



Community Biodiversity Survey

'Panboola', Pambula, NSW South Coast



**A report prepared for Pambula Wetlands
& Heritage Project Inc.**

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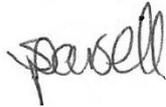
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Front Cover Image

A male Eastern Water Dragon 'Gippsland Form' (*Physignathus lesueurii howitti*) found during spotlighting surveys along Pambula River. Photo: Steve Sass.

Executive Summary

EnviroKey were engaged by the Management Committee of Pambula Wetlands and Heritage Project Inc. to undertake a Community Biodiversity Survey (CBS) at Panboola, a 77 ha area of floodplain near Pambula on the NSW Far South Coast. Given existing knowledge from past studies, the CBS focused on mammals, reptiles and bats.

A desktop analysis was conducted to obtain an understanding of the mammals, reptiles and bats that have been previously recorded with a 5km radius of Panboola. Field surveys, guided by the Community Biodiversity Survey Guidelines – 3rd Edition for Comprehensive Surveys, detected the presence of nine mammal species, six reptile species and 12 bat species. Five species listed as threatened under the schedules of the NSW *Threatened Species Conservation Act 1995* or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* were recorded.

Discussion is provided on presences and absences, threatened species and observed differences in communities across different habitats for mammal, reptile and bat communities at Panboola.

A series of recommendations are provided that detail specific actions for habitat management, habitat restoration, community awareness and future survey and monitoring.



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1 INTRODUCTION

Panboola is a 77 hectare (ha) area of floodplain managed by the Management Committee of Pambula Wetlands and Heritage Project Inc. in conjunction with the Pambula Wetlands and Heritage Reserve Trust. It is situated adjacent to the township of Pambula on the far south coast of NSW, Australia.

Panboola comprises a series of diverse estuarine and freshwater wetlands on a river floodplain. The fauna that occupy floodplain environments are often specialised and usually dependent on floodplain habitats and their variability (Healey *et al.* 1997; Mac Nally and Horrocks 2002). To date, few studies have attempted to encapsulate the full range of fauna that are likely to occur at Panboola.

Previous studies that consider the fauna of Panboola are the Panboola Plan of Management (IronoutVCAConsultants 2006), the Frog Diversity of Panboola (EnviroKey 2011), a baseline study of microchiropteran bats (EnviroKey 2010) as well as ongoing monitoring of bird communities lead by the Office of Environment and Heritage and Far South Coast Birdwatchers Inc. The Panboola Plan of Management details management of the natural wetlands including volunteer effort, funding and presentation of the site (IronoutVCAConsultants 2006). The frog study is detailed in nature and was conducted over a number of months enabling a throughout understanding of the frog communities that occur within Panboola (EnviroKey 2011). The Far South Coast Birdwatchers Inc. has completed seasonal bird surveys of Panboola since 1997. These surveys provide a significant knowledge base as to the avifauna that utilise the habitats of Panboola. However, the microchiropteran bat study provides a baseline dataset from two brief surveys and an insight into the microchiropteran bats that use the habitats of Panboola (EnviroKey 2010).

Conversely, no fauna surveys have been completed for reptiles or mammals; all significant components of floodplain biota. In an attempt to improve knowledge and understanding of the mammal, reptile and bat communities of Panboola, PWHP sought funding from the NSW Environmental Trust for the purpose of a Community Biodiversity Survey (CBS). This funding application was successful in early 2011 and subsequently, **EnviroKey** were engaged to undertake the CBS.

This report compiles the results of the CBS and provides detailed accounts of the mammal, reptile and bat communities of Panboola for the first time.

1.1 QUALIFICATIONS AND EXPERIENCE OF PERSONNEL

The field surveys and preparation of the report has been undertaken by suitably qualified and experienced personnel. Details of each person and their involvement in field surveys and the preparation of this report are provided within Appendix 3.

1.2 DEFINITIONS AND ACRONYMS USED IN THIS REPORT

The following definitions and acronyms are used within this report:

CBS – Community Biodiversity Survey.

CMA – Catchment Management Authority

EPBC Act – Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

LGA – Local Government Area.

likely - taken to be a real chance or possibility.

locality - means the area within a 5 km radius of the study area.

local population - the population that occurs within the study area, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated.

NP&W Act – NSW *National Parks and Wildlife Act 1974*.

OEH– NSW Office of Environment & Heritage

region - means a biogeographical region that has been recognised and documented such as the Interim Biogeographical Regions of Australia (IBRA) (Thackway and Creswell 1995). The study area is located within the South East Corner Bioregion.

SEWP&C – Department of Sustainability, Environment, Water, Population and Communities.

study area – For the purpose of this report, the study area is identified within Map 1, Appendix 1. It is also referred to as 'Panboola'.

TSC Act – NSW Threatened Species Conservation Act 1995.

threatened biota - means those threatened species, endangered populations or endangered ecological communities considered known or likely to occur in the study area.

threatened species – a species specified in the schedules of the TSC Act or the EPBC Act.

2 METHODOLOGY

2.1 STUDY AREA

The study area is located at 'Panboola', on the Pambula River floodplain south of the township of Pambula on the NSW far south coast (Map 1, Appendix 1). It is broadly flanked by Ben Boyd National Park to the east, Pambula River to the south, the Princes Highway and agricultural land to the west and the town of Pambula to the north.

2.1.1 *Climate*

The study area occurs within the South East Corner Bioregion which is dominated by a relatively temperate climate usually characterised by warm summers (NPWS 2003). The closest weather station is located at Merimbula Airport, three and a half kilometres north of the study area. Data from the Bureau of Meteorology suggests that the region experiences cool to mild winters with warm to hot summers (BOM 2011). The mean minimum temperature is 9.7 degrees Celsius and the mean maximum temperature 20.6 degrees Celsius. The mean annual rainfall is 702mm (BOM 2011).

2.1.2 *Geology and Soils*

The geology and soils at Panboola are split into two groups (Talau 1997). The northern end of the study area contains backswamps and swamps in quaternary alluvium associated with the Jellat Jellat Flat soil landscape (Talau 1997). This landscape is classified as an over-cleared landscape and has an elevation of generally less than 50m.

Toward the southern end of the study area, the site is classified as having extremely variable stratigraphy (Talau 1997). This consists of generally thinly layered sands and gravels to clay with brackish saline subsoil. These are associated with minor alluvial flats and deltas of small tributary creeks generally less than five metres elevation.

2.1.3 *Vegetation Communities*

Six vegetation communities occur at Panboola (IronoutVCAConsultants 2006; Miles 2001). Descriptions within these documents suggest the presence of three threatened ecological communities listed under the *Threatened Conservation Act 1995* as endangered (DECCW 2011b).

These being:

- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.
- Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.

Miles (2001) provides further accounts of the vegetation communities and the flora species within them.

2.2 DESKTOP ANALYSIS

2.2.1 *Mammals*

Given that, to our knowledge, no previous mammal surveys have been completed at Panboola, a desktop analysis was completed to gain an understanding of the mammal fauna that might occur at Panboola. Data was sought from the OEH Atlas of NSW Wildlife in relation to mammal fauna that have been recorded within a 5km radius of Panboola (DECCW 2011a). These records were then mapped using ArcMap 10 at a scale permissible by OEH data license agreement (1:250,000). The Panboola Plan of Management was also reviewed for records of mammal fauna (IronoutVCAConsultants 2006).

2.2.2 *Reptiles*

Given that no previous specialist reptile surveys have been completed at Panboola, a desktop analysis was completed to gain an understanding of the reptile fauna that might occur at Panboola. Data was sought from OEH Atlas of NSW Wildlife in relation to reptile fauna that have been recorded within a 5km radius of the Panboola (DECCW 2011a). These records were then mapped using ArcMap 10 at a scale permissible by OEH data license agreement (1:250,000). The Panboola Plan of Management was also reviewed for records of reptile fauna (IronoutVCAConsultants 2006).

2.2.3 *Bats*

The previous study of microchiropteran bats (EnviroKey 2010) included field surveys that were conducted in December 2009 and February 2010. This study revealed the presence of eight microchiropteran bat species at Panboola. Three of these species are listed as 'threatened' under the schedules of the NSW *Threatened Species Conservation Act 1995*.

Data was also sought from OEH Atlas of NSW Wildlife on bat fauna that have been recorded within a 5km radius of the Panboola (DECCW 2011a). These records were then mapped using ArcMap 10 at a scale permissible by OEH data license agreement (1:250,000). The Panboola Plan of Management was also reviewed for records of bat fauna.

2.3 SITE SELECTION

Five sites were used for the CBS. These were selected *a priori* based on the sites selected for the 2011 frog study (EnviroKey 2011) with one exception. This being the exclusion of one site that was included in the frog study - Waterbird Sanctuary (WBS1).

Therefore, five sites were used for the CBS. These were the Waterbird Sanctuary (WBS), Tips Billabong (TIPS), Corridor (CORR), Salt Marsh (SALT), and Riparian (RIP). The

locations of the five sites at Panboola are detailed within Map 3 (Appendix 1) and a description of each site detailed within Section 2.5.

2.4 FIELD SURVEYS

Methods used in the field surveys for the CBS were guided by the form and content of the Community Biodiversity Survey Guidelines – 3rd Edition for Comprehensive Surveys including the use of pro-forma data sheets (NPA 2007) This section provides details of the methods used for mammals, reptiles and bats.

2.4.1 *Mammals*

Methods used to detect mammals were chosen due to their efficiency in detecting a wide variety of mammalian fauna. A 100m transect was established at each of the five sites. The location of this transect was chosen to encompass the widest variation of habitats within each site with the transect being the basis for all the other field survey methods. At each end of the 100m transect a stake flagged with flagging tape was placed, so that the transect could be identified easily during the survey period and at a later time for replication or future monitoring. This section provides an overview and images of each survey method employed to detect mammals. The mammal survey methods and total survey effort is summarised in Table 1.

Hair Tubes

Hair tubes are used to detect terrestrial mammals of all size but particularly target larger mammals (>500 grams), such as quolls, bandicoots and macropods. Hair tubes are A4 sized plastic with double-sided adhesive tape at each end (Figure 1). A bait mixture comprising rolled oats, honey and peanut butter was used to lure the mammal to the hair tubes, where the adhesive tape collects the hair when the mammal comes in for a closer inspection. Each bait was also laced with truffle oil as an additional attractant for potoroos and bandicoots. The plastic is held down by a U shaped metal peg. Ten hair tubes were placed at each of the five sites along the 100m transect. Once the survey was completed the hairs are sent to a hair specialist for analysis (see Appendix 3 for details). Hair tube surveys were conducted between 12th March 2011 and the 6th April 2011. Some hair tubes activated at the Corridor, Saltmarsh and Riparian sites were lost due to heavy flooding of the Pambula River during the survey period. The total number of detection nights was 1,250 nights.



Figure 1: An example of a Hair tube *insitu* at the Waterbird Sanctuary.

Elliot Traps

An Elliot trap is small (30x10x10 cm) aluminum box (Figure 2) which collapses flat for easy storage and transport when not in use. Elliot traps are used to catch small mammals, including antechinus and rats. Once assembled the trap is then baited with a mixture of rolled oats, honey and peanut butter with the bait placed at the far end of the trap. Once the animal steps on the treadle on the floor, it triggers the door to close via a spring mechanism. Five Elliot traps were placed along the 100m transect at each of the five sites. Each Elliot trap were placed within the ground habitat structure and flagged with flagging tape for easy detection. Elliot traps were activated between the 12th March and 16th March 2011 over four consecutive nights. Traps were checked daily within two hours of sunrise with all animals identified and released at the point of capture. The total survey effort using this method was 100 trap nights.



Figure 2: An example of an Elliott Trap *insitu* within the Waterbird Sanctuary

Funnel Traps and Drift Fencing

Funnel traps and drift fencing were also used within the comprehensive mammal survey, which target small, terrestrial mammals. Funnel traps and drift fencing divert terrestrial mammals that are moving through habitat into each trap. As the animals reach the drift fence, they then precede left or right where they follow the fence until they enter the funnel trap. The funnel has raised exit holes so that any individual trapped cannot escape. A 20 metre PVC drift fence, 230mm tall was established and dug into the ground 50mm so that any mammals could not move under the drift fence. The fence was held in position by 6mm diameter metal pegs 450mm long. Three pairs of funnel traps were placed along the 20 metre fencing, which were pinned against the drift fence by metal stakes, shown in Figure 3. Each entrance of the funnel was built up by the ground substrate so that any animal does not detect an unfamiliar substrate. Funnel Traps and drift fences were activated between the 12th and 16th of March 2011 over four consecutive nights. Funnel traps were checked daily within two hours of sunrise with all animals identified and released at the point of capture. The total survey effort using this method was 120 trap nights.



