Submission to the NRC on review of the Water Sharing Plan for the Macquarie Bogan Unregulated Rivers Water Sources 2012

Submission on behalf of the Bogan Shire Council, Nyngan NSW.

Bogan Shire Council would like to meet the Review Team to discuss the issues raised in this submission if possible. Bogan Shire Council would also welcome the opportunity to have further consultation involving affected parties within the Bogan Shire LGA before the Plan is finalised.

1. To what extent do you feel the plan has contributed to environmental outcomes?

The key environment outcome for the Bogan Shire is to preserve and enhance the Weir Pools at Nyngan. The Pools have always been an important oasis for the Western region but since the Albert Priest Channel was completed in 1942, they have been a permanent refuge for a variety of wildlife including an Endangered Ecological Community, a Threatened Ecological Community, nine Threatened Species including 8 birds and one fish species, four species of vulnerable Microchiropteran bats and numerous other vulnerable plants and animals (See attachment 'Nyngan Weir Pool Assessment'). They were the site for the 'Fish Arc' collection of the vulnerable Western population of the Olive Pearchlet (Ambassis agassizii) during the last drought, where over 800 were collected and used to repopulate areas where the fish had become locally extinct. It is also the summer home to the most inland colony of Grey Headed Flying Fox (Pteropus poliocephalus) and given their survival in years where air temperature has exceeded 48 degrees may well be the source of important genetics for the preservation of the species during the onslaught of Climate Change.

The key factor in the permanency of the Upper Weir pool is the ongoing connection to regulated flows via the Albert Priest Channel from the regulated Macquarie and, although this review cannot directly impact the management of the Regulated Macquarie it is important to raise the issue here. There have been 3 unsuccessful attempts to pipe the Albert Priest Channel (and thereby cut the gravity fed earthen connection to the regulated Macquarie River). Bogan Shire Council has previously not supported a pipeline due to the financial impact of such a proposal on our water users. In addition, Bogan Shire Council would require the pipeline to discharge into the existing Weir Pools. Without this pre-condition, the Nyngan Weir Pools would soon evaporate and this recreational, economic, social and environmental asset would be lost.

2. To what extent do you feel the plan has contributed to social outcomes?

The key social outcome for any water sharing plan for the Bogan Shire is to preserve the permanent Weir pools at Nyngan. The Upper Weir pool is a significant wetland with great environmental and tourist value but it's the Lower Weir that is the focus of Bogan Shire's major social well-being. The Lower Weir provides a home for the Nyngan Water Ski Club

and is consistently used throughout the year but especially Spring to Autumn. It is also home to extensive recreational fishing, swimming and other water sports.

In this context we support subclauses

53(8) Subject to subclause (32), water must not be taken under an access licence with an extraction component that specifies the Lower Nyngan Weir Pool Management Zone in the Bulbodney Grahway Creek Water Source when the water level is at or below 50% of the full capacity of Lower Nyngan Weir Pool. For the purposes of this subclause, the Minister may determine a water level at the telemetric gauge on the Bogan River at Nyngan (421138) that is to be considered equivalent to 50% of the full capacity of Lower Nyngan Weir Pool.

and

53(9) Subject to subclause (32), water must not be taken under an access licence with an extraction component that specifies the Upper Nyngan Weir Pool Management Zone in the Bulbodney Grahway Creek Source when the water level in the Upper Nyngan Weir Pool is 70 centimetres or more below the concrete sill of Upper Nyngan Weir.

3. To what extent do you feel the plan has contributed to economic outcomes?

The plan has allowed certainty with respect to the Weir Pool licences especially recognising the historic connection between the Regulated Macquarie and the Unregulated Bogan, (subclauses 53(10)-(13)) which are discussed in more detail in Question 4 and much of what we say in part 4 is grounded in economic outcomes and could have easily be repeated in this section.

The social outcomes set out in our answer to Question 2 regarding the recreational outcomes of the Lower Weir Pool also create a great deal of economic benefit in the form of attracting a multitude of visitors to the town to participate in those activities, not only staying for days in Nyngan's various accommodation options, but eating out and spending in shops during their stays.

4. To what extent do you feel the plan has contributed to meeting its objectives?

The Plan has gone some way towards meeting it's objectives but we consider there is scope to relax some of the more restrictive trading rules as set out in the discussion below.

Bogan Shire supports the rules regarding commence to pump, cease to pump and drawdown which have provided security and certainty for the residents of the Bogan Shire and protected the town water supply during times of low inflows.

There have been no recorded breaches of these rules since the Water Sharing Plan was declared and no actions by Weir Irrigators endangered Town Water Supply even during the record drought of 2017-2020.

We also support subclauses 53(2)(b)(i) and (ii):

Subject to subclause (32), water must not be taken under an access licence when there is no visible flow at the location at which water is proposed to be taken. This subclause does not apply to—
(a) the taking of water from an in-river pool or an off-river pool, or
Note—

***Visible flow**, **in-river pool** and **off-river pool** are defined in the Dictionary.*

(b) the taking of water under an access licence with a share component or extraction component that specifies—
(i) the Lower Nyngan Weir Pool Management Zone in the Bulbodney Grahway Creek Water Source,

(ii) the Upper Nyngan Weir Pool Management Zone in the Bulbodney Grahway Creek Water Source,

Which allows our irrigators to a small share of the Weir pool water as defined below

(8) Subject to subclause (32), water must not be taken under an access licence with an extraction component that specifies the Lower Nyngan Weir Pool Management Zone in the Bulbodney Grahway Creek Water Source when the water level is at or below 50% of the full capacity of Lower Nyngan Weir Pool. For the purposes of this subclause, the Minister may determine a water level at the telemetric gauge on the Bogan River at Nyngan (421138) that is to be considered equivalent to 50% of the full capacity of Lower Nyngan Weir Pool.

And

(9) Subject to subclause (32), water must not be taken under an access licence with an extraction component that specifies the Upper Nyngan Weir Pool Management Zone in the Bulbodney Grahway Creek Source when the water level in the Upper Nyngan Weir Pool is 70 centimetres or more below the concrete sill of Upper Nyngan Weir.

Though we ask for clarification as to the reasoning behind clause 32(d)(i), which seemingly prohibits taking of water using Runoff harvesting dam which may protect leached chemicals from reaching the intakes of the Bogan Shire.

We also support clause 53 (10)-(13) which recognises, in some small way, the historic right of Nyngan Weir Irrigators to access Macquarie River water, unregulated flows since 1942 and regulated flows since 1969.

Clause 53(10) Subject to subclauses (11) and (32), the taking of water under an access licence with an extraction component that specifies the Lower Nyngan Weir Pool Management Zone or the Upper Nyngan Weir Pool Management Zone in the Bulbodney Grahway Creek Water Source must not be commenced following a period in which access was suspended under subclause (8) or (9) unless—

(a) there is a visible flow in the Bogan River at Neurie Plains gauge (421039), and

(b) water has spilled over Lower Nyngan Weir.

(11) Subclause (10) does not apply to the taking of water under an access licence where—
(a) the licence holder also holds an access licence with a share component that nominates the Macquarie and Cudgegong Regulated Rivers Water Source at the time of the taking of the water and has ordered water under that access licence to be delivered to Lower Nyngan Weir Pool or Upper Nyngan Weir Pool via the Albert Priest Channel,

(b) the licence holder is a member of the Albert Priest Channel Association,

(c) the volume of water taken is less than or equal to 80% of the volume of water ordered, and

(d) the water is taken within 30 days of the delivery of the water to Upper Nyngan Weir Pool.

(12) Water must not be taken under an unregulated river (regulated supply—local water utility) access licence or an unregulated river (regulated supply) access licence with an extraction component that specifies the Lower Nyngan Weir Pool Management Zone or the Upper Nyngan Weir Pool Management Zone in the Bulbodney Grahway Creek Water Source unless—
(a) the licence holder also holds an access licence with a share component that nominates the Macquarie and Cudgegong Regulated Rivers Water Source at the time of the taking of the water and has ordered water under that access licence to be delivered to the unregulated river water source that is specified in the share component of the unregulated river (regulated supply—local water utility) access licence or unregulated river (regulated supply) access licence, and

(b) the volume of water taken is less than or equal to 70% of the volume of water ordered.

(13) Water must not be taken under an unregulated river (regulated supply—local water utility) access licence or an unregulated river (regulated supply) access licence with an extraction component that does not specify the Lower Nyngan Weir Pool Management Zone or the Upper Nyngan Weir Pool Management Zone in the Bulbodney Grahway Creek Water Source, unless—
(a) a licence holder who holds an access licence with a share component that nominates the Macquarie and Cudgegong Regulated Rivers Water Source at the time of the taking of the water has ordered water under that access licence to be delivered to the unregulated river water source that is specified in the share component of the unregulated river (regulated supply—local water utility) access licence or unregulated river (regulated supply) access licence for the purpose of taking the water under the unregulated river (regulated supply—local water utility) access licence or unregulated river (regulated supply) access licence, and

(b) the volume of water taken is less than or equal to the volume of water ordered.

We also support the continued protection of replenishment flows under clause 53(26) to support our ratepayers who rely on those flows to top up their stock and domestic dams from the Bogan River (in the section between Nyngan and the confluence of the Gunningbar creek) during times of low bogan river flows.

Clause 53(26) Water must not be taken from replenishment flows made according to clause 58 of the Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source 2016 (or any relevant replacement plan) under an access licence other than a domestic and stock access licence with a share component or extraction component that specifies—
(a) the Backwater Boggy Cowal Water Source,

(b) the Lower Nyngan Weir Pool Management Zone in the Bulbodney Grahway Creek Water Source,

(c) the Upper Nyngan Weir Pool Management Zone in the Bulbodney Grahway Creek Water Source,

We also support the following trading clauses that allow Weir Irrigators to trade out of their Management Zone including:

70(2)(h) an assignment of water allocation to an access licence with a share component that specifies the Lower Bogan River Water Source, unless the assignment of allocation is from an access licence with a share component that specifies one of the following water sources—

(i) Bulbodney Grahway Creek Water Source,

(ii) Upper Bogan River Water Source,

And

70(2) (n) *an assignment of water allocation to an access licence with a share component that specifies the Upper Bogan River Water Source, unless the assignment is from an access licence with a share component that specifies one of the following water sources—*

(i) Bulbodney Grahway Creek Water Source,

(ii) Lower Bogan River Water Source.

5. What changes do you feel are needed to the water sharing plan to improve outcomes?

Bogan Shire Council would like to see further protection of local low flows to ensure they reach the Upper Weir Pool via consideration of additional 'commence to pump' rules on Bulbodney Grahway Management Zone licences within 50 kms upstream of the Weir Pool, possibly including a condition that water has spilled over the Lower Nyngan Weir. We would like a consultation period before any changes were made.

We also note the current WSP provides in clause 11:

11 Economic objectives

(1) The broad economic objective of this Plan is to maintain, and where possible improve, access to water to optimise economic benefits for agriculture, surface water-dependent industries and local economies.

(2) The targeted economic objectives of this Plan are as follows—
(a) to maintain, and where possible improve, water trading opportunities for surface water-dependent businesses,

(b) to maintain, and where possible improve, access to water for agriculture, surface water-dependent businesses and landholders,

Yet the trading restrictions placed on the entitlement and allocation trades into the Nyngan Weir Pools have severely restricted trade.

According to clause 11(4) and (5) there should an assessment to measure the success of reaching the objectives in 11(1) and (2). We know the assessment would show the opposite has been achieved.

After consultation with the representative of the Weir Irrigators Association, both Bogan Shire Council and the Weir Irrigators agree that there should be a less blunt licence solution that both preserves the historic right to draw down the Weir Pool but allows more entitlement trades to help further develop local irrigation. Adding further volume to the already existing holdings on the Upper and Lower Weir Pools will contribute to the economic well-being of Nyngan, promote further development and create additional jobs and economic output. Importantly it will not endanger the Weir Pools as additional entitlement/allocation will not alter the ability to breach or otherwise alter the existing minimum height drawdown criteria.

As set out at page 36 of the Background Document for this Water Sharing Plan, the key protection asked for during the discussions with Weir Irrigators and the Department prior to the creation of this Water Sharing Plan was that only existing irrigators would have the right to draw down the Weir pool as set out in Clause 53(2)(b)(i) and (ii), 53(8) and 53(9) but in drafting this protection the Department came up with a total ban on water trading into the Weir Pool Management Zones.

We support the Weir Irrigators in requesting that those trade bans be removed and a new, more tailored approach be taken.

