher	1				2	2	1	4				2	2
Azure Kingfisher												4	

Sacred Kingfisher			3	6	3	1				2		
Rainbow Bee-eater	16		3	6	15	3	3			6	8	6
Latham's Snipe												1
Red-backed Fairy wren	15	1	4	7	6	8	5	8	5	10	6	2
Dollarbird			1						1			
White Throated Gerygone	1			1		1		2			5	4
fairy gerygone			1									
Helmeted Friarbird			1	1						4		
Little Friarbird	1					2		4		2	1	
Noisy Friarbird	1				1	2			2	2	3	2
Blue-faced Honeyeater	1				3	3		1		4	2	2
Yellow Honeyeater	15	2	3	7	11	7	8	12	3	13	16	7
White Throated Honeyeater	11	1			4	3	2	6		1		2
Brown Honeyeater	1		2	1	7	9	2	15	2	3	12	8
Bar-breasted Honeyeater	3								2		1	
Lewin's Honeyeater											5	
Dusky Honeyeater					1		1			2	3	2
Scarlet Honeyeater											1	
Lemon-bellied flycatcher	2					2		1				2
Rufous Whistler	2			1		3	2	1			5	2

Restless Flycatcher												1	
Leaden Flycatcher	13			2	3	4	2	9	2	3	1	2	6
Magpie-lark	16		4	2	10	3	5	5	3	4	9	3	5
Willie Wagtail	21	2	8	8	9	11	5	11	14	3	13	6	
Grey Fantail					11	10	6				6	1	11
Rufous Fantail							1						
striated pardalote			4	1		1							
Spangled Drongo	5	1	1	4	1	2				3	3	1	2
Spectacled Monarch							1						
White-eared Monarch						1							
White-bellied Cuckoo-shrike	1				2	5	9	2	3				
Black-faced Cuckoo-shrike	3		1	2	5	9	6	5	1	4	3	4	
White-winged Triller	1												
Cicdabird			1						2				2
Varied Triller	5		3	1		1	1	1		1		3	1
Olive-backed Oriole	6							4					1
Figbird	12				1	2		4	1			4	5
White-breasted Woodswallow	3	1						2					
Pied Butcherbird			2		1	8	1	2		1	4		
Australian Magpie			4		5	10	2	4	8	3	7		3

Torresian Crow	18	2	13	2	4	3	3	5	3	6	5	3	13
Red-Browed Finch	20	1			10	16	7	3	3	14			5
Chestnut-breasted Mannikin	60	2				8		28		8			7
Yellow-bellied sunbird		1				3		3				1	1
Tawny Grassbird	4							8					
Golden-headed Cisticola	6	3	1	1				11	2			1	3
Clamorous Reed-Warbler			1	5	7					2	5	7	
Comb-Crested Jacana				1									
white-brown robin				2	1	1	2						
little shrike-thrush				1									
Fairy Martin	17						3					28+	3
Welcome Swallow							4					30+	
Mistletoebird				1								1	2
Richard's pipit												1	1

(* Refers to the time period either prior, during or after the rehabilitation of Sandringham Lagoon)

Table #. Bird data comparison between certain months of each year

Month / Year	Individuals	Species	Time period
November 2006	500	59	Prior to Rehabilitation
November 2007	123	32	During Rehabilitation
February 2007	27	17	Prior to Rehabilitation
January 2008	177	37	During Rehabilitation
17 August 2007	129	35	During Rehabilitation
17 August 2008	286	52	After Rehabilitation
September 2007	271	48	During Rehabilitation
September 2008	243+	50	After Rehabilitation

DRY

Water Quality Sampling

Table #. Complete water quality results for the three sites along Sandringham Lagoon.

Date	Site	Time of Test	Air Temp °	Water Temp °	pH	DO %	DO mg/L	Electrical Conductivity (µS/cm)	Phosphate	Water Clarity (NTU)	Comments
05/12/06	Site 1	1:30 PM	29.4	30.3	6.88	88.4	6.78	259	0.2	0	
	Site 2	1:30 PM	29.4	30.3	6.88	88.4	6.78	259	0.2	0	
	Site 3	2:35 PM	31	28.9	6.23	26.6	2.08	209	0.1		
15/01/07	Site 1	3:10 PM	31.4	32	7.154	159	12.1	301	0.5	21	
	Site 2	2:30 PM	32.2	27.6	6.008	5.7	0.42	239	0.1	158.7	
	Site 3	1:40 PM	30.8	30.2	6.288	35.1	2.7	233	0.2	20	
12/02/07	Site 1										
	Site 2	1:50 PM	33.7	30.1	6.154	18.2	1.35	131.6	0.4	25.51	
	Site 3	1:10 PM	30.9	28.9	6.288	11.2	0.8	119.4	0.3	12.47	
20/03/07	Site 1										
	Site 2	9:50 AM	31.1	27.2	6.323	28.2	2.23	102	0.2	80.78	Sampled in small shallow area, Temp error although temp reading same as other meters.
	Site 3	10:40AM	31.2	24	6.029	6.6	0.56	122.8	0.2	58.23	
1/06/07	Site 1	8:10 AM	24	23.1	6.48	4.7	0.45	155.8	0.2	13.02	Error on pH metre
	Site 2	10:20AM	25.3	22.7	6.2	38.8	3.15	157.9	0.2		Sampled in shallow open area.
	Site 3	9:45 AM	24.2	21	6.133	6	0.38	147.2	0.2	18	

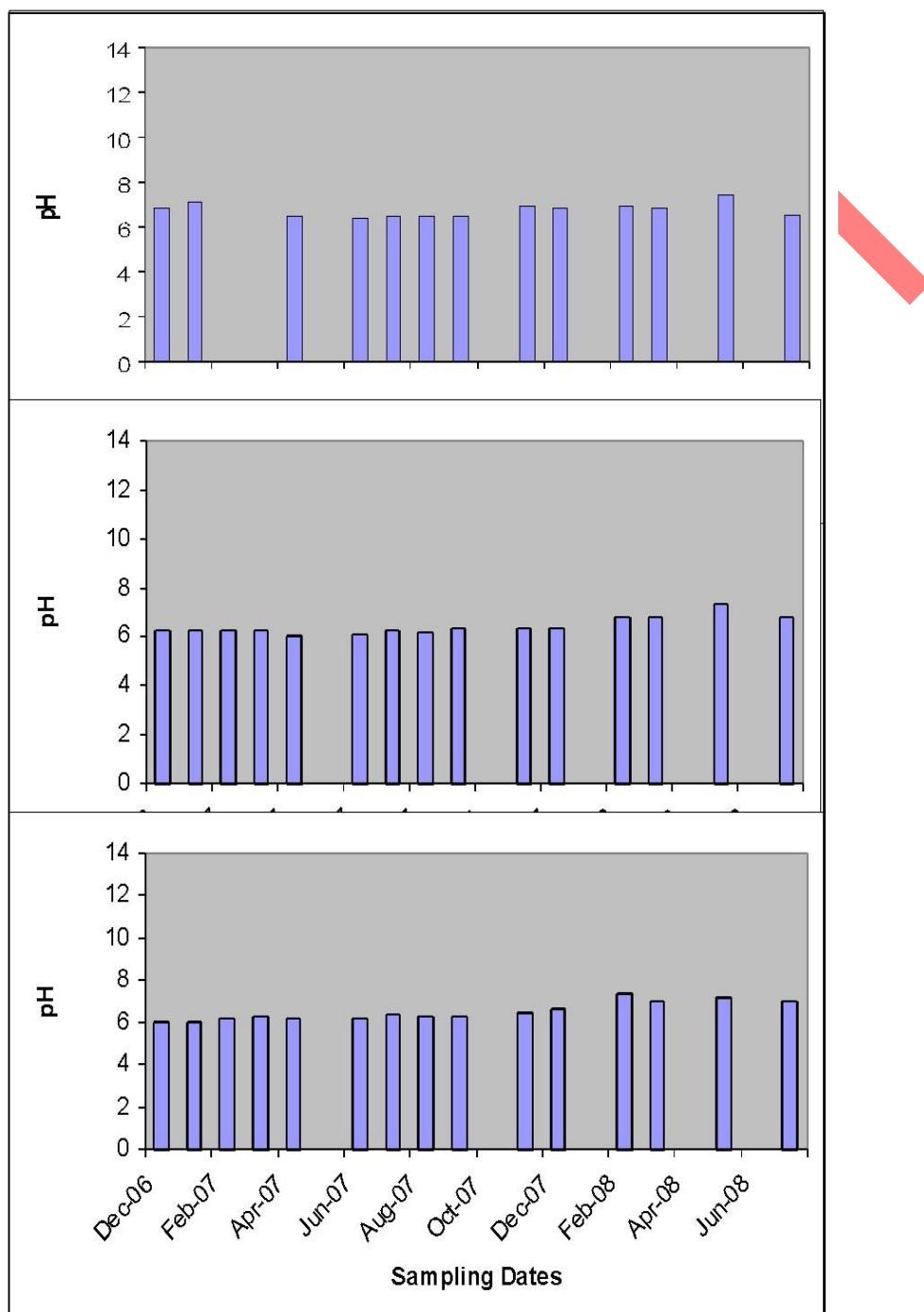
13/07/07	Site 1	8:50 AM	22.4	21.5	6.4	6	0.56	181.7	0	26	Error on pH metre
	Site 2	9:30 AM	15	14.7	6.329	11	1.13	101	0.2	17.16	Sampled in shallow open area.
	Site 3	9:00 AM	13.9	14.1	6.296	4.4	0.41	89.9	0.2	21	
21/08/07	Site 1	8:30 AM	19.9	18.4	6.515	37.5	3.5	128.2	0	94.31	
	Site 2	10:15AM	21.7	18.1	6.278	29.3	2.78	127.6	0.1	84.75	
	Site 3	9:20 AM	21.8	16.9	6.213	7.7	0.74	96.9	0	86.72	
19/09/07	Site 1	9:00 AM	22.9	20.9	6.45	11.2	1.03	145.7	0	30.1	
	Site 2	9:45 AM	24.3	19.8	6.38	6.6	0.57	106.5	<0.2	49.82	
	Site 3	9:45 AM	24.3	19.8	6.38	6.6	0.57	106.5	<0.2	49.82	
6/11/07	Site 1	10:00AM	29.2	27.2	6.93	61.3	5.15	169.8		90	Phosphate not sampled
	Site 2	11:15AM	29.5	28.3	6.48	48.1	3.77	158.5	--	60	Phosphate not sampled
	Site 3	10:30 M	28.1	26	6.36	19.8	1.61	124.7	--	55	Phosphate not sampled
12/12/07	Site 1	10:10AM	29.9	29.4	6.85	36.1	2.73	251	na	16.76	
	Site 2	11:40AM	31.9	32.9	6.65	42.3	3.02	236	--	12.33	Phosphate not sampled
	Site 3	10:40AM	30.1	28.8	6.33	22.6	1.73	153.7	--	33.84	Phosphate not sampled
25/02/08	Site 1	9:20 AM	28.8	29.8	6.98	60.7	4.75	118.9	0.3	12.74	Phosphate unfiltered
	Site 2	10:30AM	32.1	31.2	7.34	107.6	8.05	95	0.3	6.91	Phosphate unfiltered
	Site 3	10:15AM	30.1	29.8	6.84	65.6	5.06	87.9	0.3	9.18	Phosphate unfiltered
26/03/08	Site 1	9:00 AM	25.6	27.9	6.88	34.3	2.16	91.1	<0.2	10.4	

	Site 2	10:10AM	32.7	28.7	6.99	76.3	5.83	88.5	>0.2	12.67	
	Site 3	9:40 AM	27.4	27.2	6.77	43.4	3.4	87.2	<0.2	13.15	
07/05/08	Site 1	2:00 PM	22.9	24.6	7.46	139.5	11.85	100.2	0	12.8	
	Site 2	3:00 PM	26	23.3	7.21	94.5	7.92	97.7	--	12.05	Phosphate not sampled
	Site 3	2:40 PM	26	22.7	7.36	101.5	8.94	95.2	0	13.74	
29/07/08	Site 1	8:10 AM	15	16.3	6.59	32.7	3.2	146.6	--	17.2	Phosphate not sampled
	Site 2	9:00 AM	15.2	17	7.01	53.3	5.26	131.4	--	10.4	Phosphate not sampled
	Site 3	8:40 AM	14.1	15.7	6.84	58	5.78	122	0	14.03	

DRAFT

Throughout the sampling period the pH levels stayed constant, the average reading was 6.44, but the results varied between 6.008 and 7.46. Higher pH values were recorded between February and June 2008 a trend noted over each of the three sites (figure #).

Water clarity (turbidity) showed a decrease in levels at each site between October 2007 and July 2008, during and after the rehabilitation of Sandringham Lagoon. Numbers peaked during the removal of the weed mat at each site, varying from 26 to 94.31 to 16.76 NTU at Site 1, 17.16 to 84.75 to 12.33 NTU at Site 2 and 21 to 86.72 to 33.48 NTU at Site 3 (June to December 2007).



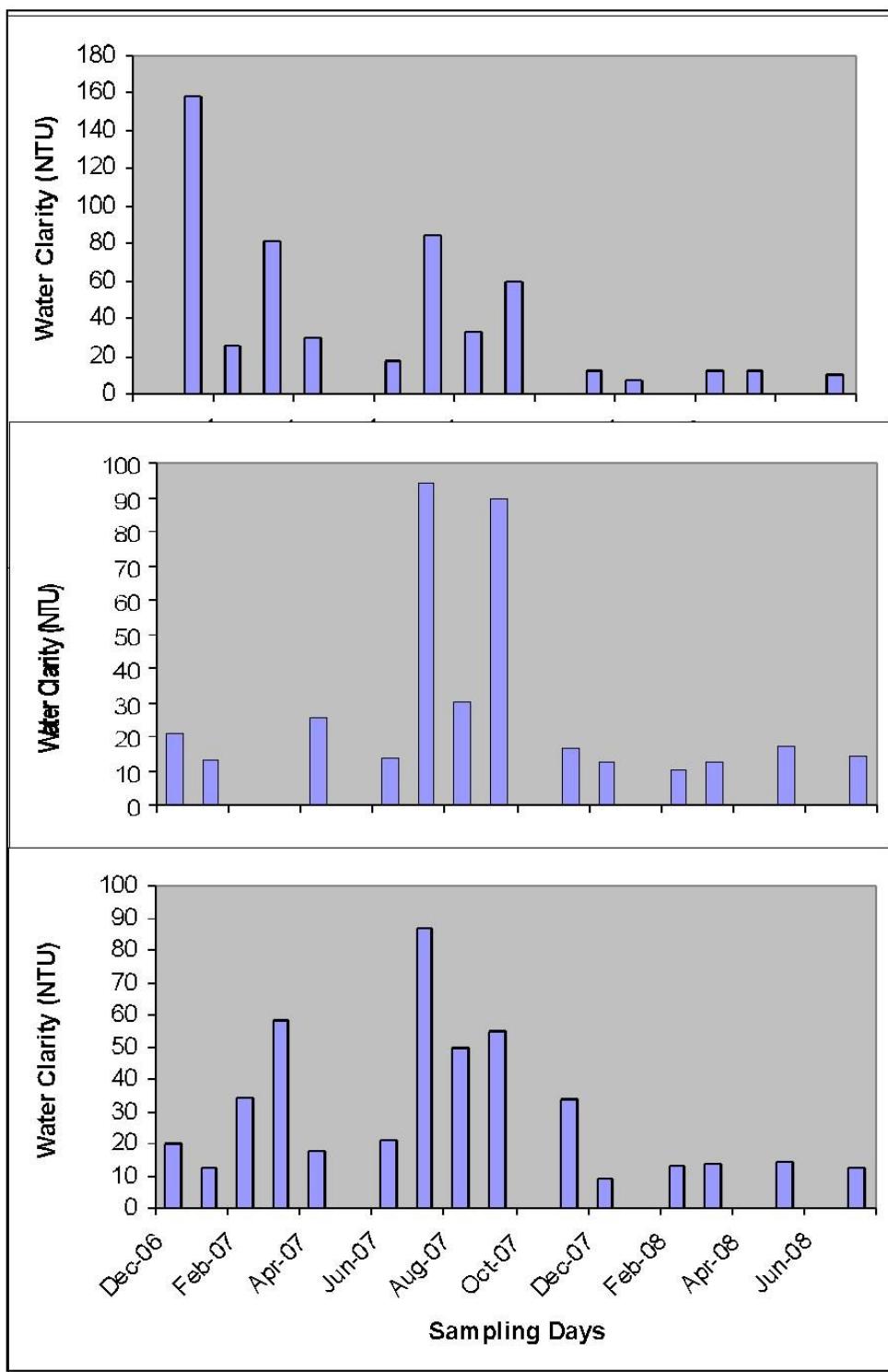
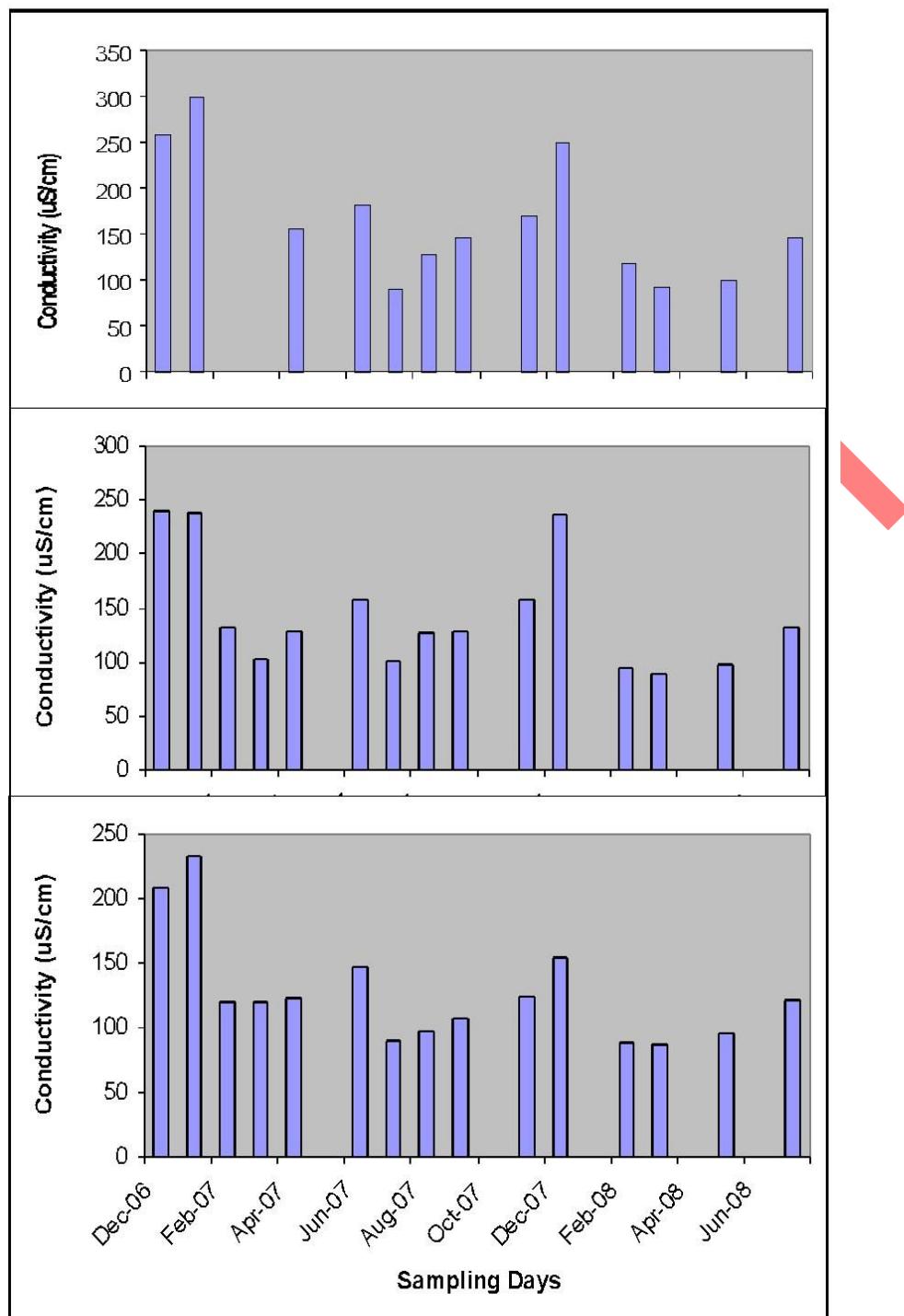


Figure #. pH and Water clarity (turbidity) levels taken at Sandringham Lagoon, Sites 1, 2 and 3 respectively

Conductivity varied at each site throughout the sampling period, each site showing a similar trend in results. The highest results peaked mostly before and during the rehabilitation of the lagoon. The conductivity levels were also increasing after the weed mat had been removed.

