MCARTHUR RIVER MINE EXPANSION

RIPARIAN BIRD MONITORING PROGRAM

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1.0 INTRODUCTION

MRM/Xstrata currently operate an underground zinc/lead/silver mine and processing facility (McArthur River Mine) in the lower Gulf Region of the Northern Territory. The operation is located approximately 45 km southwest of the township of Borroloola and 740 km southeast of Darwin. MRM/Xstrata proposes to replace the underground operation with an open cut operation, that would require rechannelling of the McArthur River and creation of bunds to protect the mine from floodwaters. The open pit operation would commence with the construction of a diversion of the McArthur River and construction of a bund wall to protect the future pit workings from inundation during localised wet season flooding.

Guidelines for the Preparation of a PER for the rechannelling of the river and development of the open cut pit (EPA 2006) requires that an assessment of the potential for the project to impact on the white-browed robin and riparian habitat connectivity must be presented and measures to minimise these impacts provided. As a component of the project this report presents a draft riparian bird monitoring program that will provide data on the suite of bird species occurring in the riparian habitats of the McArthur River and associated tributaries, and the river realignment in the vicinity of the mine, as well as assessing the status of two birds that are riparian habitat specialists (white-browed robin and purple-crowned fairy-wren).

The purple-crowned fairy-wren and white-browed robin are found in suitable riverine habitat along both the McArthur River and Glyde River. They are largely restricted to dense riverine forest habitat, although the purple-crowned fairy-wren is also seen in adjacent grasslands and weed infested areas, and the white-browed robin occurs in monsoonal vine forest. The local race of the purple-crowned fairy-wren (*macgillivrayi*) is considered more secure than the western race (*coronatus*), which is classified as Vulnerable under the *EPBC Act 1999*. The

monitoring program may also provide incidental data regrading two additional significant species that occur in the region at low densities, the red goshawk and grey falcon.

The monitoring program is currently in draft form and will be finalised following agreement between Xstrata and NRETA should the proposed open cut expansion be approved.

1.1 ENVIRONMENTAL SETTING

Habitat along the main McArthur River channel within the mine project area is characterised by a relatively narrow dense fringing riverine *Melaleuca leucadendra* tall closed forest, surrounded by open floodplain forest types (generally *Eucalyptus papuana* tall woodland). The canopy of the riverine forest is relatively dense and common plant species include *Melaleuca leucadendra, Eucalyptus papuana, Casuarina cunninghamiana* and sparse *Pandanus aquaticus.* During the late wet season large areas of the ground layer in this habitat supports dense stands of noogoora burr (*Xanthium strumarium*). Floodplains surrounding fringing riparian vegetation on the McArthur River support a number soil and vegetation types ranging from low-lying open woodland with black soil grassland understorey to dry eucalypt or mixed woodland. Ground cover consists mainly of small shrubs and seasonal grasses. The area has historically been utilised for cattle grazing as a part of the McArthur River Station.

1.2 MANAGEMENT ISSUES

Fauna surveys conducted in riparian habitats in the vicinity of the McArthur River mine indicate that this vegetation type is species rich when compared to adjacent habitats. These habitats support a suite of bird species that include generalists that occur across a range of habitats within the local area, as well as species that are more likely to be associated with denser and more complex vegetation types and a small number of riparian habitat specialists.

In the northern Australian wet-dry tropics large rivers and streams support narrow bands of riparian vegetation that contrast strongly with adjacent open forests and savanna woodlands (Woinarski *et al.* 2000). Major features of these habitats are that they incorporate elements of monsoonal rainforests, they present a continuous linked habitat of dense vegetation which generally displays higher structural and floristic diversity than surrounding habitats, and they are generally more productive and wetter than surrounding habitats (Woinarski *et al.* 2000; Martin *et al.* 2006). Australian riparian habitats support a disproportionately large number of plant and animal species relative to their area when compared to drier open forest and savanna woodland habitats (Martin *et al.* 2006).

The high diversity of fauna species noted in riparian habitats in the northern wet-dry tropics extends to birds, with one study showing that riparian sites support approximately twice the number of bird species (and total individuals) as all other habitat types (Woinarski *et al.* 2000). Bently & Catterall (1997) found that within continuous bushland riparian areas support higher species richness and total bird abundances that dryland habitats. This is potentially related to higher moisture and nutrient levels producing a more diverse plant community with associated higher levels of structural complexity, greater number of resources and higher niche availability (Bently & Catterall 1997).