Specifically we support the removal of the following:

Access Licences dealing rules:

Clause 67 (within water sources)

67(c) an access licence with an extraction component that specifies the Bulbodney Grahway Management Zone in the Bulbodney Grahway Creek Water Source to an access licence with an extraction component that specifies the Upper Nyngan Weir Pool Management Zone or the Lower Nyngan Weir Pool Management Zone in the Bulbodney Grahway Creek Water Source,

Clause 68 (changes of water source)

68(d) the granting of an access licence with a share component that specifies the Bulbodney Grahway Creek Water Source, unless—
(i) the extraction component of the new access licence specifies the Bulbodney Grahway Management Zone, and

Clause 69 (amendment of extraction component dealings)

69(b) an access licence with an extraction component that specifies the Bulbodney Grahway Management Zone in the Bulbodney Grahway Creek Water Source being varied to specify the Upper Nyngan Weir Pool Management Zone or the Lower Nyngan Weir Pool Management Zone in the Bulbodney Grahway Creek Water Source,

Clause 70 (Assignment of water allocations dealings)

70(1)(d) an access licence with an extraction component that specifies the Bulbodney Grahway Management Zone in the Bulbodney Grahway Creek Water Source to an access licence with an extraction component that specifies the Upper Nyngan Weir Pool Management Zone or the Lower Nyngan Weir Pool Management Zone in the Bulbodney Grahway Creek Water Source,

and

(2) (e) an assignment of water allocation to an access licence with a share component that specifies the Bulbodney Grahway Creek Water Source, unless the assignment—

(i) is to an access licence with an extraction component that specifies the Bulbodney Grahway Management Zone,

(And any other restriction which we may have inadvertently overlooked.)

In place of these restrictions we would like to see the Department place a new condition on **only the Weir Pool licences that existed in 2016** (that haven't been cancelled or traded out of the Management Zone) which states that they have the right to draw down a maximum of xML (where X equals the volumetric entitlement(water shares) they had in 2016) under clause 53(2) and 53(8) (lower Weir licences) or 53(2) and 53(9)(upper Weir licences).

In applying this, we note the Department's practice will be to note a 'draw down right' of zero Megalitres on any new licence transfer via Section 71M of the Water Management Act 2000. Any increase of entitlement via Section 71R or entitlement increase via Section 71T will have no impact on the drawdown volume already existing on the transferee licence.

We thank you for the opportunity to provide feedback and again offer to be available for further consultation.

[redacted]

Bogan Shire Council

30 April 2022

Nyngan Weir Pool, Second Ecological Assessment

Bogan Shire Council

ecological AUSTRALIA
A TETRA TECH COMPANY

1300 646 131
www.ecoaus.com.au

DOCUMENT TRACKING

Project Name	Nyngan Weir Pool, Second Ecological Assessment
Project Number	16200
Project Manager	Ronnie Hill
Prepared by	Ronnie Hill, Rodney Armistead, Alicia Scanlon, Tomas Kelly
Reviewed by	Peter Hancock
Approved by	Peter Hancock
Status	**Final**
Version Number	**version 2**
Last saved on	**19 January 2021**
Photo	The photo on the front page (Plumed whistling ducks) of this report and all included in Appendix B have been taken by Tomas Kelly of Eco Logical Australia during the second site visit

This report should be cited as 'Eco Logical Australia 2020. *Nyngan Weir Pool, Second Ecological Assessment*. Prepared for Bogan Shire Council.'

Template 2.8.1

Contents

List of Figures

List of Tables

Abbreviations

Abbreviation	Description
BC Act	*Biodiversity Conservation Act 2016*
BSC	Bogan Shire Council
DoEE	Department of the Environment and Energy
DPIE	Department of Panning, Industry and Environment
EEC	Endangered Ecological Community
ELA	Eco Logical Australia
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESA	European Space Agency
FM Act	*Fisheries Management Act 1994*
NDMI	Normalised Difference Moisture Index
OEH	NSW Office of environment and Energy
PCT	Plant Community Type
TEC	Threatened Ecological Communities

1. Introduction

Eco Logical Australia (ELA) was engaged by Bogan Shire Council (BSC) to undertake a second biodiversity assessment of the Nyngan weir pool. The aim of this assessment was to further build on the understanding of biodiversity values discovered during the original assessment in September 2019. In particular, this assessment focuses on the contrast of ecological values present at the weir between periods of abundant water supply observed in 2020 and that of drought conditions that were experienced in 2019. The spatial extent of the survey area was increased for the second survey, to include more of the land adjacent to the upstream reach of the weir pool.

2. Methods

2.1 Biodiversity assessment methods

The biodiversity assessment methodology included a literature review and field survey. The field survey was undertaken by a qualified ecologist to validate information gathered from the literature review and identify any new information relevant to the site. This included validating the extent and quality of the Nyngan Weir Pool and surrounding vegetation, identifying any potential threatened species or populations or their habitat, and any other matters of ecological significance.

2.1.1 Literature review, antecedent conditions and database search

A review of readily available databases and literature pertaining to the ecology and environmental features of the site and surrounding locality was conducted to identify key ecological matters relevant to the area and the regional context. This was used to infer what was likely to be present in the study area to refine the field survey. Database records and relevant literature included:

- NSW Office of Environment and Heritage (OEH) Atlas of NSW Wildlife (10 km search radius) (accessed 3 July 2020)
- Department of the Environment and Energy (DoEE) online search for Matters of National Significance (10 km buffer search) (3 July 2020)
- NSW Fisheries – listed protected and threatened species and populations including species profiles, 'Primefact' publications and expected distribution maps (Riches et al. 2016)
- Antecedent flow conditions (BSC)
- OzArk Environment and Heritage Management Pty Ltd (Ozark, 2013) Environmental Impact Statement Nyngan Waste and Resource Management. Facility Appendix 6: Ecology Assessment
- Nyngan Weir Pool Biodiversity Assessment (ELA, 2019).
- Aerial imagery

Analysis of vegetation moisture content was undertaken using remotely sensed data from the European Space Agency (ESA) Sentinel 2 program, acquired through the ESA Sentinel Hub Data Portal. Imagery from the Sentinel 2 Level 2A sensor was used, with bands 8A and 11 used to create the NDMI (Normalised Difference Moisture Index) following the equation (B8A - B11)/(B8A + B11). NDMI is used to assess the level of moisture content within vegetation.

2.1.2 Field survey

The study area was inspected by ELA ecologist Tomas Kelly from 22 to 24 June 2020. The aims of the field survey were to:

- Assess and identify significant ecological matters within the area
- Identify the extent and condition of riparian vegetation
- Assess key areas identified during the literature review and database search
- Identify disturbed areas
- Identify key flora and fauna habitat, such as hollow-bearing trees, nests, fringing aquatic vegetation and instream snags
- Opportunistic flora and fauna sightings
- Deploy ANABAT bat detectors and undertake nocturnal frog surveys.

Vegetation mapping

Parts of the site was traversed on foot, whilst upper reaches of the Bogan River were accessed via boat with rapid data points being taken on a handheld GPS to identify and record the extent and condition of native woodland vegetation in the investigation area. These areas were mapped to Plant Community Type (PCT) numbers with aerial imagery being used to extrapolate PCTs to a 1000 m buffer along the Bogan River. Extent of the native grassland west of the Bogan River was determined with information and photographs provided by Richard Bootle, a landholder who lives on the western bank of the weir pool.

Fauna

Targeted fauna surveys included nocturnal searches for frog species at seven sites for 20 minutes each. Six ANABAT ultrasonic bat detectors were also set for two nights to assess bat activity. Opportunistic fauna sightings were undertaken on foot and by boat. Fauna data was complemented by historical records and photographs provided by Richard Bootle.

3. Results

3.1 Desktop Analysis

3.1.1 Ecological Context

The investigation area is located on the southern outskirts of Nyngan in central-western New South Wales (Figure 3). The total catchment area of the Bogan River upstream of Nyngan is approximately 18,000 km^2 (Green et al, 2011). It is located within the Bogan-Macquarie sub-region of the Darling Riverine Plains IBRA. The Bogan River is part of the *Lowland Darling River aquatic ecological community*, listed as Endangered under the Fisheries Management Act 1994, and as a result, all aquatic plants and animals are protected.

A total of 60 listed species under Commonwealth and state legislation are known to occur within this sub-region and a further seven are predicted. Six endangered ecological communities are found within the sub-region. There are three key threatening processes recognised as having an impact on these species and communities (DPIE, 2020a). Several species are currently known to be extinct from the

central west catchment. These include the Bilby, Burrowing Bettong, Eastern Hare Wallaby and *Euphrasia arguata* (OzArk, 2013).

Vegetation in the catchment has been largely cleared for agriculture. Large remnant areas of native vegetation are either in national parks, state forest, reserves, or in areas unsuitable for grazing and cultivation (OzArk, 2013).

Wetlands are a major ecological feature of the region, providing suitable habitat for many ecologically significant species and communities. They include all major watercourses and streams, as well as associated billabongs and waterholes. The Bogan River, starting in the Hervey Range near Peak Hill and flowing north-west to Nyngan, has several weirs along it, including the Nyngan Weir, which spans the width of the channel. The weir isolates the upstream and downstream sections of Bogan River until the water level exceeds the weir height and flows downstream into the lower weir pool approximately 3 km downstream.

3.1.2 Antecedent conditions

An analysis of antecedent conditions was completed to better understand the local environmental conditions and trends associated with field observations of the investigation area.

Climate

Climatic data from January 2019 to November 2019 was analysed to assist in interpreting the effects recent temperature and rainfall conditions have had on the investigation area. Total rainfall was below the long-term average for nine of the eleven months within the analysed period. Observed maximum and minimum temperatures were also above the long-term average (Figure 1). Weather data was unavailable from November 2019 to the date this report was delivered.

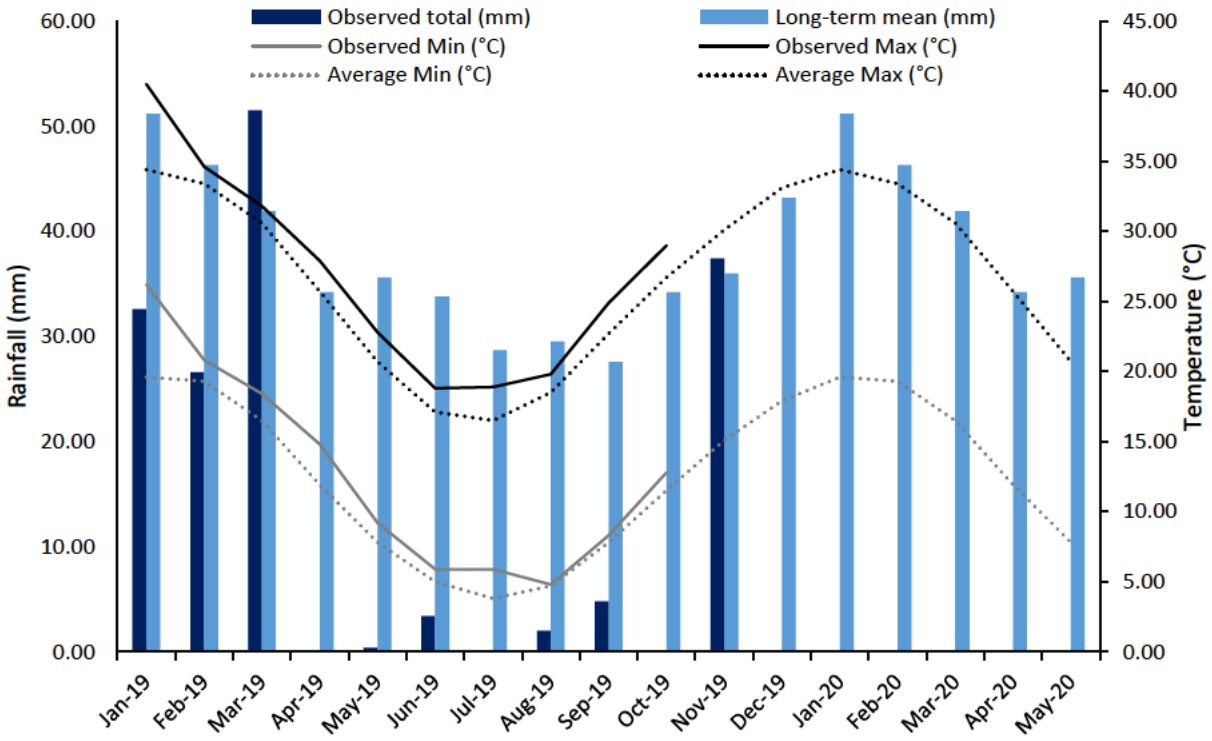

Figure 1: Antecedent climatic conditions (051039 - Nyngan Airport (BoM 2020)) Note: no data available following November 2019 at the time of writing this report.