Figure 3: Drift Fencing and Funnel Traps established at SALT (left) and daily checks of Funnel Traps at CORR (right).

Scat Collection

Scat (animal droppings) collection was used to help detect mammals within each of the survey sites. This method provides another opportunity to detect cryptic species either not easily observed or not easily trapped. Scats were collected (while the collector was wearing latex gloves) during the survey period during one search along the 100m transect and

placed within a paper bag. On the paper bag specific data was recorded, including date and site identification.

The scat along with information was sent a specialist for analysis (details provided in Appendix 3).

Motion Activated Infrared Camera

Two motion activated infrared cameras were also used to detect cryptic and trap-shy mammals within the study area. A bait station was set in front of a Reconyx PC900 Professional series motion activated infrared camera. The bait station was comprised of a 50mm plumbing vent cap with a sponge inside the cap soaked with truffle oil. Each bait station was then pinned to the ground with a metal tent peg. Each camera was set to take 10 shots, one second apart, for every motion detected. One camera was set up in the WBS with the second camera at RIP (Figure 4). The motion activated infrared cameras were in use between the 12th March and 16th of March 2011 over four consecutive nights. Cameras were downloaded at the conclusion of the CBS and animals identified from photograph. The total survey effort using this method was 10 camera days.



Figure 4: Motion activated Infrared Cameras used during the CBS. The left image is from RIP and the right, WBS.

Opportunistic Survey

Opportunistic field surveys are used to record any animals that were detected while travelling between study sites or outside specific survey times. Data recorded included: Date, Time, Location, Species, number of animals and activity type. Opportunistic Surveys were conducted whenever the survey team was within the study area for the CBS. Only mammals not recorded using other survey methods were noted.

Spotlighting Survey

Nocturnal field survey methods also included spotlighting. While birds were not the subject of the CBS, nocturnal birds such as owls rely on the presence of small, terrestrial mammals for prey. The presence of owls at Panboola could suggest a rich small, terrestrial mammalian community. Prior to the commencement of spotlighting, a listening period of 3 minutes was conducted. The purpose of this was to listen for any calling owls. After the listening period, the call of the Masked Owl and then the Barking Owl was transmitted using an MP3 player and FM modulator through a pair of 50W speakers. The transmission of each call was conducted over 2 minutes. A further listening period of one minute was undertaken after each call was played. Nocturnal surveys commenced at sunset (approx. 8.30pm) and continued for approximately two hours (approx. 10.30pm). Spotlighting targeted nocturnal mammals such as the Common Ring-tailed Possum. Spotlighting involved walking along the 100m transect looking for eye shine and any moving nocturnal mammals. Spotlighting was conducted at each of the five survey sites for four consecutive nights by two experienced ecologists, and was undertaken during the survey period (12-16th March 2011). The total survey effort using this method was approximately 20 person-hours.

Licensing and Animal Research Authority

The mammal surveys were conducted under a current Scientific License (SL100110) issued under Clause 23 of the *National Parks and Wildlife Regulation 2002* and section 132C of the *National Parks and Wildlife Act 1974* by OEH and an Animal Research Authority issued by the Director-General's Animal Care and Ethics Committee of Industry and Investment NSW.

Table 1: Summary of mammal field survey methods and effort during the CBS.

Survey type	Survey Methods and Effort	Target fauna
Hair Tubes	Ten hair tubes were placed at each of the five sites along the 100m transect. Total number of detection nights was 1250 nights.	Terrestrial mammals of all size but particularly larger mammals (>500 grams), such as quolls, bandicoots, rodents and macropods
Elliot Traps	Five Elliot traps were placed along the 100m transect at each of the five sites. The total survey effort using this method was 100 trap nights.	Small mammals, including antechinus and rats.
Scats Collection	Approx. 1 person-hour at each of the five sites. Total search effort approximately 5 hours.	All mammal fauna.
Funnel traps and drift fencing	Three pairs of funnel traps were placed along a 20 metre drift fence, at each site over four consecutive nights. The total survey effort using this method was 120 trap nights.	Small terrestrial mammals.
Motion activated infrared cameras	One camera was set up in the WBS while the other at RIP. Cameras were set up for five	All mammal fauna.

Survey type	Survey Methods and Effort	Target fauna
	consecutive days. The total survey effort using this method was 10 camera days.	
Spotlighting Survey/ Call Play Back	Spotlighting was conducted at each of the five survey sites for four consecutive nights. The total survey effort using this method was approximately 20 person-hours.	Nocturnal mammals.
Opportunistic	Any fauna observed during the field survey was recorded.	All fauna.

2.4.2 Reptiles

Methods used to detect reptiles were chosen due to their efficiency in detecting a wide variety of reptilian fauna. A 100m transect was established at each of the five sites. The location of this transect was determined to encompass the widest variation of habitats within each site with the transect being the baseline for all the other field survey methods. At each end of the 100m transect a stake flagged with flagging tape was placed, so the transect could be identified easily during the survey period and at a later time for replication or future monitoring. This section provides an overview and images of each survey method adopted to detect reptiles. Table 2 summarises the reptilian survey methods and effort.

Funnel Traps and Drift Fencing

Funnel traps and drift fencing were used within the comprehensive reptile survey, which target small, reptiles. The funnel traps and drift fencing divert reptiles moving through habitat into each trap. When they reach the drift fence, then proceed left or right where they follow the fence until they enter the funnel trap. The funnel has raised exit holes, so that any individual trapped cannot escape. A 20 metre PVC drift fence was established that was 230mm tall and dug into the ground 50mm so that any reptiles could not move under the drift fence. The fence was held in position by 6mm diameter metal pegs 450mm long. Three pairs of funnel traps were placed along the 20 metre fencing, which were pinned against the drift fence by metal stakes, shown in Figure 3. Each entrance of the funnel was built up by the ground substrate, so the animal does not detect an unfamiliar substrate. Funnel Traps and drift fences were activated between the 12th and the 16th of March 2011 over four consecutive nights. Funnel traps were checked daily within two hours of sunrise with all animals identified and released at the point of capture. The total survey effort using this method was 120 trap nights.

Systematic Area Search

Systematic area searches provide an effective method for revealing reptile species within an area of habitat. At each of the five transects, a standard area of 50m x 100m was systematically searched for one-person hour each day during the CBS by detecting basking and active animals and inactive animals by non-destructive searches of microhabitat and by

walking slowly along the transect. A total of four surveys were undertaken at each of the five sites giving a total of 20 surveys (20 survey hours).

Opportunistic Survey

Opportunistic field surveys are used to record any animals that were detected while travelling between study sites or outside specific survey times. Data recorded included: Date, Time, Location, Species, number of animals, and activity type. Opportunistic Surveys were conducted whenever the survey teams were within the study area. Only reptiles not recorded using other survey methods were noted.

Licensing and Animal Research Authority

The reptile surveys were conducted under a current Scientific License (SL100110) issued under Clause 23 of the *National Parks and Wildlife Regulation 2002* and section 132C of the *National Parks and Wildlife Act 1974* by OEH and an Animal Research Authority issued by the Director-General's Animal Care and Ethics Committee of Industry and Investment NSW.

Table 2: Summary of reptile field survey methods and effort during the CBS.

Survey type	Survey Methods and Effort	Target fauna
Funnel traps and drift fencing	Three pairs of funnel traps were placed along a 20 metre drift fence, at each site over four consecutive nights. The total survey effort using this method was 120 trap nights.	Small terrestrial reptiles
Systematic Area Search	Active and passive searches for reptiles along the 100m transect using a 50m width. A total of four surveys were undertaken at each of the five sites giving a total of 20 survey hours.	All reptiles
Opportunistic	Any fauna observed during the field survey was recorded.	All reptiles.

2.4.3 Bats

Using an Anabat Echolocation Call Recorder (Model:SD1) the 100m transect at each of the five sites was walked each night during the CBS holding the Anabat unit at an angle of approximately 30 degrees to record the echolocation calls of passing microchiropteran bats. This survey method was conducted during the spotlighting survey for efficiency. This method was used at all five sites over the four consecutive nights. For megachiropteran bats, visual surveys were conducted by visually scanning the night sky and overstorey vegetation for passing or feeding individuals during the spotlighting surveys. The total Anabat survey effort was approximately 20 hour recording/person hours. The bat survey effort is summarised within Table 3.

Licensing and Animal Research Authority

The bat survey was conducted under both a current Scientific License (SL100110) issued under Clause 22 of the *National Parks and Wildlife Regulation 2002* and section 132C of the *National Parks and Wildlife Act 1974* by the OEH and an Animal Research Authority approved by, and in accordance with, the Animal Care and Ethics Committee (ACEC) of the Director-General of the NSW Department of Primary Industries.

Table 3: Summary of bat survey methods and effort during the CBS.

Survey type	Survey Methods and Effort	Target fauna
ANABAT echolocation call recording	30 minutes transects during spotlighting survey. Total survey effort over four consecutive nights was approximately 20 recording/person hours.	Microchiropteran bats
Visual Surveys	During the spotlighting transects, visual searches were conducted scanning the night sky and overstorey vegetation for individuals.	Megachiropteran bats

Anabat Analysis

The Anabat analysis was completed by an experienced ecologist with extensive experience with the microchiropteran bats of the NSW far south coast (see Appendix 3 for details), a reference call collection and a 'Guide to the Bats Calls of NSW' (Pennay *et al.* 2004). For the purpose of the CBS, a recorded call was defined as a sequence of three or more consecutive pulses of similar frequency. Due to variability in the quality of calls and the difficulty in distinguishing some species the identification of each call was assigned a confidence rating as follows:

D = Definite: Species identification not in doubt.

PR = Probable: Call most likely to represent a particular species, but there exists a low probability of confusion with species of similar call types.

PO = Possible: Call characteristics are comparable with the species, but there exists a reasonable probability of confusion with one or more bat similar species or the quality or length of call prohibits a confident identification.

Those calls unable to be identified due to poor call quality resulting in a lack of diagnostic features were assigned 'Unidentifiable'.

It should be understood that the total number of calls cannot be used to indicate species abundance as multiple calls could have been made by one bat. It can however, provide some indication of relative activity in relation to other bat species.

2.4.4 Species Identification

With the exception of scat, hair and echolocation call analysis, all fauna recorded during the CBS were identified at the point of capture or observation. While the CBS was led by an experienced ecologist, field guides were also used to assist in identification where required. For mammals (excluding bats) (Menkhorst and Knight 2001) was consulted, for bats (Churchill 2008) and for reptiles, the latest field guide for the reptiles of NSW (Swan *et al.* 2004) except where modified by recent taxonomic revisions (Sass 2011; in press).

2.5 PHYSICAL ENVIRONMENT

2.5.1 Fauna Habitats

While this study relied upon sites selected *a priori*, all five sites encompass the full range of fauna habitats available at Panboola. This section provides site descriptions are recorded on CBS proforma datasheets. Photographs of each of the five survey sites are provided (Figure 5).

Water bird Sanctuary - WBS

The WBS is located in the northern section of Panboola. According to data sheets within the CBS guidelines (NPA 2007), the vegetation type was best classified as being closed forest with grassy clearings. Only a small portion of the site showed signs of weed invasions with only five percent cover recorded. Past uses of the land were likely to be grazing given the past history of Panboola, but now the primary use is for conservation, especially bird species. Due to the topography of the site, it is best classified as a floodplain. There is no obvious slope and the soil is best described as a dark brown loam. There was evidence of domestic animals and while the WBS has signs advising that dogs are not permitted, evidence of dog walking was observed (scats).

Ground habitats relevant to the target fauna of this study include varying levels of leaf litter, fallen timber and clumps of *Lomandra* within the tree plantings. However, structure such as fallen timber could be enhanced by further additions.

The habitat at WBS was identified as Closed Forest (CF) according to CBS guidelines.

Tips Billabong – TIPS

Tips Billabong (TIPS) is also located in the northern section of Panboola, and contains a fresh water wetland abundant with native reeds extending up to 2m high with numerous other native aquatic species present. Past uses of the land were also likely to be grazing given the history of Panboola. As with the WBS, soil colour and texture were typical of floodplain environments being best described as a dark brown loam. There is an old building to the west that could provide potential habitat for a number of animals including microbats and frogs. A number of feral animals degrade the quality of the site as a fauna habitat including house mice and black rat.

Many parts of the site are impacted by maintenance activities undertaken at Panboola. Regular slashing around the southern periphery of the billabong compromises grassy habitats by potentially disconnecting the site from habitats in the south for small, terrestrial fauna.

The habitat at TIPS is identified as Freshwater Wetland (FWW) according to CBS guidelines.