Significant seasonal changes in the suite of birds associated with riparian habitats in the northern wet-dry tropics have also been noted. Woinarski *et al.* (2000) found that bird abundance and species richness in riparian areas was far greater in the early mid dry season, that some foraging guilds (eg nectarivores and foliage-gleaning insectivorous honeyeaters) display an increase in abundance in riparian areas from early mid dry season to late dry - early wet season, and that riparian habitats display significant increases in the abundance of wet season migrants. These factors suggest that the differences in the suite of bird species and bird abundances between riparian and non-riparian habitats vary significantly depending on seasonal conditions (Woinarski *et al.* 2000). Another significant factor relates to the fact that riparian zones offer increased resource stability across various seasonal conditions in a highly seasonal environment, for example acting as dry season refugia and providing protection from fire (Woinarski *et al.* 2000). The riparian vegetation of major river systems is also influenced by significant stochastic events that significantly impact and influence the riparian corridor, such as the major floods that occur seasonally on the McArthur River floodplain.

Habitat connectivity can also influence the suite of species present in riparian habitats. Riparian habitats on major rivers provide a long continuous link through the landscape. This is in sharp contrast to the other main habitat for species that are dependant on structurally diverse habitats in the northern Australian wet-dry tropics, monsoonal vine forests. The latter habitats characteristically occur as a fragmented patchwork in the wider landscape (Price *et al.* 1995; Woinarski *et al.* 2000).

It has been identified that fragmentation of forested habitats has negative impacts on forest dependant biota remaining in the fragments, and that these impacts can be particularly significant if riparian corridors are impacted (Catterall 2003). While fragmentation of habitat can have biogeographic consequences and physical impacts on forest-dependent species, the size, shape, and position in the landscape can also influence how the changes impact biota utilising the fragments (Saunders *et al.* 1995; Jansen 2005). The effects of fragmentation may be ameliorated by restoration of the habitat, and in the case of the

McArthur River mine expansion by re-establishing an alternative riparian corridor of sufficient width on the realigned river channel. This strategy will potentially re-establish connectivity along the linear riparian corridor following successful establishment of an alternative corridor.

The determination of the width of a rehabilitated riparian corridor requires consideration of a variety of factors, including the need to facilitate wildlife movements, particularly for species that are less likely to occur in or cross adjacent open habitats. Catterall (1993) provides a review of published literature on riparian zones and their importance to terrestrial wildlife, in which the definition and value of vegetated riparian buffer zones/corridors are discussed in relation to the protection of the environmental values. The width of the corridor will determine the relative impact in the longer term of a number of factors that act on linear remnants of habitat, including edge effects, weed invasion, predation etc. Generic guidelines outlining corridor design for the purpose of wildlife movement or conservation generally specify greater buffer widths than those required to control erosion and protect water quality in the receiving environment.

Most studies focusing on the use of corridors by wildlife have examined corridors which have been left in a fragmented landscape, rather than restored corridors or projects that aim to re-establish riparian corridors (Jansen 2005). Many of the studies associated restoration of mined areas in northern Australia concentrate on the rehabilitation of areas of habitat within an undisturbed surrounding landscape, rather than the re-establishment of a narrow band of a specific habitat within a wider habitat matrix. The factors influencing the restoration may be further complicated by the re-channelised river with its associated engineering works. However Jansen (2005), in a study of the restoration of riparian vegetation linking remnant rainforest patches in the wet tropics of Queensland, found that a riparian restoration project could re-establish connectivity for forest birds and provide habitat for closed forest specialists. The high biodiversity associated with riparian zones is likely to be partly linked to the condition of surrounding habitats, suggesting that consideration must be given to the management of habitats adjacent to the riparian zone, the riparian restoration area and the general landscape context of the project (Martin *et al.* 2006).

2.0 RIPARAIN BIRDS IN THE VICINITY OF THE MCARTHUR RIVER MINE

Birds occurring in riparian habitats in the McArthur River, Barney Creek and Glyde River have been assessed during impact assessment studies (Hollingsworth, Dames & Moore 1992, Ecostudy 1992). Timed area searches (20min /2ha searches) conducted in these riparian habitats on the McArthur and Glyde Rivers (n=11) during 2003 by the author recorded 51 bird species (Table 1). Two significant raptor species that occur at low abundances within the local

area and region, the red goshawk and grey falcon, have been recorded in the vicinity of the project area or lower McArthur River catchments. Two additional bird species that are strongly associated with riparian habitats are present in the project area. The white-browed robin and purple-crowed fairy-wren were found to be relatively common during surveys conducted during 2003, the former species being observed in 27.3% of the timed/area searches and the latter species in 45.5% of the timed/area searches (Barden unpublished records).