Hydrology

Analysis of the previous eight years river height measurements at Nyngan weir revealed a mean height of 2.64 m. This period included three major events in which the river surpassed 5 m. The 2019 survey

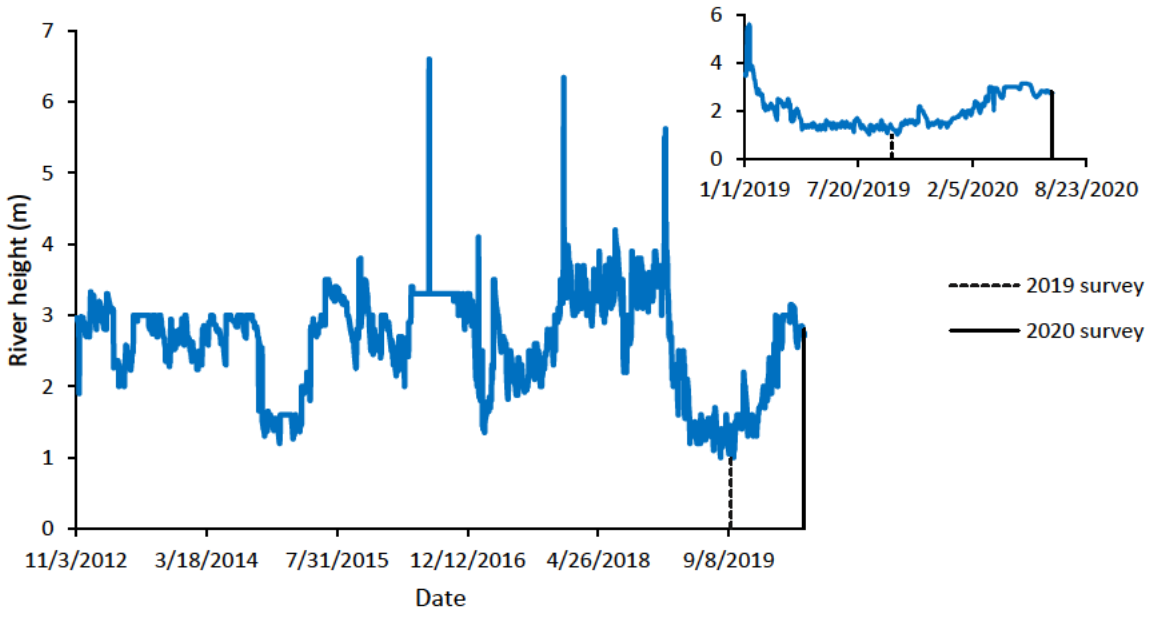

Figure 2: historic river heights at Nyngan weir (Bogan Shire Council)

period occurred when the river had reached a low point of 1.3 m, whilst during the 2020 survey period river height was 2.74 m (Figure 2).

Moisture Index

The moisture index (Figure 3) highlights the shift in vegetation moisture content between the 2019 'dry' and the 2020 'wet' survey period. The 2019 moisture content was low with only small areas of medium-high moisture in parts of the Bogan River and irrigated land. As 2020 progressed, the Bogan River rose and began to fill oxbows and reaches of the Bogan River that had been dry for most of the 2018-19 period. The spreading of the river, along with increased rainfall in 2020 has led to a substantial increase in overall moisture content across the region.

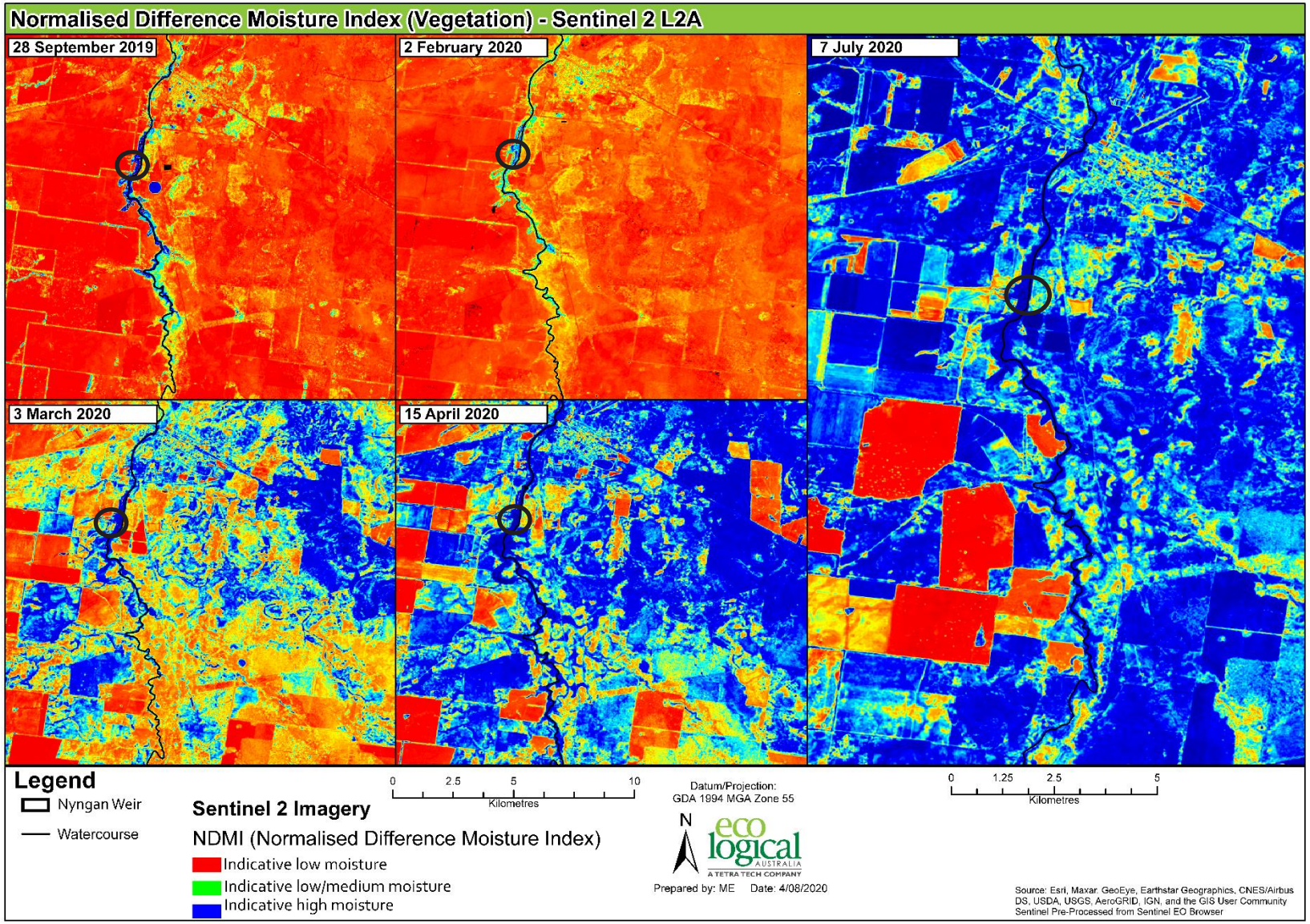

Figure 3: Vegetation NDMI showing the progression from a dry period (28 September 2019) to a wet one (7 July 2020). The black circle on each image shows the Nyngan Weir Pool

3.1.3 Vegetation extent

Native vegetation was mapped in the 1000 m buffer of the Bogan River. Of the total assessed area (1868 ha), the extent of native woodland vegetation in this area is 905 ha (48 %), and the extent of native grassland is 331 ha (18 %). The remaining area is made up of cleared land, infrastructure and the Bogan River. Aerial imagery shows the most densely vegetated area as being within the riparian zones of the Bogan River. Contiguous vegetation exists east of the Bogan River, with land only partially cleared. The riparian zone contains the contiguous vegetation and therefore is a remnant habitat corridor for less mobile fauna. Vegetation beyond the riparian zone west of the Bogan River consists of native grassland which has been left ungrazed and allowed to return to its natural state. (Figure 4).

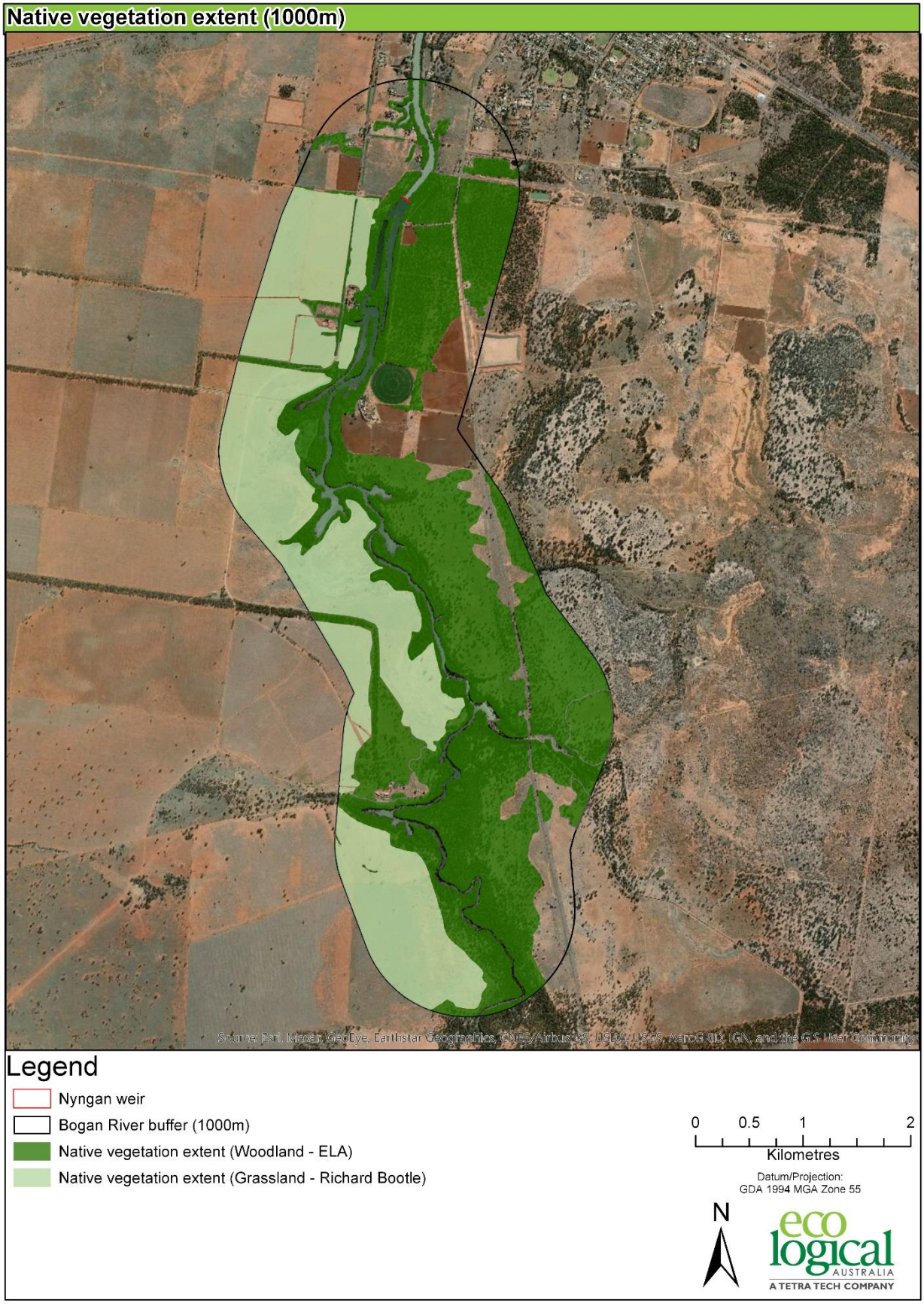

Figure 4: Native vegetation extent (1000 m)

3.1.4 Threatened ecological communities, species and populations

A database review, including the EPBC Protected Matters Search Tool, found four threatened ecological communities as potentially occurring in the locality. These were:

- Coolibah: Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions - (Endangered under the BC and EPBC Acts)
- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia – (Endangered under the BC and EPBC Acts)
- Weeping Myall Woodlands – (Endangered under the BC Act and Critically Endangered under the EPBC Act)
- Lowland Darling River aquatic ecological community - (Endangered under the FM Act).

A search of the Atlas of NSW Wildlife (NSW BioNet) was updated on the 3 July 2020 and identified fourteen listed fauna species within 10 km of the Nyngan Weir investigation area. This included eleven species listed as vulnerable under the BC Act (including one under the EPBC Act). Two species were also listed marine species, and one was a migratory species under the EPBC Act (Figure 5).

Figure 5: Threatened species records in locality (<10 km, BioNet)

3.2 Field survey results

3.2.1 Vegetation communities

Three vegetation communities were identified within the Nyngan weir investigation area. These included:

- PCT 36 - River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
- PCT 37 - Black Box woodland wetland on NSW central and northern floodplains including the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion
- PCT 56 - Poplar Box - Belah woodland on clay-loam soils on alluvial plains of north-central NSW.
- Undefined areas consisting of cropped or cleared land, infrastructure, and the Bogan River

A total of 905 ha within the buffer area was mapped as a PCT, with 397 ha being PCT 36, 403 ha of PCT 37 and 105 ha of PCT 56. There is 331 ha of native grassland on the eastern side of the weir pool. The species composition of this community was not surveyed, but it is dominated by native grasses and has not been grazed for many years (Richard Bootle pers comm.). Undefined areas such as cleared land, cropping, infrastructure and the Bogan River did not meet the definition of native vegetation and have been intentionally left blank (Figure 6).