Corridor - CORR

The Corridor site (CORR) is located in the central portion of Panboola. It is best described as open grassland with as much as 60% of the site affected by exotic flora. This site encompasses a range of ephemeral wetlands and rain-filled depressions that flow in from the west and drain toward the Saltmarsh area. As with the other sites at Panboola and according to the CBS classification, the topography is classified as a floodplain and the soil colour and texture are regarded as a dark brown loam. Past uses of the land were likely to be grazing, but now the primary use is conservation.

The ephemeral wetlands and rain-filled depressions are likely to provide important levels of connectivity across the floodplain.

The habitat at CORR is identified as Open Grassland (OG) according to CBS guidelines.

Saltmarsh - SALT

The Saltmarsh (SALT) is located in the south-eastern portion of Panboola. The site, according to CBS guidelines is classified as open low shrubland. The topography is classified as a floodplain with a soil colour and texture as black sandy clay loam. Past uses of the land have been dominated by use as a racecourse. While no longer utilised as a racecourse, the track is still present and is used as one of Panboola's walking and cyclist track.

A large extent of native reed flanks the western boundary of the site which is up to 2m tall. This reed bed is likely to provide a significant refuge for fauna within this area.

Evidence of domestic animals occupancy was common, with numerous scats observed.

The habitat at SALT is identified as Coastal Saltmarsh (CS) according to CBS guidelines.

Riparian - RIP

RIP is located along the Pambula River in the south-western portion and within the area known as 'the bubble'. It is best classified as Melaleuca shrubland with scattered emergent eucalypts. The site was compromised by heavy weed growth dominated by wandering dew and rye grass. Weed cover was estimated at approximately 50% coverage. Along the banks of the Pambula River, some bank erosion was present. This was recorded as stabilized and minor with only 10% noted. Past uses of the land includes grazing, but the site is now primarily used for conservation. As with the other sites at Panboola, according to the CBS

classification, the topography is classified as a floodplain. The soil colour and texture was identified as a dark grey silty loam.

Along the edges of the Pambula River, there is dense layer of grass and fallen timber. This could provide potential habitat for ground dwelling mammals and reptiles. Also along the river banks are a dense stand of Melaleuca which could provide potential nesting habitat for small bird species.

The habitat at RIP is identified as Riparian Shrubland (RS) according to CBS guidelines.

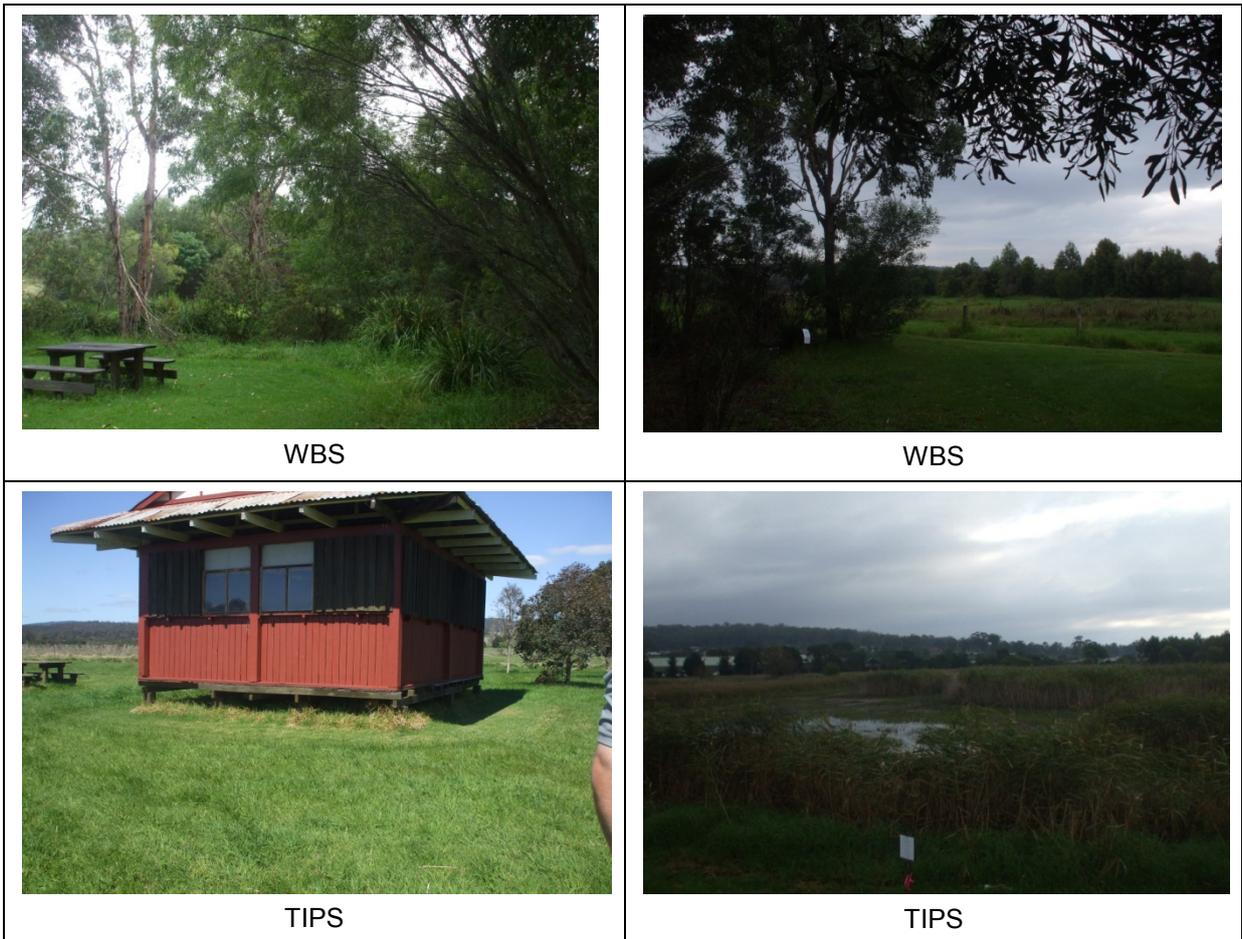




Figure 5: Fauna Habitats at Panboola.

2.5.2 Weather Conditions

Weather conditions during the CBS were considered relatively mild (Table 4) (BOM 2011). The lowest overnight low during the CBS was 16.4 degrees Celsius on the 16th March while

the highest daytime temperature during the survey period was 28.5 degrees Celsius on the 13th March 2011. During all but one day some rainfall, albeit a small amount, was recorded.

Table 4: Weather conditions during the CBS as recorded at the closest weather station to Panboola, the Merimbula Airport (BOM 2011).

Date	Min (degrees Celsius)	Max (degrees Celsius)	Rainfall (mm)
12/3/2011	17.5	25.5	0.2
13/3/2011	17.1	28.5	0
14/3/2011	19.4	23.9	6.6
15/3/2011	16.7	23	0.4
16/3/2011	16.4	20.8	7.8

2.6 NOMENCLATURE

Nomenclature within this report follows Morcombe (2004) for birds, Menkhorst & Knight (2001) for mammals (except bats), Churchill (2008) for bats and for reptiles the latest field guide for the reptiles of NSW (Swan *et al.* 2004) except where modified by recent taxonomic revisions (Sass 2011; in press). Where no common name is provided with these texts, a generally accepted name is used.

2.7 LIMITATIONS OF THIS STUDY

While this study was completed during Autumn 2011 when field conditions were conducive to detecting many of the target fauna species that are known to occur in the locality, a common limitation of many ecological studies is the short period of time in which they are conducted. When combined with a lack of seasonal sampling this can lead to either low detection rates or false absences being reported. This is also particularly relevant to highly mobile species that can use different habitats across their range at any given time. For these reasons, it should be recognised that it may be impossible to rule out species absence for some species during field surveys.

It was intended to conduct some statistical analysis during the CBS. However, with numerous zeros in the data this was not possible. The CBS included an evaluation of habitats and the existing environment to assist in determining whether target biota recorded in the locality were likely to use the study area, but went undetected. In the future, as additional surveys and monitoring collect additional data, statistical analysis may then be able to be used to identify statistical differences between sites and between faunal communities.

3 RESULTS

3.1 DESKTOP REVIEW OF PREVIOUS RECORDS

3.1.1 *Mammals*

The desktop analysis revealed that 23 mammal species have been recorded within the locality comprising 19 native species and four introduced species. An evaluation of the potential for Panboola to provide potential habitat for each species based on known habitat requirements is completed (Table 5).

Table 5: Results of the desktop analysis of mammals recorded within the locality and an evaluation of the potential for Panboola to provide habitat for each species (P=Protected, V=Vulnerable, E=Endangered).

Common Name	Scientific Name	Legal Status	Habitat	Potential habitat in the study area
Agile Antechinus	<i>Antechinus agilis</i>	P NP&W	Found in wet or moist forest, utilising both heath and woodland from sea level to 1800m.	Yes in WBS.
Australian Fur-seal	<i>Arctocephalus pusillus doriferus</i>	V TSC	Prefers rocky parts of islands at sea with flat, open terrain.	No. Study area not located on the ocean.
Black Wallaby	<i>Wallabia bicolor</i>	P NP&W	Found in a wide range of forest, woodland, scrub and heath from tropical rainforest to dry brigalow, box-ironbark and some mallee.	Yes, most likely within RIP and SALT
Bottlenose Dolphin	<i>Tursiops truncatus</i>	P NP&W	Found throughout tropical and temperate oceans, mostly offshore out to the continental shelf.	No. Study area not located on the ocean.
Brown Antechinus	<i>Antechinus stuartii</i>	P NP&W	Found in a wide range of moist habitats, including rainforest, sclerophyll forest, woodland and heath, from sea level to sub-alps.	Yes. Most likely within RIP and SALT
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	V TSC	Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest.	No. Due to a paucity of tree hollows.
Cat	<i>Felis catus</i>	-	Found in all habitats from rainforest to desert to cities.	Yes.

Common Name	Scientific Name	Legal Status	Habitat	Potential habitat in the study area
Common Ringtail Possum	<i>Pseudocheirus peregrinus</i>	P NP&W	Found in open and closed forests, coastal scrub and gardens, especially where tall scrub layer is dense and diverse.	Yes. Most likely within RIP and WBS where tree abundance is higher.
Common Brushtail Possum	<i>Trichosurus vulpecula</i>	P NP&W	Found in most treed environments, including cities, towns and farmland.	Yes. Most likely within RIP and WBS where tree abundance is higher.
Common Wombat	<i>Vombatus ursinus</i>	P NP&W	Inhabits wet/dry forest, coastal scrub and heath from sea level to above snowline.	Yes, found in most habitat sites.
Domestic dog	<i>Canis lupus familiaris</i>	-	Found in association with humans worldwide and in a wide variety of habitats.	Yes. People regularly walk their dogs at Panboola.
Dugong	<i>Dugong dugon</i>	E TSC	Occurs in wide shallow protected bays, wide shallow mangrove channels and in the lee of large inshore islands.	No, Study area not located on the ocean
Dusky Antechinus	<i>Antechinus swainsonii</i>	P NP&W	Inhabits dense wet vegetation, from coastal heath to wet sclerophyll forest, rainforest and subalpine heath.	Yes. Most likely along the Pambula River and WBS.
Eastern Grey Kangaroo	<i>Macropus giganteus</i>	P NP&W	Found in open-forest, woodland and farmland with remnant vegetation, extending to semi-arid Western NSW	Yes. Most likely to occur within all habitats.
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	V TSC	Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred.	No. Due to the absence of <i>Banksia</i> as a food source.
Feathertail Glider	<i>Acrobates pygmaeus</i>	P NP&W	Needs high diversity of trees and shrubs to provide year-round nectar. Most common in wet and old-growth forest.	No. Due to a lack of a regular and diverse food source.
Fox	<i>Vulpes vulpes</i>	-	Found in most habitats from wet forest to desert and suburbs.	Yes. Likely to be found in all habitats.