A number of additional birds are likely to be of interest in terms of identifying changes in riparian habitat quality. Woinarski *et al.* (2000) document 157 bird species as occurring in riparian habitats across the top end of the Northern Territory, and 45 of these species were significantly more common in riparian habitats. On a regional scale the bird fauna of the McArthur River in the vicinity of the mine is considered to be of relatively low species diversity and abundance (Woinarski *et al.* 2000), with important riparian indicator species being the purple-crowned fairy-wren, crimson finch, white-browed robin, restless flycatcher, yellow-tinted honeyeater and peaceful dove.

Table 1

Birds Recorded in Timed Area Searches (20min/2 ha area searches) In Riparian Habitat, McArthur River and Glyde River (n=11), April 2003 and November 2003

	Counts					Surveys		Sites	
Common Name	**Total**	**Max**	**NS**	**CMean**	**SMean**	**Freq**	**%**	**Freq**	**%**
Little Pied Cormorant	1	1	1	1	0.09	1	9.1	1	20
Great Egret	1	1	1	1	0.09	1	9.1	1	20
White-faced Heron	1	1	1	1	0.09	1	9.1	1	20
Black Kite	3	1	3	1	0.27	3	27.3	2	40
Whistling Kite	6	1	6	1	0.55	6	54.5	4	80
Grey Falcon	1	1	1	1	0.09	1	9.1	1	20
Peaceful Dove	14	5	5	2.8	1.27	5	45.5	4	80
Bar-shouldered Dove	13	2	9	1.44	1.18	9	81.8	4	80
Red-tailed Black-Cockatoo	62	50	3	20.67	5.64	3	27.3	1	20
Galah	1	1	1	1	0.09	1	9.1	1	20
Sulphur-crested Cockatoo	8	5	3	2.67	0.73	3	27.3	3	60
Northern Rosella	3	2	2	1.5	0.27	2	18.2	1	20
Red-winged Parrot	4	2	2	2	0.36	2	18.2	2	40
Rainbow Lorikeet	14	10	3	4.67	1.27	3	27.3	1	20
Brush Cuckoo	1	1	1	1	0.09	1	9.1	1	20
Australian Koel	1	1	1	1	0.09	1	9.1	1	20
Channel-billed Cuckoo	4	2	3	1.33	0.36	3	27.3	2	40
Pheasant Coucal	1	1	1	1	0.09	1	9.1	1	20
Southern Boobook	1	1	1	1	0.09	1	9.1	1	20
Azure Kingfisher	2	1	2	1	0.18	2	18.2	2	40
Blue-winged Kookaburra	6	2	4	1.5	0.55	4	36.4	3	60

	Counts					Surveys		Sites	
Common Name	**Total**	**Max**	**NS**	**CMean**	**SMean**	**Freq**	**%**	**Freq**	**%**
Sacred Kingfisher	3	1	3	1	0.27	3	27.3	3	60
Rainbow Bee-eater	11	4	4	2.75	1	4	36.4	2	40
Fairy Martin	2	2	1	2	0.18	1	9.1	1	20
White-bellied Cuckoo-shrike	2	1	2	1	0.18	2	18.2	1	20
Rufous Fantail	2	2	1	2	0.18	1	9.1	1	20
Restless Flycatcher	3	2	2	1.5	0.27	2	18.2	1	20
White-browed Robin	5	2	3	1.67	0.45	3	27.3	2	40
Rufous Whistler	11	5	5	2.2	1	5	45.5	3	60
Grey Shrike-thrush	3	2	2	1.5	0.27	2	18.2	2	40
Red-backed Fairy-wren	6	6	1	6	0.55	1	9.1	1	20
Variegated Fairy-wren	2	2	1	2	0.18	1	9.1	1	20
Purple-crowned Fairy-wren	18	5	5	3.6	1.64	5	45.5	2	40
Weebill	1	1	1	1	0.09	1	9.1	1	20
Mistletoebird	1	1	1	1	0.09	1	9.1	1	20
Striated Pardalote	9	2	7	1.29	0.82	7	63.6	3	60
Brown Honeyeater	15	5	6	2.5	1.36	6	54.5	4	80
Dusky Honeyeater	1	1	1	1	0.09	1	9.1	1	20
Banded Honeyeater	3	3	1	3	0.27	1	9.1	1	20
White-gaped Honeyeater	15	4	8	1.88	1.36	8	72.7	4	80
Yellow-tinted Honeyeater	11	3	5	2.2	1	5	45.5	4	80
Grey-fronted Honeyeater	1	1	1	1	0.09	1	9.1	1	20
Rufous-banded Honeyeater	1	1	1	1	0.09	1	9.1	1	20
Olive-backed Oriole	1	1	1	1	0.09	1	9.1	1	20
Black-faced Woodswallow	3	2	2	1.5	0.27	2	18.2	1	20
Little Woodswallow	15	4	4	3.75	1.36	4	36.4	3	60
Pied Butcherbird	1	1	1	1	0.09	1	9.1	1	20
Great Bowerbird	5	2	4	1.25	0.45	4	36.4	3	60
Australian Raven	1	1	1	1	0.09	1	9.1	1	20
Crimson Finch	20	8	6	3.33	1.82	6	54.5	2	40
Chestnut-breasted Mannikin	2	2	1	2	0.18	1	9.1	1	20