PCT 36 mainly occurs within the riparian zone of the investigation area. Vegetation formation ranges from tall open forest to woodland with canopy species primarily consisting of River Red Gum (*Eucalyptus camaldulensis*), Black Box (*Eucalyptus largiflorens)* and Coolabah *(Eucalyptus coolabah* subsp*. coolabah*).

PCT 37 is positioned higher on the plains of the Bogan River. Vegetation formation ranges from open forest to open woodland dominated by Black Box, often with Poplar Box *(Eucalyptus populnea subsp. bimbil*), Coolabah or Belah (*Casurina cristata*).

PCT 56 is positioned on the alluvial plains of the Bogan River. It is characterized by a tall to mid-high woodland dominated by Poplar Box and Belah, commonly with the small tree Western Rosewood (*Alectryon oleifolius*).

A full description of these PCTs can be found within the BioNet Vegetation Classification database.

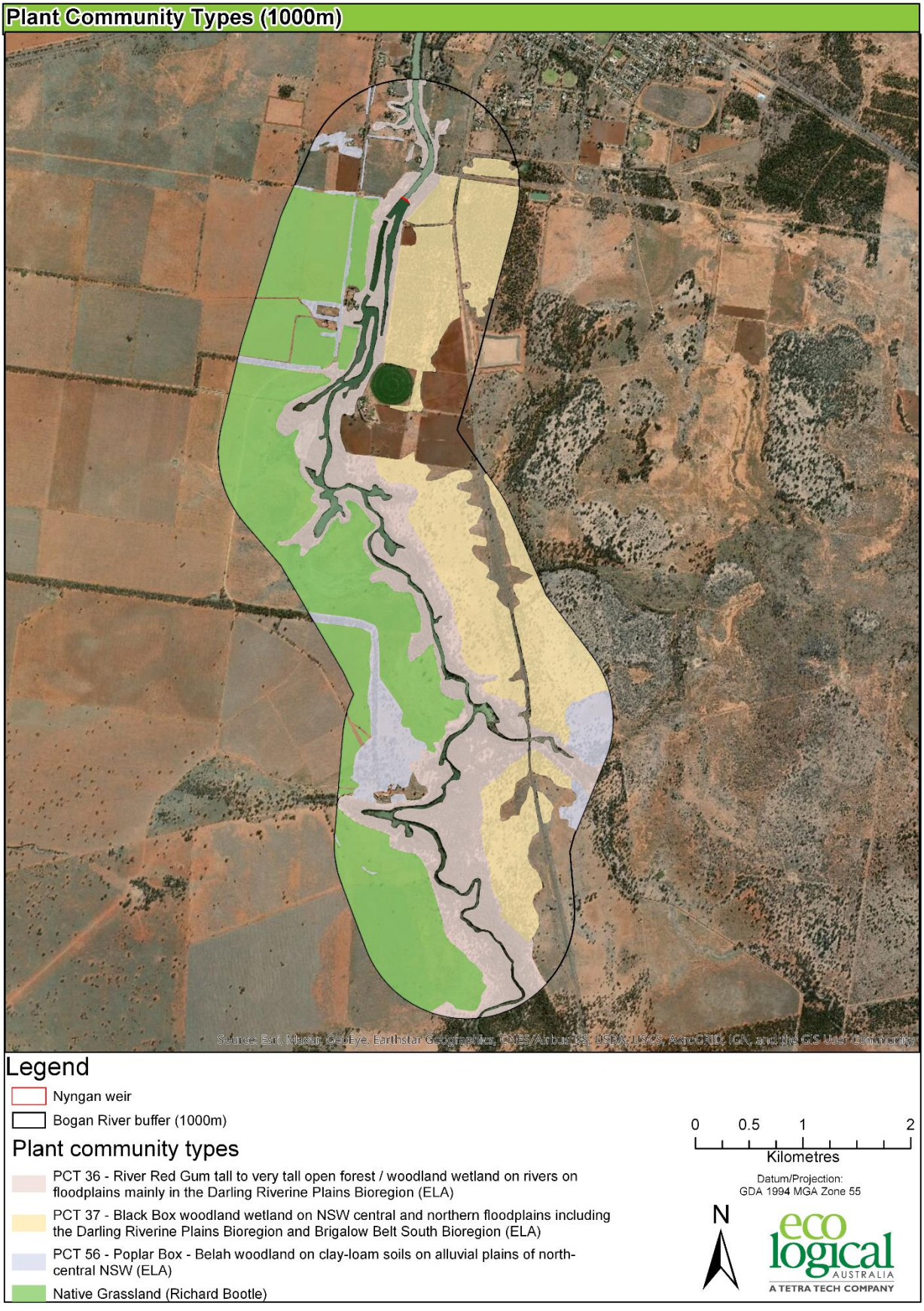

Figure 6: Plant community types within investigation area

3.2.2 Threatened ecological communities, species and populations

Threatened Ecological Communities

One Endangered Ecological Community (EEC) under the BC and EPBC Acts was identified in the project area during the field survey:

- Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions

This community is found within the extent of PCT 37 (Figure 6) and is characterised by grey, self-mulching clays of periodically waterlogged soils including floodplains, swamp margins, ephemeral wetlands, and stream levees. Community composition is primarily Coolabah and Black Box, although composition is primarily determined by the frequency and duration of inundation (DPIE, 2012).

One Threatened Ecological Community (TEC), listed under the FM Act, was also identified:

- Lowland Darling River aquatic ecological community

This aquatic ecological community of the lowland Darling River includes all native fish and aquatic invertebrates within all-natural creeks, rivers, streams and associated lagoons, billabongs, lakes, anabranches and floodplains of the Darling River within NSW. It occurs in a lowland riverine environment, characterised by meandering channels and a variety of habitats, including deep channels, pools, wetlands, gravel beds and flood plains. The listed determination includes the Bogan River from below Peak Hill (NSW DPI, 2007).

3.2.3 Threatened species and populations

A total of nine threatened species were observed between the two survey periods, including eight bird and one fish species. Five of the eight bird species were listed as a vulnerable species under the BC Act including one also listed under the EPBC Act. The three other bird species are part of vulnerable populations under the BC Act. The vulnerable western population of Olive Perchlet (*Ambassis agassizii*) was also caught in the littoral zone of the Nyngan weir pool during the 2019 survey period.

Up to three additional species of Microchiropteran bats, listed as vulnerable under the BC Act, have potentially been recorded in the 2019 and 2020 survey periods. This includes Little Pied Bat (*Chalinolobus picatus*), Large Bent-winged Bat *(Miniopterus orianae oceanensis*), Corben's Long-eared Bat (*Nyctophilus corbeni*) and Inland Forest Bat *(Vespadelus baverstocki*).

In addition to the species pictured below, Richard Bootle a local whose property adjoins the Weir Pool, has recorded breeding pairs of Major Mitchell's Cockatoo (*Lophochroa leadbeateri*), Magpie Goose (*Anseranas semipalmata*) and Brolgas (*Grus rubicunda*) of which the latter regularly return to the site.

A full list of observed fauna, including listed species is given in Appendix A and photos captured in Appendix B.

Figure 7: Threatened species records (ELA surveys)

3.2.4 Fauna species and habitat observations

A total of 102 native fauna species have been recorded within the investigation area over the course of the two survey periods and include records from Richard Bootle. This sum included 78 birds, nine amphibians, five mammals, four definite microchiropteran bats, three reptiles and three fish species.

Signs of breeding, including nests, ducklings, cygnets and mating behaviour coupling have been observed for a total of nine bird species within the investigation area.

A broad range of habitat within the investigation area supports the occurrence of these species. This includes vegetation features such as riparian zones, hollow bearing trees, reed stands, woody debris, rocks and leaf litter. Aquatic habitat features have also been observed in abundance including pools, aquatic vegetation, over-hanging branches, snags and shorelines.

As only one night of fish trapping was undertaken over the course of the survey period, few fish have been collected. The number of fish species inhabiting the investigation area is realistically much higher and would likely include species such as the Murray Cod (*Maccullochella peelii*), Spangled Perch (*Leiopotherapon unicolour*), Freshwater Catfish (*Tandanus tandanus*), Golden Perch (*Macquaria ambigua*), Western Carp Gudgeon (*Hypseleotris klunzingeri*) and Australian Smelt (*Retropinna semoni).* The exotic species Carp (*Cyprinus carpio*) and Mosquitofish (*Gambusia holbrookii*) are also known to occur in the Weir Pool. The presence of piscivorous birds such as the Australian Pelican (*Pelecanus conspicillatus*), White-bellied Sea-eagle (*Haliaeetus leucogaster*), Little Pied Cormorants (*Microcarbo melanoleucos*) and Yellow-billed Spoonbills (*Platalea flavipes*) suggests an abundance of fish are situated in the area.

Water-rat (*Hydromys chrysogaster*) individuals have also been observed in the weir pool. This carnivorous rodent is specialised for an aquatic existence and creates nests in river-side burrows.

The ultrasonic bat analysis recorded at least five (5) and up to eleven (11) species recorded during the 2020 survey. White-striped Free-tailed Bat (*Austronomus australis*) and Inland Broad-nosed Bat (*Scotorepens balstoni*) were the only two species that could be confidently identified from their calls. However calls from three other species groupings were recorded, including the *Ozimops* species complex (comprising three possible species), a *Vespadelus / Miniopterus orianae oceanensis* (Large Bent-winged Bat) species complex (comprising three possible species) and a *Nyctophilus* species complex (comprising three possible species).

A full list of observed fauna and comments is given in Appendix A. The ultrasonic bat analysis report is given in Appendix C.

4. Discussion

Results from the past field surveys and historic records have shown that the Nyngan weir pool and adjacent vegetation communities create a dynamic ecosystem that hosts a range of plant and animal species. As a large body of water in a generally dry region, the Nyngan weir pool is a central and essential component to the ecology of the region, supporting the longest contiguous forest of native vegetation, as well as a diverse riparian and aquatic ecological community.

Native vegetation mapping (Figure 4), demonstrated that the riparian zone was the final piece of contiguous woodland habitat on the western side. The condition of this habitat is therefore important for species living in the area, and to migratory species visiting or passing through. River Red Gum, Black Box and Coolibah provide a broad range of habitat for resident fauna. To remain in good condition, River Red Gum and Black Box require inundation for a maximum of once every three years (Roberts 2011, Cassanova 2015). Coolibah trees are sustained in good condition if they are inundated once every 7-15 years. For these three species, regular large flows resulting in inundation are essential for sustaining their ecological health. Beyond the western riparian zone, the vegetation has been left to return to native grassland, which could eventually become colonised by native trees.

The moisture index (Figure 3), shows a clear lack of moisture in the Bogan River riparian zone and broader region during the 2018-19 drought period. The inflow of water to the Bogan River by April 2020 correlates with a distinct increase in overall vegetation moisture in the riparian zone, which would improve overall tree health and facilitate recruitment. Allocated environmental flows into the Bogan River at Nyngan would likely replicate the similar outcomes as the natural flows and allow occasional over-bank flows.

Many listed species such as the Brolga, Major Mitchell's Cockatoo, Magpie Goose and White-bellied Sea-eagle, along with five other native bird species have been observed breeding in the investigation area. At least one pair of Brolgas regularly returns to breed along the river. This signifies that the area is an important piece of habitat for these ecologically significant species.

The lower Nyngan weir pool, which offers similar habitat features to the upper pool, only receives water once flows have overtopped the Nyngan Weir. As established previously (ELA 2019), whilst the Nyngan weir pool and upper reaches of the Bogan River offer refuge habitat, restricted flow downstream of the weir reduces habitat quality. This could be partially amended by increasing the flow of water over the weir, and by upgrading the weir design to include fish ladders.

Although the Nyngan weir pool is an artificial habitat, it has been in place for decades and has become an important habitat for aquatic and non-aquatic plants and animals. When there is no flow in the Bogan River, the Nyngan weir pool relies on flow transferred from Burrendong Dam via the Albert Priest Channel. This transfer water is essential for maintaining the aquatic habitat of the area, particularly given the lack of large permanent waterbodies in the surrounding landscape. The weir pool acts as a refuge during dry periods, allowing aquatic animals and birds to wait out drought and then disburse throughout the landscape during wet periods. It is also an important resting area for migratory birds.

5. Conclusion

Nyngan weir pool supports a diverse faunal community (102 species recorded during 2019/2020 surveys), many of which are dependent on the weir pool itself, or the vegetation community surrounding it. As a permanent waterbody in an otherwise dry area, the weir pool plays a critical role in maintaining aquatic and terrestrial biodiversity across the region. Aquatic species using the weir pool during drought, are able to spread upstream or downstream along the Bogan River during periods of flow, while birds are able to move out into the adjacent floodplain (or beyond in the case of more mobile species).

As the Bogan River upstream of Nyngan is dry for large periods of time, water transfers from Burrendong Dam are critical in maintaining this important ecological asset. Occasional environmental water allocations would assist in providing water requirements to riparian zones and preserve the breeding and foraging habitat for resident species.