Common Name	Scientific Name	Legal Status	Habitat	Potential habitat in the study area
Humpback Whale	<i>Megaptera novaeangliae</i>	V TSC V EPBC	Migrates from summer cold-water feeding grounds in Sub-Antarctic waters to warm-water winter breeding grounds in the central Great Barrier Reef.	No. Study area not located on the ocean
Killer Whale	<i>Orcinus orca</i>	P NP&W	Found throughout all oceans, most common in cold waters and within 800m of continents.	No. Study area not located on the ocean
Koala	<i>Phascolarctos cinereus</i>	V TSC	Inhabit eucalypt woodlands and forests. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size.	Yes. Within RIP due to the presence of Forest Red Gum.
Leopard Seal	<i>Hydrurga leptonyx</i>	P NP&W	Found throughout Southern Ocean.	No. Study area not located on the ocean
Long-nosed Bandicoot	<i>Perameles nasuta</i>	P NP&W	Found in wet sclerophyll forest, scrub, rank grass and suburban gardens.	Yes. Most likely within the RIP and WBS where understory is most abundant.
Long-nosed Potoroo	<i>Potorous tridactylus</i>	V TSC V EPBC	Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understory with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature.	No. Due to the lack of dense understory and contiguous habitat.
Platypus	<i>Ornithorhynchus anatinus</i>	P NP&W	Inhabits freshwater streams, ranging from alpine creeks to tropical lowland rivers, also lakes, shallow reservoirs and farm dams. Prefers areas with steep banks.	No. Due the lack of flowing fresh water.
Red-necked Wallaby	<i>Macropus rufogriseus</i>	P NP&W	Found in sclerophyll forest and coastal scrub.	Yes. Most likely to occur within RIP.
Short-beaked Echidna	<i>Tachyglossus aculeatus</i>	P NP&W	Found in almost all terrestrial habitats except intensively managed farmland.	Yes. Most likely in all habitats.

Common Name	Scientific Name	Legal Status	Habitat	Potential habitat in the study area
Sperm Whale	<i>Physeter macrocephalus</i>	V TSC	Tend to occur where the seabed rises steeply from a greater depth, beyond the continental shelf.	No. Study area not located on the ocean
Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	V TSC E EPBC	Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline.	Yes. Most likely at RIP and WBS.
Sugar Glider	<i>Petaurus breviceps</i>	P NP&W	Widespread in wet and dry sclerophyll forest and woodland from cool-temperate to wet/dry tropical.	Yes. Most likely at RIP and WBS where tree abundance is higher.
Yellow-bellied Glider	<i>Petaurus australis</i>	V TSC	Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils.	No. Due to lack of tall mature eucalypt forest.
White-footed Dunnart	<i>Sminthopsis leucopus</i>	V TSC	The White-footed Dunnart is found in a range of different habitats across its distribution, including coastal dune vegetation, coastal forest, tussock grassland and sedgeland, heathland, woodland and forest.	No. Species does not occur on floodplains.

The evaluation completed within Table 5 suggests that based on the habitats present at Panboola, 17 species of mammal could occur there. The distribution of previous mammal records within the locality is mapped and provided within Appendix 1.

3.1.2 Reptiles

The desktop analysis revealed that 11 reptile species have been recorded within the locality. An evaluation of the potential for Panboola to provide potential habitat for each species based on known habitat requirements is completed (Table 6).

Table 6: Results of the desktop analysis of reptiles recorded within the locality and an evaluation of the potential for Panboola to provide habitat for each species (P=Protected, V=Vulnerable, E=Endangered).

Common Name	Scientific Name	Legal Status	Habitat	Potential habitat in the study area
Common Death Adder	<i>Acanthophis antarcticus</i>	P NP&W	Dry sclerophyll forest, woodlands and heath.	No. Species does not occur on floodplains.
Garden Sun-skink	<i>Lampropholis delicata</i>	P NP&W	Found in moist habitats including open forest, edges of moist forest, grasslands and suburban gardens.	Yes. Most likely found in maximum sun exposure areas within all habitats.
Diamond Python	<i>Morelia spilota spilota</i>	P NP&W	Prefers rainforest and heavily timbered areas. Also found in suburban areas.	Yes. Only within the RIP and WBS.
Eastern Blue-tongue	<i>Tiliqua scincoides</i>	P NP&W	Found in dry sclerophyll forest, open woodland, heath and grasslands. Also common in suburban gardens.	Yes. Within all habitats.
Hawksbill Turtle	<i>Eretmochelys imbricata</i>	P NP&W	An inhabitant of tropical and warm temperate waters.	No. Study area not located on the ocean.
Mountain Dragon	<i>Rankinia diemensis</i>	P NP&W	Found in woodland, open forest and heathland.	No. Species does not occur on NSW South Coast at low elevation. Records are mostly misidentifications of Jacky Dragon.
Mustard-bellied Snake	<i>Drysdalia rhodogaster</i>	P NP&W	Inhabits dry sclerophyll forest, heathlands and tussock grasslands.	Yes. Within all habitats.
Eastern Water Dragon	<i>Physignathus lesueurii</i>	P NP&W	Occurs in watercourses. Diurnal and semi aquatic, mostly seen on tree branches hanging over the water and around coastal rocks.	Yes. Within RIP only.
Grass Sun-skink	<i>Lampropholis guichenoti</i>	P NP&W	Found in open forest, edges of moist forest, grasslands and suburban gardens.	Yes. Most likely found in maximum sun exposure areas within all habitats.
Red-bellied Black Snake	<i>Pseudechis porphyriacus</i>	P NP&W	Found in the vicinity of creeks, swamps, rivers or	Yes. Most likely to occur within all

Common Name	Scientific Name	Legal Status	Habitat	Potential habitat in the study area
			lakes.	habitats.
Tiger Snake	<i>Notechis scutatus</i>	P NP&W	Found in rainforest, wet and dry sclerophyll forest, grasslands, swampy and moist areas.	Yes. Most likely to occur within all habitats.
Weasel Skink	<i>Saproscincus mustelinus</i>	P NP&W	Inhabits moist forest, also found in suburban gardens and appears to require a complex microhabitat structure.	Yes. Most likely found in WBS, where fallen timber and leaf litter are abundant.
White-lipped Snake	<i>Drysdalia coronoides</i>	P NP&W	Found in dry sclerophyll forest and subalpine woodlands, prefers tussock grass areas.	Yes, most likely occur within all habitat sites.
Yellow-bellied Water Skink	<i>Eulamprus heatwolei</i>	P NP&W	Occurs in wet and dry forests, open woodlands, heathlands, and usually near water.	Yes. Mostly likely within WBS and TIPS.

The evaluation completed within Table 6 suggests that based on the habitats present at Panboola, nine species of reptile could occur there. The distribution of previous reptile records within the locality is mapped and provided within Appendix 1.

3.1.3 Bats

The desktop analysis revealed that 12 bat species have been recorded within the locality. An evaluation of the potential for Panboola to provide potential habitat for each species based on known habitat requirements is completed (Table 7).

Table 7: Results of the desktop analysis of bats recorded within the locality and an evaluation of the potential for Panboola to provide habitat for each species (P=Protected, V=Vulnerable, E=Endangered).

Common Name	Scientific Name	Legal Status	Habitat	Potential habitat in the study area
Chocolate Wattled Bat	<i>Chalinolobus morio</i>	P NP&W	Habitats include rainforest, wet and dry sclerophyll forest, woodlands and mallee as well as scrublands.	Yes. Potential roost sites could occur under the various bridges throughout the site, the old bar within Tips Billabong, and the shed. Foraging habitat present.
East-coast Freetail Bat	<i>Micronomus norfolkensis</i>	P NP&W	Mostly occur in dry eucalypt forest and woodland on the coastal	Yes. Potential roost sites could occur in stags along the Pambula River.

Common Name	Scientific Name	Legal Status	Habitat	Potential habitat in the study area
			side of Great Dividing Range.	Foraging habitat is present.
Eastern Bentwing-bat	<i>Miniopterus oriana oceanensis</i>	V TSC	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.	Yes. Potential roost sites could occur under the various bridges throughout the site, the old bar within Tips Billabong, and the shed. Foraging habitat present.
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	V TSC	Prefers moist habitats, with trees taller than 20 m but found in a variety of habitats.	Yes. Potential roost sites could occur in stags along the Pambula River. Foraging habitat present.
Eastern Freetail Bat	<i>Mormopterus ridei</i>	P NP&W	Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. Roost sites are mainly tree hollows, but are known to roost in under bark, buildings and cracks in posts.	Yes. Potential roost sites could occur in stags along the Pambula River. Foraging habitat present.
Gould's Wattled Bat	<i>Chalinolobus gouldii</i>	P NP&W	Found in virtually all habitats throughout Australia, from alpine to tropical rainforests, eucalypt forests and woodlands, deserts, grassland, agricultural land use and urban areas. Roost sites include buildings, tree stumps, and among leaves.	Yes. Potential roost camps could occur in stags along the Pambula River. Foraging habitat present.
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V TSC V EPBC	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.	Yes. Potential roost camps could occur along the <i>Melaleuca</i> along the Pambula River. Foraging habitat is likely amongst all vegetation.

Common Name	Scientific Name	Legal Status	Habitat	Potential habitat in the study area
Large Forest Bat	<i>Vespadelus darlingtoni</i>	P NP&W	Occurs in rainforest, wet and dry sclerophyll forest, Blackwood swamps, open forest, and coastal Mallee. Roosts in tree hollows with up to 80 bats.	Yes. Potential roost sites could occur in stags along the Pambula River. Foraging habitat present.
Lesser Long-eared Bat	<i>Nyctophilus geoffroyi</i>	P NP&W	Widespread, from deserts to rainforests, wet and dry sclerophyll forests, tropical to alpine woodlands, grasslands, mangroves, agricultural land and urban areas.	Yes. Foraging and roosting.
Little Forest Bat	<i>Vespadelus vulturnus</i>	P NP&W	Occurs in wet and dry sclerophyll forest, river red gum forest, montane and dry woodland, blackwood swamp, briglow mulga and mallee.	Yes. Potential roost sites could occur in stags along the Pambula River. Foraging habitat present.
Little Red Flying-fox	<i>Pteropus scapulatus</i>	P NP&W	Found a broad range of habitats, from semi-arid areas to tropical and temperate eucalypt forests, paperbark swamps and monsoon forests.	Yes. Potential roost camps could occur along the <i>Melaleuca</i> along the Pambula River.
Southern Forest Bat	<i>Vespadelus regulus</i>	P NP&W	Inhabits rainforest, wet and dry sclerophyll forest, shrublands and low shrub woodland, mixed temperate woodland, mallee and open woodland.	Yes. Potential roost sites could occur in stags along the Pambula River. Foraging habitat is present.

The evaluation completed within Table 7 suggests that based on the habitats present at Panboola, 12 species of bat could occur there. The distribution of previous bat records within the locality is mapped and provided within Appendix 1.

3.2 MAMMAL COMMUNITY

3.2.1 *Distribution and Abundance of mammals at Panboola*

A total of nine mammal species were recorded during the CBS (Table 8).

The most abundant mammal species during the CBS was the Eastern Grey Kangaroo (*Macropus giganteus*) (Figure 6) with as many as 28 individuals recorded on one occasion at

CORR. The least abundant mammal species during the CBS were the Agile Antechinus (*Antechinus agilis* (WBS) (Figure 7), Common Wombat (*Vombatus ursinus*) (RIP) and the Short-beaked Echidna (*Tachyglossus aculeatus*) (TIPS) with only one individual recorded. Two introduced species were recorded during the CBS. These being the House Mouse (*Mus musculus*) and Black Rat (*Rattus rattus*).



Figure 6: Eastern Grey Kangaroo were the most abundant mammal at Panboola during the CBS. These individuals were observed grazing in the Coastal Saltmarsh.



Figure 7: The Agile Antechinus (*Antechinus agilis*) was recorded only at the WBS during the CBS.

A pair of Masked Owl (listed as Vulnerable under the TSC Act) and a pair of Barn Owl were detected during the CBS. The Masked Owl responded to call playback at RIP coming in from the east and landing close to the survey site on one occasion during the CBS. The Barn Owl were recorded at CORR, TIPS and RIP on several occasions in response to Masked Owl call playback.

The diversity and abundance of mammals recorded at Panboola during the CBS is provided (Table 8).

Table 8 : Mammal diversity and abundance recorded during the CBS.

Common Name	Scientific Name	WBS	TIPS	CORR	SALT	RIP	Total
Dusky Antechinus	<i>Antechinus swainsonii</i>	0	0	0	1	3	4
Agile Antechinus	<i>Anthechinus agilis</i>	1	0	0	0	0	1
House Mouse	<i>Mus musculus</i>	0	3	1	0	1	5
Swamp Rat	<i>Rattus lutreolus</i>	0	3	0	0	0	3
Black Rat	<i>Rattus rattus</i>	0	1	0	0	2	3
Eastern Grey Kangaroo	<i>Macropus giganteus</i>	0	0	30	2	19	51
Common Ringtail Possum	<i>Pseudocheirus peregrinus</i>	1	0	0	0	0	1
Short-beaked Echidna	<i>Tachyglossus aculeatus</i>	0	1	0	0	0	1
Common Wombat	<i>Vombatus ursinus</i>	0	0	0	0	1	1
	Total	2	8	31	3	26	

3.2.2 Comparison of mammal communities across different habitats

The Riparian Shrubland was the most diverse habitat with five mammal species recorded (Table 9). The least diverse mammal communities were the habitat types of Closed Forest, Open Grassland and Saltmarsh.