Phosphate levels showed varied results, due to a lack of information gathered. There was a general decreasing trend in levels at site 1, however site 2 and 3 did not vary greatly in levels.



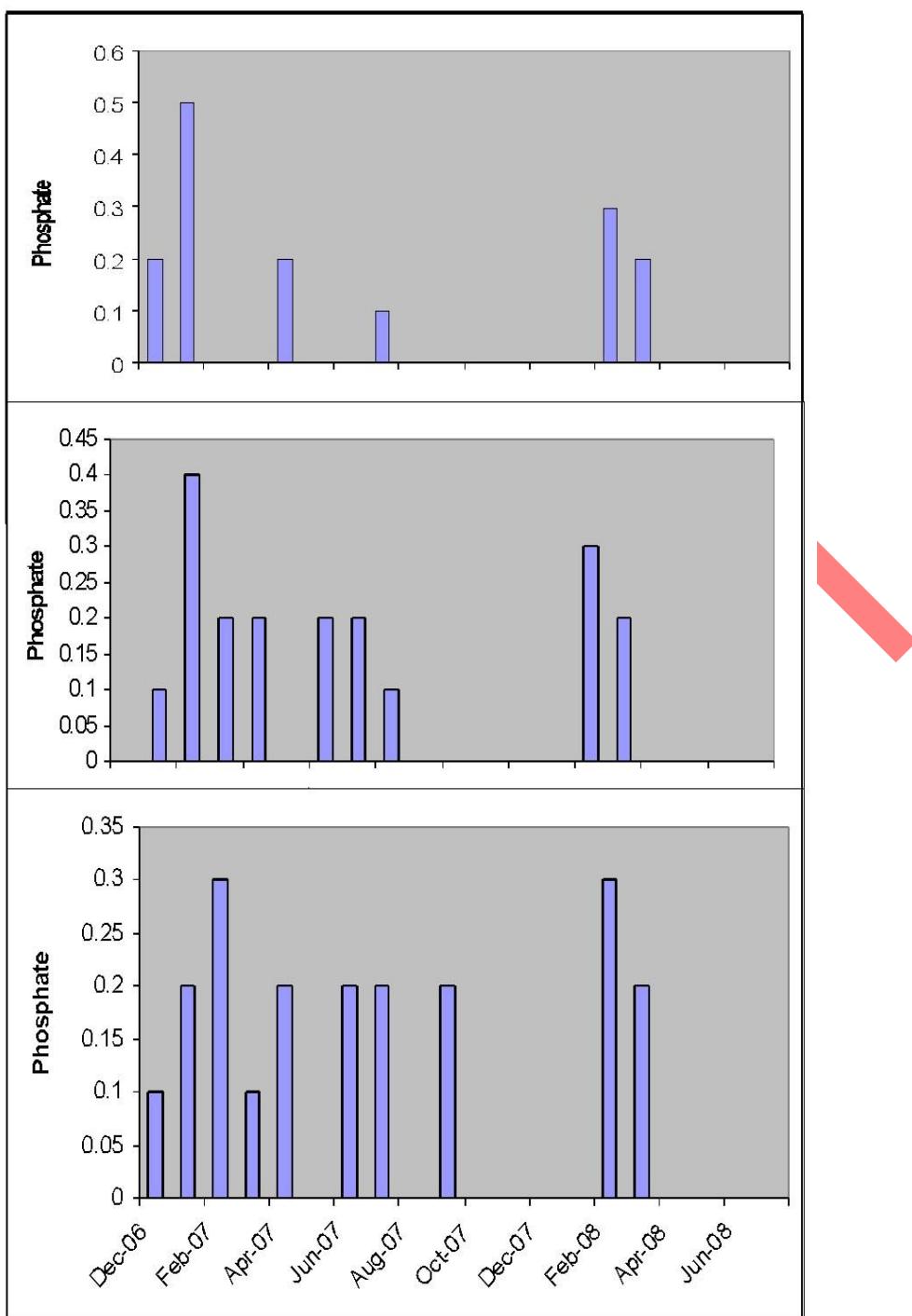
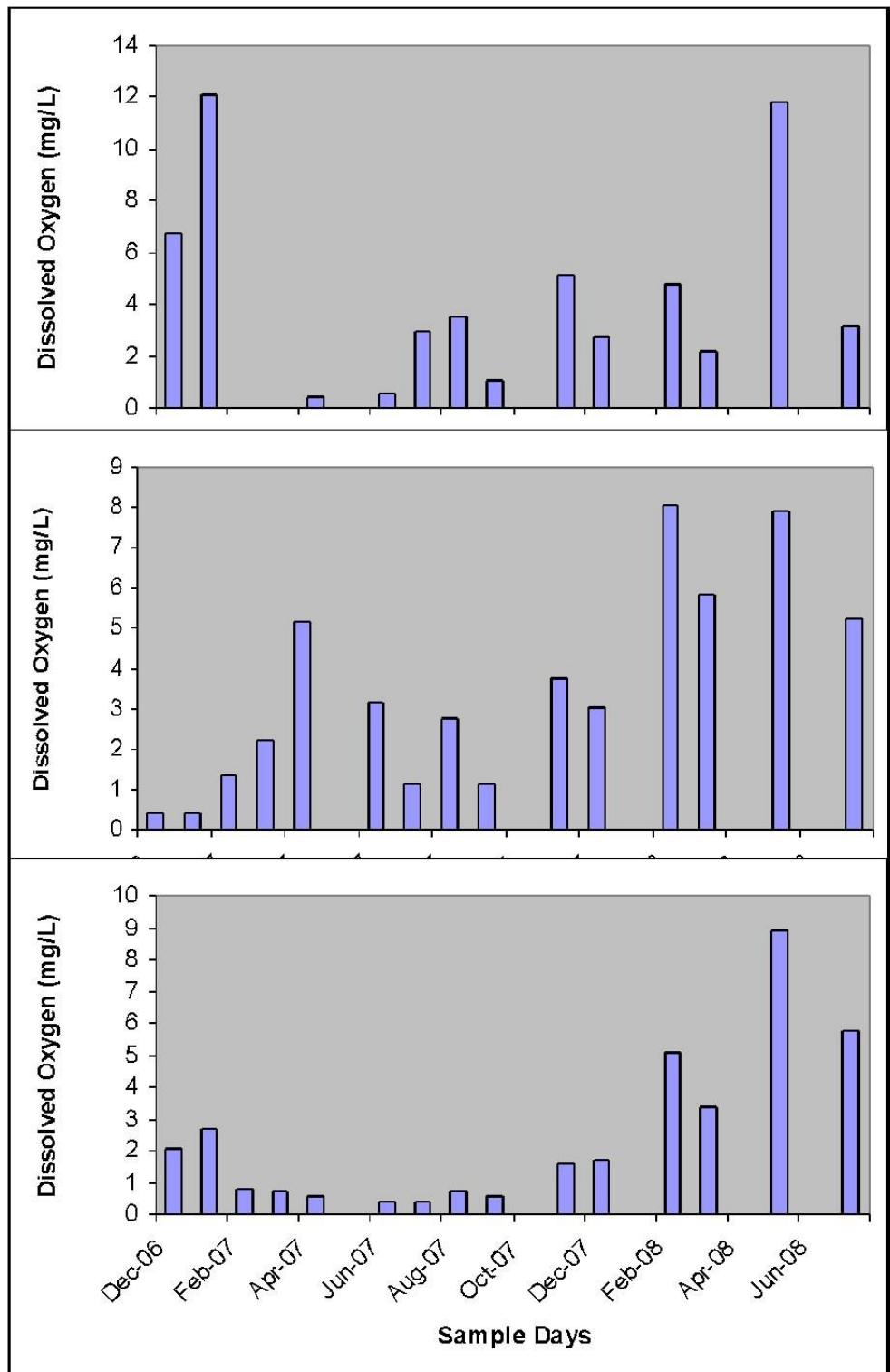


Figure #. Conductivity and Phosphate levels taken at Sandringham Lagoon, Sites 1, 2 and 3 respectively

Dissolved Oxygen levels differed between each site, site 1 (see figure #) had high levels in the first samples (6.78 and 12.1mg/L), the levels then dropped throughout June and July 2008, and then rising and falling over the continuing months, peaking in April 2008 (following the weed mat removal from the lagoon). However at both sites 2 and 3, (see figures # and #), the dissolved oxygen levels increased throughout the sampling period, peaking between February and June 2008, during the months following the majority of the weed mat removal.

Water temperature levels varied greatly throughout the sampling period, varying between 14.1oC and 32.9oC. This varying trend was noted at each site. Figure # shows the comparison between water quality, pH and dissolved oxygen throughout the sampling period at each of the three sites. These graphs indicate a positive correlation between water temperature and dissolved oxygen. Site 1 followed the trend, as Temperature increased so did the dissolved oxygen, and as the temperature dropped so did the Dissolved Oxygen. Site 2 also followed this trend – temperature and dissolved oxygen both increased and decreased in values together. Site 3 however only displayed this trend in the last few months between October 2007 and June 2008.

DRAFT



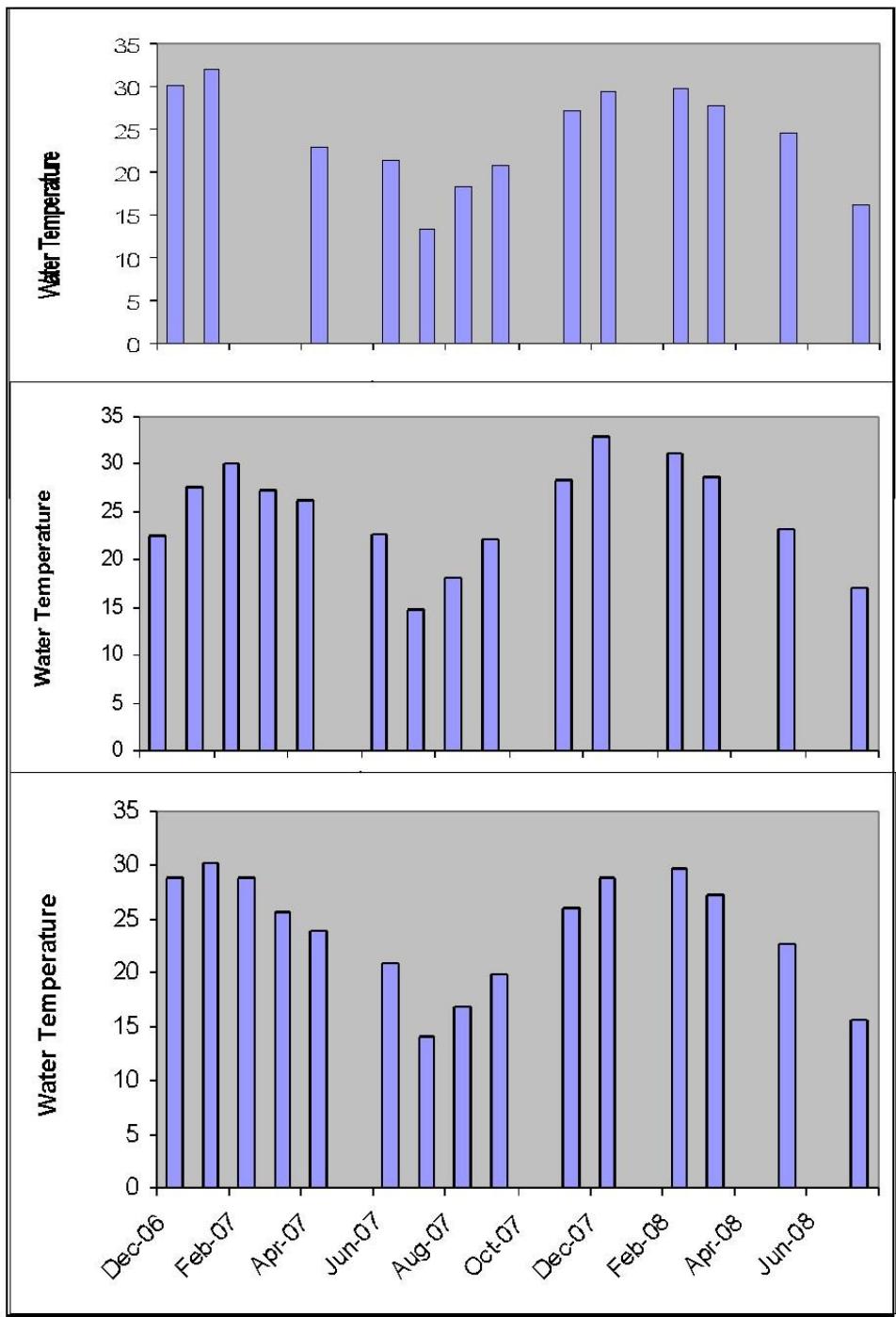


Figure #. Dissolved and Water Temperature levels taken at Sandringham Lagoon, Sites 1, 2 and 3 respectively

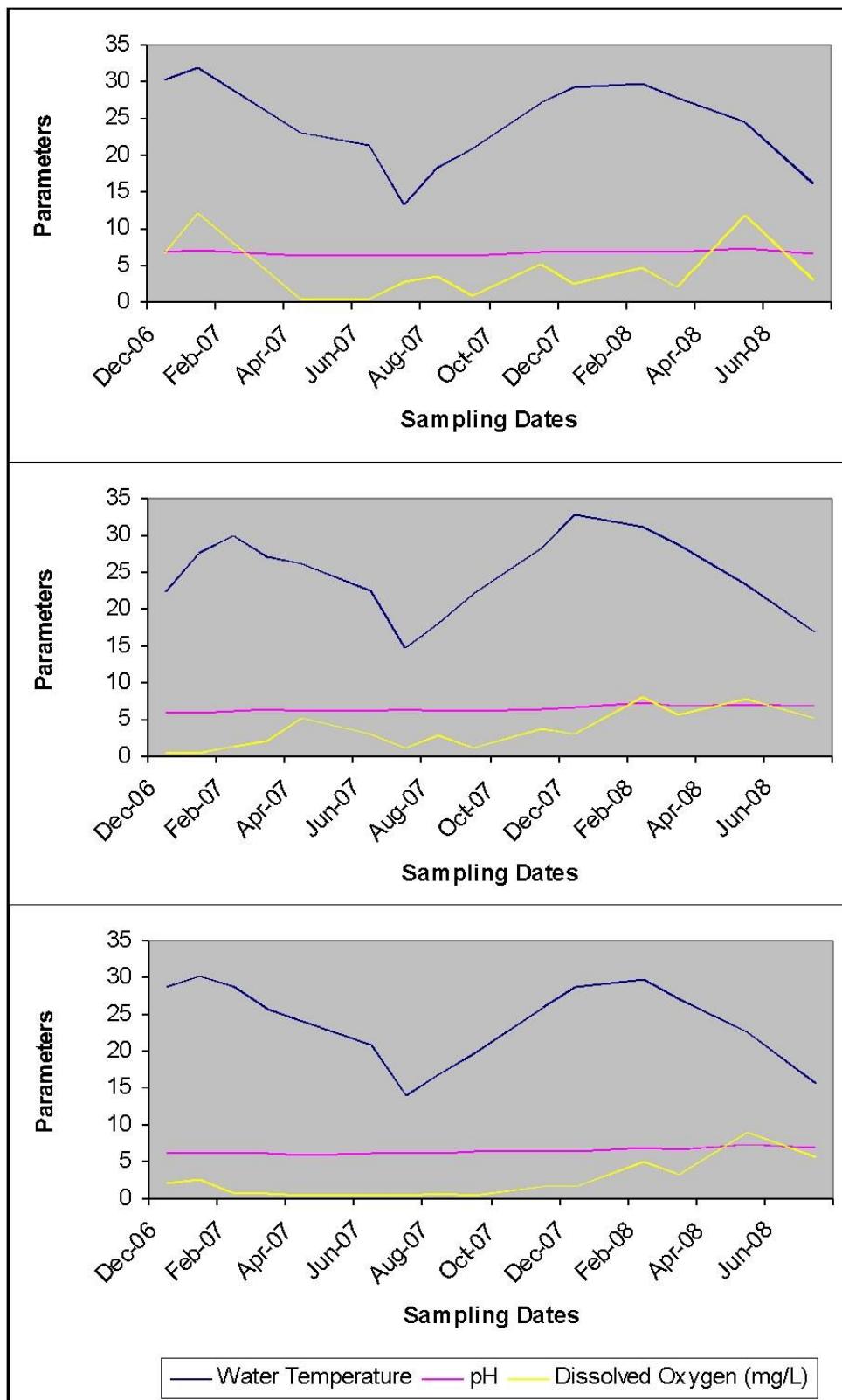


Figure #. Comparison between Water Temperature, pH and Dissolved Oxygen for Sites 1, 2 and 3 respectively.

Fishway Construction

One 30 metre long full width rock ramp was constructed from the causeway at the exit of the lagoon to the entrance to first constructed pond (for location see figure 11). This fishway (figures XX and XX) has not yet been sampled but initial indicators from the fish community sampling and observations indicate that the structure has had an influence on the increased fisheries community within Sandringham Lagoon.



Figure XX. The top section of the fishway on the exit of the culvert on Campbell's Ridge Road.