Total = total number observed; Max = maximum no. observed in a single 20min/2ha count; NS = No. of surveys during which a species was recorded; CMean = sum divided by NS; SMean = total divided by no of surveys; Freq = No of surveys where the species was recorded; % = percentage of surveys where the species was recorded.

White-browed Robin (*Poecilodryas superciliosa*)

The white-browed robin has been identified as a species that is strongly associated with riparian habitats and monsoon vine thickets, and that has declined in the Northern Territory in these habitats due to the impacts of grazing and fire (Woinarski *et al.* 2000). Within the McArthur River area the white-browed robin is common in riparian vegetation along the main McArthur River channel and in the riparian vegetation and small monsoon vine thickets associated with side gorges in the Bukalara Range/Glyde River area (Barden unpublished records). Elsewhere on McArthur River Station this species has also been observed in

isolated monsoon vine forest in the Abner Range, in habitat that is distant from contiguous riparian habitats (K. Martin pers comm. May 2006).

During timed area searches (20 min/2 ha) undertaken in riparian habitats on the McArthur River (adjacent to the existing mine) and on the Glyde River during 2003, the white-browed robin was a relatively common species, with a mean number of observations per 20-minute sample of 0.45 individuals (19th of 51 species). The white-browed robin was detected in 27.3% of surveys within riparian habitats (n=11). Most observations were associated with denser vegetation on the banks of the river on the main McArthur River channel, and small patches of monsoon vine forest and Melaleuca species in the Glyde River gorge. Birds were recorded singly or in pairs.

The ability of this species to disperse and move within the landscape remains poorly known, and while it is thought to be relatively sedentary, local movements (<10km) have been reported (Higgins *et al.* 2002). The presence of this species in relatively isolated patches of suitable habitat, such as monsoon vine forest in the Abner Range and small patches of habitat separated for some distance by apparently unsuitable habitat in the Glyde River/Bukalara range, suggests that the white-browed robin is able to move across areas of unsuitable habitat.

Purple-crowned Fairy-wren (*Malurus coronatus*)

The purple-crowned fairy-wren has been identified as a species that is strongly associated with riparian habitats and that, as for the white-browed robin, has declined in the Northern Territory (Woinarski *et al.* 2000). In the Northern Territory this species typically occurs in dense riparian vegetation (Higgins *et al.* 2002) and in the lower Gulf region populations are known from the known from the Limmen Bight, McArthur, Robinson and Calvert Rivers. Within the McArthur River area the purple-crowned fairy-wren is common in riparian vegetation along the main McArthur River channel, and during 2003 this species was recorded at one site in the Glyde River gorge in the Bukalara Range at Amelia Springs (P. Barden & K. Martin, unpublished records, 2003).

In the vicinity of the McArthur River mine, in the area between Djirrinmini water hole and Mount Stubbs, purple-crowed fairy-wrens were common on the upper banks and adjacent habitats, particularly where dense annual grasses or a dense understorey of noogoora burr (*Xanthium occidentale*) created suitable ground cover. During timed area searches (20 min/2 ha) undertaken in riparian habitats on the McArthur River (adjacent to the existing mine) during 2003, the purple-crowed fairy-wren was locally common, with a mean number of observations per 20-minute sample of 1.64 individuals (3rd of 51 species). The numbers of individuals encountered during timed area searches was enhanced by the fact that many

observations of this species were of small groups of birds rather than individuals. The purple-crowed fairy-wren was detected in 45.5% of surveys within riparian habitats (n=11).