Mammal communities across Panboola showed no apparent similarities (Table 9) however, five mammal species exhibited possible habitat specificity being recorded in only one habitat type. These being the Agile Antechinus (*Antechinus agilis*) (Closed Forest), Swamp Rat (*Rattus lutreolus*) (Freshwater Wetland), Common Ringtail Possum (*Pseudocheirus peregrinus*) (Closed Forest), Short-beaked Echidna (*Tachyglossus aculeatus*) (Freshwater Wetland) and Common Wombat (*Vombatus ursinus*) (Riparian Shrubland).

Table 9: Mammal communities within each habitat type during the CBS (P = Present) (CF=Closed Forest, FWW=Freshwater Wetland, OG=Open Grassland, CS=Coastal Saltmarsh, RS=Riparian Shrubland).

Common Name	Scientific Name	CF	FWW	OG	CS	RS
Dusky Antechinus	<i>Antechinus swainsonii</i>				P	P
Agile Antechinus	<i>Anthechinus agilis</i>	P				
House Mouse	<i>Mus musculus</i>		P	P		P
Swamp Rat	<i>Rattus lutreolus</i>		P			
Black Rat	<i>Rattus rattus</i>		P			P
Eastern Grey Kangaroo	<i>Macropus giganteus</i>			P	P	P
Common Ringtail Possum	<i>Pseudocheirus peregrinus</i>	P				
Short-beaked Echidna	<i>Tachyglossus aculeatus</i>		P			
Common Wombat	<i>Vombatus ursinus</i>					P
	Total Species	2	4	2	2	5

3.3 REPTILE COMMUNITY

3.3.1 *Distribution and Abundance of reptiles at Panboola*

A total of 6 reptile species were recorded during the CBS (Table 10).

The most abundant reptile species recorded was the Eastern Water Dragon 'Gippsland Form' (*Physignathus lesueurii howitti*) with 10 individuals recorded at RIP (Figure 8). The least abundant species was Eastern Blue-tongued Lizard (*Tiliqua scincoides*) with one individual recorded (RIP). The most abundant reptile recorded around TIPS and WBS was the Yellow-bellied Water Skink (*Eulamprus heatwolei*). Individuals were also observed within existing fence posts (Figure 9).

The diversity and abundance of reptiles recorded at Panboola during the CBS is provided (Table 10).



Figure 8: Eastern Water Dragon 'Gippsland Form' (*Physignathus lesueurii howitti*) was the most abundant reptile recorded at Panboola during the CBS. This is an adult male identified by its vivid colouration under the chin.

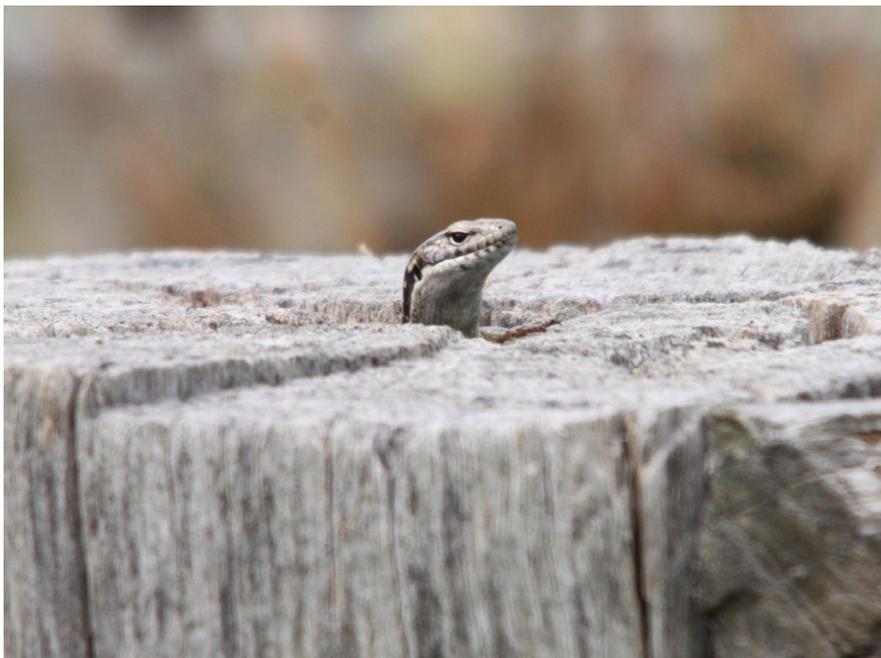


Figure 9: Yellow-bellied Water Skink (*Eulamprus heatwolei*) emerging from a fence post at WBS.

Table 10: Reptile Diversity and abundance recorded during the CBS.

Common Name	Scientific Name	WBS	TIPS	CORR	SALT	RIP	Total
Weasel Skink	<i>Saproscincus mustelinus</i>	3	0	0	0	0	3
Garden Skink	<i>Lampropholis guichenoti</i>	2	0	0	0	0	2
Garden Skink	<i>Lampropholis delicata</i>	0	1	1	4	2	8
Yellow-bellied Water Skink	<i>Eulamprus heatwolei</i>	4	2	0	1	0	7
Eastern Blue-tongue Lizard	<i>Tiliqua scincoides</i>	0	0	0	0	1	1
Eastern Water Dragon	<i>Physignathus lesueurii howitti</i>	0	0	0	0	10	10
	Total	9	3	1	5	13	31

3.3.2 Comparison of reptile communities across different habitats

The Riparian Shrubland and Closed Forest habitats were the most diverse for reptiles each with three species recorded (Table 11). The Open Grassland had the least diverse reptile community with only one species recorded (Table 11).

Reptile communities were identical between the Freshwater Wetland and Coastal Saltmarsh habitats. Four reptile species exhibited possible habitat specificity during the CBS (Table 11). These were the Weasel Skink (*Saproscincus mustelinus*) and Garden Skink (*Lampropholis guichenoti*) (Figure 10) recorded only in the Closed Forest while Eastern Blue-tongued Lizard (*Tiliqua scincoides*) and Eastern Water Dragon 'Gippsland Form' (*Physignathus lesueurii howitti*) were recorded only in the Riparian Shrubland.



Figure 8: Weasel Skink (*Saproscincus mustelinus*) and Garden Skink (*Lampropholis guichenoti*) were recorded only in the Closed Forest habitat at Panboola during the CBS.

Table 11: Reptiles communities within each habitat type during the CBS (P = Present) (CF=Closed Forest, FWW=Freshwater Wetland, OG=Open Grassland, CS=Coastal Saltmarsh, RS=Riparian Shrubland).

Common Name	Scientific Name	CF	FWW	OG	CS	RS
Weasel Skink	<i>Saproscincus mustelinus</i>	P				
Garden Skink	<i>Lampropholis guichenoti</i>	P				
Garden Skink	<i>Lampropholis delicata</i>		P	P	P	P
Yellow-bellied Water Skink	<i>Eulamprus heatwolei</i>	P	P		P	
Eastern Blue-tongue Lizard	<i>Tiliqua scincoides</i>					P
Eastern Water Dragon	<i>Physignathus lesueurii howitti</i>					P
	Total Species	3	2	1	2	3

3.4 BAT COMMUNITY

3.4.1 *Distribution and Relative Activity of Bats at Panboola*

A total of 12 bat species were recorded during the CBS (Table 12).

It should be remembered that the total number of calls cannot be used to indicate species abundance as multiple calls could have been made by one bat. It can however, provide some indication of relative activity in relation to other bat species.

The most active bat species was the Gould's Wattled Bat (*Chalinolobus gouldii*) with 42 echolocation calls recorded (Table 12). The least active was the Long-eared Bat (*Nyctophilus sp.*) with only one call recorded (Table 12).

The distribution of bats at Panboola appeared biased around the WBS and TIPS. Almost 87% of the bats recorded during the CBS were at either the WBS or TIPS.

Five species of bat recorded are listed as threatened under the schedules of the NSW *Threatened Species Conservation Act 1995* or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

The results of the anabat analysis including confidence rankings of microchiropteran bat echolocation call identification are provided in full in Appendix 2.

Table 12: Bat diversity and relative activity during the CBS (**bold** denotes threatened species).

Common Name	Scientific Name	WBS	TIPS	CORR	SALT	RIP	Total
Eastern Bentwing Bat	<i>Miniopterus orianae oceanensis</i>	9	14	0	0	2	25
Eastern Falsistrelle	<i>Falsistrellus tasmaniensis</i>	7	0	0	0	0	7
Eastern Freetail Bat	<i>Micronomus norfolkensis</i>	6	7	0	0	0	13
Eastern Freetail Bat	<i>Mormopterus ridei</i>	15	9	0	0	0	24
Gould's Wattled Bat	<i>Chalinolobus gouldii</i>	23	15	2	0	2	42
Grey-headed Flying-fox	<i>Petropus poliocephalus</i>	8	5	0	0	4	17
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	0	3	2	2	0	7
Large Forest Bat	<i>Vespadelus darlingtoni</i>	14	14	0	0	1	29
Little Forest Bat	<i>Vespadelus vulturnus</i>	3	0	0	0	0	3
Long-eared Bat	<i>Nyctophilus sp.</i>	0	0	0	0	1	1
Southern Forest Bat	<i>Vespadelus regulus</i>	8	0	0	0	0	8
White-striped Freetail Bat	<i>Austronomus australis</i>	4	6	8	1	1	20
	Total	97	73	12	3	11	196

3.4.2 Comparison of bat communities across different habitats

Bat communities varied greatly between those within the Closed Forest and Freshwater Wetland to those within the Coastal Saltmarsh (Table 13).

The bat community at both the Closed Forest habitat and the Freshwater Wetland was the most diverse with bats likely to be demonstrating a preference for these two habitats at Panboola (CF and FWW) in comparison to other habitats present (OG, SALT, and RIP).

Table 13 : Bat communities within each habitat type during the CBS (P = Present) (CF=Closed Forest, FWW=Freshwater Wetland, OG=Open Grassland, CS=Coastal Saltmarsh, RS=Riparian Shrubland) (bold denotes threatened species).

Common Name	Scientific Name	CF	FWW	OG	CS	RS
Eastern Bentwing Bat	<i>Miniopterus orianae oceanensis</i>	P	P			P
Eastern Falsistrelle	<i>Falsistrellus tasmaniensis</i>	P				
Eastern Freetail Bat	<i>Micronomus norfolkensis</i>	P	P			
Eastern Freetail Bat	<i>Mormopterus ridei</i>	P	P			
Gould's Wattled Bat	<i>Chalinolobus gouldii</i>	P	P	P		P
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>		P	P	P	
Grey-headed Flying-fox	<i>Petropus poliocephalus</i>	P	P			P
Large Forest Bat	<i>Vespadelus darlingtoni</i>	P	P			P
Little Forest Bat	<i>Vespadelus vulturnus</i>	P				
South-eastern Long-eared Bat	<i>Nyctophilus sp.</i>					P
Southern Forest Bat	<i>Vespadelus regulus</i>	P				
White-striped Freetail Bat	<i>Austronomus australis</i>	P	P	P	P	P
	Total Species	10	8	3	2	6

4 DISCUSSION

4.1 MAMMAL COMMUNITY AT PANBOOLA

Presences and absences

The mammal community of Panboola is considered moderately diverse with 10 species recorded during the CBS from the 23 species known from the locality. Based on the desktop analysis, habitat for 17 of these was identified at Panboola, and therefore, there is some potential for the remaining seven species to occur. All of the species recorded within the CBS have been previously detected within the locality.

The Sugar Glider (*Petaurus breviceps*) was one species identified as having potential habitat at Panboola but was not recorded during the CBS. This is likely due to the lack of hollow bearing trees and tree hollows, particularly in the northern portion of Panboola. The Sugar Glider uses hollows for denning (Lindenmayer 2002) so the paucity of hollows is likely limiting the potential for this species to occupy the habitats of Panboola. Given that most of the trees are young, breeding boxes could be used to provide denning opportunities for this species and other hollow-dependent species which have been used with success elsewhere (Beyer and Goldingay 2006; Menkhorst 1984).

The Long-nosed Bandicoot (*Perameles nasuta*) was also identified as having potential habitat at Panboola but was not recorded during the CBS. The habitats within WBS and possibly within RIP could support a population of this species. However, bandicoots are likely to be susceptible to habitat fragmentation (Claridge *et al.* 1991; DECCW 2011b; Lindenmayer and Fischer 2006) despite being known to occur within urban areas and it may be that the past land uses of Panboola such as grazing have isolated the site despite the regeneration and restoration that has occurred within the WBS.