References

Bureau of Meteorology (BoM) (2020). Climate Data Online Portal. Accessed July 2020 from: http://www.bom.gov.au/climate/data/index.shtml

Casanova, M.T. (2015). Review of Water Requirements for Key Floodplain Vegetation for the Northern Basin: Literature review and expert knowledge assessment. Report to the Murray–Darling Basin Authority, Charophyte Services, Lake Bolac.

Eco Logical Australia 2019 (ELA, 2019). Nyngan Weir Pool Biodiversity Assessment. Prepared for Bogan Shire Council.

NSW Department of Primary Industries (NSW DPIE) (2012) Coolibah - Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions - endangered ecological community listing.

Green D., Petrovic J., Moss P., Burrell M. (2011) Water resources and management overview: Macquarie-Bogan catchment, NSW Office of Water, Sydney.

Murray Darling Basin Authority (MDBA) 2017. Native Vegetation: 2017 Basin Plan Evaluation. December 2017. Retrieved from: https://www.mdba.gov.au/sites/default/files/pubs/BPE-tech-reports-vegetation-2.pdf.

NSW Department of Primary Industries (NSW DPI) 2007. Endangered ecological communities in NSW: Lowland Darling River aquatic ecological community.

NSW Office of Environment and Heritage (OEH, 2019a). Threatened Species found in Bogan-Macquarie IBRA sub-region. Accessed 4/10/19 from: https://www.environment.nsw.gov.au/threatenedspeciesapp/cmaSearchResults.aspx?SubCmaId=282

OzArk Environment and Heritage Management Pty Ltd (Ozark, 2013) Environmental Impact Statement Nyngan Waste and Resource Management. Facility Appendix 6: Ecology Assessment.

Appendix A Nyngan weir species list

Table A1: Nyngan weir species list (ELA 2019-20, Richard Bootle)

Species	Common Name	Status		Comments	Date	Source
		BC	EPBC			
			Birds			
Acanthagenys rufogularis	Spiny-cheeked Honeyeater				22-24th June 2020	ELA 2020
Accipiter cirrocephalus	Collared Sparrowhawk				22-24th June 2020	ELA 2020
Acrocephalus australis	Australian Reed Warbler				16-17th September 2019 22-24th June 2020	ELA 2019-20
Anas gracilis	Grey Teal				22-24th June 2020	ELA 2020
Anas superciliosa	Pacific Black Duck			Ducklings also present	16-17th September 2019 22-24th June 2020	ELA 2019-20
Anhinga novaehollandiae	Australasian Darter				16-17th September 2019 22-24th June 2020	ELA 2019-20
Anseranas semipalmata	Magpie Goose	V		Breeding pairs have been observed	22-24th June 2020	ELA 2020, Richard Bootle
Aprosmictus erythropterus	Red-winged Parrot				22-24th June 2020	ELA 2020
Ardea alba	Great Egret		Ma		22-24th June 2020	ELA 2020
Ardea pacifica	White necked Heron				22-24th June 2020	ELA 2020
Artamus cyanopterus	Dusky woodswallow	V			16-17th September 2019	ELA 2019
Artamus leucorynchus	White-breasted woodswallow				22-24th June 2020	ELA 2020
Elseyornis melanops	Black-fronted Dotterell				22-24th June 2020	ELA 2020

Species	Common Name	Status		Comments	Date	Source
		BC	EPBC			
Cacatua galerita	Sulphur-crested Cockatoo				16-17th September 2019 22-24th June 2020	ELA 2019-20
Cacatua sanguinea	Little Corella				22-24th June 2020	ELA 2020
Cacomantis pallidus	Pallid Cuckoo				22-24th June 2020	ELA 2020
Charadriinae spp.	Plover			Nesting pairs of plovers use the river annually	-	Richard Bootle
Chenonetta jubata	Australian Wood Duck			Ducklings also present	16-17th September 2019 22-24th June 2020	ELA 2019-20
Chlamydera maculata	Spotted Bowerbird				22-24th June 2020	ELA 2020
Climacteris picumnus	Brown Treecreeper	V			22-24th June 2020	ELA 2020
Colluricincla harmonica	Grey Shrikethrush				22-24th June 2020	ELA 2020
Coracina novaehollandiae	Black-faced Cuckoo-shrike				22-24th June 2020	ELA 2020
Corcorax melanorhamphos	White-winged Chough				22-24th June 2020	ELA 2020
Corvus bennetti	Little Crow				22-24th June 2020	ELA 2020
Corvus coronoides	Australian Raven				16-17th September 2019 22-24th June 2020	ELA 2019-20
Cracticus nigrogularis	Pied Butcherbird				22-24th June 2020	ELA 2020
Cracticus tibicen	Australian Magpie				16-17th September 2019 22-24th June 2020	ELA 2019-20
Cracticus torquatus	Grey Butcherbird				22-24th June 2020	ELA 2020

Species	Common Name	Status		Comments	Date	Source
		BC	EPBC			
Cygnus atratus	Black Swan			Cygnets also present	22-24th June 2020	ELA 2020
Dacelo novaeguineae	Laughing Kookaburra				22-24th June 2020	ELA 2020
Dendrocygna eytoni	Plumed Whistling Ducks				22-24th June 2020, 31st July 2019	ELA 2020, Richard Bootle
Egretta novaehollandiae	White faced Heron				22-24th June 2020	ELA 2020
Entomyzon cyanotis	Blue-faced Honeyeater				22-24th June 2020	ELA 2020
Eolophus roseicapilla	Galah				16-17th September 2019 22-24th June 2020	ELA 2019-20
Falco longipennis	Hobby Falcon				22-24th June 2020	ELA 2020
Falcunculus frontatus	Crested Shrike-tit				22-24th June 2020	ELA 2020
Fulica atra	Eurasian Coot				22-24th June 2020	ELA 2020
Gallinula tenebrosa	Dusky Moorhen				22-24th June 2020	ELA 2020
Geopelia placida	Peaceful Dove				22-24th June 2020	ELA 2020
Grallina cyanoleuca	Magpie-lark				22-24th June 2020 22-24th June 2020	ELA 2019-20
Grallina cyanoleuca	Magpie-lark				16-17th September 2019	ELA 2019
Grus rubicunda	Brolga	V		Three pairs who regularly breed along the river	-	Richard Bootle
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	Ma	Pair seen circling above investigation area	22-24th June 2020	ELA 2020

Species	Common Name	Status		Comments	Date	Source
		BC	EPBC			
Haliastur sphenurus	Whistling Kite				16-17th September 2019 22-24th June 2020	ELA 2019-20
Hirundo neoxena	Welcome Swallow				16-17th September 2019 22-24th June 2020	ELA 2019-20
Lichenostomus penicillatus	White-plumed Honeyeater				22-24th June 2020	ELA 2020
Lophochroa leadbeateri	Major Mitchell Cockatoo	V		Breeding pair	16/09/2019	Richard Bootle
Malurus assimilis	Purple-backed Fairy-wren				22-24th June 2020	ELA 2020
Manorina flavigula	Yellow-throated Miner				22-24th June 2020	ELA 2020
Manorina melanocephala	Noisy miner				16-17th September 2019	ELA 2019
Megalurus mathewsi	Rufous Songlark				22-24th June 2020	ELA 2020
Melithreptus gularis	Black-chinned Honeyeater	V			22-24th June 2020	ELA 2020
Melopsittacus undulatus	Budgerigar				22-24th June 2020	ELA 2020
Microcarbo melanoleucos	Little Pied Cormorant				16-17th September 2019 22-24th June 2020 May-August, yearly	ELA 2019-20, Richard Bootle
Milvus migrans	Black Kite				16-17th September 2019 22-24th June 2020	ELA 2019-20
Myiagra inquieta	Restless Flycatcher				22-24th June 2020	ELA 2020
Ninox xonnivens	Barking Owl	V			22-24th June 2020	ELA 2020

Species	Common Name	Status		Comments	Date	Source
		BC	EPBC			
Nycticorax caledonicus	Nankeen Night Heron				22-24th June 2020	ELA 2020
Nymphicus hollandicus	Cockatiel				22-24th June 2020	ELA 2020
Ocyphaps lophotes	Crested Pigeon				22-24th June 2020	ELA 2020
Pachycephala rufiventris	Rufous Whistler				22-24th June 2020	ELA 2020
Pelecanus conspicillatus	Australian Pelican			Large numbers up to 300 arrive around May each year and use the area as habitat until approximately August	16-17th September 2019 22-24th June 2020, May-August, yearly	ELA 2019-20 Richard Bootle
Petrochelidon nigricans	Tree Martin				22-24th June 2020	ELA 2020
Phalacrocorax sulcirostris	Little Black Cormorant				16-17th September 2019 22-24th June 2020	ELA 2019-20, Richard Bootle
Phalacrocorax varius	Pied Cormorant				22-24th June 2020	ELA 2020
Platalea flavipes	Yellow-billed spoonbill			Juvenile also present	16-17th September 2019 22-24th June 2020	ELA 2020
Polytelis swainsonii	Superb Parrot	V	V		22-24th June 2020	ELA 2020
Pomatostomus temporalis	Grey-crowned Babbler	V			22-24th June 2020	ELA 2020
Psephotus haematonotus	Red-rumped Parrot				22-24th June 2020	ELA 2020
Rhipidura albiscapa	Grey Fantail				22-24th June 2020	ELA 2020
Rhipidura leucophrys	Willie Wagtail				16-17th September 2019 22-24th June 2020	ELA 2020

Species	Common Name	Status		Comments	Date	Source
		BC	EPBC			
Struthidea cinerea	Apostlebird				16-17th September 2019 22-24th June 2020	ELA 2020
Sturnus vulgaris	Common Starling				22-24th June 2020	ELA 2020
Tachybaptus novaehollandiae	Australasian Grebe				22-24th June 2020	ELA 2020
Threskiornis moluccus	Australian White Ibis				22-24th June 2020	ELA 2020
Threskiornis spinicollis	Straw-necked Ibis				16-17th September 2019 22-24th June 2020	ELA 2019-20
Todiramphus sanctus	Sacred Kingfisher				22-24th June 2020	ELA 2020
Vanellus tricolor	Banded Lapwing				22-24th June 2020	ELA 2020
			Fish			
Ambassis agassizii	Western Olive Perchlet		E	Bait trap (2 ind), Observed	17th September 2019 22-24th June 2020	ELA 2019-20
Hypseleotris klunzingeri	Western carp gudgeon			Bait trap, 3 individuals	16-17th September 2019	ELA 2019
Paratya australiensis	Freshwater Shrimp			Bait trap, 14 individuals	16-17th September 2019	ELA 2019
			Bats			
Austronomus australis	White-striped Free-tailed Bat				16-17th September 2019 22-23rd June 2020	ELA 2019-20
Chalinolobus gouldii	Gould's Wattled Bat				16-17th September 2019	ELA 2019

Species	Common Name	Status		Comments	Date	Source
		BC	EPBC			
Scotorepens balstoni	Inland Broad-nosed Bat				16-17th September 2019 22-23rd June 2020	ELA 2019
Scotorepens greyii	Little Broad-nosed Bat				16-17th September 2019	ELA 2019
			Reptiles			
Morelia spilota	Carpet Snake				-	Richard Bootle
Pseudechis australis	King Brown Snake				-	Richard Bootle
Pseudechis porphyriacus	Red-bellied Black Snake				-	Richard Bootle
			Amphibians			
Crinia parinsignifera	Eastern Sign-bearing Frog				22-24th June 2020	ELA 2020
Limnodynastes dumerilii	Banjo Frog				-	Richard Bootle
Limnodynastes salmini	Salmon Striped Frog				-	Richard Bootle
Limnodynastes tasmaniensis	Spotted Marsh Frog				-	Richard Bootle
Litoria peronii	Peron's Tree Frog				-	Richard Bootle
Notaden bennettii	Crucifix Frog				15th March 2011	Richard Bootle
Limnodynastes peronii	Striped Marsh Frog				-	Richard Bootle
			Mammals			
Hydromys chrysogaster	Water Rat (Rakali)				16-17th September 2019	ELA 2019-20
Macropus giganteus	Eastern Grey Kangaroo				16-17th September 2019 22-24th June 2020	ELA 2019-20
*Oryctolagus cuniculus**	European rabbit*				16-17th September 2019	ELA 2019

Species	Common Name	Status		Comments	Date	Source
		BC	EPBC			
Tachyglossus aculeatus	Short-beaked Echidna			Nine observed	-	Richard Bootle
Walbalbia bicolor	Swamp Wallaby				22-24th June 2020	ELA 2020, Richard Bootle

* Denotes exotic species. (V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory, Ma = Marine)

Appendix B Site Photographs

Riparian vegetation (PCT 36) and main channel of the Bogan River

Barking Owl observed perched during a nocturnal survey

Great Egret observed in flight over the investigation area

Grey-crowned Babblers observed perched nearby the Bogan River

White-Bellied Sea-eagles observed flying above the investigation area

Yellow-billed Spoonbill observed within investigation area

Nankeen Night-heron observed perched upon a stag

Appendix C Ultrasonic Analysis Report

PROJECT BACKGROUND AND SITE DESCRIPTION

Eco Logical Australia (ELA) were engaged by Bogan Shire Council (BSC) to undertake a second biodiversity assessment of the Nyngan Weir Pool. The aim of this assessment was to further build on the understanding of biodiversity values discovered during the original assessment that was undertaken in September 2019. This assessment focused on the contrast of ecological values present at the weir between periods of abundant water supply observed in 2020 and that of drought conditions that were experienced in 2019. The spatial extent of the survey area was increased for the second survey, to include more of the land adjacent to the upstream reach of the weir pool.