DRY



Figure XX. The bottom section of the fishway

Mechanical Removal of Weeds

The total volume of material removed from Sandringham Lagoon was 30,000 tonnes consisting of terrestrial grasses, ferns, water hyacinth, water lettuce, hymenocahne and melaluca trees. All material removed was dumped and treated repeatedly for regrowth. This mechanical removal cleared 80% of the lagoon of weeds.



Figure XX. After the removal of Water Lettuce and Water Hyacinth from the top end of Sandringham Lagoon.

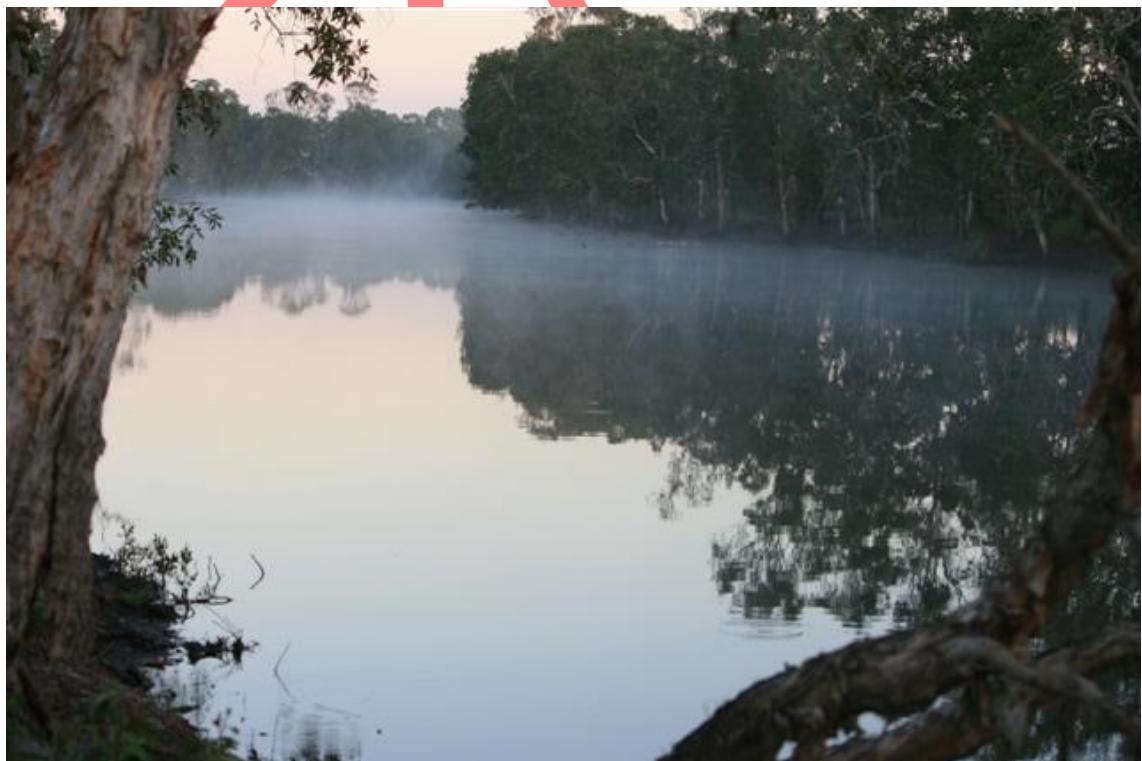


Figure XX. The middle of Sandringham Lagoon after the completion of mechanical removal of weeds.



Figure XX. A section of the cane drain linking Sandringham Lagoon to Sandringham Creek after cleaning with an excavator.

Weed Spraying

The spraying program used 45 litres of Roundup BioActive which proved to be an efficient killer of weed (figures XX and XX). The regrowth that occurred appeared from the understory of the dead weed and was easily dealt with on follow up sprays.



Figure XX. The results of spraying Roundup BioActive in the lower section of Sandringham Lagoon.

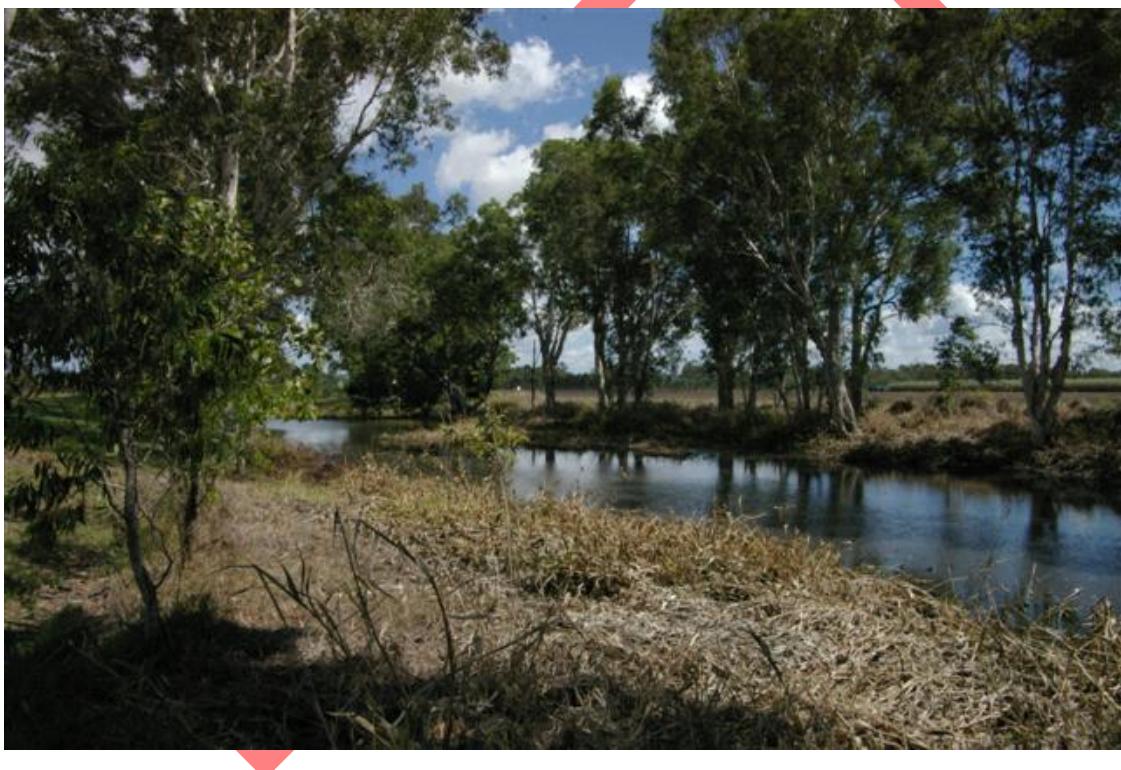


Figure XX. The lower section of Sandringham Lagoon after decomposition of weeds from spraying.

Sediment and Fish Refuge Ponds

Three sediment retention and fish refuge habitat ponds were created. The first pond, 2 metres deep and 180 m² in size, occurs immediately downstream of Sandringham Lagoon. It provides sediment deposition for material exiting the lagoon proper and fish refuge habitat for species caught after the last navigable flow exits the lagoon. The second pond, 2 metres deep and 200 m² in size, occurs mid way through the cane drain section. It provides sediment retention from drainage of the surrounding cane fields and fish habitat refuge for species caught in the drain after

the last navigatable flows have occurred. The third pond, 3 metres deep and 650 m² in size, occurs at the end of the cane drain section. It provides sediment retention from drainage of the surrounding cane fields and fish habitat refuge for species caught exiting Sandringham Creek into the cane drain after the last navigatable flows have occurred.



Figure XX. Pond 1 at the base of the fishway.

DF



Figure XX. Pond 2 in the middle section of the cane drain linking Sandringham Creek to Sandringham Lagoon.



Figure XX. Pond 3 immediately after completion of excavation and prior to revegetation.

Revegetation

The number of trees sourced for the revegetation of Sandringham Lagoon and creek did not meet the original number set out in the contract. 3640 trees out of the initial 5000 were sourced and the majority of those were provided by local suppliers. The main lagoon required 1710 plants, detention pond 1 and 2 together required 700 plants and detention pond 3 required 1230, (see table # for species and numbers). Mulch and stakes were also required to complete the project, 36 bales of sugarcane trash /mulch and 3640 bamboo stakes were used, the stakes were provided by a intra-state company and the mulch was provided by a local cane farmer.

Table #. Plant species used in Revegetation at Sandringham Lagoon

Plants	Lagoon	Pond 1&2	Pond 3
<i>Dianella sp</i> (Flax Lilly)	50		
<i>Acacia leptocarpa</i>	50		
<i>Eucalyptus tereicornis</i>	250	100	200
<i>Melaleuca leucandendra</i>	150	100	200
<i>Ficus racemosa</i>	20	50	80
<i>Dianella caerulea</i>		100	100
<i>Casuarina cunninghamiana</i>	100	100	100
<i>Lomandra hystrix</i>	100	100	150
<i>Juncus usitatus</i>		150	250
<i>Eucalyptus camaldulensis</i>			100
<i>Dianella caerulea</i>			50
<i>Syzygium australis</i>	200		
<i>Crinum pendunculatum</i> (Swamp lily)	10		
<i>Lophostemon suaveolens</i>	10		
<i>Terminalia sericocarpa</i>	100		
<i>Premna serratifolia</i>	50		
<i>Cryptocarya hypospodia</i>	20		
<i>Acemena clauiflorum</i>	50		
<i>Diplog oblovata??</i>	50		
<i>Argyrodendron spp</i> (tulip Oak)	80		

<i>Pittosporum venulosum</i>	60		
<i>Planchonia careya</i>	25		
<i>Pittosporum ferrugineum</i>	16		
<i>Euroschinus falcata</i>	80		
<i>Livistonia decipiens</i>	10		
<i>Mimusops elengi</i>	39		
<i>Alphitonia phoenicis</i>	50		
White beach	30		
<i>Commersonia bartramia</i> (Brown Kurrajong)	80		
<i>Dysoxylum gaudichaudianum</i> (Ivory mahogany)	30		



Figure XX. Revegetation on banks of pond 2 in the middle sections of the cane drain.

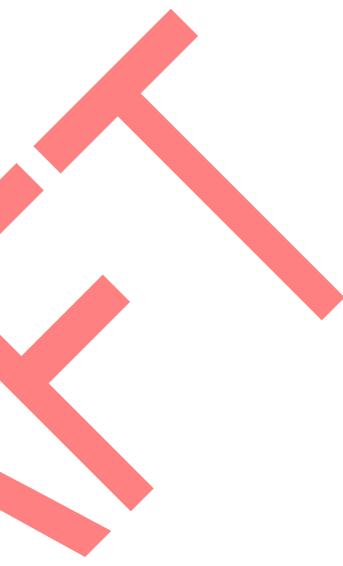


Figure XX. Revegetation on bank of pond 1 prior to mulching with cane trash.



Figure XX. Understory revegetation to increase competition for weed growth and increase the shading to further dampen weed growth.

Consultations and Public Education

The communication with the landholders surrounding Sandringham Lagoon and Creek system resulted in access at all times for all works. It further provided a positive environment to engage landholders to undertake the spraying post the major works being undertaken. This positive environment also developed relationships that resulted in landholders providing dumping points for the removed material and land adjacent to the lagoon that was used to construct the sediment and fish refuge ponds.

Consultations with XXXXXXXX, Mackay City Council, Conservation Volunteers Australia, Mackay Whitsundays Natural Resource Management Group and XXX resulted in quality input to the decisions made on species for revegetation and the process for the mechanical removal and spraying of weeds.

The public education undertaken provided quality information to interested parties about the significant damage that untreated weeds can have on an environment and how to manage those infestations. Two presentations were made to a total of 100 attendees on site and two further presentations were made to a total of 100 attendees off site.

Landholder Incentives

Ten landholders have been provided with 180 litres of Roundup BioActive and \$3700 of incentive funding to continue the follow up weed spraying program. All landholders in the project area have indicated that they intend to continue the follow up spraying at the conclusion of the incentive funding.

Discussion

Fish Community Sampling and Water Quality

Undertaking the Sandringham Lagoon project meant the complete rehabilitation of almost an entire system. Whilst split over two financial years, the initial project was to solely focus on the weed removal of the lagoon. From this bore the second project – to rehabilitate the banks of the lagoon as well as the adjoining creek.

The three detention ponds have already shown success with the large number of fish recorded after the completion of the rehabilitation. Almost 4000 fish were identified over 16 species of those the Empire Gudgeon was the most abundant. This species prefers habitat around fallen branches, snags and aquatic vegetation.

By removing the weed mat, water quality has increased significantly. Dissolved oxygen, water clarity and pH levels have all improved. A significant trend was shown between water temperature and Dissolved Oxygen. Through the sampling period the dissolved oxygen levels were more elevated during periods of higher water temperature. Higher water temperatures were noted during the hotter summer months and lower temperatures were noted during the winter months.

Water Clarity also differed with the removal of the weed mat, the increased in solutes during the removal period indicated that much of the trapped sediments in the weed mat were left in the water column. However the water clarity levels decreased significantly during January and February 2008. These two months saw heavy rain periods including the flooding of the Mackay region in February 2008. Much of this rain fall flushed out much of the solutes and reduced the water clarity levels. This trend was also noted prior to any rehabilitation being completed on the lagoon. December 2007 also saw heavy rain periods, which brought about a flushing of the system.

Conductivity varied greatly in levels over the entire sampling period, peaking in December 2006, February, June and December 2007 and July 2008. Many of these spikes in Conductivity have resulted because of rainfall periods. If the samples were taken on the beginning of a flow, then higher readings would be expected due to the movement of particulates through the water column. Lower readings for conductivity can be seen in February, April and July 2007 as well as in February, April and June 2008. Many of these drops were also a result of a rainfall period. If the samples were taken on the tail end of a flow then the lower readings would be expected due to the system having been flushed out. The lower readings indicate that the water is quite fresh and clear of particulates.

Due to the lack of information gathered for Phosphate samples, the results do not show much of a correlation. Initially the samples were spiked in February 2007, at the tail end of a flow then dropped and levelled out between March and July 2007 (all prior to the rehabilitation of the lagoon). However few phosphate samples were taken during and after the lagoon was rehabilitated. Those samples that were taken indicated a spike in levels over January and February at each site in 2008. This period was again at the end of a major flow period indicating that Phosphate levels were being brought in from the surrounding farms during the rainfall, then settling out in low flow periods.

The removal of the weed mat also brought about the increase in fish habitat. Prior to the weed mat removal, there were very few open areas of the lagoon. Due to this lack of open water and availability to the lagoon, only one site could be electrofished. This sample produced very little fish numbers, 23 individual fish over 3 different species were recorded. Although the numbers were small and the site availability limited, this first survey was able to indicate the potential for improvement. The most abundant species in this survey was the Eastern Rainbow Fish, which prefers a variety of different habitats including rivers, creeks, swamps, marshy lagoons, lakes and reservoirs. The size variations of this fish in this sample varied between 44mm and 66 mm, indicating they were adult fish.

During the removal of the weed mat and the rehabilitation of the lagoon, new areas of open water were made available and therefore 3 sites (over 6 shots) were electrofished in the lagoon and 2 sites (over 3 shots) were electrofished in an off site dam and stream (these overflow into the lagoon during high flow periods). From these sites, 396 fish over 11 species were recorded in the main lagoon and 228 fish over 10 species were recorded in the off site dam and stream. The most abundant species recorded in the main lagoon was the Empire Gudgeon, with 285 individual fish sited. This species prefers habitat around fallen branches, snags and submerged vegetation. The size variations noted through this survey, between 23mm and 85mm, which indicates a range of age classes.

In the dam and stream the most abundant species was the Empire Gudgeon and the Purple Spotted Gudgeon (60 and 61 individual fish respectively). The Purple

Spotted Gudgeon prefers slower flowing areas of rivers, creeks and billabongs and they are often found among vegetation on the rocky bottoms of riffle zones. The size variances were between 41mm and 101mm again indicating different age classes present. The size variances in the Empire Gudgeon in the stream and dam section varied between 30mm and 82mm (indicating a range of age classes).

After the complete removal of the weed mat, the entire lagoon was made available to electrofish. Six sites along the lagoon were sampled which resulted in 3992 individual fish over 16 different species recorded. The most abundant species was the Empire Gudgeon (a trend seen through the entire sampling period). The size classes seen in this species varied from 10mm to 75mm. This diverse range in sizes indicates that various age classes are present in the system. This intern means that by removing the weed mat and rehabilitating the lagoon, the system is able to provide suitable habitat (including improved water quality) to support the increased number of individuals and species within the lagoon.

During the rehabilitation of Sandringham Lagoon, there were two species noted but not recorded in the electrofishing sampling - these include Sea Mullet and Barramundi. These two particular species are of significant value to both recreational and commercial fisheries. By increasing the passage into the lagoon may new species are utilising the area. The juvenile barramundi was seen moving through the creek section just downstream of the causeway along Campbell's Ridge Road, and the sub-adult mullet was noted in the main body of the lagoon. By having both these species in the lagoon indicates that the environment is suitable to sustain a many number of fish, and is now acting as a nursery for many species away from most predators ensuring populations can be sustained and even increased.

Introduced species of freshwater fish were noted throughout the sampling period in Sandringham Lagoon. The Mosquito Fish, the Platy and the Guppy were all recorded, the most abundant was the Mosquito Fish (*Gambusia*). This species was found in high numbers during the weed mat removal and again in lower numbers after the weed mat had gone. The decrease in number (as in all the introduced fish) was brought about by the increase in water quality and the decrease in their habitat. The Mosquito fish prefer still waters in and around aquatic vegetation and in shallow areas of water bodies. It was noted that in the last round of electrofishing (after weed mat removal), that the majority of the Mosquito fish were caught around a small patch of hymenachne indicating there is a correlation between the pest weed and the pest fish.

The Platy is often found in creeks, drains, and swamps that slow water movements, warm water and are often found around weeds close to the edge of banks. Although the number of Platys only decreased by one fish, the catch rate was much less, decreasing from 0.191fish/minute to 0.1667 fish/minute. This decrease in catch rate indicates that the total number of this particular introduced species in the lagoon is much lower than it was during the weed mat removal. This decrease is again due to the loss in habitat (weeds removed) and the increase in water quality.

The guppy was only noted during the weed mat removal and only one individual fish was noted. Again this species prefers warm slow moving waters and is often found near aquatic vegetation.



Figure XX. A juvenile barramundi observed in the cane drain migrating upstream during the wet season flows of 2008.

Bird Observations

The large number of fish that have returned to the lagoon has initiated a return in many bird species. Whilst the lagoon has always sustained a number of birds, the number currently utilising the lagoon has increased significantly since the beginning of the project. There have also been increases in the number and diversity of species returning to the area. There were 4 significant species noted utilising the lagoon since the completion of the project they include: - the White-Bellied Sea-Eagle, the Little Eagle, the Brahminy Kite and the Lemon-Bellied Flycatcher.

The White-Bellied Sea-Eagle is a large predator that feeds on larger fish, indicating that there is significant food and habitat in the lagoon to sustain such a large bird.