Ben Boyd National Park, located to the south and east of Panboola, may provide a source population that could be linked to Panboola over time. The provision of corridors between other patches of habitat either through designed tree plantings, softening of the matrix through the use of microhabitats such as fallen timber and fence posts, and the reviewing of grass slashing protocols could provide this opportunity (Angold *et al.* 2006; Beier and Noss 1998; Bentley 2008; Cook *et al.* 2004; Fischer *et al.* 2004; Lemckert *et al.* 2005; Lindenmayer and Nix 1993; MacDonald 2003).

The presence of two species of owl (Masked and Barn) during the CBS is indicative of the diverse mammal community that is present which undoubtedly provide important prey for these species.

Threatened or regionally significant species

No threatened species were recorded during the CBS. Two threatened mammal species that have been previously recorded in the locality were found to have potential habitat at

Panboola. These were the Koala (*Phascolarctos cinereus*) and Spotted-tailed Quoll (*Dasyurus maculates*); neither of which were recorded during the CBS.

The Spotted-tailed Quoll is known to prefer a variety of habitats including Forests and Woodland (DECCW 2011b; Menkhorst and Knight 2001). However, the closed forest habitat that occurs at Panboola (within the WBS) is small in extent and occurs only due to restoration works (~ 8 years) post-agricultural land use. In addition, complex microhabitats such as large logs with hollows at ground level are not present which this species is known to use for denning. However, Spotted-tailed Quoll have been recorded in semi-urban areas elsewhere (S. Sass, pers.obs) and given an apparent absence of Red Fox and Cat, this suggests that over time and with habitat enhancement, this species may forage across the habitats of Panboola in the future. Habitat enhancement should include linkages to nearby Ben Boyd National Park and the improvement of microhabitat structure with a focus on WBS and RIP and with the aim to linking to off-site habitats.

For the Koala, the RIP, and indeed other areas where the known koala feed tree Forest Red Gum (*Eucalyptus tereticornis*) is present, represents potential habitat for this species. However, in reality, Koala populations on the NSW south coast have experienced significant population declines (DECC 2008; Lunney and Leary 1988; Matthews *et al.* 2007). The last known record for a Koala in the locality was at Greigs Flat, south of Panboola in 1931 (DECCW 2011a) and given the clearing and subsequent habitat fragmentation that has occurred on the coastal floodplain, it is unlikely that a population still exists.

Differences in Communities across different habitats

The CBS provides a baseline dataset on the mammal communities at Panboola. Given the limited data collected during the CBS, we are unable to undertake statistical analysis on the results. However, observed differences between communities warrant discussion. Firstly, the observed differences may be an artifact of survey effort. While the CBS was extensive and conducted over a week, it should only be regarded as a baseline data set, one which could then be built upon over time. Secondly, the observed differences could in fact be correct. Habitat preferences and specificity is well known across all biodiversity, with biota occurring in habitats that best suit their ecological and morphological needs (Kavanagh and Stanton 2005; Scott *et al.* 2006). During the CBS, five mammal species exhibited possible habitat specificity. The Agile Antechinus (*Anthechinus agilis*) and Common Ringtail Possum (*Pseudocheirus peregrinus*) are known from forests across the region (Lunney *et al.* 2001; Menkhorst and Knight 2001). We recorded these species only within the Closed Forest habitats at Panboola, and given the known ecological requirements of these species, this record of specificity is likely correct. It should also be remembered that the Closed Forest within the WBS at Panboola is the result of restoration efforts on the floodplain. While Common Ringtail Possum are regularly recorded in urban areas, Agile Antechinus are not and their presence within the Closed Forest suggests that these individuals are part of a relictual population that has persisted despite past agricultural land use or a newly colonised population from offsite.

Conversely, the Swamp Rat (*Rattus lutreolus*) is known to occur within freshwater wetlands, creeks and moist vegetated gullies (Menkhorst and Knight 2001). During the CBS, this species was only recorded within Freshwater Wetland, however, it may also occur in RIP and CORR but went undetected.

The results of the CBS suggest that some level of habitat specificity between mammal communities occurs at Panboola. For long-term management of habitats, all habitats should be considered important in maintaining the moderately diverse mammal community present.

4.2 REPTILE COMMUNITY AT PANBOOLA

Presences and absences

The reptile community of Panboola is considered moderately diverse with six species recorded during the CBS from the 14 species known from the locality. However, one of the species known from the locality, the Mountain Dragon (*Rankinia diemensis*) is likely a misidentification given that the species does not occur on the south coast at low elevations (Wilson and Swan 2010) and that the commonly recorded and similar in appearance Jacky Dragon (*Amphibolurus muricatus*) was not listed in the locality records. Based on the desktop analysis, habitat for 11 of these was identified at Panboola, and therefore, there is some potential for the remaining five species to occur.

The White-lipped Snake (*Drysdalia coronoides*) was one of the species identified as having potential habitat at Panboola, but was not recorded during the CBS. This species favours tussock grass areas, usually found under logs and other ground habitats (Swan *et al.* 2004). Regular slashing across Panboola is considered a significant site disturbance that has the potential to disrupt movement across the site and affect the 'softness' of the matrix between habitats. The retention of corridors across Panboola and habitat enhancement within these areas would be of significant benefit to the reptile community of Panboola.

Two reptile species were detected during the CBS that have not been recorded within the locality. These were the Eastern Water Dragon 'Gippsland Form' (*Physignathus lesueurii howitti*) and the Yellow-bellied Water Skink (*Eulamprus heatwolei*). Both species are considered abundant across the region (Daly 2007) where suitable habitats (wetlands, creeks, rivers) are present and the detection of these species within the locality for the first time suggests that a paucity of knowledge exists of the distribution of reptile communities across NSW far south coast.

Most reptile species that have potential to occur at Panboola are considered to be reliant on complex microhabitats. In parts, Panboola is parklike in appearance and it is likely that this management could be negatively impacting the reptile community (Hadden and Westbrooke 1996). Reptiles are also sensitive to habitat disturbances (Sass 2007; 2004; Sass and Wilson 2006; Wassens *et al.* 2005) and processes such as past grazing, habitat fragmentation and subsequent isolation are also likely to be negatively influencing the reptile community of Panboola (Driscoll 2004).

Two reptiles previously recorded at Panboola were not recorded during the CBS (IronoutVCAConsultants 2006). These were the Red-bellied Black Snake (*Pseudechis porphyriacus*) which has also been detected in the locality and the Eastern Long-necked Turtle (*Chelodina longicollis*) where no records exist within the locality.

The Red-bellied Black Snake is known to occur within the proximity of wetlands, creeks, dams and rivers (Wilson and Swan 2010) and despite not being detected during the CBS, the species is considered to be resident. Frogs provide a significant proportion of the diet of this species and others such as the Tiger Snake. Panboola supports a diverse frog community (EnviroKey 2011) that in turn, could support a population of both snake species. Detection of snakes is often difficult using conventional trapping methods unless high densities are present (Denny 2005; Garden *et al.* 2007; Greenberg *et al.* 1994) and records of these species are often the result of important observations made by members of the public (Sass 2008; Sass and Swan 2010; Shine and Koenig 2001) and outside of specific biodiversity surveys.

Eastern Long-necked Turtle has been previously recorded by members of the Panboola management committee (IronoutVCAConsultants 2006). The most likely habitats for this species at Panboola are the freshwater wetlands of TIPS and WBS given the known habitat preferences of this species (Swan *et al.* 2004; Wilson and Swan 2010). The absence of this species during the CBS is not surprising given that target surveys using specialised trapping equipment for turtles was not employed.

Threatened or regionally significant species

There are no threatened reptile species recorded within the locality or the NSW far south coast. The Swamp Skink (*Liopholis conventryi*) is listed as a threatened species under Victorian legislation (DSE 2003; 2011) and is known from freshwater wetlands and swamps in coastal eastern Victoria (Clemann and Beardsell 1999; Wilson and Swan 2010). To date, the species has not been detected in NSW.

Differences in Communities across different habitats

Two habitats at Panboola supported an identical reptile community. These were the Freshwater Wetland and Coastal Saltmarsh habitats. Despite the floristic differences between each of these habitats, the reptiles recorded within each were the same during the CBS. These being the Garden Skink (*Lampropholis delicata*) and the Yellow-bellied Water Skink (*Eulamprus heatwolei*).

The Garden Skink (*Lampropholis delicata*) was a consistent member of reptile communities across all habitats within the exception of the Closed Forest which was inhabited by the sympatric *Lampropholis guichenoti* (Howard *et al.* 2003; Torr and Shine 1996).

Habitat specificity is widespread and commonly detected in reptiles (Pianka 1968; Sass 2006). Four species recorded within the CBS exhibited potential habitat specificity (Garden Skink (*Lampropholis guichenoti*), Weasel Skink (*Saproscincus mustelinus*), Eastern Blue-

tongued Lizard (*Tiliqua scincoides*), Eastern Water Dragon 'Gippsland Form' (*Physignathus lesueurii howitti*). Eastern Water Dragon are generally found in water bodies, those which are free-flowing and often with rocky and sandy substrates that provide both thermal stability and breeding environments (Swan *et al.* 2004; Thompson 1993). The presence of this species at Panboola is not surprising along the Pambula River where fresh or brackish water occurs. The Eastern Blue-tongued lizard is regarded as a habitat generalist (Armstrong and Reid 1992; Shea 1982; 1992) and while only detected at RIP, the species is likely to occur across all other habitats at Panboola.

4.3 BAT COMMUNITY AT PANBOOLA

Presences and absences

The bat community of Panboola is considered highly diverse with 12 species recorded during the CBS. Based on the desktop analysis, only two bat species recorded within the locality were not recorded during the CBS. These were the Chocolate Wattled Bat (*Chalinolobus morio*) and the Little Red Flying-fox (*Pteropus scapulatus*). One species was recorded during the CBS that has not previously been recorded within the locality: the White-striped Freetail bat (*Austronomus australis*).

The absence of those two species is likely an artifact of survey effort given that potential habitat is present and with further survey effort, these two species are likely to be detected. The White-striped Freetail Bat has been regularly recorded in the Bega Valley LGA with 85 records currently known (DECCW 2011a). Previous survey at Panboola have not detected the species (EnviroKey 2010) but during the CBS, it was recorded at all five survey sites. The absence of this species within the locality is likely due to a lack of survey rather than commonality.

Bat diversity was highest at TIPS and WBS with 87% of all bats recorded at these two sites. Bats and particularly microchiropteran bats, require fresh water for regular drinking during foraging activity and they are commonly recorded around water bodies (Angold *et al.* 2006; Churchill 2008; DEWHA 2010; Fenton 1982; Lloyd *et al.* 2006).

Threatened or regionally significant species

Five species of bat recorded are listed as threatened under the schedules of the NSW *Threatened Species Conservation Act 1995* (TSC Act) or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

These were the Eastern Bentwing Bat (*Miniopterus orianae oceanensis*) (Vulnerable, TSC Act), Eastern Falsistrelle (*Falsistrellus tasmaniensis*) (Vulnerable, TSC Act), Eastern Freetail Bat (*Micronomus norfolkensis*) (Vulnerable, TSC Act), Grey-headed Flying Fox (*Pteropus poliocephalus*) (Vulnerable, TSC Act and EPBC Act) and Greater Broad-nosed Bat (*Scoteanax reuppellii*) (Vulnerable, TSC Act).

Previous surveys have only detected the presence of three of these species (Eastern Bentwing Bat, Eastern Falsistrelle and Eastern Freetail Bat) (EnviroKey 2010).

Differences in Communities across different habitats

Observed differences between bat communities across the habitats of Panboola were recorded. Ten and eight species of bat were recorded in the Closed Forest and Freshwater Wetland respectively, while the bat community at the Coastal Saltmarsh comprised of only two species.

This discrepancy is best explained by the presence of freshwater around TIPS and WBS, providing opportunity for regular drinking and the proximity of street lights that could provide increased foraging. Regular drinking allows bats to digest food more quickly and with less energy, enabling individuals to forage over a longer period of time (Churchill 2008). The Closed Forest while deficient in hollows, does provide open clearings between tree plantings which hosted many foraging bats observed during the CBS. The highly mobile nature of bats also suggests that bats are likely to be using these two habitats sympatrically given their adjoining location (Barclay *et al.* 2000; Law *et al.* 1999; Pennay and Freeman 2005). Similarly, these same bats could be foraging at RIP with as many as five species recorded. Numerous stags along Pambula River provide potential roost and maternity locations for microchiropteran bats. In light of the high diversity of microchiropteran bats recorded at Panboola, target 'stagwatching' of these trees should be undertaken.