The investigation area is located on the southern outskirts of Nyngan in central-western New South Wales. The total catchment area of the Bogan River upstream of Nyngan is approximately 18,000 km2 (Green et al, 2011). It is located within the Bogan-Macquarie sub-region of the Darling Riverine Plains IBRA. The Nyngan weir pool acts as a permanent waterbody within the Bogan River channel. It is one of the last pools that will dry in the event of a severe drought. The permanent nature of the channel attracts animals creating a biodiverse ecosystem, especially when other water resources are scarce.

METHODS

Three SD2 Anabat detectors (Titley Scientific) were set across six survey sites between 22 and 23 June 2020. The ultrasonic call data was recorded passively across the entire night in Zero Crossing format. This survey invovled a total effort of six detector nights.

- Sites 1, 2, 3, 4 and 6 were established in PCT 36: River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
- Site 5 was established in PCT 56 - Poplar Box - Belah woodland on clay-loam soils on alluvial plains of north-central NSW

DATA ANALYSIS

The data collected during this survey was analysed by Rodney Armistead using Anabat Insight (Version 1.9.2-0g2fd2328). Call identifications by Rodney Armistead were informed by regional guides, including the echolocation calls of microbats in New South Wales (Pennay et al 2004) and south-east Queensland and north-east New South Wales (Reinhold et al 2001), and the reference library of over 200 calls from Sydney Basin, NSW (available at http://www.forest.nsw.gov.au/research/bats/default.asp). Species identification was guided by considering probability of occurrence based upon the general distribution information that is provided in Churchill (2008); Pennay et al. (2011), Van Dyck and Strahan (2008) and Van Dyck et al. (2013). A technical review of this report and a sample of the calls was performed by Alicia Scanlon also from ELA. Alicia has over 13 years of experience in the identification of ultrasonic call recordings.

To ensure reliable and accurate results the following protocols (adapted from Lloyd et al 2006) were applied:

- Search phase calls are used preferentially when analysing the data, rather than cruise phase calls or feeding buzzes (McKenzie et al 2002).
- Recorded calls containing less than three pulses are not analysed as they are often too short to confidently determine the identity of the species (Law et al 1999). These short sequences (as stated previously) were either removed manually or were labelled as being unidentifiable.

- For those calls that are able to be used to identify the species making the call, two categories of confidence are used (Mills et al1996):
    - Definitely present – the quality and structure of the call profile is such that the identity of the bat species making the calls is not in doubt.
    - Potentially present – the quality and structure of the call profile is such that there is some / low probability of confusion with species that produce similar calls profiles.
- Calls made by bats that cannot be used for identification purposes such as social calls, short and low-quality calls, cruise and approach phase calls were removed from the data.
- *Nyctophilus* spp. (Long-eared bats) are difficult to identify or separate confidently to species level based upon their recorded calls. Therefore, we have made no attempt to identify any *Nyctophilus* spp. calls recorded during this survey to species level (Pennay et al 2004). There are three potential *Nyctophilus* species that could occur in the study area. Two are non-threatened species, *N. geoffroyi* (Lesser Long-eared Bat) and *N. gouldii* (Gould's Long-eared Bat). Both of these Long-eared Bat species are relatively common and widely distributed across NSW, and other parts of Australia. However, the third species, *N. corbeni* (Corben's Long-eared Bat) is listed as vulnerable under the NSW *Biodiversity Conservation Act 2016* (BC Act) and *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). According to Churchill (2008), Penny et al. (2011) and the Department of Agriculture, Wataer and Environment (DAWE) Species Profile and Threats Database, Corben's Long-eared Bat is likely to occur within the locality of the study area due to the presence of its preferred habitat. Where *Nyctophilus* spp. calls were recorded, we have included this threatened microbat species as potentially being present. To confirm the presence / absence of Corben's Long-eared Bat within the study area, further survey effort would be required that involves the use of mist or harp traps to conduct live capture and release. These surveys should be consistent with the Commonwealth Survey Guidelines for Australia's threatened bats. For further information regarding the distribution of this species, please refer to the following link, http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=83395.
- The Free-tailed Bats (previously referred to as the genus *Mormopterus*) have recently undergone taxonomic revision (Reardon et al 2014) and published reference calls for this group of species (Pennay et al 2004) are believed to contain errors (Greg Ford pers comm.). This report uses nomenclature for Free-tailed Bat species as referred to in Jackson and Groves (2015). The correlation between nomenclature used in this report and that used in NSW State legislation is presented in Table C1 below. All Free-tailed Bats in the new genus *Ozimops* potentially occurring within the survey area will therefore be referred to as *Ozimops* species complex. This species grouping includes *Ozimops petersi* (Inland Free-tailed Bat), *O. planiceps* (Southern Free-tailed Bat) and *O. ridei* (Ride's Free-tailed Bat).
- Jackson & Groves (2015) list the Eastern Bent-winged Bat (*Miniopterus schreibersii oceanensis*) under the new name of *M. orianae* (Large Bent-winged Bat). However, we follow the NSW Department of Planning, Industry and Environment (DPIE) nomenclature as it applies to the eastern form of the species which occurs in NSW as a distinct sub-species; *M. o. oceanensis* (see https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10534).
- Sequences not attributed to microbat echolocation calls (e.g. insect buzzes, wind, train and vehicle movement) were dismissed from the analysis.

Table C1: Correlations between current and previous nomenclature for the Free-tailed bats of NSW

Jackson and Groves 2015	Previously known as	Common Name	BC Act
Austronomus australis	Tadarida australis	White-striped Free-tailed Bat	
Micronomus norfolkensis	Mormopterus norfolkensis	Eastern Coastal Free-tailed Bat	Vulnerable
Ozimops petersi	*Mormopterus* species 3 (small penisform)	Inland Free-tailed Bat	
Ozimops planiceps	*Mormopterus* species 4 (long penis form)	Southern Free-tailed Bat	
Ozimops ridei	Mormopterus species 2	Ride's Free-tailed Bat	
Setirostris eleryi	Mormopterus species 6	Bristle-faced Free-tailed Bat	Endangered

RESULTS AND DISCUSSION

General

There were 122 call sequences recorded during this survey. Of these, 57 (46.72%) were deemed useful, because the call profile was of sufficient quality and/or length (number of pulses) to enable positive identification of a bat species. The remaining 65 (53.28%) call sequences were either too short (less than three pulses) or of low quality, thus preventing positive identification of a bat species.

There were at least five (5) and up to eleven (11) species recorded during this survey (Table C2 – Table C8, Figure C1 – Figure C7). Calls from the White-striped Free-tailed Bat (*Austronomus australis*) and *Scotorepens balstoni* (Inland Broad-nosed Bat) were the only two species that could be confidently identified. However calls from three other species groupings were recorded, including the *Ozimops* species complex (comprising three possible species), a *Vespadelus / Miniopterus orianae oceanensis* (Large Bent-winged Bat) species complex (comprising three possible species) and a Nyctophilus species complex (comprising three possible species). Three of the potentially occurring species; Large Bent-winged Bat, *Nyctophilus corbeni* (Corben's Long-eared Bat) and *Vespadelus baverstocki* (Inland Forest Bat) are listed as Vulnerable under the BC Act. Corben's Long-eared Bat is also listed as Vulnerable under the EPBC Act. The call profiles of these potentially occurring species could not be distinguished confidently because:

- the calls may have overlapped with one or more of the common and non-threatened species also recorded during this survey or that are known to occur in this region, or
- the call profile was of poor quality and it was not possible to assign to a single microbat species.

Species diversity and abundance

The most common recordings was from the *Ozimops* species complex with 35 (61.14 %) of the 57 identifiable calls, whilst in contrast, just one potential *Scotorepens balstoni* (Inland Forest Bat) was recorded during this survey at Site 2 (Table C4**Error! Reference source not found.**).

The activity across the six sites is considered very low, with just 57 identifiable calls and a further 65 low quality calls being recorded (Table C3 – Table C8). The greatest number of identifiable calls was recorded at Site 6 with 42 identifiable and low-quality calls being recorded (Table C8**Error! Reference source not found.**). In contrast no microbat calls of any kind were recorded at Site 3 (Table C5).

The low activity levels (based on the low number of calls) recorded over the six survey nights is likely to be in response to the cooler climatic conditions in June. Those microbats that do not migrate to warmer

climates will spend the seasonally cooler months in their overwinter roosts where they undertake bouts of torpor that can last for a few hours or up to consecutive days. Torpor, especially during winter, is a critical life history phase for these small mammals, as it allows them to avoid the high energy demands associated with winter conditions and the threat of starvation at a time of the year when their main food resource is scarce (Hill and Smith 1984; Geiser and Kortnor 2010; Geiser and Stawski 2011).

Interpretation of survey results

The potential presence of Corben's Long-eared Bat, Inland Forest Bat and Large Bent-winged Bat within the study area requires further consideration.

Corben's Long-eared Bats occur across the Murray Darling Basin and western slopes and plains of NSW (Churchill, 2008). This species occurs where the vegetation has a distinct canopy and dense cluttered understorey, in a variety of vegetation types including river red gum, black box, *Allocasuarina*, brigalow / belah, mallee, open woodlands and savannahs (Churchill, 2008; Turbill et al. 2008). In NSW, Corben's Long-eared Bats are often found in box, ironbark and cypress woodlands and there are trapping records from within 50 km of the site. This species roosts in tree hollows, fissures in branches, under loose bark and will forage up to 3 km from roost locations. Whilst it is possible that this species occurs on site, further surveys would be required to confirm presence of this species. The ultrasonic calls alone are not a reliable indicator of presence (or absence) in regard to this species, as it impossible to separate the calls from non-threatened Long-eared Bat species (e.g *N. geoffroyi* (Lesser Long-eared Bat) or *N. gouldi* (Gould's Long-eared Bat)) that could also occur on site.

The Inland Forest Bat has a broad distribution across inland arid and semi-arid parts of Australia where the average rainfall is less than 400 mm (Churchill 2008; Reardon et al. 2008). Vegetation communities associated with species include Acacia*, Callitris, and Casuarina* woodlands, mallee, open eucalypt woodland, river red gum woodland, shrub and grassland. Inland Forest Bats are known to roost individually or in groups of up to 50 in tree hollows and buildings (Churchill 2008; Reardon et al. 2008).

There are three records of the species within a 50 km radius of the study area. Two records are located to the north-west of the study area near to the Hermidale Rd, between Girilmbone and Hermidale. The nearest record is approximately 20 km west of the site (see Australian Bat Society web page (https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:cac5de82-dda4-45d7-b8c0-b13453b5dd6b#). Confirmation of the presence of Inland Forest Bats on the site would require capture of individuals. This species call profile cannot be separated from the more common Little Forest Bat that may also occur and use the same habitat types.

The Large Bent-winged Bat is a subterranean roosting species that will roost in cement culverts, stormwater drains, bridges, disused mine shafts and caves (Churchill 2008). Breeding occurs over the summer months and bats disperse to other non-breeding winter and hibernation roosts between March and August each year (Churchill, 2008; Hoye and Hall 2008).

There is some uncertainty about the potential presence of this species within the study area based solely upon a small number of call profiles that overlap with two other microbat species. This uncertainty is further heightened by the nearest records of this species being from a unknown location near to Nymagee, which is located approximately 100 km to the south-west of the study area (see Australian Bat Society web page https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:c15c77e3-49a4-4528-a3d4-38a9007b609e). Confirmation of the presence of the Large Bent-winged Bat at the

study area would require further surveys, including live capture and release. As discussed in greater detail below, the call profiles of this species cannot be separated from the Inland and Little Forest Bats.

Results tables

Table C2: Microbat species diversity recorded ultrasonically within the study area

Species name	Common name	Presence
Austronomus australis	White-striped Free-tailed Bat	Definite
*Miniopterus orianae oceanensis**	Large Bentwing Bat	Potential
*Nyctophilus corbeni*1*	Corben's Long-eared Bat	Potential
Nyctophilus geoffroyi	Lesser Long-eared Bat.	Potential
Nyctophilus gouldi	Gould's Long-eared Bat	Potential
Ozimops petersi	Inland Free-tailed Bat	Potential
Ozimops planiceps	South-eastern Free-tailed Bat	Potential
Ozimops ridei	Ride's Freetail Bat	Potential
Scotorepens balstoni	Inland Broad-nosed Bat	Definite
*Vespadelus baverstocki**	Inland Forest Bat	Potential
Vespadelus vulturnus	Little Forest Bat	Potential

*listed as threatened under the BC Act. 1 Listed as threatened under the EBPC Act

Table C3: Microbat species diversity and number of calls recorded ultrasonically at Site 1 on SN82126 on the4 22 June 2020.