The purple-crowned fairy-wren is usually restricted to linear strips of riparian vegetation within close proximity to water, however it has been reported to commonly occur in dense grassy woodlands adjacent to this habitat (>100m from water) at Victoria River Crossing, NT (Higgins *et al.* 2000). At Borroloola the purple-crowned fairy-wren has been observed ~600m from a water. Within the McArthur River project area this species was most commonly observed on the higher banks of the river and adjacent grassy and weed infested areas where suitable cover was present (up to100m from the river margin) (Barden unpublished records).

The purple-crowed fairy-wren is sedentary and maintains territories throughout the year (Rowley 1993; Higgins *et al.* 2000). Documented movements of this species have been in relation to relation to flooding of territories, dispersal of young and dispersal into new territories, usually less then 1-2 km (Higgins *et al.* 2000). Rowley (1993) suggests that the poor powers of flight of the purple-crowned fairy-wren may limit dispersal and its ability to recolonise areas. However in a demographic study of this species Rowley & Russell (2003) found that unoccupied territories were sometimes filled by birds that had dispersed across unknown habitat from outside the study area. The presence of this species in the Glyde River gorge at Amelia Springs at a site that is isolated from other apparently suitable habitats suggests that it may be able to colonise and move between areas of intervening habitat that include gorge areas devoid of vegetation. The presence of the purple-crowed fairy-wren in areas of dense noogoora burr infestation adjacent to the McArthur River riparian corridor also indicates that this species may continue to utilise disturbed habitats if microhabitat requirements are met.

3.0 MONITORING OBJECTIVES

The monitoring program and objectives (including specific objectives of the sampling program, sampling frequency, site numbers, treatment types etc) described in this section are currently in draft form and will be finalised following agreement between Xstrata and NRETA should the proposed open cut expansion be approved.

The broad objectives of the monitoring program will be to provide data relating to the following issues:

1. Does the project have an impact on the riparian bird assemblage as a whole, and in particular the riparian specialist species?

2. What is the nature of the potential impact, what is the scale of the potential impact and does this impact exceed any identified threshold?
3. What are the processes that produce the impact (e.g. altered water flows, vegetation loss or disturbance, loss of habitat connectivity)?
4. What is the influence of ameliorative measures (e.g. restoration of a riparian corridor on the realignment), and how are these measures influencing local riparian bird populations and riparian specialist species?
5. What is the relationship between monitoring results, their interpretation and management response (eg the pathway to remedial intervention)?
6. Is the monitoring program adequate to detect detrimental change, and frequent enough to detect change in a timely manner?

The presence of birds in a broad variety of feeding guilds and niches within an ecosystem suggests that they are ideal indicators of environmental conditions (Burnett *et al.* 2005). Data on bird populations is readily compiled using observational and call based surveys, and there are well established standardised methods. Existing databases of bird observations enable observations to be compared to larger sets of data, such as the national Atlas of Australian birds (Barett *et al.* 2003).

Monitoring of bird populations is relatively cost effective when compared to the effort required to monitor other vertebrate fauna groups, and monitoring of a population of birds provides researchers with feedback from a whole community of organisms rather than a single species (Burnett *et al.* 2005). Monitoring birds can therefore provide a useful measure of the relative success of a habitat restoration project (Burnett *et al.* 2005). Monitoring of bird populations can provide the following in relation to the design and application of an ecosystem-based restoration project:

- Data on the distribution and habitat uses of birds prior to the restoration;
- Feedback on the short-term effects restoration activities may have on bird populations;
- Data on species preferences and habitats that can be used to develop restoration design and revegetation options;
- Feedback on the overall success of restoration.

The McArthur River bird monitoring program will be designed to:

- Select sites where birds will be monitored at least twice per year (wet and dry season surveys).
- Choose sites randomly within a stratified framework that allows a comparison of the following treatments; upstream McArthur River main channel, downstream McArthur river main channel, pit area main channel, and diversion area.
- Establish and permanently mark monitoring areas at each site (2 ha linear transect plots).
- Include adequate replication of sites to collate data for appropriate analysis;
- Standardise the time of all surveys;
- Conduct seasonal sampling within a two-week period.
- Base the collection of bird data on the Birds Australia Atlas (2 ha, 20-minute surveys) methodology (Barrett *et al.* 2003).