The Little Eagle is a very rare species in the Mackay/Whitsunday region, 2 individuals were seen at the top end of the lagoon.

The Brahminy kite (Slater, 1994) is usually found along Coastal Mangrove and Estuarine areas, for this species to be seen over the lagoon again indicates that the lagoon is sustainable to many different species including those of different habitats

According to Slater, 1994 the Lemon Bellied Flycatchers lower limits is Bowen, however 7 were noted before, during and after the rehabilitation of Sandringham Lagoon.

These species are significant mostly because they are rarely seen in an environment like Sandringham Lagoon so to identify them in this region is rather special.

Not all the bird surveys could be conducted, although they were completed for much of 2007 due to other issues Ms Marge Andrews could only conduct them when she was available which meant that many of the months in early to mid 2008 were not sampled. This did not negatively affect the results, merely reducing comparison to that time period of the previous year's results.

Although there was an increase in bird numbers during and after the project was completed, there were some species that did not return to the region. The 14 species only identified prior to the rehabilitation of Sandringham Lagoon include: - The Comb-crested Jacana, The Australiasian Grebe, the Magpie Goose, The Swamp Harrier, the Bush Hen, the Buff-banded Rail, the Pied Imperial Pigeon, Horsefield's Bronze Cuckoo, Gould's Bronze Cuckoo, the Shining Bronze Cuckoo, The Fairy Gerygone, The White-Winged Triller and the Little Shrike-Thrush. The majority of these species did not return to the lagoon as most of their

habitat had been removed. Although the purpose of the project was to rehabilitate the area and increase species potential, the weed mat was not natural and those species mentioned above would not have originally been found around the lagoon before it was infested with weeds.

As these species have not returned to the area, even though they are all common to the Mackay/Whitsunday region, many of these species are migratory there is still the potential of them returning to the lagoon. Although many did lose parts of their usual habitat – floating vegetation, emergent reeds, wet grasslands and marshy vegetation, and the conversion from open grassy woodland to open water wetland. Some are quite rare like the Pied Imperial Pigeon, which was over culled in the 19th century as it was thought to be a pest. And the Little Bronze Cuckoo whose lower limit is actually Bowen only uses the White-Throated Warbler's nest to lay its eggs. The Gould's Bronze Cuckoo also uses a specific bird to lay their eggs in – the Large-Billed Gerygone. Mackay is the lower limit in this species range, usually seen much further north. The Fairy Gerygone is commonly found in mangrove forests, so for this species to be found in around the lagoon (prior to rehabilitation) is quite uncommon.

Even though many species did not return to the lagoon area, others were only sited after the lagoon had been restored. The following 12 species were those only recorded after rehabilitation: - Richard's pipit, the Scarlet Honeyeater, The Restless Flycatcher, Lewin's Honeyeater, Latham's Snipe, The Azure Kingfisher, the Little Eagle, the Brahminy Kite, the Australian Pelican, the Royal Spoonbill and the Black-necked Stork.

For many of these birds, new habitat had been made available to them. Most of these species prefer woodlands near waterways. Some however are usually found in completely different environments, such as the Brahminy Kite, which is usually found around Mangroves along the coast. Then there is the Little Eagle, which is a very rare species for the Mackay region, so to have recorded 2 individual birds on the lagoon indicates that the work completed has enhanced the potential of the system significantly.

Fishway Construction

The full width rock ramp fishway was chosen as the most appropriate solution to overcoming the flow velocities in the culvert and the drop on the downstream side. The fishway will be most effective in periods of low to medium flow.

Mechanical Removal of Weeds

Initially these projects called for a spray based program for the removal of weeds. After further analysis of the weed based problem it was decided that spraying the weed mat would cause a large amount of surface based rotting vegetation in which new growth would develop. The risk associated with the weed mat sinking and causing further water quality problems was also high. The only other solution available was to mechanically remove as much of the weed mat as possible.

Lessons learnt from the Lagoon Creek project (GBR Coastal Wetlands Protection Program – Pilot Program) in North Queensland showed that the use of a weed harvester in conjunction with an excavator with a weed rake would provide the most efficient removal (pers comms Dave Hudson, Conservation Volunteers Australia and Vern Viech, Australian Centre for Tropical Freshwater Research). Consultations with the excavator contractor resulted in the development of an extension arm to improve the reach of the machine.

Some of the issues encountered during the removal of weeds were;

- Manual cutting of sections and pulling of these sections to the bank proved to be very time and energy inefficient and would only work where large debri was not present,
- Submerged objects such as fallen trees (figure XX) caused damage to equipment or jammed large sections of the weed mat and took considerable time to remove,
- The weed mat was up to one metre thick in places and the weed harvester was very slow in being able to cut tracks through,
- The volume of material removed from the lagoon (30,000 tonnes) proved to be an expensive and time consuming exercise in transport to the dump sites (figure XX),
- Seasonal flooding moved large sections of the weed mat (as it was now not attached to banks) and caused some blockages which required urgent removal, and
- Unseasonal rain in June 2007 slowed the progress significantly due to boggy ground.

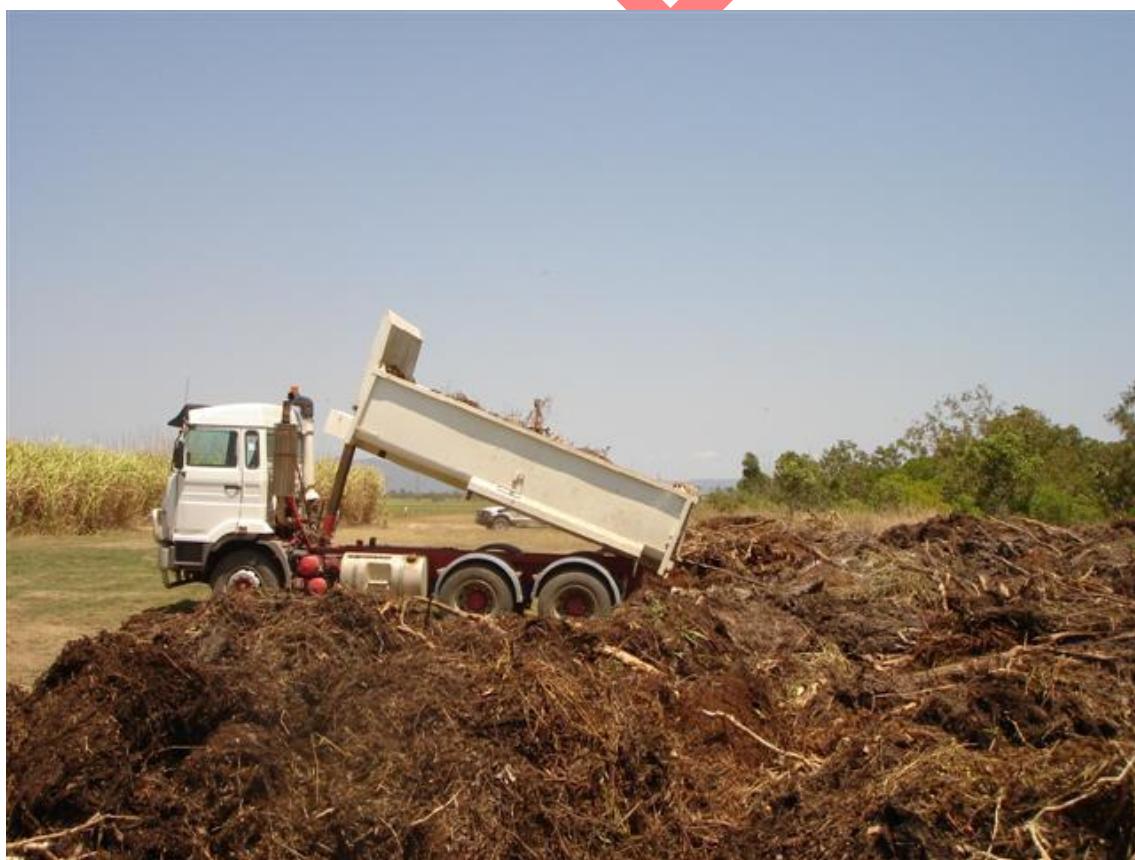


Figure XX. Some of the 30,000 tonnes of material.



Figure XX. The excavator removing a stand of melaluca's growing hydroponically on a remaining section of weed mat.



Figure XX. Large logs entangled in the weed mat became an obstacle to removal of many sections of the mat in the middle reaches of Sandringham Lagoon.

Mechanical removal of weeds proved to be the only viable option for removal of large infestations of weeds to prevent further contamination of the water course with rotting vegetation or significant regrowth.

Weed Spraying

The spraying of weeds was critical to the success of the project to remove infestations that could not be removed by mechanical means and to ensure any regrowth was managed. Originally the project called for spraying of the weed only using the trialled method of spraying in a previous DNR&W?? project which was to spray 1/3rd of the weed mat and allow a period of 3 months for decomposition and then spray the next 1/3rd. This method of spraying would not have been successful on such a large scale as the mat would not have decomposed in that time and significant regrowth may have occurred in the time before follow up spraying could have occurred.

The most effective spraying initially was that undertaken using the 200 litre tank unit as it provided a better “drenching” of the growth as well as covering larger areas quickly. Spraying with this unit was restricted to low wind days and consequently some spraying was delayed due to the concern of “over spray” reaching productive cattle pastures or cane production.

The back pack and hand held units are most effective for small outbreaks of weeds or for sensitive areas around revegetation where the spray jet can be more effectively handled and used under the revegetation canopy.

Sediment and Fish Refuge Ponds

The constructed ponds have only been constructed to a depth of 2 metres for ponds 1 & 2 and 3 metres for pond 3 due to striking sand. A depth of 4 metres is desirable to provide deeper water so less weed growth can occur. These ponds provide a key element to the management of sediments and nutrients and can provide refuge habitat for fish species on their migration runs from estuary to freshwater habitats.

Revegetation

Of the original 5000 plants quoted in the contract, 3640 plants could be sourced. These plants were sourced from both local and intra-state suppliers. On a recent inspection of the lagoon (approximately 4 months after the revegetation was completed) the majority of the plants looked healthy and of the 3640 trees planted a success rate of approximately 85% has been maintained.

Consultations and Public Education

Communication with landholders and stakeholders proved to be the key to the successful completion of the project. Landholders were able to provide the access required, dump sites for the excavated material and follow up spraying. One landholder, Stuart Herman, along with the lessees of the land, Colin and Ian Dunn, gave up productive cane land for the construction of two of the sediment and fish refuge ponds. Another landholder Bruce Davies allowed access to construct the third sediment and fish refuge pond.

The input from XXX etc provided the expertise required to ensure that the revegetation undertaken was consistent with the species from the bio region.

Landholder Incentives

The landholder incentives provided a catalyst for creating the habits for continued follow up spraying. Whilst the cost of the chemical and labour recompense was relatively low in the context of the project it was a vital component to help put landholders on side and to obtaining general agreement to continue the spraying program after the incentives had concluded as most of the "hard work" had already been done and the problem no longer looked insurmountable.

Conclusions

One of the key drivers of success for this project has been the desire to achieve all outcomes by the project managers. There have been many obstacles during the course of the project such as weather and the availability of equipment and personnel however all obstacles were overcome and the Sandringham system is once again a productive system. The major improvements in water quality and habitat has led to a large increase in fish species utilising the system has then been reflected in the increase the bird counts. This shows a significant improvement in the ecological value of the Sandringham system. The continued control of weed outbreaks by landholders will keep the system from returning to its degraded state. The fishway will assist with migration of catadromous species to further enhance the fish community within Sandringham Lagoon. The sediment retention ponds will assist with the deposition of sediment from surrounding agricultural land before entering Sandringham Bay as well as provide refuge habitat for migrating fish (figure xx) when the system ceases to flow.



Figure XX. Empire Gudgeons migrating upstream during the 2008 wet season flows in the Sandringham system.

References

Acknowledgements

We wish to acknowledge the support provided by all the project funders who were flexible in allowing changes to contracts to reflect the difficulties uncovered as the project progressed.

DRAFT

Appendix 1 - Fish Species Information

Diadromous species

Long-finned eel

Anguilla reinhardtii (Steindachner, 1867)



Photograph: Gunther Schmida

Maximum Size: 2.0 m

Biology: The long-finned eel is a catadromous species, with the sub-adults spending the majority of their lives in fresh or brackish water. Breeding occurs in the Coral Sea, with juveniles undertaking extensive migrations throughout coastal drainages. A demersal species which occurs in coastal lagoons, rivers, streams, lakes, swamps and farm dams. Mainly a nocturnal feeder, long-finned eels feed on small water birds, fish, crustaceans, insects, molluscs and some plant material.

Distribution: This species is widespread, commonly found along the East Coast of Australia from Northern Cape York Peninsula to Melbourne (Vic), and the northern and eastern coast of Tasmania. Also occurs in New Caledonia, New Guinea and Lord Howe Island.

Favoured Habitats: Adults prefer riverine habitats, while juveniles are found abundantly in riffle zones.

Migratory Requirements: Adults require unrestricted downstream access, this can be affected by hydroelectric systems. Elvers require upstream access, especially during the wet season.

Population Status: Populations have declined in areas where barriers to migration are present and where commercial fishing pressure is high.

Potential Threats: Barriers to migration, destruction of habitat, commercial fishing.

Conservation Status: Not listed.

References: McDowall and Beumer 1980, Merrick and Schmida 1984, Marsden 2001, Allen et al. 2002.

Swamp Eel

Ophisternon gutturale (Richardson, 1845; McClelland, 1845)



Maximum Size: 600 mm

Biology: Swamp Eel's are cryptic, nocturnally active species that burrow in bottom sediments. They are usually found in fresh and brackish waters and are capable of surviving short periods out of water. There is no published information on the diet of *Ophisternon spp.* in Australia.

Distribution: Lower reaches of coastal streams in the Gulf of Carpentaria and Timor Sea drainage division, widespread in the wet tropics region. Recorded also from small streams near Cardwall and from the Fitzroy River (Qld).

favoured Habitats: Soft bottom sediments in well-vegetated backwaters of brackish estuaries and nearby swamps. Found in both brackish water and lower freshwater reaches of rivers.

Migratory Requirements: Little information is known of the movement of swamp eels, but greater numbers have been noted during years with good rainfall. Herbert *et al.* reported the presence of swamp eels in a small fishway below a road crossing near Weipa but does not state whether they were ascending or descending.

Population Status: The population status of this species is unknown and requires further study.

Potential Threats: Until a better picture of the taxonomic identity, indigenous status, distribution and biology of these species is assembled, it is difficult to determine what threats may exist.

Conservation Status: Non-Threatened

References: Pusey *et al.* 2004, Allen *et al* 2002, Herbert and Peeters 1995

Empire gudgeon

Hypseleotris compressa (Krefft, 1864)



Photograph: Gunther Schmida

Maximum Size: 100 mm

Biology: Empire gudgeons are common in the lower reaches of river systems where they are found in both still and flowing waters. Breeding occurs during the warmer months in freshwater reaches where the male establishes a breeding territory and displays its vibrant colours in order to attract a mate. Juveniles may be swept downstream during high flows, as large numbers of these are recorded moving upstream in the wet season. Empire gudgeons feed on small fish, aquatic invertebrates, insects, and plant material.

Distribution: This species is found commonly in the drainages of Pilbara region (WA) and north from the Kimberly region (WA) around the north coast of Australia to the Towamba River (NSW).

Favoured Habitats: The empire gudgeon takes refuge around fallen branches and aquatic vegetation.

Migratory Requirements: Large migrations of adult fish occur during the wet season, while juvenile and sub-adult fish undertake upstream migrations whenever flow is available, but particularly on large flow events.

Population Status: There is no information about population changes for this species, however is likely to have undergone reduction due to extensive habitat modification and barriers to migration.

Potential Threats: Barriers to migration, destruction of habitat and poor water quality.

Conservation Status: Not Listed.

References: Merrick and Schmida 1984, Allen *et al.* 2002, Marsden *et al.* 2003

Sea mullet (striped mullet)

Mugil cephalus (Linnaeus, 1758)



Photograph: Gunther Schmider

Maximum Size: 750 mm

Biology: Sea mullet are primarily a marine species, however, they commonly penetrate considerable distances into freshwater streams. Sea mullet feed on algae, detritus and benthic invertebrates and are generally found in habitats with suitable substrate for foraging.

Distribution: This species is distributed worldwide in temperate and tropical seas and is found in coastal streams all around Australia. They are generally more common in temperate waters.

Favoured Habitats: Commonly found over soft substrates that are suitable for foraging such as sand and mud.

Migratory Requirements: They are considered to be an amphidromous species that penetrates well upstream in many coastal catchments. Sea mullet migrate downstream en masse during autumn in preparation for spawning at sea in the winter months, after which, primarily juveniles return upstream during the warmer months whilst most adults remain at sea.

Population Status: Barriers to migration have led to significant changes to freshwater populations of sea mullet, with even small barriers greatly affecting numbers. In the Pioneer River, significant mullet runs were recorded as far upstream as Finch Hatton prior to the construction of three weirs within the system. Sea mullet are no longer recorded upstream of Dumbleton Weir in the lower reaches of the system. In systems with few barriers, numbers of sea mullet appear to be stable, despite there being little information available from these waterways.

Potential Threats: Barriers to migration, destruction of habitat, poor water quality and commercial fishing.

Conservation Status: Not listed.

References: Merrick and Schmida 1984, McGill and Marsden 2000, Allen *et al.* 2002.

Barramundi

Lates calcarifer (Bloch, 1790)



Photograph: Gunther Schmida

Maximum Size: 1.8 m

Biology: Barramundi are a large (1.8 m max) carnivorous species that feed on a wide range of fish and crustaceans. They are unusual as all smaller fish are male and larger fish are generally female. Males undergo a sex change at around 4-5 years of age, forming the female population. Breeding occurs in the warmer months with an early peak for estuary based fish and a later peak for fish from fresh waters, these fish rely on wet season floods to migrate downstream to estuarine spawning grounds. There are several genetic stocks of barramundi in different geographical regions throughout Australia. Barramundi are widely distributed through river systems, with juveniles of this species found in the lower reaches of freshwater streams and wetlands, as well as in upper tidal reaches of estuarine systems. Sub-adult and adult fish are found up to 300km from estuarine areas in large freshwater streams, although a proportion of the population do not leave estuarine waters. Large adults who have spawned remain in estuarine and near shore areas.

Distribution: The distribution of this species is widespread along the north coast of Australia, from Shark Bay (WA) to the Mary River (Qld), it is also found throughout tropical areas of the Indo-West Pacific Region from the Persian Gulf to Japan, New Guinea and Australia.

Favoured Habitats: Barramundi inhabit a wide range of habitats within rivers, but are generally found around logs, aquatic macrophytes, mangrove roots, rocks and overhanging vegetation.

Migratory Requirements: Barramundi are a catadromous species whose movements are stimulated by the onset of the wet season. Juveniles migrate upstream from spawning grounds at the mouth of rivers into small lowland freshwater creeks and wetlands where they remain for approximately 12 months. As sub adults, they then undertake extensive upstream migrations in larger creeks and rivers and may penetrate up to 300 km inland. They remain in these habitats for a number of years before migrating downstream to spawn as adults. After spawning adults generally remain in estuarine areas and do not return to freshwater.