Scientific Name	Common Name	Definitely present	Potentially present	Total calls
Nyctophilus spp. In this region the threatened *N. corbeni**1 the non-threatened *N. geoffroyi*, *N. gouldii* and are likely to be present.	In this region the threatened Corben's Long-eared Bat and the non-threatened Lesser Long-eared Bat and Gould's Long eared Bat are likely to be present.	-	5	5
Ozimops species complex. In this region *O. petersi, O. planiceps and O. ridei* are likely to be present.	In this region Inland, Ride's and South-eastern Free-tailed Bat are likely to be present.	-	2	2
Unknown				5
Identifable calls				7
Total Calls				12
Percentage Identifable calls				58.33

* Threatened species listed under BC Act, 1 Listed as threatened under the EBPC Act

Table C4: Microbat species diversity and number of calls recorded ultrasonically at Site 2 on SN82115 on the 22 June 2020

Scientific Name	Common Name	Definitely present	Potentially present	Total calls
Austronomus australis	White-striped Free-tailed Bat	1	0	1
Nyctophilus species complex. In this region the threatened *N. corbeni**1 as well as the non-threatened *N. geoffroyi, N. gouldii* and are likely to be present.	In this region the threatened Corben's Long-eared Bat and the non-threatened Lesser Long-eared Bat and Gould's Long eared Bat are likely to be present.	0	1	1
Ozimops species complex. In this region *O. petersi, O. planiceps and O. ridei* are likely to be present.	In this region Inland, Ride's and South-eastern Free-tailed Bat are likely to be present.	0	4	4
Scotorepens balstoni	Inland Broad-nosed Bat	1	0	1
Unknown				2
Identifable calls				7
Total Calls				9
Percentage usable calls				77.78

* Threatened species listed under BC Act.

Table C5: Microbat species diversity and number of calls recorded ultrasonically at Site 3 on SN485466 on the 22 June 2020

Scientific Name	Common Name	Definitely present	Potentially present	Total calls
No microbat calls were recorded on this detector				

Table C6: Microbat species diversity and number of calls recorded ultrasonically at Site 4 on SN82126 on the4 22 June 2020.

Scientific Name	Common Name	Definitely present	Potentially present	Total calls
Unknown				37
Identifable calls				0
Total Calls				37
Percentage Identifable calls				0

table C7: Microbat species diversity and number of calls recorded ultrasonically at Site 5 on SN485466 on the 22 June 2020

Scientific Name	Common Name	Definitely present	Potentially present	Total calls
Nyctophilus spp. In this region the threatened *N. corbeni**1 the non-threatened N. *geoffroyi, N. gouldii* and are likely to be present.	In this region the threatened Corben's Long-eared Bat and the non-threatened Lesser Long-eared Bat and Gould's Long eared Bat are likely to be present.	0	1	1
Unknown				1
Identifable calls				1
Total Calls				2
Percentage Identifable calls				50.00

*** Threatened species listed under BC Act, 1 Listed as threatened under the EBPC Act**

Table C8: Microbat species diversity and number of calls recorded ultrasonically at Site 6 on SN482115 on the 22 June 2020

Scientific Name	Common Name	Definitely present	Potentially present	Total calls
*Miniopterus orianae oceanensis** / *Vespadelus baverstocki** / *Vespadelus vulturnus*	Large Bent-winged Bat / Inland Forest Bat / Little Forest Bat	0	5	5
Ozimops species complex. In this region the *O. petersi, O. planiceps* and *O. ridei*.	In this region Inland, and South-eastern and Ride's Free-tailed Bats are likely to be present.	0	29	29
*Vespadelus baverstocki** / *Vespadelus vulturnus*	Inland Forest Bat / Little Forest Bat	0	8	8
Unknown				22
Identifable calls				42
Total Calls				64
Percentage Identifable calls				65.63

*** Threatened species listed under BC Act.**

SURVEY LIMITATIONS

Apart from the seasonal limitations, other factors can affect our ability or confidence to identify some species of bat solely based upon the call profiles.

For example, calls were only positively identified when the defining characteristics were present and there was no chance of confusion between species with overlapping and/or similar calls. In this survey, there were some call sequences that could not be positively identified to species level. Further, some species recorded in this survey can have call profiles that overlap with other species. When overlap

occurs, species with similar call profiles are assigned to multi species groups of two or three potential species depending on the characteristics displayed in the recorded call sequences. Calls with intermediate characteristics were assigned mixed species labels.

The species recorded in this survey with overlapping call profiles are described below.

Within the inland arid regions of the NSW western slopes and plains, the characteristic frequency of the calls produced by the Inland Forest Bat ranges between 39 – 46 kHz, whilst for the Little Forest Bat calls range between 42.5 – 48 kHz. Both species produce calls with pulses that are curved with upward facing tails. Consequently, it can be difficult to separate the call produced by these species based on the structure of the call profile when the characteristic frequency is between 42.5 and 46 kHz. It is possible to separate these species based on characteristic frequency when calls fall below 42.5 kHz, the species can be identified as Inland Forest Bat, and when calls fall above 46 kHz the species can be identified as Little Forest Bat. When it is not possible to separate a call based on the characteristic frequency, it is assigned a multi-species label.

The calls of Large Bentwing Bat on the Western Slopes and Plains of NSW (44 and 48 kHz) overlap in frequency with those of Inland Forest Bat and Little Forest Bat. Large Bentwing Bat calls can be distinguished by the following characteristics: a down-sweeping tail, drop of 2 kHz between the knee and characteristic section of the call and variable pulse shape and time between calls. Inland Forest Bat (39 – 46 kHz) and Little Forest Bat calls (42.5 – 48 kHz) are curved, have a regular pulse shape and generally up-sweeping tails. When no distinguishing call characteristics are present calls are assigned to a multi-species label.

As previously mentioned, it is impossible to separate or assign *Nyctophilus* (Long-eared Bat) or *Ozimops* species complex calls to species level (Section A3 Data Analysis).

Furthermore, calls produced by different bat species differ in fundamental ways related to the foraging mode / activity of each species. Calls of different species and the different types of calls produced by each species (cruise, search, social, approach, attack) are not equally recorded by ultrasonic detectors. Weather and climatic conditions affect the quality and quantity of recorded data as well as the availability of insect prey and therefore the suitability of each site at a given time as foraging habitat. The survey was conducted in June during a period of cool temperatures.

EXAMPLE CALL PROFILES

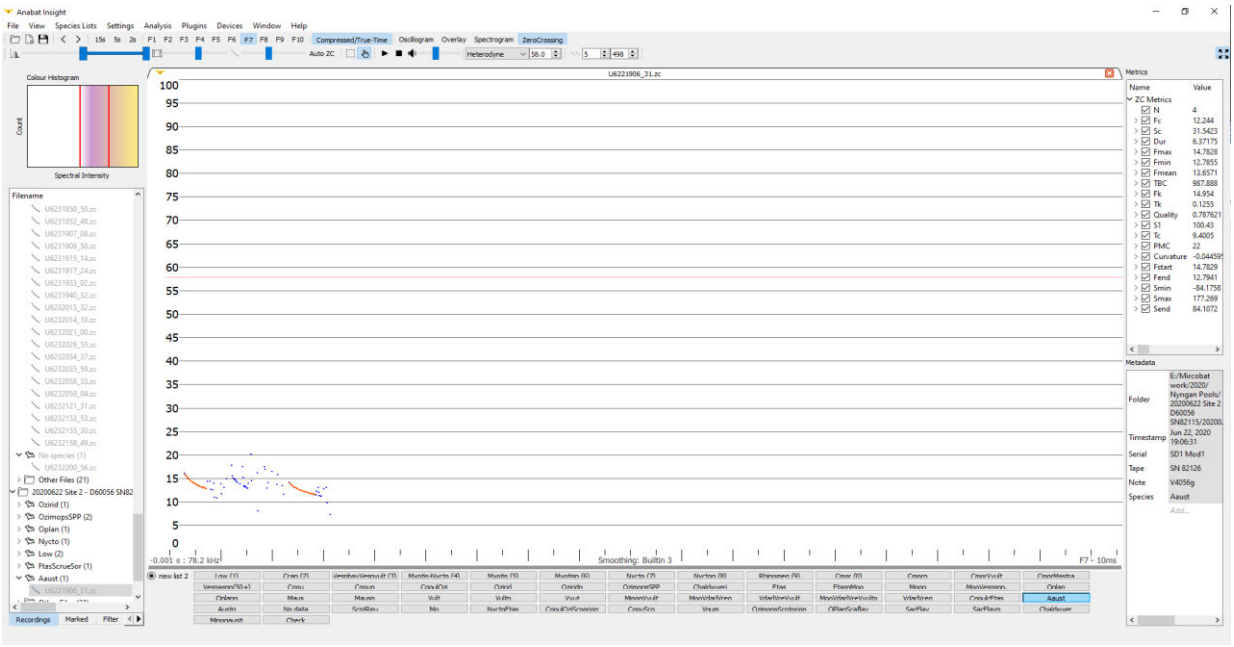

Figure C1. Call profile for *Austronomus australis* (White-striped Free-tailed Bat) recorded at Site 2 on SN82115 at 1906 (7:06 p.m.) on 22 June 2020.

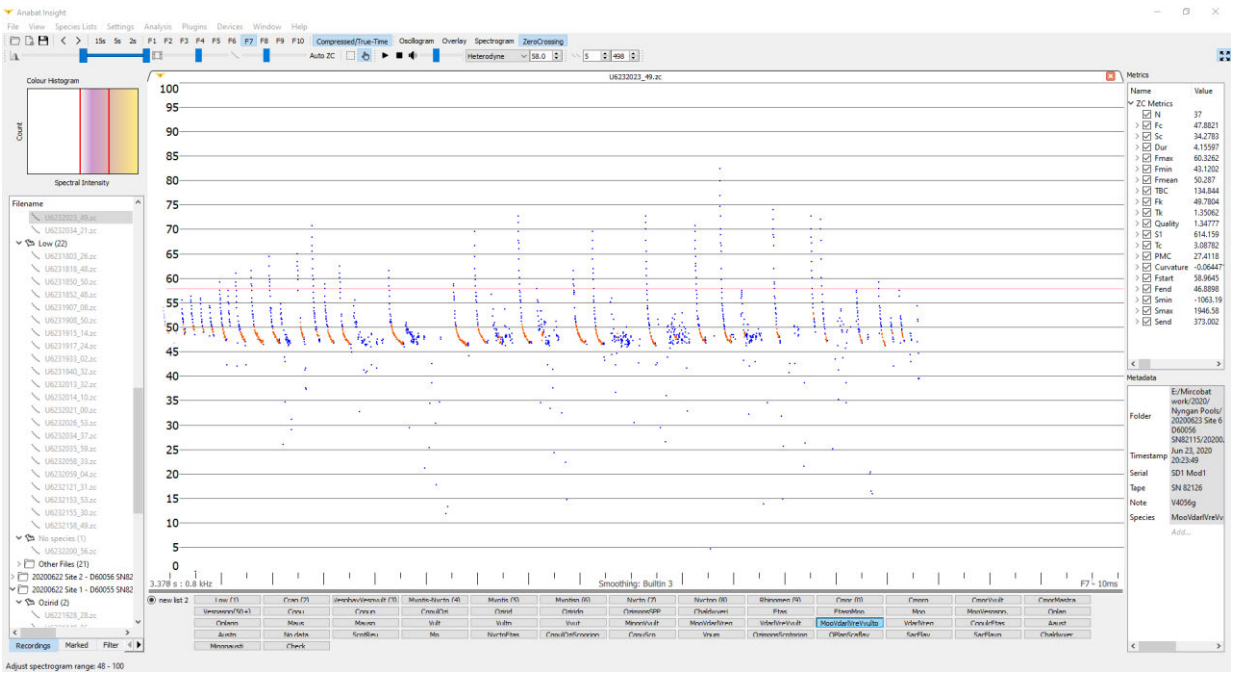

Figure C2. Potential call profile for *Miniopterus orianae oceanensis* (Large Bent-winged Bat) or *Vespadelus vulturnus* (Little Forest Bat) recorded at Site 6 on SN82115 at 2023 (8:23 p.m.) on 23 June 2020.