3.1 SAMPLE SITES

Treatments to be sampled within the project area include:

- Existing riparian vegetation on the McArthur River upstream of the proposed open cut pit and river diversion;
- Existing riparian vegetation on the McArthur River downstream of the proposed open cut pit and river diversion;
- Existing riparian vegetation on the McArthur River within the bund area (impact area); and
- McArthur River re-alignment channel (riparian restoration area);

The number of replicate sites for each treatment will be determined following consultation with NRETA and relevant agencies.

3.2 FIELD SAMPLING METHODS

Barrett *et al.* (2003) describe a standardised bird monitoring method that has been utilised for the national Birds Australia Atlas of Australian Birds. This survey method involves searching a two hectare area for 20 minutes, with the recommended shape being 100 m x 200 m area. The method has been successfully used in studies of bird populations in riparian zones, and can be adapted to narrow riparian strips by altering the shape of the 2 ha area. Martin *et al.* (2006) used the 20 minute/2 hectare method to assess the status of riparian strips, with a 2 ha search area based on a 25m x 800m quadrat. The 2 ha area search is appropriate to the McArthur River bird monitoring project, as it will provide data that will be comparable to a

regional and nationwide data set (Birds Australia Atlas of Australian Birds data), it is well suited to the sampling of linear riparian habitats (Martin *et al.* 2006), and can be compared to bird survey data collated in the study area during 2003 using the 20 minute/2 ha area search method.

3.2.1 Habitat Data

Habitat and structural data and other relevant environmental variables will be compiled for each site during each seasonal sample period. Data will be compiled in standard habitat data sheet and include climatic data encountered during the sampling period, vegetation structure, disturbance etc.

3.2.2 Sampling Plan

The 20 minute/2 ha area search requires that a 20 minute search is conducted within a defined 2 ha area (eg 100 x 200m quadrat, to be determined based on width of riparian habitats to be sampled), during which all birds seen or identified by call are recorded, including those seen flying over the 2 ha plot (Barrett *et al.* 2003). Survey considerations include:

- Sites will be traversed in a single direction and care taken to avoid double counting of individual birds (Martin *et al.* 2006);
- Experienced bird surveyors will undertake the sampling. Surveyors will be adept at identifying birds from their calls, as reliance on this method of identification can potentially minimise issues related to abundance estimates and unevenness of detectability of birds within plots (Jansen 2005; Martin *et al.* 2006). Conducting surveys along a narrow 2 ha area plot will reduce error related to detectability, as most birds should be detectable by sight or call within this area regardless of the density of vegetation;
- For records obtained from call identification, an estimate of the number of birds calling will be recorded;
- Any additional data on the bird assemblage will be recorded where relevant, including breeding records;
- For observations of target species (eg white-browed robin, purple-crowned fairy wren), additional observational data will be compiled, including distance from the centre of the river/creek/transect and/or location within the plot, comments on microhabitat or general habitat use, breeding observations etc).
- Sites will be located parallel to the watercourse, and birds on both sides recorded;
- If possible the distance between sites will be at least 1 km, to ensure independence between the sites;
- Sites will be sampled in a restricted random fashion within the sampling period;

- During each seasonal sample, each site will be sampled for a minimum of four 20 min 2 ha area counts, preferably with one count per morning at each site.
- Local climatic conditions will be recorded at the commencement of each timed area search, including cloud cover, temperature, wind direction, wind velocity, precipitation etc.

3.2.3 Sample Requirements

Minimum of four timed area searches per site (total 80 minutes) per seasonal sample. Samples to be taken in the dry season, and repeated in the wet season. Sampling would commence prior to the construction phase to collate baseline data, and monitor the operational phase across the establishment of the riparian habitat restoration.

3.2.4 Analysis of Data

A number of treatment categories would be considered, including upstream undisturbed riparian habitat, downstream undisturbed riparian habitat, impacted riparian habitat within the bund and restored riparian habitat on the re-aligned channel. Analyses should be conducted for the following sets of variables: bird species richness, individual species abundance, and total species relative abundance. Data analysis could also specifically consider:

- Analysis of abundance and species richness for specific habitat, foraging guilds and individual species;
- Comparison of species richness, abundance and guild characteristics between impacted sites, restored habitats and control sites;
- Analysis of frequency and abundance of target species (eg white-browed robin) across the sites; and
- Analysis of species turnover and bird community similarity across the sites.

3.2.5 Data Reporting & Feedback

Monitoring data would be reported at least annually, with interpretation highlighting any change in population size, distribution and change in species composition of the riparian bird community. This data could then be used to inform ongoing management in the project area and in particular to guide revegetation/restoration measures.

4.0 REFERENCES

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