Several species of bat were recorded in only one habitat type. These include two species of forest bat (*Vespadelus vulturnus* and *V.regulus*) and the Eastern Falsistrelle which were recorded only in the Closed Forest. These records are consistent with the known habitat preferences of these species (Churchill 2008).

Given the highly mobile nature of bats in general, with some species foraging as far as 20km in one evening, the bat community at Panboola should be regarded as a single entity for the purpose of management. Habitats within the WBS could be enhanced with the provision of specialist bat boxes in the absence of tree hollows (Goldingay and Stevens 2009).

5 RECOMMENDATIONS

A number of recommendations relevant to mammals, reptiles and bats at Panboola have been specifically developed based on the results of the CBS and the specific knowledge of these taxa by the authors. Four areas have been identified and within each, specific actions are provided to assist in the future management and restoration activities at Panboola.

Habitat Management

1. It is understood that while a certain level of grass slashing is required to ensure the safety of visitors to Panboola, where possible, this should be minimised. In particular, a corridor of unslashed vegetation (or alternatively see Habitat Restoration Point 2) should be retained to link TIPS with the vegetation link that joins with the Pambula River. Slashing of vehicular tracks is likely to have no impact on fauna habitat.

Habitat Restoration

1. Microhabitat restoration such as terrestrial and aquatic fallen timber restoration. The focus of this should be at WBS, CORR, RIP and TIPS.
2. Softening of the matrix, particular in existing clearings. Piles of fallen timber, old fence posts or railway sleepers can provide value 'stepping stones'. Existing clearings within TIPS, WBS and CORR as well as the Bubble would benefit from this activity.
3. Linkages with Ben Boyd National Park. This national park is likely to provide a 'source' population of many fauna species. Where practical, an attempt should be made to enhance habitat linkages with this national park to Panboola.
4. Enhancement of habitat for microchiropteran bats. Specialist bat boxes (not bird boxes) have been used in other locations with success to provide roosting and maternity habitat for microchiropteran bats. The WBS and TIPS should be the focus of this activity.
5. Glider/Bird boxes. Boxes suitable for arboreal mammals and birds should be established within WBS.

Community Awareness

1. Panboola volunteers and the community could assist in establishing and monitoring bird and bat boxes.
2. Interpretive signs highlighting the diverse fauna of Panboola should be established. The results of the CBS could be used to inform these signs.
3. This report could be placed onto the Panboola website to provide additional awareness to members and the community.

Future Survey and Monitoring

1. Ongoing fauna survey should be conducted at Panboola with the aim of building a long-term dataset. This will be valuable in determining the results of restoration and management activities.
2. A specialist turtle study should be conducted within TIPS and WBS. A herpetofauna specialist holding a current scientific license issued by OEH and specialist survey permit issued by NSW Fisheries should be engaged to conduct this study.
3. Stagwatching (combined with an anabat detector) of all hollow-bearing trees along the Pambula River should be undertaken to confirm if a microchiropteran bat roost or maternity site is present. This would be best undertaken in summer.
4. Any additional surveys or monitoring should include Panboola volunteers where possible to enable them to build skills and knowledge of the fauna of Panboola and the wider region.

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7 APPENDICES

APPENDIX 1 – MAPPING



Legend

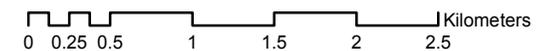
 Study Area

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

Data Source:
Study Area: EnviroKey
Aerial image: Google Earth

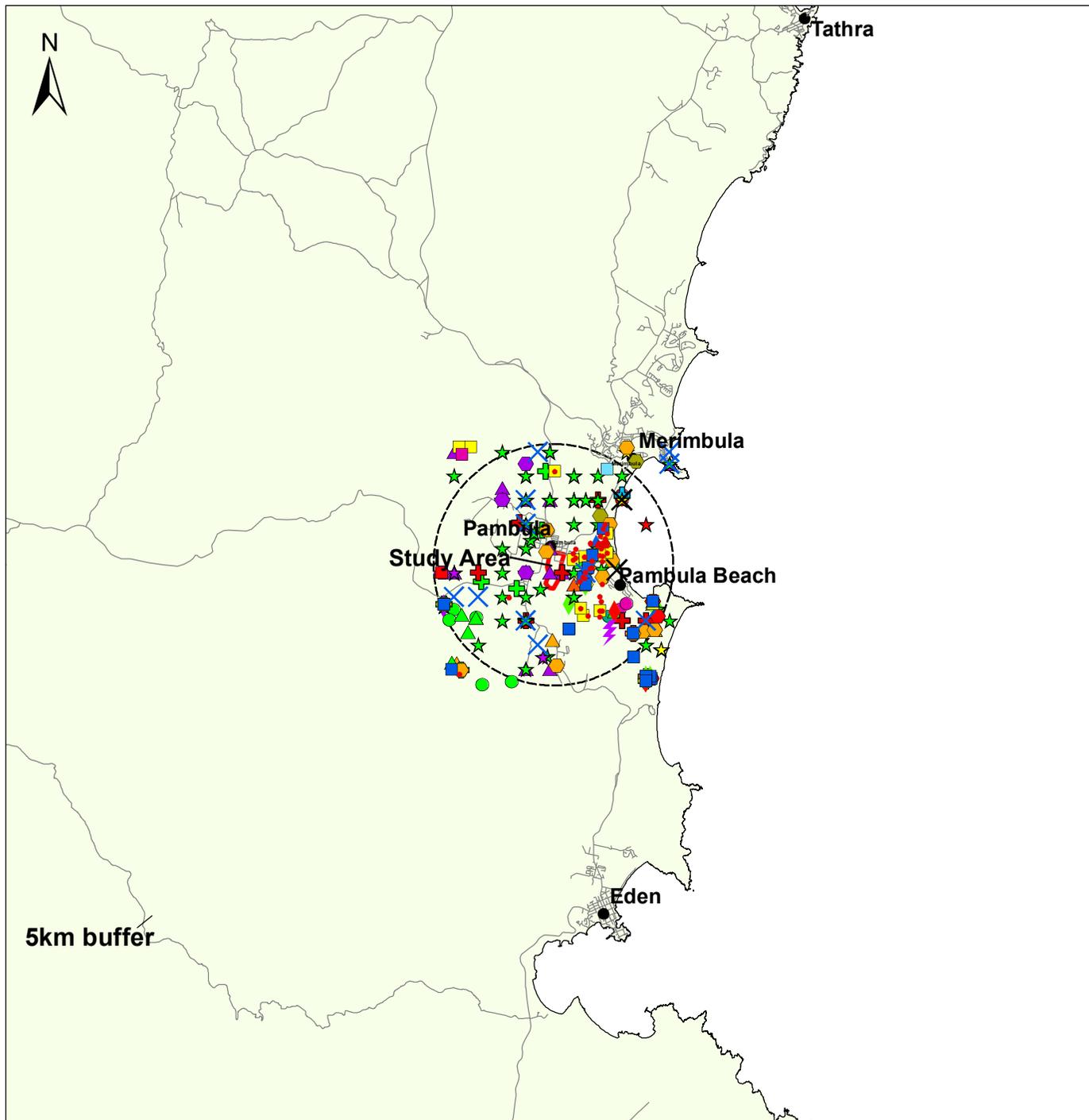
Mapping date: June 2011

Scale 1:46,000 (A4)



PO Box 7231 Tathra NSW 2550. t: 02 6494 5422

Map 1: Location of the Study Area



Legend

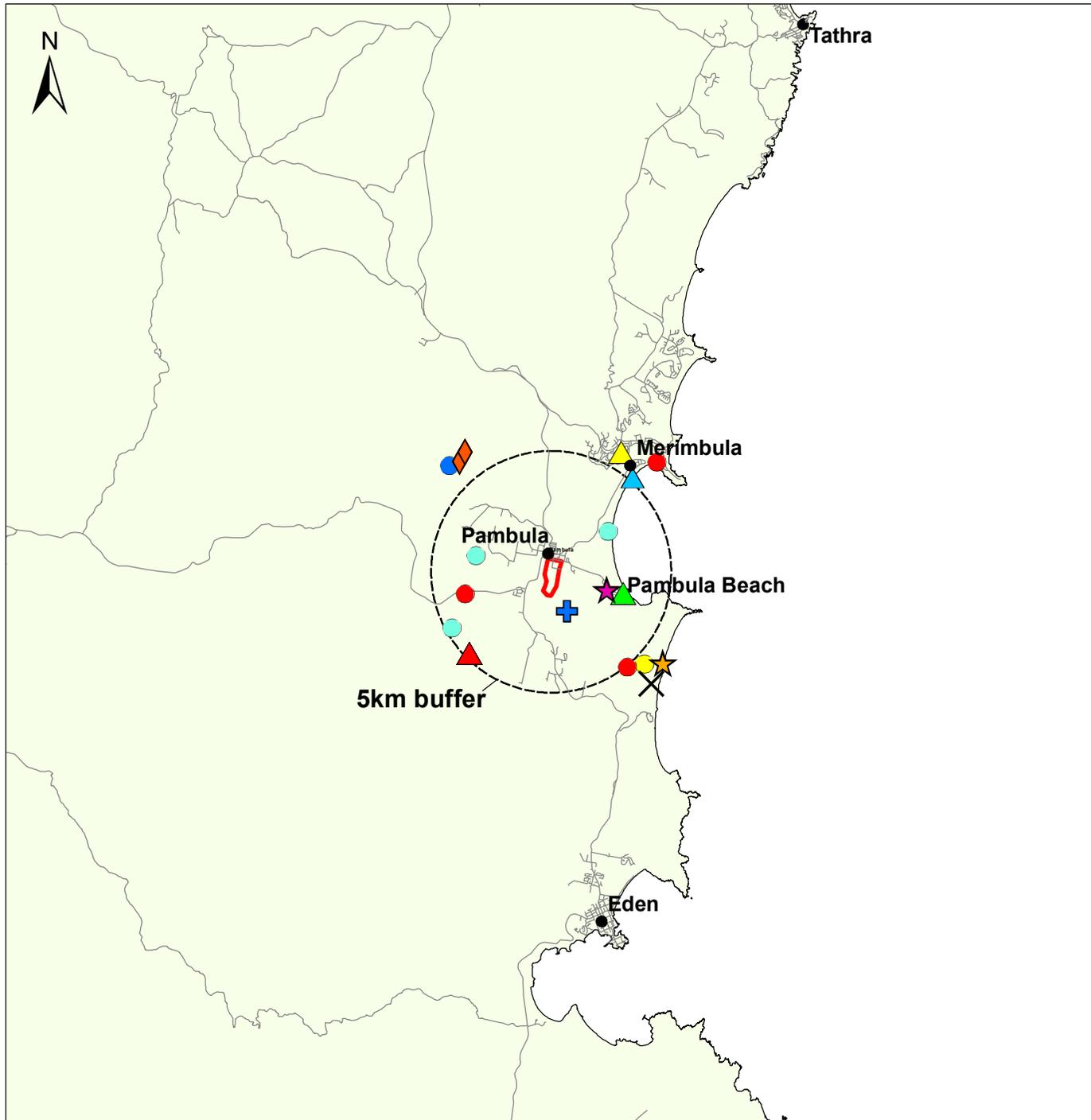
- | | |
|---------------------------|--------------------------|
| ● Agile Antechinus | ★ Fox |
| ● Australian Fur-seal | ★ Humpback Whale |
| ● Black Rat | ★ Killer Whale |
| ● Bottlenose Dolphin | ★ Koala |
| ● Brown Antechinus | ★ Leopard Seal |
| ▲ Brush-tailed Phascogale | ● Long-nosed Bandicoot |
| ▲ Bush Rat | ● Long-nosed Potoroo |
| ▲ Cat | ● Platypus |
| ▲ Common Brushtail Possum | ● Red-necked Wallaby |
| ▲ Common Ringtail Possum | ● Short-beaked Echidna |
| ✚ Common Wombat | □ Sperm Whale |
| ✚ Dingo, domestic dog | ■ Spotted-tailed Quoll |
| ✚ Dugong | ■ Sugar Glider |
| ✚ Dunnart | ■ Swamp Wallaby |
| ✚ Dusky Antechinus | ■ Unidentified Eptesicus |
| ◆ Eastern Grey Kangaroo | ✕ Unidentified Seal |
| ◆ Eastern Pygmy-possum | ⚡ White-footed Dunnart |
| ◆ European cattle | ● Yellow-bellied Glider |
| ◆ Feathertail Glider | ✕ unidentified Bandicoot |

Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994
 Grid: Map Grid of Australia, Zone 55
 Data Sources:
 Study Area: EnviroKey
 Threatened Sp. Data: OEH under data agreement (CON09007)
 Mapping date: June 2011
 Scale 1:250,000 (A4)



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Map 2a. Previous Records of Mammals (excl. Bats) in the Locality



Legend

- Carpet & Diamond Pythons
- Common Death Adder
- Dark-flecked Garden Sunskink
- Diamond Python
- ▲ Eastern Blue-tongue
- ▲ Hawksbill Turtle
- ▲ Mountain Dragon
- ▲ Mustard-bellied Snake
- ◆ Pale-flecked Garden Sunskink
- + Red-bellied Black Snake
- × Tiger Snake
- ★ Weasel Skink
- ★ White-lipped Snake
- Study Area

Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994
 Grid: Map Grid of Australia, Zone 55

Data Sources:
 Study Area: EnviroKey
 Threatened Sp. Data: OEH under data agreement (CON09007)

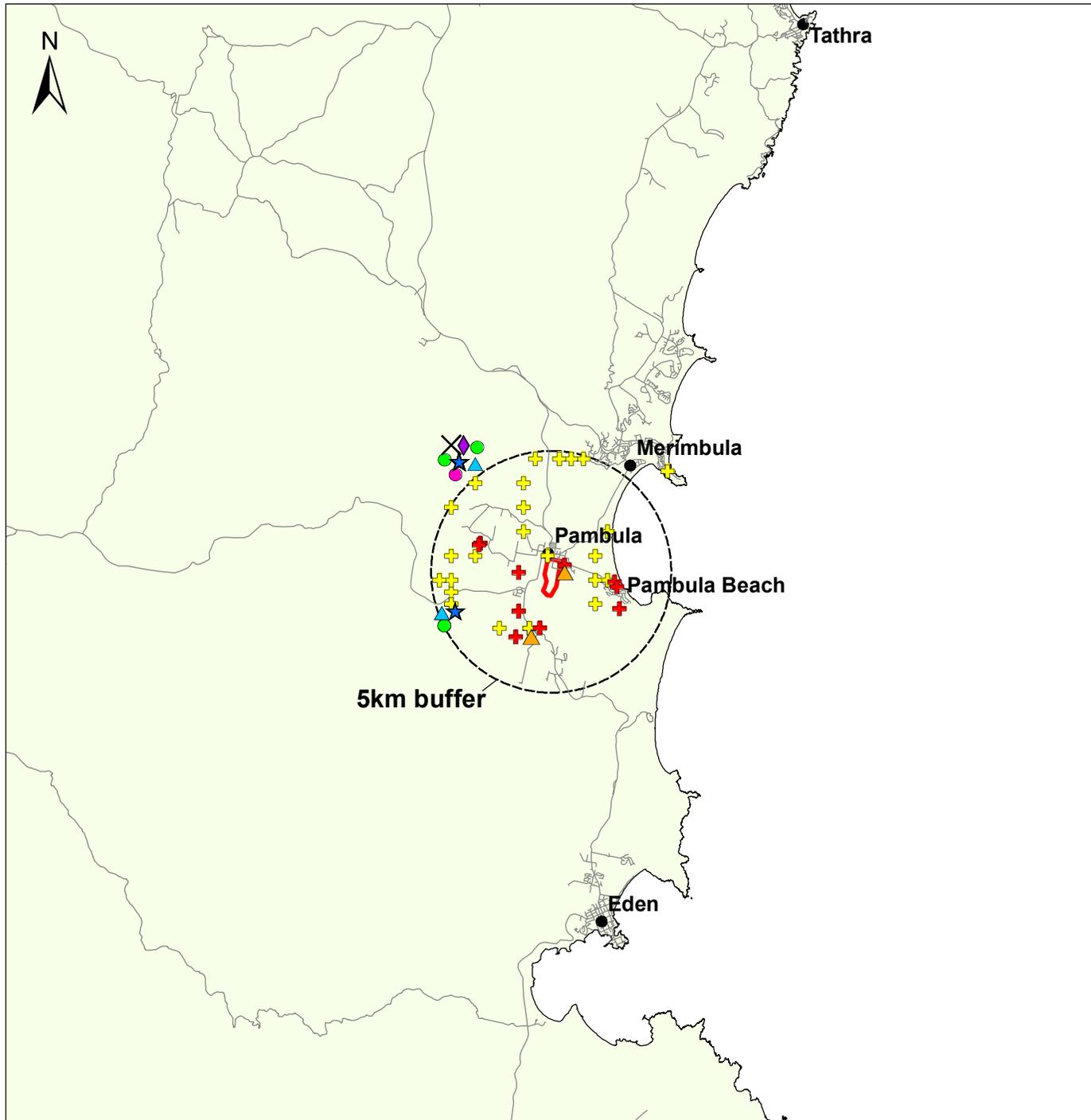
Mapping date: June 2011

Scale 1:250,000 (A4)



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Map 2b. Previous Records of Reptiles in the Locality



Legend

- Chocolate Wattled Bat
 - Eastern Bentwing-bat
 - + Flying-fox
 - + Grey-headed Flying-fox
 - ▲ Lesser Long-eared Bat
 - ▲ Little Red Flying-fox
 - × Long-eared bat
 - ★ Southern Forest Bat
 - ◆ White-striped Freetail-bat
- ▭ Study Area

Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994
 Grid: Map Grid of Australia, Zone 55

Data Sources:
 Study Area: EnviroKey
 Threatened Sp. Data: OEH under data agreement (CON09007)

Mapping date: June 2011

Scale 1:250,000 (A4)



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Map 2c. Previous Records of Bats in the Locality



Legend

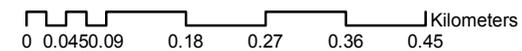
- ▲ CORRIDOR
- ★ RIPARIAN
- SALTMARSH
- + TIPS
- ◆ WBS
- Study Area

Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994
 Grid: Map Grid of Australia, Zone 55

Data Source:
 Study Area, survey sites: EnviroKey
 Aerial image: Google Earth

Mapping date: June 2011

Scale 1:8,500 (A4)



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Map 3. Locations of Survey Sites for this Study

APPENDIX 2 – ANABAT ANALYSIS

Panboola Anabat Analysis – CBS 2011

Methods

A total of 233 files were analysed into bat and non-bat origin resulting in 178 bat files. These were then analysed using the software package AnabookW guided by the 'Bat Calls of New South Wales: Region based guide to echolocation calls of microchiropteran bats', the authors reference call collection and the experience of the analyst, Steve Sass. It should be noted that members of the *Nyctophilus* genus were unable to be identified to species level due to a lack of differentiation between species and are identified to genus level only.

A call was defined as a sequence of three or more consecutive pulses of similar frequency. Due to variability in the quality of calls and the difficulty in distinguishing some species the identification of each call was assigned a confidence rating as follows:

D = Definite: Species identification not in doubt.

PR = Probable: Call most likely to represent a particular species, but there exists a low probability of confusion with species of similar call types.

PO = Possible: Call characteristics are comparable with the species, but there exists a reasonable probability of confusion with one or more bat similar species or the quality or length of call prohibits a confident identification.

Those calls unable to be identified due to poor call quality resulting in a lack of diagnostic features were assigned 'Unidentifiable'.

Nomenclature follows that used by Churchill (2008) Australian Bats, 2nd edition.

Results

WBS

Total files: 111

Bat files: 92

Species	Confidence Ranking			
	PO	PR	D	Total
<i>Unknown</i> (definitely a bat call, but poor quality did not allow for identification)	-	-	3	3
<i>Not bat</i> (likely insects)	-	-	19	19
<i>Austronomus australis</i>	-	-	4	4
<i>Chalinolobus gouldii</i>	6	5	12	23
<i>Falsistrellus tasmaniensis</i>	4	3	1	7
<i>Miniopterus orianae</i>	3	2	4	9

Species	Confidence Ranking			
	PO	PR	D	Total
<i>oceanensis</i>				
<i>Micronomus norfolkensis</i>	2	3	1	6
<i>Mormopterus ridei</i>	7	5	3	15
<i>Vespadelus darlingtoni</i>	6	4	4	14
<i>Vespadelus regulus</i>	6	2	-	8
<i>Vespadelus vulturnus</i>	-	3	-	3
			Total	111

TIPS

Total files: 82

Bat files: 70

Species	Confidence Ranking			
	PO	PR	D	Total
<i>Unknown</i> (definitely a bat call, but poor quality did not allow for identification)	-	-	2	2
<i>Not bat</i> (likely insects)	-	-	12	12
<i>Austronomus australis</i>	-	-	6	6
<i>Chalinolobus gouldii</i>	3	5	7	15
<i>Miniopterus orianae oceanensis</i>	4	4	6	14
<i>Micronomus norfolkensis</i>	1	3	3	7
<i>Mormopterus ridei</i>	1	6	2	9
<i>Scoteanax rueppellii</i>	2	1	-	3
<i>Vespadelus darlingtoni</i>	6	4	4	14
			Total	82

CORRIDOR

Total files: 17

Bat files: 9

Species	Confidence Ranking			
	PO	PR	D	Total
<i>Unknown</i> (definitely a bat call, but poor quality did not allow for identification)	-	-	1	1
<i>Not bat (likely insects)</i>	-	-	8	8
<i>Austronomus australis</i>	-	-	4	4
<i>Chalinolobus gouldii</i>	-	-	2	2
<i>Scoteanax rueppellii</i>	1	1	-	2
			Total	17

RIPARIAN

Total files: 14

Bat files: 7

Species	Confidence Ranking			
	PO	PR	D	Total
<i>Not bat (likely insects)</i>	-	-	7	7
<i>Austronomus australis</i>	-	-	1	1
<i>Chalinolobus gouldii</i>	-	-	2	2
<i>Miniopterus orianae oceanensis</i>	1	1	-	2
<i>Nyctophilus sp.</i>	-	-	1	1
<i>Vespadelus darlingtoni</i>	1	-	-	1
			Total	14

SALTMARSH

Total files: 9

Bat files: 3

Species	Confidence Ranking			
	PO	PR	D	Total
<i>Not bat (likely insects)</i>	-	-	6	6
<i>Austronomus australis</i>	-	-	1	1
<i>Scoteanax rueppellii</i>	1	1	-	2
			Total	9

APPENDIX 3 – QUALIFICATIONS AND EXPERIENCE OF PERSONNEL

Name and Qualifications	Experience
<p>Steve Sass B.App.Sci (Env.Sci) (Hons) Principal Ecologist</p> <p>Certified Environmental Practitioner, EIANZ</p>	<p>Steve is a highly experienced Ecologist, having undertaken hundreds of ecological surveys and research projects across Australia since 1992. His expertise extends across the widest range of projects including landscape scale biodiversity surveys and assessments.</p> <p>Steve has an extensive scientific background and is an Adjunct Associate of the Ecology and Biodiversity Group within the Institute for Land, Water and Society, a leading research group at Charles Sturt University and is recognised as a Certified Environmental Practitioner by the Environment Institute of Australia and New Zealand.</p> <p>Steve led the field surveys during the CBS and was the senior author of the report. With his extensive experience in echolocation call analysis, Steve also completed the Anabat analysis for the CBS.</p>
<p>Sam Parsell B. Env. Sci (on-going) Assistant Ecologist</p>	<p>Sam is completing a Bachelor of Environmental Science at Charles Sturt University which is due for completion shortly. Under the direct supervision and guidance of the Principal Ecologist, Sam assisted with field surveys for the CBS.</p> <p>Sam was also a contributing author of the CBS report.</p>
<p>Linda Sass B. Gn.St (Sci) (on-going), B.A, Dip. Ed (Sec) Ecologist</p>	<p>Linda is an experienced ecologist having conducted flora and fauna surveys across NSW over the past 8 years.</p> <p>She recently completed surveys for the Endangered Merimbula Star-hair of the Tura Beach population and was a contributing author of a Plan of Management developed for Bega Valley Shire Council.</p> <p>Linda assisted with field surveys during the CBS, was a contributing author to the report, and conducted the internal review of the report.</p>
<p>Mark Harris B.App.Sci (Env Res Mgt) GIS Analyst</p>	<p>Mark is a highly experienced GIS Analyst having more than ten years' experience in mapping software.</p> <p>Mark completed the mapping that is provided within the CBS report.</p>
<p>Barbara Triggs c/o Post Office, Genoa, Victoria</p>	<p>Barbara is a specialist in mammalian fauna. She is the author of the definitive guide 'Tracks, Scats and other traces: A Field Guide to Australian Mammals'.</p> <p>Barbara provides a service to ecological consultancies for the identification of hair and scat samples that are collected across Australia.</p> <p>Barbara conducted the hair and scat analysis for the CBS.</p>