A migrating sub-adult barramundi captured below a barrier.

Population Status: Recreational fishermen report declines in the abundance of this species, while commercial catches have remained static over the last 20 years. In areas where barriers to migration are present this species has become extinct upstream of the barrier due to the requirement of the species to spawn in saltwater.

Potential Threats: Barriers to migration, destruction of habitat, poor water quality, commercial and recreational fishing.

Conservation Status: Not listed.

References: Merrick and Schmida 1984, Allen *et al.* 2002.

Tarpon (ox-eye herring)

Megalops cyprinoids (Broussonet, 1782)



Photograph: Gunther Schmida

Maximum size: 1.5 m

Biology: A predatory species, the oxeye herring diet includes small fish, crustaceans and insects. This species is tolerant of poor water quality and is known to breathe air, rising regularly to the surface to do so. Adults breed and remain offshore, while juveniles commonly migrate into freshwater and lower estuarine habitat.

Distribution: The oxeye herring is commonly found along the eastern and northern coasts of Australia. This species has a very wide distribution in tropical waters from East Africa to Tahiti.

Favoured Habitats: Oxeye herring occur in river mouths, inner bays, mangrove forests, rivers, lagoons, lakes, and swampy backwaters.

Migratory Requirements: Migration is not considered essential for species survival. Juveniles regularly captured migrating upstream during fishway monitoring. It is considered that juveniles utilise freshwater habitats as nursery areas.

Population Status: There is little evidence of change in abundance or distribution of this species, although it is no longer found above several barriers.

Potential Threats: Barriers to migration, destruction of habitat and recreational fishing pressure.

Conservation Status: Not listed.

References: Allen 1991, Kuiter and Tonozuka 2001, Allen *et al.* 2002, Coates, 1987.

Agassiz's chanda perch (agassiz's glassfish, perchlet)

Ambassis agassiz (Steindachner, 1867)



Photograph: Gunther Schmida

Maximum Size: 75 mm

Biology: This species inhabits a wide variety of habitats, including rivers, creeks, ponds, reservoirs, and swamps. Generally found close to aquatic vegetation. Agassiz's chanda perch feed on insects and small crustaceans. It is believed that breeding is stimulated by the onset of monsoonal spring rains, as it is with their close relative *A. agrammus*. The migratory needs of this species are not well-known, though it is thought that dispersal migrations occur during flow events.

Distribution: This species is distributed from the Murray-Darling system through to the coastal waterways of New South Wales and Queensland.

Favoured Habitats: This species inhabits a wide variety of habitats, including rivers, creeks, ponds, reservoirs, and swamps, but always found close to aquatic vegetation.

Migratory Requirements:

- **Life stages:** Migrates upstream for dispersal reasons, reported to move through fishways with greater successes in adults than in juveniles. Possible displacement migrations in juveniles.
- **Flow related migrations:** migration can occur on a number of different flows, but migration usually occurs because of an increase in flows.
- **Season related migrations:** Most movement occurs during late autumn/spring.

Population Status: There is no information about population changes for this species, however it is likely to have undergone reduction due to extensive habitat modification.

Potential Threats: Barriers to migration, destruction of habitat, poor water quality.

Conservation Status: Not listed.

References: Merrick and Schmida 1984, Allen *et al.* 2002

Fly-specked hardyhead

Craterocephalus stercusmuscarum ste. (Gunther, 1867)



Photograph: Gunther Schmida

Maximum Size: 70 mm

Biology: The fly-specked hardyhead is commonly found in small shoals, often mixed with other rainbowfish species. They generally inhabit still or slow-flowing waters of rivers, streams, lakes, ponds and reservoirs around aquatic vegetation, but can also be found in fast-flowing creeks. Fly-specked hardyhead feed on a variety of small insects and macroinvertebrates along with submerged vegetative matter. Breeding occurs in spring and summer, with numbers increasing at this time, before waning into the winter months.

Distribution: There are two subspecies *C. stercusmuscarum stercusmuscarum* and *C. stercusmuscarum fulvus* with the latter being found in the Murray-Darling system as well as the Mary and Brisbane Rivers. *C. s. stercusmuscarum* is found in the coastal drainages of eastern Queensland including Fraser Island, around to the Timor Sea drainages of the Northern Territory.

Favoured Habitats: Found around the inflowing waters of pools and around aquatic vegetation.

Migratory Requirements:

- **Life Stages:** Likely to migrate all year round but mostly during high flow times. Maturity is reached at 1 year at approx 27-29 mm. Completes its life cycle in freshwater, migrates upstream to spawn.
- **Flow related migration:** Has been recorded (mostly adults) migrating in small streams around Mackay in moderate numbers during flow events
- **Season related migration:** Fly-specked hardyhead's undertake spawning migrations in the wet season in late spring and summer.

Population Status: This species is common throughout its range, can be locally abundant when conditions are suitable. There is no information about population changes for this species.

Potential Threats: Barriers to migration, destruction of habitat, poor water quality.

Conservation Status: Not listed.

References: Merrick and Schmida 1984, Allen *et al.* 2002, Marsden *et al.* 2003, Milton and Arthington 1983.

Snakehead gudgeon

Giurus margaritacea



Photograph: Gunther Schmida

Maximum Size: 400 mm

Biology: This large gudgeon species feeds predominantly on fishes, insects and crustaceans. It lives amongst dense aquatic vegetation or roots from where it launches ambushes on passing prey. Snakehead gudgeons breed in the wet season, possibly responding to flood pulses. They have been observed spawning in shallow water over flooded grasses just upstream of tidal influence. The larvae appear to be transported downstream into estuarine waters. When juveniles move back upstream into freshwater is not known as this species has not previously been recorded in fishway sampling.

Distribution: Found along the northern eastern coast of Australia from Kimbolton Spring (WA) to Maryborough (Qld). Also found in a wide area of the Indo-West Pacific from Madagascar to New Guinea.

Favoured Habitats: Found in lower reaches of small streams usually captured adjacent to submerged roots or other emergent vegetation.

Migratory Requirements: Migratory habits not known, has been recorded moving upstream into the lagoon at Mackay Botanical gardens in a spawning condition on high flows. Larvae also thought to need saltwater for survival, so may require free passage upstream and downstream for displaced juveniles, more study required to determine life cycle of this species

Population Status: The species is commonly found within its range and there is no evidence of change in the abundance of this species in the Mackay Whitsunday Region.

Potential Threats: Barriers to migration, destruction of habitat and poor water quality.

Conservation Status: Not listed.

References: Merrick and Schmida 1984, Allen *et al.* 2002, Marsden *et al.* 2003.

Midgley's carp gudgeon

Hypseleotris species 1



Photograph: Gunther Schmida

Maximum Size: 40 mm

Biology: A small gudgeon species that is common around aquatic vegetation, Midgely's carp gudgeon feeds on insects, microcrustaceans and plants material. Breeding occurs during the warmer months when water temperature rises above 22°C. Eggs are deposited close to the surface in aquatic vegetation, with the males guarding the eggs until hatching. Due to the location of egg deposition close to the water surface, eggs are vulnerable to rapid drops in water levels. River regulation may therefore impact on the survival rates of eggs.

Distribution: Commonly found in the northern Murray-Darling basin, Midgely's carp gudgeon can also be found along the eastern coastal drainages of the Tully and Brisbane Rivers (Qld).

Favoured Habitats: This species shelters around aquatic vegetation, fallen branches overhanging rocks and tree roots in streams and ponds.

Migratory Requirements:

- **Life Stages:** Reproductively they are active during late winter to early autumn, spawning occurs between winter and summer.
- **Flow related migration:** Frequently recorded in fishways in the Mackay/Whitsunday region. There is possible upstream migration after displacement from a flow event. They have been recorded from the Mary River congregating immediately downstream of small obstructions to movement (e.g. road culverts) and immediately after an increase in discharge.
- **Season related migration:** Displacement migration upstream occurs during the wet season.

Population Status: There is no information about population changes for this species, however may have undergone reduction due to extensive habitat modification and river regulation.

Potential Threats: Barriers to migration, destruction of habitat and poor water quality.

Conservation Status: Not listed.

References: Merrick and Schmida 1984, Allen *et al.* 2002, Marsden *et al.* 2003.

Spangled perch

Leiopotherapon unicolor (Gunther, 1859)



Photograph: Gunther Schmida

Maximum Size: 300 mm

Biology: Spangled perch are found throughout rivers systems from the headwaters to estuarine areas, being more common in upper reaches. This species is believed to survive drought situations by aestivating in wet mud or under moist litter on the bottom of ephemeral waterholes. The spangled perch feeds on insects, crustaceans and small fish. Spangled perch undertake extensive dispersal migrations whenever flow is available and have even been recorded moving across flooded land to reach isolated waterholes (Kennard 1995).

Distribution: This species is the most widespread freshwater native fish of Australia, occurring in systems north of the Greenough River (WA) through the top end and down to the Hunter River (NSW). This species also inhabits the northern section of the Murray-Darling system and inland in the Lake Eyre/Bulloo-Bancannia drainage systems.

Favoured Habitats: Spangled perch occupy a variety of habitats including pools and riffles and even isolated bore drains.

Migratory Requirements

- **Life Stages:** They are a very capable migratory species, passing barriers that most other species are unable to negotiate. They were found to be one of only three species that were able to ascend the pool and weir fishway on Marian Weir in the Pioneer River, this fishway had drops of over 300 mm between pools that prevented other species from ascending. Adult Spangled perch migrate upstream. Adult and juvenile spangled perch undertake lateral migratory movements from dry season refuges to floodplain habitats.
- **Flow Related Migrations:** Adult Spangled perch migrate upstream to spawn during flow events. Kennard (1995) documented lateral movement of spangled perch into floodplain lagoons of the Normanby River during floods.
- **Season Related Migrations:** Bishop *et al.* (1995) documented seasonal migrations of spangled perch in the Alligator rivers region. At the commencement of the wet season spangled perch move out of perennial escarpment pools downstream onto the floodplain. Return migrations are made at the end of the wet season.

Population Status: The species is commonly found within its range and there is no evidence of change in the abundance of this species in the Mackay Whitsunday Region.

Potential Threats: Barriers to migration, destruction of habitat, poor water quality and recreational fishing.

Conservation Status: Not listed.

References: Merrick and Schmida 1984, Marsden 2000, Allen *et al.* 2002. Bishop *et al.* 1995, Kennard 1995.

DRAFT

Eastern rainbowfish

Melanotaenia splendida (Peters, 1866)



Photograph: Tim Marsden

Maximum Size: 140 mm

Biology: This species forms small shoals close to the surface, common near woody debris and aquatic vegetation. Rainbowfish are reproductively active year round, though peak spawning generally occurs in the summer months. This species feeds on a variety of small insects and macroinvertebrates as well as submerged vegetative matter.

Distribution: The Eastern rainbowfish is common throughout its range of northeastern and central Australia.

Favoured Habitats: The Eastern rainbowfish can be found in a variety of different habitats such as rivers, creeks, swamps, marshy lagoons, lakes and reservoirs.

Migratory Requirements:

- **Life Stages:** The eastern rainbowfish is a potadromous species. Adults migrate upstream to spawn and then juveniles then undertake dispersal migrations.
- **Flow related migration:** Undertakes extensive dispersal migrations during high flows, but both adults and juveniles have been recorded using fishways at low flows. These fish were between 15-70 mm in length.
- **Season related migration:** Major upstream migration occurs between November and April, in the Fitzroy River

Population Status: One of the most common species captured during sampling in the Mackay/Whitsunday Region. Still common in most streams, however does not occupy highly degraded streams. There is no information about population changes for this species, however is likely to have undergone reduction due to extensive habitat modification.

Potential Threats: Barriers to migration, destruction of habitat, poor water quality.

Conservation Status: Not listed.

References: Merrick and Schmida 1984, Allen *et al.* 2002, Marsden *et al.* 2003

Purple-spotted gudgeon

Mogurnda adspersa (Castelnau, 1878)



Photograph: Tim Marsden

Maximum Size: 120 mm

Biology: A medium size gudgeon, the purple spotted gudgeon is common in rocky, fast flowing, reaches of streams. Breeding occurs throughout the warmer months, with the eggs deposited on either aquatic vegetation or on rocks. Males attend to the eggs until hatching, fanning the eggs to maintain water movement. The purple spotted gudgeon feeds on small fish, aquatic invertebrates, worms and insects.

Distribution: Found throughout the Murray-Darling system (NSW, northern Vic and southern Qld), and occurs along the coast from the Clarence River (NSW) to the central Cape York Peninsula (Qld).

Favoured Habitats: Found in the slower flowing reaches of rivers, creeks and billabongs and among vegetation on the rocky bottoms of riffle zones.

Migratory Requirements:

Life Stages: Very little is known about the migratory aspects of purple-spotted gudgeon's. However it is thought that this species undertakes some localised movements. Purple-spotted gudgeon's have been recorded (infrequently) in fishway trapping in the Mackay Whitsunday region. It is thought that adult male purple-spotted gudgeon's undertake small migrations searching for suitable spawning substrates in anticipation of the impending spawning season.

Flow Related Migrations; A small number of juvenile and adult purple-spotted gudgeon's were observed moving upstream through the Clare Weir fishway on the Burdekin River during a high flow event. Spawning occurs in stable low flows.

Season Related Migrations: Larvae present during October and November.

Population Status: There is no information about population changes for this species, however may have undergone reduction due to extensive habitat modification and river regulation. This species has also been recorded declining in numbers where large numbers of mosquito fish are present.

Potential Threats: Introduced species, destruction of habitat and poor water quality.

Conservation Status: Not listed.

References: Merrick and Schmida 1984, Allen *et al.* 2002.

Bony bream (bony herring)

Nematalosa erebi (Gunther, 1868)



Photograph: Gunther Schmida

Maximum Size: 470 mm

Biology: Bony bream are a schooling species that commonly inhabit lowland streams of the Mackay Whitsunday Region. Frequently noted in large shoals feeding on benthic algae, but also feeds on insects and small crustaceans. Spawning may occur repeatedly in the north with a peak during the wet season, while in the south probably occurs on an annual basis in the spring.

Distribution: The bony bream is very common throughout coastal streams of northern and eastern Australia and southwestern Papua New Guinea, from Fortesque River near Dampier Archipelago in Western Australia, eastward through the Northern Territory and Queensland. Also occurs in the Murray-Darling and Lake Eyre catchments in central Australia and the Bensbach River and Digoel River in Papua New Guinea.

Favoured Habitats: This species prefers large watercourses running through rainforest, dry open eucalyptus forest or desert areas with slow or quiet waters, is also common in isolated waterholes and many impoundments.

Migratory Requirements

Life Stages: Juvenile bony bream (less than 100 mm) have been recorded moving upstream through a fishway located 64 km from the mouth of the Fitzroy River. Adults undertake spawning-associated migrations to spawning grounds. Small and intermediate sized fish make substantial movements not associated with reproduction.

Flow Related Migrations: Small (less than 75 mm) and intermediate sized bony bream (75-250 mm) recolonise reaches of river after high flow events.

Season Related Migrations: Juvenile bony bream (less than 100 mm) have been recorded moving upstream through a fishway on the Fitzroy River throughout the year but more abundantly during winter/spring.

Population Status: The population of bony bream may have increased in recent times due to increased nutrient input to waterways (increasing algae) and reductions in predator species from over fishing and barriers to migration.

Potential Threats: Barriers to migration, destruction of habitat, poor water quality.

Conservation Status: Not listed.

References: Merrick and Schmida 1984, Allen 1989, Allen et al. 2002

Western carp gudgeon

Hypseleotris kyunzingeri (Ogilby, 1898)



Maximum size: 45 mm.

Biology: A small gudgeon species that is common around aquatic vegetation, the western carp gudgeon feeds on insects, microcrustaceans and plant material. Breeding occurs during the warmer months when water temperature rises above 22°C. Eggs are deposited close to the surface in aquatic vegetation, with the males guarding the eggs until hatching. Due to the location of egg deposition close to the water surface, eggs are vulnerable to rapid drops in water levels. River regulation may therefore impact on the survival rates of eggs.

Distribution: Commonly found in the Murray-Darling basin, western carp gudgeon can also be found along the eastern coastal drainages around Rockhampton (Qld).

Favoured Habitats: This species prefers the shelter of aquatic vegetation, fallen branches, overhanging rocks and tree roots in slow flowing sections of streams.

Migratory Requirements: None known, does undertake localised movements, recorded infrequently in fishway trapping in the Mackay Whitsunday Region.

Population Status: There is no information about population changes for this species, however may have undergone reduction due to extensive habitat modification and river regulation.

Potential Threats: Barriers to migration, destruction of habitat and poor water quality.

Conservation Status: Not Listed.

References: Merrick and Schmida 1984, Allen *et al.* 2002, Marsden *et al.* 2003.

Introduced Fish Species Information

Gambusia, mosquitofish

Gambusia holbrooki (Girard, 1859)



Photograph: Chris Appleby

Maximum Size: 60 mm

Biology: Introduced into Australia during the 1920s, gambusia was released into Australian waters as a biological control agent for mosquitoes. However it is believed to have done more harm than good as the gambusia preferred to prey on aquatic invertebrates the natural predators of the mosquito larvae. Has also been implicated in the decline of small native freshwater fish in many areas of introduction.

Distribution: *G. holbrooki* is native to Northern and Central America. This fish is found abundantly throughout Victoria, New South Wales, South Australia, coastal drainages of Queensland, parts of Western Australia and the Northern Territory.

Favoured Habitats: Gambusia prefer still waters and take refuge around the shallow edges of the waterways.

Migratory Requirements: Not required, has been recorded in low numbers during fishway sampling.

Population Status: Populations expand and contract rapidly according to conditions. Unlikely to be eradicated from Australian waters. The species is a declared noxious species under the Fisheries Act in Queensland.

References: Merrick and Schmida 1984, Allen *et al.* 2002.

Guppy

Poecilia reticulata (Peters, 1859)



Photograph: Robert M. McDowall

Maximum Size: 60 mm

Biology: This species was introduced into natural waterways sometime before the 1970s as a result of aquarists discarding unwanted pets. Not as prolific as the gambusia this species is still thought to have a negative impact on native fish species. Feeds on small aquatic invertebrates and algae.

Distribution: This species commonly found along the east coast of Queensland in coastal drainages. They are more commonly found around towns and cities such as Brisbane, Rockhampton, Mackay and Cairns.

Favoured Habitats: The Guppy prefers warmer waters and is found to inhabit still or slow flowing waters near the margins of pools amongst aquatic vegetation.

Migratory Requirements: Not required, has been recorded in low numbers during fishway sampling.

Population Status: Populations expand and contract rapidly according to conditions. Unlikely to be eradicated from Australian waters.

References: Merrick and Schmida 1984, Allen *et al.* 2002.

Platy

Xiphophorus maculatus (Gunther, 1866)



Photo: Gunther Schmida

Maximum Size: 60 mm

Biology: Like swordtails, platies established wild populations in Australia in the 1960s. They can easily survive in low water qualities that are unsuitable for native fish. Omnivorous, they feed on small aquatic and terrestrial insects, crustaceans and algae.

Distribution: In Queensland, platys have been located in a few swamps and creeks of Brisbane, as well as in the Barron, Johnstone and Babinda rivers. In the Mackay Whitsunday region they have recently been located in lakes in Proserpine and Mackay.

Favoured Habitats: Platys prefer warm waters of swamps, creeks and drains with slow moving water, silty bottoms and weedy banks. Wild populations were established in Australia in the 1960s.

Migratory Requirements: Unknown, has been recorded in low numbers during pestfish sampling.

Population Status: Populations expand and contract rapidly according to conditions. Unlikely to be eradicated from Australian waters.

References: Allen et al. 2002, McDowall 1996

Appendix 2: Bird Species information

Wandering Whistling-Duck (*Dendrocygna arcuata*)

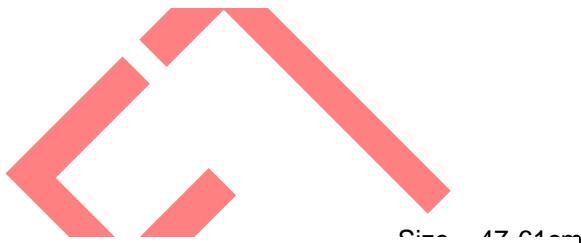
Size – 55-61 cm



Range – Freshwater wetlands and Lagoons. Found along the North and East Coasts of Australia from Northern NSW to Broom

Dark-crowned duck, with a horizontal stance, the legs and bill are dark and has short flank plumes. Feeds on aquatic weeds in the water, gathered on surface or underwater. Has a high pitched whistle.

References – Slater *et al.*, 1994, Wikipedia.com



Pacific Black Duck (*Anas superciliosa*)



Range – Freshwater Wetlands, (permanent or nomadic). Found throughout Australia.

Large dark coloured duck with two dark lines on a buff face. They have white underwing lining and green or purple speculum. The male has three quick soft noted quacks where as the female has a loud six noted quack. This duck will nest in tree hollows or create a grass cup nest in grass or reeds, they will lay between 8 & 10 whitish or pale green eggs.

Australian Darter (*Anhinga melanogaster*)

Size – 90cm



Range – Occurs in patches throughout Australia including offshore islands and in salt water. Found all along Central and Eastern Australian, and along the West Australian Coast. They are not found along the central West Australia (including the border).

Large black often grey bird with a long thin neck with pale streaks on the wings. Usually a solitary bird, makes a noise like a clicking rattle simular to a ratchet on a fishing reel. Will nest in large stick nests in trees overhanging the water, they will lay 3 to 5 pale green chalky eggs.

Little Pied Cormorant (*Phalacrocorax melanoleucos*)

Size – 50-55cm

Range – Found around freshwater lagoons and in estuaries, (not usually found in open marine environments). They are found throughout Australia, except along the Western Australia Border.

Small bird with a yellow or brownish bill, sometimes have rusty red staining on their bill. Grows up to 50cm in length.



Australian Pelican (*Pelecanus conspicillatus*)

Size – 150-180cm



Range – Most abundant in estuaries but are common on all waterways. This bird is found through Australia.

This is the only pelican found in Australia. The bill becomes quite bright when breeding, however pales after laying eggs. They can move long distances in short periods of time. This bird will nest on the ground with a nest of grass, sticks and feathers scraped together. This bird will lay 2 or 3 white eggs.

References – Slater *et al.*, 1994, Wikipedia.com

Great Egret (*Ardea alba*)

Size – 75-90cm



Range – found throughout Australia on a variety of wetlands and waterways.

This is a large white bird with a yellow bill that extends behind the eye, it also has dark legs. The neck is long and slender that often takes the shape of a question mark. The great egret will nest in colonies in trees of swamps often with other bird species.

Pacific Baza (*Aviceda subcristata*)

Size – 38-43cm



Range – Along the North & East Coasts of Australia from Central NSW up to Broom, this bird is uncommon, often scarce, but can be found in forest and woodland areas.

This hawk has a bared belly with a small crest on its head. They can be seen in small flocks usually in trees. Its call is a loud 'ee-chew'. They will create small cup nests in leafy tree forks and lay 2 or 3 white eggs. This hawk is also known as a Crested Hawk.

References – Slater *et al.*, 1994, Wikipedia.com

Black Kite (*Milvus migrans*)



Range – found throughout Australia except the west coast of Western Australia.

This kite is dark in colour and has a forked tail that is often twisted during flight. This bird is usually found around refuse tips and cattle properties mostly in flocks. The kite makes a soft whinnying sound. They will create large cup stick nests and lay 2 splotched white eggs.

Whistling Kite – (*Haliastur sphenurus*)



Range – either common or nomadic species found in all areas of Australia.

This is dingy brown looking bird, that has a long pale tail. It has a loud vigorous voice – 'pee-aar-wh-wh-wh'. It is often seen soaring with slightly bowed wings. This kite will create large bulky stick cup nests in the forks of trees and will lay 2 or 3 blue/white eggs.

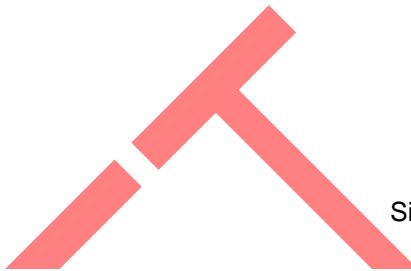
White-bellied Sea-eagle – (*Haliaeetus leucogaster*)

Size – 76-84cm



Range – common or nomadic birds usually around the coast, on rivers, dams, lakes and lagoons. Most common on the east Australian Coast, including Victoria, although they can be found around the entire coast line of Australia.

This is a large eagle with a pale tail with a white tip. It soars more like a butterfly with its wings upswept. It has a loud goose like call more like an ‘ang-ank’. This eagle will make large nests out of sticks usually in trees, but some on the ground (if on an island), they will lay 2 white eggs.



Size – 35-42cm



Range – Most common around wetlands. Throughout Queensland, NSW and Victoria, but can be found in the most southern tip of Western Australia as well as along the east coast of Tasmania.

This bird is a dusky brown with a red frontal lapel, has a thin bill with a yellow tip and has white patches on each side of its under-tail. This bird has a loud and sharp voice more like a ‘krek’. This bird will nest in well hidden grass cups or reeds and will lay

DK **Masked Lapwing – (*Vanellus miles*)**

Size – 35-38



Range – Found in open spaces throughout much of Australia (including Tasmania), although they are not common in parts of Western Australia.

This is a large plover that has yellow facial wattles and no white in the upper-wing. Its voice is a loud staccato ‘keer-kir-ki-ki’ to a trilling ‘krrr’. This plover will nest on the ground by scraping up a nest and will lay 4 olive splotched eggs.

Peaceful Dove – (*Geopelia striata*)

Size – 27-29cm



Range – Common in open woodland and tree-scattered plains near water. They are common in the eastern states of Australia, but are also found along the north coast of Western Australia and the Northern Territory.

This small grey-brown dove has barred wings and neck, it also has a bluish ring around the eyes. This bird can be found in groups that can be quite vocal. Its voice is a throaty 'crrr' or a 'doodle-doo'. This dove will nest on flimsy platforms of twigs in low trees or bush, and will lay 2 white eggs.

Bar-shouldered Dove – (*Geopelia humeralis*)

Size – 27-29cm



Range – Common in thick vegetation around water including mangroves, forests and rivers. They are found in Northern areas of Western Australia and the Northern Territory as well as along the east coast of Australia.

This large brown dove has a barred copper-coloured nape with barred wings. Flies with its head up and makes an alert 'wook-oo-coo'. They nest in flat platforms in trees, ~~scrubbers or brush~~ and will lay 2 white eggs.

Rainbow Lorikeet – (*Trichoglossus haematodus*)

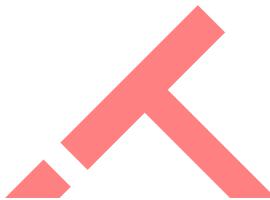
Size – 25-30cm



Range – Common in all forests, heath and woodland areas with blossoms. They are found in coastal regions of the north of Western Australia, Northern Territory, Queensland, New South Wales and Victoria.

This large bird has a blue head with an orange or red chest. It has a screechy voice usually in flight however it has a softer voice whilst it is feeding. This bird will nest in tree hollows high up in the tree and will lay between 2 & 3 eggs.

Pale-headed Rosella – (*Platycercus adscitus*)



Size – 30cm

Range – Common in open woodland areas. This species is only found in Eastern Queensland.

This rosella has white cheeks with a pale yellow head. Its chest is a pale blue and has black and yellow back feathers.

Brush Cuckoo – (*Cacomantis variolosus*)



Size – 24cm

Range – Often migrates (nests in the southern regions) and can be permanent resident of northern & eastern Australia, including Victoria.

This cuckoo has a grey head with a pale buff breast and a grey eye-ring. It has a loud call – 'ph-ph-phew, ph-ph-phew', this can become louder and more persistent. This cuckoo will lay its eggs in other birds nests and the young will be raised by their host species.

Fan-tailed Cuckoo – (*Cacomantis flabelliformis*)

Size – 24-28cm



Range – Mostly found in the southern regions of Australia, but can still be found along the eastern coast of Australia. Found in forest and woodland areas.

Is a blue-grey cuckoo with a dull chestnut breast and has a yellow eye-ring. Has trill that can carry far distances. It is often a mournful whistle – ‘wh-phweee’. (First note however may not be heard). This cuckoo will lay eggs in other birds nest and let its young be raised by other bird species.

References – Slater et al 1994 Wikipedia.com

Common Koel – (*Eudynamys scolopacea*)



Male



Female

Size – 39-46cm

Range – Found in rainforest, woodland and scrub forests in northern areas of Australia, they can still be found along the eastern coast of New South Wales & up through eastern Queensland.

Males of the species are black and females and juveniles are brown barred and spotted. They often have a barred and spotted body with a black stripe on the cheek. Its voice is a noticeable ‘koo-ee’, and can often be various raucous of notes. This cuckoo will use other birds nests and allow the other birds to raise its young.

References – Slater et al, 1994, Wikipedia.com

Channel-billed Cuckoo - (*Scythrops novaehollandiae*)

Size - 60-67cm



Range - Migrates to Australia between September and April for breeding purposes, found along the north and east coasts of Australia from New South Wales north. Usually in forest and woodland areas with native figs

This large cuckoo is mostly grey with long wings and tail, and has a heavy bill. These birds can be found in small noisy groups and can often be seen being chased by crows. It has a sound like 'Kork ork ork ork', the young are often reared in other birds nests.

Pheasant Coucal – (*Centropus phasianinus*)

Size - 60-80cm



Range - Found along the east and north coast of Australia, usually in long grass or woodland areas.

This cuckoo often changes colour between seasons - Black in summer and brown in winter. This bird is often seen running across roads in front of cars. It has a loud booming voice - 'coot coot coot coot' or a hissing 'skeowk'. This cuckoo will nest in long grass and will lay between 3 & 5 white eggs.

Azure Kingfisher – (*Alcedo azurea*)

Size - 17-19cm



Range - this migrating bird is often hard to find but will reside along creeks, rivers, lagoons and mangroves usually along the north and east coasts of Australia including Tasmania.

This short tailed kingfisher has an orange breast and feet. This bird makes a high pitches piping sound - 'pseet pseet'. It nests along creek banks usually making a hole in the bank. They will often lay between 5 and 7 white eggs.

References – Slater *et al*, 1994, Wikipedia.com

Laughing Kookaburra – (*Dacelo novaeguineae*)

Size - 46cm



Range - most commonly found in woodland, forest and around vegetated watercourses. Most commonly found along the east coast of Australia through to New South Wales and Victoria, as well as the southern most tip of Western Australia.

This large kingfisher has dark patches behind the eyes has small sections of silver over the shoulder. This kookaburra has a loud chuckling laugh that is often in chorus with other kookaburras. This bird will nest in tree hollows or by making a hole into termite mounds.

References – Slater *et al*, 1994, Wikipedia.com



Size - 40-46cm



Range – Found in open woodland and vegetated watercourses mostly along the east coast of Queensland as well as along the north coast of Australia.

This large kingfisher has a streaked head, has a white eye and a large blue patch on the shoulders. This kookaburra has a manic laugh and nests in tree hollows or in termite mounds and will lay between 2 and 4 white eggs.

References – Slater *et al*. 1994. Wikipedia.com

Forest Kingfisher – (*Todiramphus macleayii*)

Size - 19-22cm



Range – This migrating bird is an uncommon resident and will have erratic periods of residence. They can be found along the east coast of Australia from mid New South Wales to the tip of Queensland, and the very north of the Northern Territory.

This kingfisher has a blue rump with a two-toned upper body, a white window sections in its wings and a large white spot in front of the eyes. This bird has a loud scissor like 'scissor-weeyaa scissoraweeya' sound. It nests in tunnels in termite mounds and lays 4 to 6 white eggs.

References – Slater *et al*, 1994, Wikipedia.com

Sacred Kingfisher – (*Todiramphus sanctus*)

Size - 19-23 cm



Range – Found usually in wooded areas (although not in rainforests) throughout Australia.

This kingfisher has a blue rump with pale blue body. The upper body is more blue/green and has a small spot behind the eyes. They make loud 'kik kik kik kik ki' noise that is often descending in tone. And a chuckling 'ch-rrr-k' sound when it is nesting. They nest in holes in trees but will also tunnel nests into termite mounds like the Forest Kingfisher.

References – Slater et al, 1994, Wikipedia.com

Dollarbird – (*Eurystomus orientalis*)

Size- 27-30 cm



Range - Found in forest and woodland areas of north and east Australia including the eastern half of Victoria.

This bird has a red bill and a blue/white window on its wing. They have a harsh voice with calls of 'krak kak kak' and often a faster 'kek ek ek ek'. They nest in tree hollows (horizontal hollows) and will lay between 3 and 5 white eggs.

References – Slater et al, 1994, Wikipedia.com

Lewin's honeyeater – (*Meliphaga lewinii*)

Size - 19-21cm



Range - Usually found in dense vegetation and eucalypt forests along the east coast of Australia. Ranging from Cooktown down to Victoria.

This large honeyeater has a short bill and a yellow half moon patch behind the eye and beak. This species will nest in a deep grass and bark nest and will lay 2 or 3 eggs.

Yellow Honeyeater – *Lichenostomus flavus*

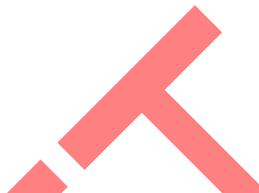
Size - 16-18 cm



Range - Found in mangrove areas, along the verges of rainforests, woodland areas, parks and gardens. This species is restricted to the north Queensland ranging from St Lawrence out to Mt Isa and north to Cape York.

This masked honeyeater has a green/yellow body with a faint musky mask extending from behind the eye. It has a loud 'cheweer cheweer' sound and makes a shallow bark and grass cup nest in tree forks. They lay 2 spotted and splotched white/pink eggs.

Brown Honeyeater – (*Lichmera indistincta*)



Size - 12-16 cm

Range - Usually resides in forest, woodland, mangrove, scrubland, gardens and in areas of vegetated water courses. This species can be found in most areas of Australia, excluding Tasmania, Victoria, and the majority of South Australia.

This honeyeater is a plain olive-brown bird with a very small patches of yellow behind the eye. Often has yellow edges to its wings and can be a washed green/yellow.

They have a loud rich voice with varied songs. Their nest is made of grass, bark and leaves, often with spider egg sacks as decoration. The nests are suspended from the forks of various vegetation, they will lay 2 or 3 spotted white eggs.

Spectacled Monarch – (*Monarcha trivirgatus*)



Size - 14-16cm

Range - Often found in the lower stratum of rainforest and damp forest areas. This bird is restricted to the east coast of Queensland and northern New South Wales.

This flycatcher has a black face with a white belly and a generally black tail with white edges. It has a loud jingling chattering voice and will nest in the forks of small saplings. Their nest is often decorated with moss and lichens, and they will lay 2 freckled pinkish eggs.

Leaden Flycatcher – (*Myiagra rubecula*)



Male



Female

Size - 15cm

Range - Often found residing in mangroves, forests and woodland areas of the coastal areas of Victoria, New South Wales and Queensland. As well as along the north coasts of Western Australia, Northern Territory and Tasmania.

This flycatcher differs between the male and the female, the male is a dark blue/grey body with a glossy head and breast. The female has a brown/grey body with a rust coloured chest and has a bluer head than the male. Their voice varies between a frog like 'queeark' to a loud 'peter peter'. This bird nests in a neat cup nest made of bark and cobwebs, and will lay

Magpie-Lark – (*Grallina cyanoleuca*)



Size - 27cm

Range - Found throughout Australia (except Tasmania) in most habitats except forest areas.

This species has a black and white body, the male has a black chest and a white eyebrow. The female has a white throat and does not have an eyebrow and the under body of both genders is white. This bird has a loud voice often 'pee o wit' sounds. It will use a mud nest often placed on horizontal branches of trees, but will also use windmills, electrical poles or a suitable substitute for their nests.

Willie Wagtail – (*Rhipidura leucophrys*)



Size - 20cm

Range - Found throughout Australia and northern Tasmania, usually in most habitats except in treeless grasslands and dense forests.

This fantail has a large black fanned tail with a white belly and a white eyebrow. It has a sweet voice, but will have a strict chatter if annoyed. They will nest in a small cup and lay 2 or 3 spotted white eggs.

Spangled Drongo – (*Dicrurus bracteatus*)

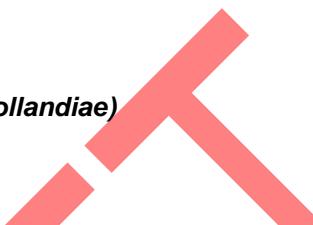
Size - 28-32 cm



Range - Found in most habitats along the east coast of Australia from New South Wales to Cape York, including the north coast of Western Australia and the Northern Territory.

This species is black all over with a fish shaped tail and has iridescent blue spangles on its chest. The Spangled Drongo is a noisy bird often with a harsh call of 'grut grut cris grut'. It nests in a neat twig cup and lays between 3 and 5 splotched light pink to light purple eggs.

References – Slater. et al. 1994. Wikipedia.com

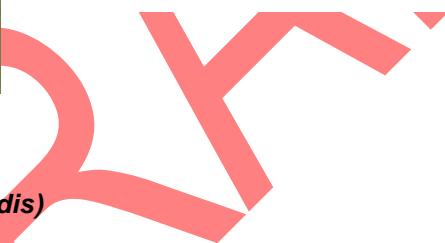


Size - 33cm



Range - Found throughout Australia in most habitat types (with trees)

This cuckoo-shrike species is has a medium grey body with a black face that extends behind the eye and down the chest. It nests in flat twig and grass cup nests and will lay 2 or 3 blotched green eggs.



Figbird – (*Sphecotheres viridis*)



Male



Female

Size - 27-29 cm

Range - Mostly found in trees bearing fruit in the eastern regions of New South Wales, Queensland and northern reaches of Northern Territory and occasionally they are found in the Prince Regent Region of Western Australia.

This bird is very sociable with a short squat bill it has either: red, pink or grey around the eye and has thick white tips along the edge of the tail in the males. They have a pleasant voice often a warble and is sometimes a mimic. They will nest on the outer branches of paperbarks or fig trees, sometimes in small colonies. They lay 2 or 3 spotted or splotched green/brown eggs in a small cup nest.

Pied Butcherbird – (*Cracticus nigrogularis*)

Size - 32-35cm



Range - Resides in woodland areas, and in areas of thicker vegetation for protection, they are found throughout Australia, excluding Tasmania and southern parts of Victoria and South Australia.

This butcherbird has a black head and throat, a white belly and a black back and white edged wings and tail. It can sometimes be a mimic, but usually it has a pleasant fluting sound. This species nests in a messy cup nest made of sticks and grass in forks of tree branches. They will lay between 3 & 5 spotted olive or brown eggs.

Australian Magpie – (*Gymnorhina tibicen*)

Size - 34 - 44 cm



Range - usually found in woodland, urban and rural clearing areas throughout Australia. There are 5 different versions of *Gymnorhina tibicen*, the most common is the Black-backed Magpie.

This species generally have a black body with a white nape of the back of its neck, white patches on their wings and a white rump and under-tail. Although there are 5 different versions of the Magpie, all differing in colour patterns, they are all still considered to be the same species just hybridised in colour.

The magpie is a sociable often tame bird that nests in messy twig cup shaped nests, lined with grass and other soft materials. They will lay 3 spotted smeared brown / blue eggs, and can often be violent and defensive during breeding seasons.

Torresian Crow – (*Corvus orru*)



Size - 50 cm

Range - Found throughout the central to northern areas of Australia, in most habitat types, although often rare in extreme desert areas.

This crow is a glossy black colour that has white bases of the neck feathers, they have a nasal call with a high pitched 'uk uk uk', 'ork ork ork' or an 'arr arr arr'. This species nests in large stick nests and lays between 3 and 6 eggs.

Richard's Pipit – (*Anthus novaeseelandiae*)

Size - 15-17 cm,



Range - Usually found in grassland, paddocks, pasture and coastal dune areas throughout Australia.

This pipit is a streaked brown colour with a thin pale bill that varies from grey/brown to cinnamon in colour depending of location. This species wags it tail up and down and has a trilling voice. They make cup shaped grass nests under brush or tussock grasslands, and are very well-hidden. They will lay 3 or 4 freckled whitish eggs.

References – Slater, et al. 1994, Aust. Bird image database



Plumed Whistling Duck - *Dendrocygna eytoni*

Size - 41-61cm

Range - dams, waterholes, wetlands and lagoons of northern WA, NT and all of the east coast.

A light coloured duck with long flank plumes and light pink legs and bill. Often feeds at night flying long distances to find food.



Magpie Goose - *Anseranas semipalmata*

Size 70-90cm

Range - sub coastal wetlands of northern WA, NT and north and eastern Queensland.

A large black and white goose with light coloured beak and legs. They make large floating nests from aquatic vegetation in emerging rushes or grasses. Page 60



Brown Quail - *Coturnix australis*

Size 18cm

Range – common in long grass near water in northern, eastern and south-western Australia; also in Tas (called swamp quail).

A large quail with variable brown plumage and fine barring on its breast and underbelly. It has a sad voice often a rising 'ph-phweeeep'. Nesting: lined scrape in long grass; they lay between 4 and 7 spotted eggs. Page 88



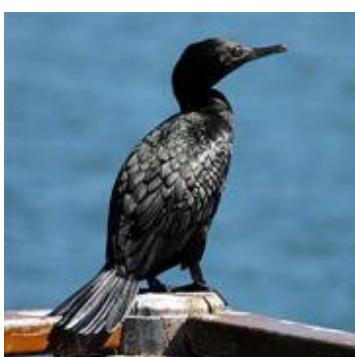
Australasian grebe - *Tachybaptus*

novaehollandiae

Size - 25cm

Range - most freshwater areas; ponds, dams, lagoons, wetlands etc, rarely on salt water areas (including estuaries). Found from central Australia to the east coast, and along the west coast of WA.

Small brownish bird with a chestnut stripe on the side of a dark head, yellow eyes and a broad white wing stripe. A noisy bird, it calls throughout the day and night. Forms a mounded nest from aquatic vegetation and lays between 3 and 7 white eggs. Page 12



Little Black cormorant - *Phalacrocorax sulcirostris*

Size - 60-65cm

Range - freshwater and estuarine areas throughout mainland Australia and Tasmania.

These small black cormorants with black faces often swim in groups, gathering schools of fish. They make a croaking, whistling and ticking noise and nest in large stick nests that overhang water. They are colonial animals that lay 3 or 4 light green eggs. - Page 48



Intermediate Egret - *Ardea intermedia*

Size - 65cm

Range - found in coastal areas of most of mainland Australia except southern WA and SA and sometimes visits NW Tas.

These birds have a yellow bill (not extending behind eye), a white body and dark legs. During breeding they often have a red bill and a green tinge to the face. This species will often stand up with its neck straight. Colonial animals, they nest in overhanging trees of freshwater or mangrove swamps. They lay between 3 and 5 light blue/green eggs. - Page 52



Cattle egret - *Ardea ibis*

Size - 48-53cm

Range - found in many habitats of the north, east and west coasts of Australia. Common near livestock in grazing paddocks.

These small sociable egrets have a yellow bill and legs and will nest in colonies in trees that overhang water. They lay 3-6 pale blue eggs.

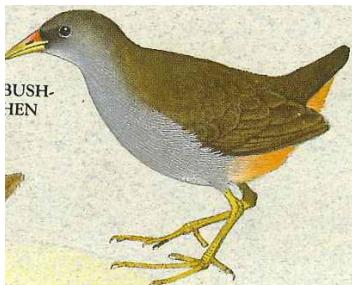


Buff-banded rail – *Rallus philippensis*

Size – 31cm

Range – distributed irregularly in swamps or grasses near water and also on islands in the south-west, northern, eastern, south-eastern mainland and Tasmania.

These birds are a short-billed rail with heavily banded underbellies broken by a buff patch on the breast. It makes a rapid ‘tuk-e-te-ka’, a throaty ‘krek’ and a ‘swit~swit’. They nest in well hidden grass cups in dense vegetation and lay 5-8 blotched eggs. – Page 94



Bush hen – *Gallinula olivacea*

Size – 26cm

Range – common in the north, summer visitor in the south, in thick and marshy vegetation. Found in the north-east from Weipa to Brisbane, Qld.

This bird is a small, grey breasted gallinule. Its bill is bright green with a red base and it has olive green legs. It makes a loud call between 10-15 notes and nests in a grass cup in tall grass or tangled vegetation. This bird lays 4-7 freckled pinkish eggs. – Page 94.



Pied imperial pigeon - *Ducula bicolor*

Size 38-44cm

Range – common in coastal areas of northern Australia from the Kimberley to Rockhampton. Eastern populations are migratory.

A large plump white pigeon with areas of black on lower part of wings, end of tail as well as black bars under tail and on lower belly. Legs and feet are grey, eyes black and the bill pale. Can often be heard ‘coo-wooing’ at dawn and dusk, and is often seen in flocks. They nest in mangroves, palms or vines laying a single egg.



Horsefield bronze cuckoo – *Chrysococcyx basalis*

Size – 17cm

Range – common nomad or resident in woodland throughout mainland Australia and Tasmania. Mainly found inland and is not common in thick forested areas.

A dull bronze-cuckoo with a dark ear patch, fine partial bars on each side of the breast and flanks and a reddish-brown base to the sides of the tail. Makes a series of whistles with downward inflection. This bird parasitises dome or cup-shaped nests (especially wrens, thornbills and robins). – Page 182

Picture - <http://www.ozanimals.com>



Gould's bronze cuckoo - *Chalcites minutillus russatus*

Range - coastal tropical and subtropical QLD from Cape York to NSW border. Either solitary or in twos in dense vegetation, including mangroves, paperbark thickets, gallery forests, monsoon forests and often near watercourses.

Parasitises domed-nests (especially gerygones) laying one olive-bronze egg.

Picture - <http://www.redmillhouse.com.au>



Rainbow bee-eater – *Merops ornatus*

Size – 23cm

Range – The rainbow bee-eater is a common migrant from September to April in woodland and timberland plains throughout Australia. Resident population in the North.

This bird is a colourful blue, green and orange bee-eater with extended central tail feather shafts. Usually in small groups but often roost in small leafy trees in the 100's. This bird makes a pleasant 'prrrp-prrrp' sound and nests in long tunnels in sand banks or sloping sandy soil. Lays 4-7 white eggs. – Page 188



Red-backed fairy-wren – *Malurus melanocephalus*

Male in breeding plumage

Size – 12-13cm

Range – common resident or short-range nomad in tropical and subtropical woodland with grass understorey Cape Keraudren, West Australia to Port Stephens, NSW.

The smallest of the fairy-wrens, the male is black with a red back and the females and young males a drab brown. There are two forms: scarlet-backed (Atherton, Qld to Port Stephens, NSW; and crimson-backed from WA to Atherton, QLD. This wren makes a soft 'tsst'. They nest in a neat dome of grass in a tussock or small shrub and lay 3-4 spotted white eggs. – Page 248



White-throated gerygone – *Gerygone olivacea*

Size – 10-11cm

Range – residents or migrants in forests and woodland in eastern and northern Australia from Broome, WA, to south-eastern, SA.

This bird is a yellow breasted warbler with white on the tip of the tail and on the throat. Females are a paler yellow than the males. It makes a descending melody followed by an explosive ‘pheee~ee’ew’. They nest in a suspended dome of bark and grass, decorated with spiders’ egg sacs (bottom), and bag-nest caterpillar droppings (top). It lays 2-3 freckled and blotched pink eggs. Page 262



Noisy friarbird – *Philemon corniculatus*

Size – 25-29cm

Range – common nomad or migrant in forest and woodland, favouring eucalypt, paperbark and fruiting trees in eastern Australia from Murray River, SA to Cape York Peninsula, QLD.

The eastern friarbird has a knob on the top of the bill and except for a few tufts of feathers on the eyebrow and chin, the entire head is naked black skin. The tail has a distinctive white tip. They display a loud cackling ‘four o’clock...’; ‘chock...’; ‘chewlip’. The noisy friarbird nests in large deep pendant cups made of bark, rootlets and wool and they lay 2-4 blotched pink eggs. Page 276



Little friar bird – *Philemon citreogularis*

Size - 25-29cm

Range – common resident or nomad in open forest and woodland mainly in eucalupt, grevillea and paperbark blossoms in eastern and northern Australia from Eyre Peninsula, SA, to about Port Hedland, WA.

A friarbird with naked bluish or leaden skin on face and no knob on bill. Juveniles have a yellow patch on the throat and pale edges to the back feathers. Calls vary in each region. They nest in deep cups of grass, bark and wool suspended in outer tree foliage, and lay 2-3 spotted pink, salmon or purplish-red eggs.



Blue faced honey eater – *Entomyzon cyanotis*

Size – 25-30cm

Range – common in small flocks in open woodland to edges of rainforest, mangrove and paperbark swamps in northern and eastern Australia from Broome, WA to south-eastern SA.

A large noisy honey-eater with blue skin surrounding the eye in adults. Two forms occur: northern form has a large white patch in wing; eastern form has a small beige patch in wing. They use a loud metallic ;keet; or 'kwok'. Blue-faced honeyeaters' rarely build their own nests, preferring to use old nests of Grey-crowned Babbler, friarbird or Apostlebird, lining them with bark and grass. They will lay 2-3 eggs. Page 278



White-throated honeyeater – *Melithreptus albogularis*

Size -13-15cm

Range – common resident in forest, woodland and riverine vegetation in northern and eastern Australia from Broome, WA, to Macleay River, NSW.

A small black-headed honeyeater with a white nape extending to eye, white chin, pale blue wattle over eye and a bright olive-yellow back. High pitched 'tserp-tserp...', and 'tee tee, tee tee...'. They form suspended nests in deep cups made from bark, grass and other plants in the outer foliage of trees and lay 2 blotched and freckled pink eggs.
Page 280



Lemon-bellied flycatcher – *Microeca flavigaster*

Size – 11-13cm

Range – locally common resident in woodland, paperbark swamp, riverine forest and mangrove in northern Australia from Broome, WA, to about Bowen, Qld.

A brown-tailed flycatcher with yellow or whitish underparts and dark legs. Breast colour varies from bright yellow (Cape York), lemon-yellow (south of Cape York across to Ord River), white (Kimberley coast). They have a very musical call with a 'chew-chew' and 'swee-so-wu-chew'. They make tiny nests from bark and cobwebs in horizontal tree forks and lay only one blotched pale greenish-blue egg.



Rufous whistler – *Pachycephala rufiventris*

Size 17cm

Range – common resident or partial migrant in open forest and woodland throughout

mainland Australia.

Males of the species are rufous-breasted with a black breastband and a white throat. Females are a brownish-grey with a buff-coloured breast with dark streaks. They have a loud vigorous song; 'ee-chong' and 'joey-joe...'. Nests are untidy grass cups in tree forks usually in lower leaf clumps and 2-4 freckled olive eggs are typically laid.



White-bellied cuckoo shrike – *Coracina papuensis*

Size - 28cm

Range – common residents in the north and nomads in the south-east in forest, woodland, mangrove and riverine forest in northern and eastern Australia.

A pale-grey cuckoo shrike with black between the eye and the beak. Northern forms have a white breast and eastern forms a grey. Voice consists of a 'kisseek' and 'quee-erk'. Nests are a flat platform of twigs and cobwebs and 2-3 blotched green eggs are laid.



White-winged triller – *Lalage tricolor*

Size – 18cm

Range – In the north a common resident and in the south a sporadic migrant. Found in open woodland, particularly mulga, throughout Australia, vagrant to Tasmania.

When breeding, males are black from the head down the back with a grey rump, white shoulder and breast and a black brow. When not breeding the males black back and crown are replaced with a brown. A vigorous extended ch-ch-joeys-joeys-joeys' is used by the males while the females remain silent. Nests are a flat cub in a fork with 2-3 blotched green eggs.



Varied triller – *Lalage leucomela*

Size 18-21cm

Range – An uncommon nomad in rainforest, sclerophyll forest mangroves and riverine forest in northern and eastern Australia, from north-west Kimberley to about Taree, NSW.

A small plump cuckoo-shrike with a prominent white eyebrow, white edges to wing feathers, underbelly often faintly barred, and buff undertail coverts. Males have a black back while females tend to be more grey. Males can vary between regions. Voices tend to be a ‘chee-urr’; ‘drr-eea, drr-eea’. Nests are flat cups in horizontal forks and only one blotched green egg is laid. Page 212



Olive-backed oriole – *Oriolus sagittatus*

Size – 25-28cm

Range – common nomad in north and east from south of Broome, WA, to Adelaide, SA. Generally found

An oriole with a slender pinkish bill, streaked white underparts and a narrow white tip to grey tail. The males are a brighter greenish-olive on top with a greenish-grey throat whereas females are a little duller on top with a streaked throat. Voices tend to be a harsh sneezing ‘snee-ach’ along with a melodious monotonous ‘cholonk-cholonk’. Nests are formed in deep cups in outer branches and two spotted and blotched cream eggs are laid. Page 314



White breasted woodswallow - *Artamus leucorhynchus*

Size 17cm

Range – common resident or partial migrant in mangrove and woodland near water, northern central and eastern Australian and Tasmania. Usually found in small groups in coastal mangroves and inland along tree-lined watercourses.

A dark grey woodswallow with a white breast and rump. It is the only woodswallow without a white tailtip. Voice tends to be a harsh 'eyeck' and nesting is in upright tree hollows where 3-4 spotted cream or pinkish eggs are laid. Page 318



Red-browed finch – *Neochmia temporalis*

Size – 11-12cm

Range - common resident in forest woodland and mangrove in eastern Australia from Cape York, Qld, to Kangaroo Island, SA. An introduced population exists in the Darling Ranges, WA, near Perth. They are seen in small flocks in seeding grasses.

An olive-backed bird with a red eyebrow, grey underparts and golden patch on the side of the neck. A high-pitched 'pseet' is voiced and nesting is a globe of grass placed in a clump of leaves in creepers or crowns of saplings. Typically 4-6 white eggs are laid. Page 306



Chestnut-breasted manikin – *Lonchura*

castaneothorax

Size – 10cm

Range – Common resident or nomad in grassland and grassy woodland, particularly near water, in the east and north from Derby, WA, to Shoalhaven R, NSW. Frequently seen in very large flocks

A grey-billed finch with a black face, chestnut breast and a yellowish rump and tail. A bell-like 'treet' is often heard and nests are large globes of flattened grass in long grass or bush where 5-6 white eggs are laid.



Fairy martin – *Hirundo ariel*

Size – 11-12cm

Range- found throughout mainland Australia usually seen in flocks often on dead trees or near culverts.

A white-rumped martin with clean white underparts and a rusty coloured head. Has a churring call and bottle-shaped nests are made from mud under culverts or eaves. 4-5 freckled white eggs are laid. Page 200



Tawny grass bird – *Megalurus timoriensis*

Size - 19cm

Range – common resident or nomad in moist grassland and heath in eastern and northern Australia.

A Grassbird with a rufous streaked back, a rich red-brown rump and a long drooping tail. In summer the males sing on a prominent perch and performs display flights. Nests are well hidden cups of grass in long grass where 3 freckled eggs are laid. Page 242



Golden-headed Cisticola - *Cisticola exilis*

Size – 10cm

Range – A common resident in grasslands and crops in eastern, northern and north-western Australia and also King Island.

A small streaked grassbird with beige underparts and a buff tip to the tail. In winter the tail grows slightly longer. In summer the male crown turns golden and in winter it is streaked like the female. A buzzing ‘zzzt’ often followed by a double ‘lik’ and ‘keet keet’ is typically heard. Nests are domes of grass lined with plant-down and spiderweb, stitched to leaves in long grass with the entrance on the top side. Four blotched blue eggs are typical. Page 244



Yellow-bellied sunbird - *nectarinia jugularis*

Size – 10-12cm

Range – common resident on the margins of rainforests, mangroves, riverine vegetation and gardens in north-eastern QLD, from Cape York to Gladstone.

A long-billed sunbird with yellow eyebrows and bright yellow underparts. The male has a black with blue/purple iridescence on the throat and breast while the female is all yellow underneath. Voices are a shrill 'tsee-tsee-tsee tss-ss-ss' and 'dzit-dzit'. Nests are made as long pendants with a hooded entrance in the side from bark, grass, leaves and feathers bound together with cobwebs and usually suspended from a twig, rope or wire. Two – three mottled greenish eggs are typically laid. Page 298



White-faced heron - *Ardea novaehollandiae*

Size – 65-70cm

Range – very common throughout Australia and Tasmania in or near wetlands.

A slender heron with a fine bill that is pale grey all over except for prominent white around the face area. Nests are solitary in treetops often well away from water where 3-5 pale green eggs are laid. Page 54



Striated pardalote – *Pardalotus striatus*

Size – 9-11.5cm

Range – common throughout mainland Australia and Tasmania in forests and woodlands.

Many identifiable forms of the striated pardalote occur:

- a) Black-crowned forms: yellow-rumped form in north; and cinnamon-rumped form in north-east, south to northern NSW.
- b) Stripe-crowned forms: south-eastern form with a red spot and narrow white stripe in wing; western form with a red spot and broad white stripe on wing; yellow-spotted form with yellow spot and narrow stripe in wing, breeding in Tasmania and migrating to south-east.

Voices also have local variations. Nests are domes or cups of bark lined with grass in holes in banks or tree hollows. Two – five white eggs are generally laid. Page 304



Fairy gerygone – *Gerygone palpebrosa*

Size – 10-11.5cm

Range – Resident in mangroves, rainforest or contiguous woodland in north-east from Rockhampton to Cape York, Queensland.

A yellow-breasted warbler with little or no white in the tail. Two forms occur in the males only: southern form has a white throat with a dusky chin and a white eye-ring and the northern form has a blackish-brown throat with a white ‘moustache’. Females all have a greyish-white throat and a white eye-ring. The voice of this gerygone tend to be a reeling ‘whit ee whit you’. They nest in a pendant dome of grass, bark and rootlets, often near wasp nests and lay 2 freckled white eggs. Page 262



Helmeted friarbird - *Philemon buceroides*

Size – 30-37cm

Range – common nomad or resident in forest and woodland (QLD), mangroves, monsoon forest and sandstone gorges (NT).

A large tropical friarbird with a large knob on the bill, a black-skinned face, a greyish-brown crown, nape and throat and no white on the tail. Voices can be varied: ‘watch out...’; ‘chilane chilane’; ‘chank chank...’; ‘wack a where’; ‘poor devil poor devil’. Nests are large deep cups of bark, twigs and rootlets in leafy horizontal tree forks. Three – four spotted pink eggs are laid. Page 276

<http://dl.id.au>



Cicadabird – *Coracina tenuirostris*

Size – 24-26cm

Range – common migrants in forests and woodland in northern and eastern Australia.

The male cicadabird is a dark blue-grey with a black face and the female a barred brownish-grey with a dark streaked ear patch, buff edges to wing feathers and buff underparts with faint bars. Voices are a far-carrying cicada like call, ‘kree-kree...’ with a downward trend; and ‘clewk clewk’. Small flat cup nests in horizontal forks are formed where one blotched green egg is laid. Page 212



Australian reed-warbler – *Acrocephalus australis*

Size 17cm

Range – common resident or migrant in reedbeds throughout mainland Australia and Tasmania.

An unstreaked reed bird that has a pale eyebrow, an olive-brown back and pale beige underparts. The reed-warbler has melodious ‘twitchy twitchy twitchy quartz quartz quartz’; sharp ‘cheet’. They nest in deep cups of grass or dried reed sheaths laying 3-4 spotted and blotched bluish or brownish eggs. Page 242



Comb-crested jacana – *Jacana gallinacea*

Size 20-24cm

Range – common resident or nomad on lagoons and ponds with floating vegetation in northern and eastern Australia.

A jacana with dark shoulders and a red or orange comb on the forehead. Adults have a dark bronze back and wings and the black crown extends down into a broad breast-band. Nests are made as a low pile on floating vegetation and 3-4 lovely glossy brown eggs with black lines are laid. Page 94

<http://www.birdsinbackyards.net>



White-browed robin – *Poecilodryas superciliosa*

Size – 14-18cm

Range – a relatively uncommon robin found in dense tropical vegetation along rivers and creeks in northern Australia from Rockhampton, Qld to Derby, WA.

A brownish robin with a prominent white eyebrow found in undergrowth along tropical creeks and rivers. Two forms are present: white-sided on Cape York south to Rockhampton, QLD; and buff-sided form with a darker face in the NT and Kimberley, WA. It is a very active robin that often raises its tail, opens the wings and hops through the undergrowth and on the ground voicing a loud whistle ‘peet-peet-peet-peet’. Nests are small cups lined with grass and commonly decorated with white barks and lichens. Two to three spotted green to blue eggs are laid. Page 216

<http://www.flickr.com/>



Little shrike thrush – *Colluricincla megarhyncha*

Size – 17-19cm

Range – an uncommon resident in rainforest, riverine forest, paperbark forest and

mangroves in north-eastern and northern Australia.

A small, short-tailed, robust-billed shrike-thrush with brown upperparts and rufous underparts. Two forms exist: rufous form from the north-east is bright rufous with a little white on the throat and with a pale brown bill; black-billed form from NT and Kimberley is pale rufous below with whitish throat and has black bill. Nests are well hidden cups of leaves, bark and twigs where 2-3 freckled white eggs are typically laid.
Page 226



Mistletoe bird – *Dicaeum hirundinaceum*

Size – 10-11cm

Range – common nomad throughout Australia wherever mistletoe occurs and in gardens with introduced plants such as the Japanese Pepper.

Males of the species have an iridescent dark blue back and tail, with a red breast with a black stripe in the centre of the belly. Females have a pale grey breast with some faint speckles, a dusky grey streak on the centre of the belly and dark grey upperparts. Mistletoebirds voice is a high pitched 'swee-swit' or 'swit'; as sharp 'wit' during flight and they will also mimic other bird voices. Nests are a neat suspended boot shape made of plant-down and spiderweb, sometimes decorated with caterpillar droppings. Three to four white eggs are laid.

<http://www.birdsinbackyards.net>



Dusky honeyeater – *Myzomela obscura*

Size – 12-14cm

Range – common nomad in forest and woodland in eastern Australia, less common south of Sydney.

The plainest of all the honeyeaters being a uniform dusky brown with a slightly darker chin. Typically found in parties or small groups, the dusky honeyeater is aggressive and lively, often seen with other species of honeyeaters. Voices tend to be a soft whistle followed by a rapid chirped 'see-see-see'. Nests are made from rootlets and grass bound together with cobwebs as flimsy cups in outer tree foliage. Two freckled pinkish eggs are laid. Page 294



Grey fantail – *Rhipidura fuliginosa*

Size – 16cm

Range – common migrant, nomad or resident in any habitat with trees throughout mainland and Tasmania.

A small and active grey fantail with white tail feather shafts. Several easily recognisable forms exist: southern forms (Tasmania and Vic) are mid-grey above with a narrow breast band, and often migrate north in winter as far as Cape York; white-tailed forms from the central and western desert region; mountain forms (Cooktown to Townsville) found in rainforest on mountains above 700m are much darker with a broad black breast band; and mangrove forms from the northern region are a pale brownish-grey, with large white bars in the wing. Voices are a vigorous chatter and a sharp 'jeck'. Nests are neat cups made from grasses, bark and cobwebs on a horizontal twig and generally have a tail to the nest to aid run-off in wet weather. Two to four spotted pale buff eggs are laid. Page 234



Straw-necked ibis – *Threskiornis spinicollis*

Size – 58-76cm

Range – A greatly travelled ibis common throughout Australia near wetlands or pastures.

An ibis with black back and wing plumage glossed with blue, purple and green iridescence. It has long yellow plumes on the neck and yellow naked skin under the wings. Large cup-shaped nests are built in dense colonies on lignum or in bushes and trees over water. Four to five white eggs are laid. Page 58



Swamp harrier – *Circus approximans*

Size – female 50cm; male 58cm

Range – common resident or migrant in grasslands, reedbeds and crops in the north, east, south-east and south-west of mainland Australia and a migrant in Tasmania.

A large harrier with a white rump and a faintly barred tail. Males are brown with grey wings and tail and females are brown with a pale patch in the underwing and darker streaking. Nests are a flat cup in reeds or crops and 3-6 white eggs are typically laid.
Page 74



Brown falcon – *Falco berigora*

Size – females 45cm – male 55cm

Range – common resident or nomad in open woodland, tree-scattered plains and paddocks throughout the mainlands and Tasmania.

A long-legged falcon that varies from a pale sandy brown to almost black, but always has dark thighs and pale flight feathers on the underwing. There are a number of distinct adult forms: dark all over or with breast feathers that may be speckled, striped, white, grey, sandy or red. The brown falcon like other falcons does not build its own nest but rather uses cliff ledges, tree hollows and nests of other raptors and corvids. They will lay 3-5 blotched pinkish-buff eggs. Page 80



Shining (Golden) bronze-cuckoo – *Chrysococcyx lucidus*

Size – 17-18 cm

Range – common migrant (Aug-Apr) in forests and woodland in the mainland's east and south-west and in Tasmania.

An iridescent green bronze-cuckoo with complete bars on the underparts that extend to the chin. Two forms occur: golden form (breeds in Australia) with the head and throat bars a coppery bronze and little white freckling on the forehead; and the shining form (breeds in NZ) with the head and throat bars and iridescent green with extensive white freckling on the forehead. Voices are a series of whistles with upward inflection, followed by a few downward trills. They parasitises mainly dome-shaped nests of warblers, thornbills and scrubwrens, less often the nests of fantails, robins etc. Page 182



Little bronze cuckoo – *Chrysococcyx minutillus*

Size – 15-16cm

Range – migrant or resident in rainforest, forest, woodland and mangrove in northern and eastern Australia.

Small bronze-cuckoo with a red eye-ring, dull bronze-green above, broad incomplete bars on underparts and some rufous in the outer tail. Two forms occur: in coastal north-east Qld from Bowen to Cape York resident with rufous colouring on the breast and outer tail; and the migratory white-breasted form found in woodlands of northern and eastern Australia with a white breast and outer tail. . A distinctive downward trill is a common voice 'tew-tew-tew-teeew'. Both forms parasitise nests, typically warblers' and will lay small brown eggs. Page 182



White eared monarch – *Monarcha leucotis*

Size – 13cm

Range – a rather uncommon monarch in rainforest and occasionally mangroves and

paperbark swamps in eastern Australia from Tweed River, NSW to Cape York, Qld.

A black and white monarch with white markings on the head and edges to the wing and outer tail feathers. The throat is white with some black patches. An active feeder in the upper canopy, the white-eared monarch chases insects in a fantail fashion. Nests are made high in rainforest trees from grass, bark and moss with spide's egg sacs as decoration. Two spotted and blotched eggs are laid. Page 230



Welcome swallow – *Hirundo neoxena*

Size – 15cm

Range – common around habitations in southern and eastern mainland and Tasmania – vagrant elsewhere.

A rusty-throated swallow with grey underparts, black crown and back, no breast band and with white spots in tail. Voice is a pleasant twittering. Nests are mud cups usually among rafters and under eaves, bridges and overhanging rocks where 2-5 spotted whitish eggs. Page 200



Australia white ibis – *Threskiornis molucca*

Size – 65-75cm

Range – found in northern, eastern and south-eastern Australia often in large flocks parading across mown areas hunting for grubs and other creatures of the soil.

A black and white ibis with a long curving black bill, black naked skin on the head and upper neck, a white body, wings tipped with black and black plumes on the tail. Legs and feet are a reddish-brown. Nests are colonially built on lignum, mangroves, bushes or in trees in marshes. JCU



Rufous fantail – *Rhipidura rufiventris*

17cm

Range – common migrant or resident in rainforest and forest in eastern and northern

mainland; vagrant in Tasmania and SA.

Small active brown fantail with a rufous forehead and rump mostly seen with its tail spread in thickets and undergrowth close to the ground. The voice is a high-pitched 'pseet' and nests are built as a small neat cup with a long tail. Two to three spotted buff eggs are typically laid.



Australian wood duck – *Chenonetta jubata*

Size – 48cm

Range – common on wetlands throughout the mainland and visits Tasmania, particularly on lakes with standing dead timber, dams and occasionally on estuaries.

Greyish duck with dark maned head and rather goose-like stance. The males head is dark brown with a prominent mane and black undertail coverts. The females head is paler brown with pale eyebrow stripe and less obvious mane and white undertail coverts. It is the only duck with white secondary and dark primary flight feathers. Nests are found in tree hollows lined with down and contain 7–10 white eggs.



Radjah shelduck – *Tadorna radjah*

Size 40-60cm

Range – becoming rare at extremes of range which extends from Derby, WA, to Mackay, QLD

Large white-headed duck with pink bill. Usually in small flocks which prefer to stand on banks, logs or in shallow water. Feeds in shallow water on aquatic insects and some water weeds. Nests are found in tree hollows with a small amount of down and usually contain 6–12 white cream eggs.



Pied cormorant – *Leucocarbo fuscescens*

Size 70-75cm

Range – Common on the coast, islands and estuaries in the west and in the east on the coast, islands, estuaries, lakes and rivers. Found in Bass Straight but not in Tasmania.

Large pied cormorant with orange and yellow face. The juveniles back is browner and the face a dull yellow. Often occurs in large flocks and colonial nesting occurs in bulky stick nests on the ground on an island or in a trees over water. Nests contain 2-5 pale greenish eggs which are often stained.



Black Bittern – *Ixobrychus flavicollis*

Size 54-66cm

Range – In wetlands and mangroves from south west Australia around northern coastal areas to southern NSW.

Sooty black or dark brown bittern with yellow plume on neck. The male is black with yellow neck plumes and the female is dark brown, often with faint freckling on edges of back feathers with more yellowish plumes and streaking on the neck.. The juveniles back feathers have pale edges. The black bittern is more likely to feed in the open diurnally compared with other bitterns. Nests are solitary in dense trees overhanging water or mangroves and contain 3-5 pale blue-green eggs (usually 3).



Black necked stork (Jabiru) – *Ephippiorhynchus*

asiaticus

112-115cm

Range – Uncommon nomad over most of range from Broome, WA to Newcastle, NSW and a rare vagrant further south.

Large pied stork with iridescent neck. The male has a brown eye and the female a yellow eye. The immature bird is brown with buff-white areas where adult is white. The wingspan on adult birds is 200cm and it flies with its neck extended. Nesting is in a large stick nest in the top of a tree and contains 2-4 white eggs.



Brahminy kite – *Milvus indicus*

Size – female 51cm; male 45cm

Range – Common around coastal northern Australia from Carnarvon, WA to Hastings River, NSW.

Deep chestnut kite with head and breast white. Immature birds are brown with paler head and breast. Juveniles are dark brown with head and neck a streaked buff. Usually seen along beaches and mangroves and occasionally rivers. Nesting is in a large stick cup in mangroves and contain 2-3 blotched whitish eggs.



Royal spoonbill – *Platalea regia*

Size 75-80cm

Range – Common throughout northern and eastern Australia wherever suitable water exists but not widespread in southern WA or Tasmania.

White spoon bill with black bill but when breeding it has long plumes on the head and a yellow spot over the eyes and red patch on the forehead. Nesting is in large stick nests in colonies in trees or lignum over water and contain 2-4 spotted white eggs.



Brown goshawk – *Accipiter fasciatus*

Size – female 50cm; male 42cm

Range – Common resident or migrant in woodland, forests and riversides throughout Australia (southern form overlaps tropical form).

A barred brown hawk with long rounded tail. Adult birds are greyish-brown above and finely barred pale rufous below with a complete rufous collar. Juvenile birds are dark brown above, heavily streaked brown on the breast and with a broadly barred abdomen. In year 2 they become slaty brown above with narrower pale rufous bars on the breast and abdomen and no chestnut collar. In year 3 the bars become finer and the rufous collar is incomplete. The tropical form has longer toes, greyer above and more apricot bars below. Nesting is undertaken in a large stick nest in a tall tree and contains 2-4 white eggs sometimes spotted.



Little eagle – *Hieraetus morphnoides*

Size – female 55cm; male 48cm

Range – Uncommon in woodlands and tree lined water courses throughout Australia but not Tasmania.

A small eagle with a short square tail. Two phases occur – The Common light phase which is pale brown above, darker on the wings except a pale shoulder patch. Pale buff below with distinctive underwing pattern and faint bars in the tail. The juvenile is similar but the head and is rufous. The darker phase which is rare is dark brown all over with paler shoulder patches and a dark underwing with an obscure bullseye. The juvenile is similar but a dark reddish brown. Soars on flat wings with slow wingbeats. Nesting is in a large stick nest in the fork or on a horizontal limb and contains 2 blotched white eggs.



Wedge-tail eagle – *Aquila audax*

Size – female 100cm; male 90cm

Range – Common resident or nomad in most habitats throughout Australia but uncommon in settled areas.

A large brown or black eagle with long wedge-shaped tail. The adult is black with rufous or bland nape and shoulder patch and pale undertail coverts. The juvenile is dark brown above with black throat, breast and abdomen, feathers tipped pale at first and with pale rufous nape and shoulder patch. Adult plumage can take 5-7 years. Soars to great heights on unswept wings. Nesting is in enormous stick nests in large trees and contains 1-3 blotched white eggs.



Bush stone curlew – *Burhinus grallarius*

Size 55cm

Range – Common to rare resident or nomad throughout Australia, less common in the south and interior.

A small billed stone-curlew with streaked neck, found in any habitat with ground litter. Lays 1-2 blotched pale umber eggs on the ground.



Latham's snipe – *Gallinago hardwickii*

Size 24-26cm

Range – Common migrant from Japan and Kuril Island to eastern Australia and Tasmanian swamps and wet grasslands.

Latham's Snipe is the common snipe of eastern Australia and has 16-18 tail feathers with the outer four narrower that are barred black and white.



Scarlet honeyeater – *Myzomela sanguinolenta*

Size 10-11cm

Range – Common nomad in forest and woodland in eastern Australia but less common south of Sydney.

The male is a red honeyeater with black wings and tail and white abdomen. The female is a brown honeyeater and is paler below with reddish chin. The juvenile female is similar to the female but yellow base to the bill. The juvenile male has varying amounts of red on the head and breast. Nesting occurs in a flimsy cup of bark and grass bound with cobwebs in foliage and contains 2-3 spotted and blotched white eggs.



Restless flycatcher – *Myiagra inquieta*

Size 19-21cm

Range – Uncommon to common migrant or nomad (eastern Australia) or resident

(south-west and northern Australia) in woodlands, usually near water, in eastern, south-eastern, south-western and northern Australia.

A shining black monarch with underparts white, faintly buff breast and paler lores in the female. The juvenile has grey edges to the wing feathers and a buff breast. Nesting is in a neat cup decorated with paperbark and spiders eggsacs' containing 2-4 usually 3 blotched whitish eggs.

References - <http://www.ozanimals.com>

References:

www.wikipedia.org

www.aviceda.org = Australasian bird image database

www.geocities.com

www.wikimedia.org

Slater, P., Slater, P., Slater, R., 1994 & 2008, *The Slater Field Guide to Australian Birds*, NSW

/www.ntbirdspecialists.com.au (black bittern)

Ian Montgomery birdway.com.au (dusky honeyeater)

<http://www.birdsinbackyards.net> (olive backed oriole)