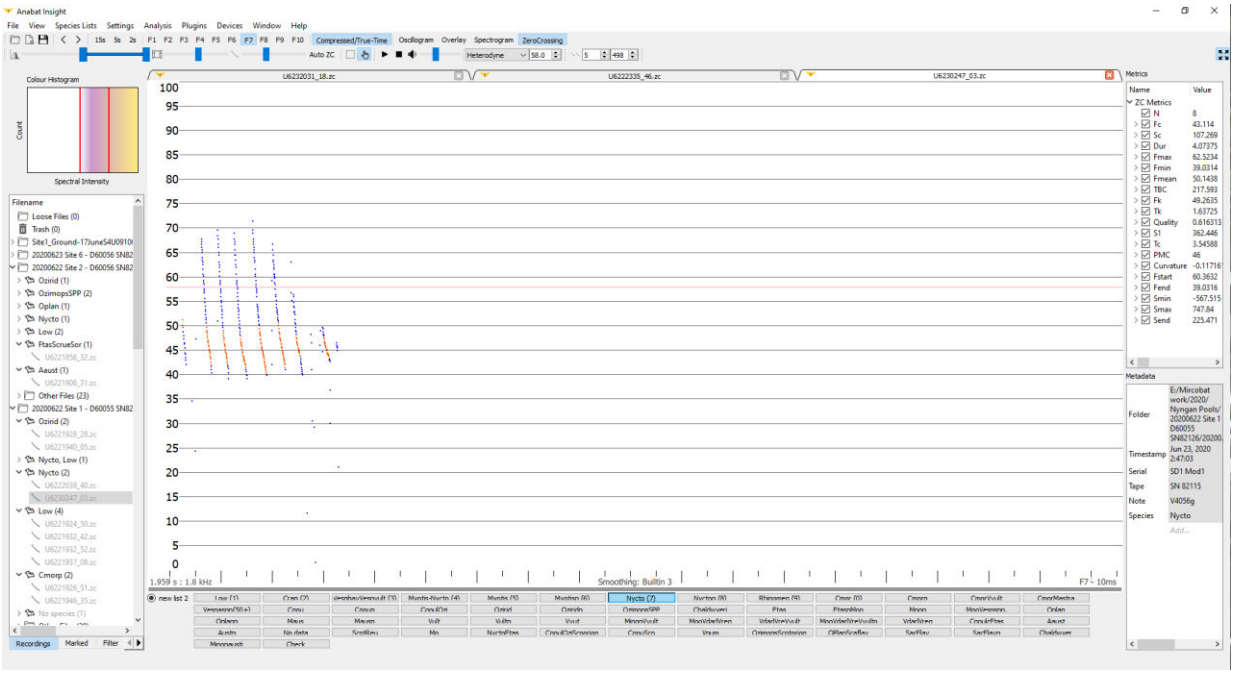

Figure C3. Potential call profile for *Nyctophilus* species complex that in this region could include *Nyctophilus corbeni* (Corben's Long-eared Bat), *Nyctophilus geoffroyi* (Lesser Long-eared Bat) and *Nyctophilus gouldii* (Gould's Long-eared Bat) at Site 1 on SN82126 at 0247 (2.47 a.m.) on 23 June 2020.

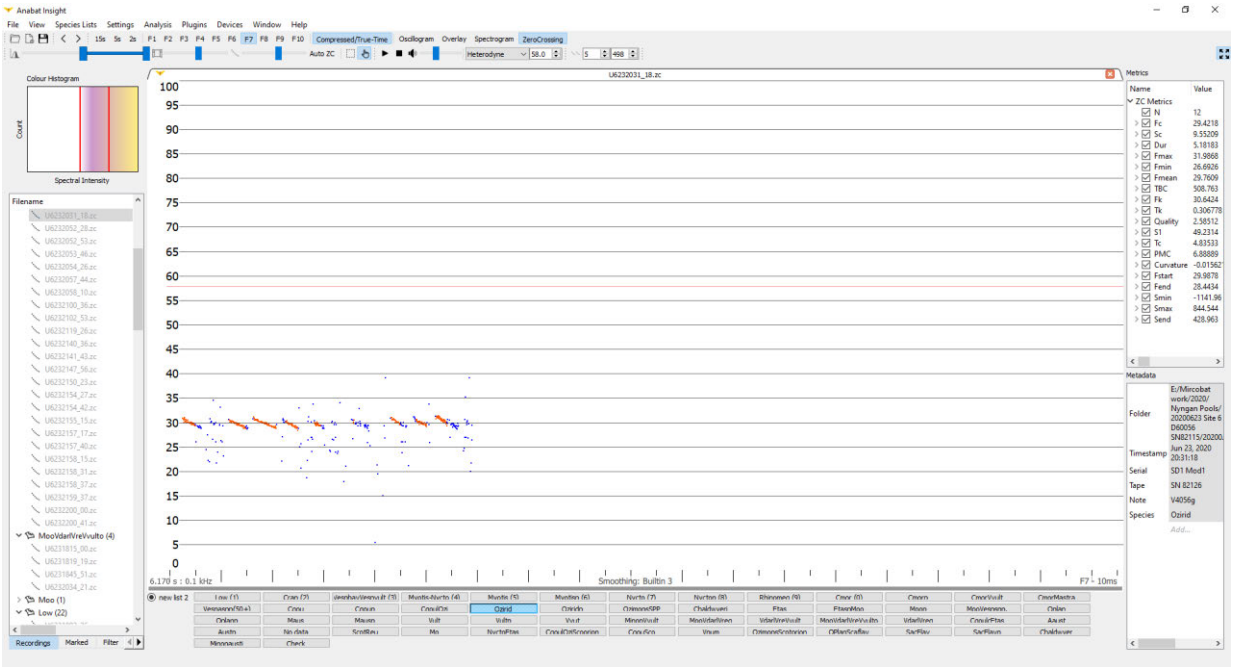

Figure C4. Potential call profile for *Ozimops* species complex, that in this region could include *Ozimops petersi* (Inland Free-tailed Bat), *Ozimops planiceps* (South-eastern Free-tailed Bat) and *Ozimops ridei* (Ride's Free-tailed Bat) recorded at Site 6 on SN82115 at 2031 (8:31 p.m.) on 23 February 2020.

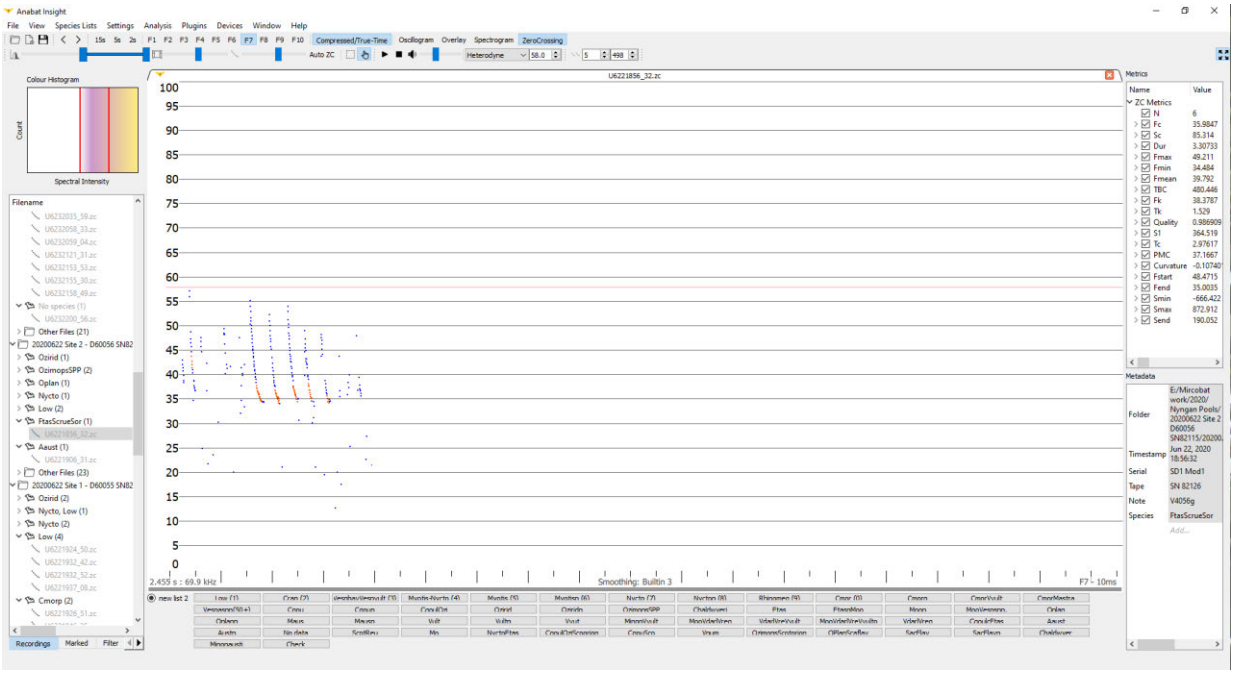

Figure C5. Call profile for *Scotorepens balstoni* (Inland Broad-nosed Bat) recorded at Site 2 on SN82126 at 1856 (6:56 a.m.) on 22 June 2020.

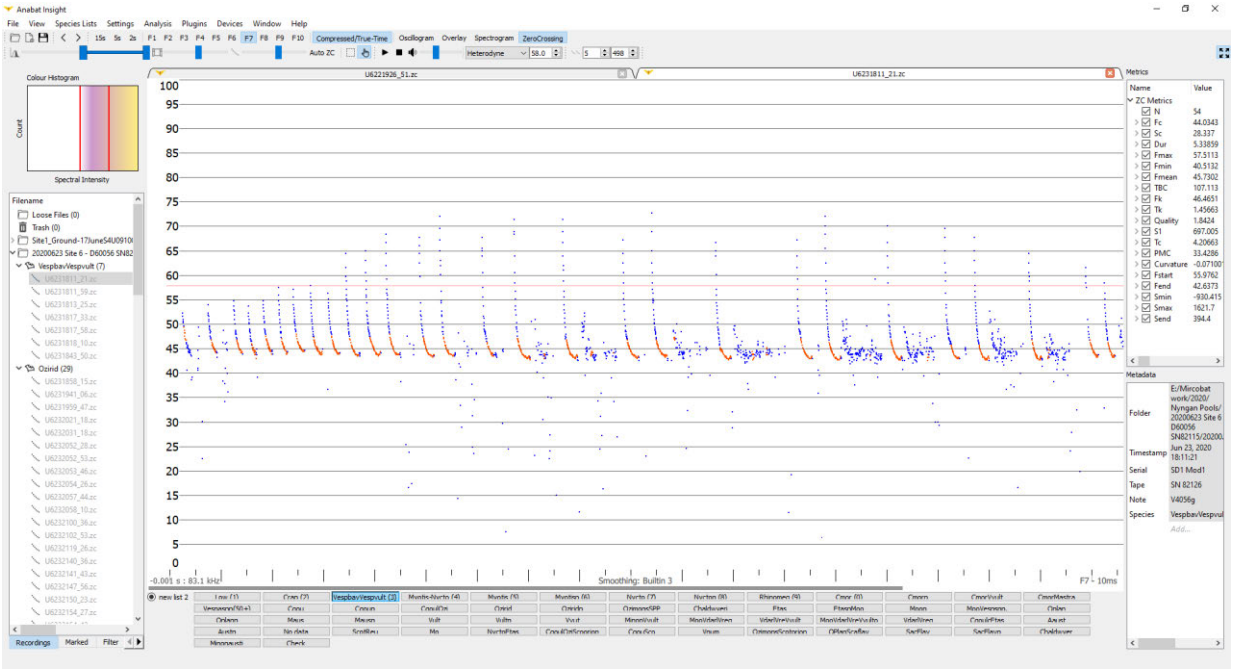

Figure C6. Potential call profile for *Vespadelus baverstocki* (Inland Forest Bat) or *Vespadelus vulturnus* (Little Forest Bat) recorded at Site 6 on SN82115 at 1811 (6:11 p.m.) on 23 June 2020.

REFERENCES

Churchill, S. 2008. Australian Bats. Second Edition. Allen & Unwin, Crows Nest, Sydney.

Geiser, F. and Kortner, G. 2010 Hibernation and daily torpor in Australian mammals. Australian Zoologist 35 (2) 204 - 215

Geiser. F., and Stawski. C. 2011. Hibernation and Torpor in Tropical and Subtropical Bats in relation to Energetic, Extinctions, and the Evolution of Endothermy. Integrative and Comparative Biology. 51. Pp 337 – 348.

Hill. J. E., and Smith. J. D. 1984. Bats. A Natural History. Rigby Publishers. Cambridge.

Jackson, C. and Groves, S. 2015. Taxonomy of Australian Mammals. CSIRO Publishing.

Law, B. S., Anderson, J., and Chidel, M. 1999. Bat communities in a fragmented forest landscape on the south-west slopes of New South Wales, Australia. Biological Conservation 88, 333-345.

Lloyd, A.M., Law, B.S., and Goldingay, R. 2006. Bat activity on riparian zones and upper slopes in Australian timber production forests and the effectiveness of riparian buffers. Biological Conservation 129, 207-220.

McKenzie, N. L., Start, A. N., and Bullen, R. D. 2002. Foraging ecology and organisation of a desert bat fauna. Australian Journal of Zoology 50, 529-548.

Mills, D. J., Norton, T. W., Parnaby, H. E., Cunningham, R. B., and Nix, H. A. 1996. Designing surveys for microchiropteran bats in complex forest landscapes - a pilot study from south-east Australia. Special issue: Conservation of biological diversity in temperate and boreal forest ecosystems 85, 149-161.

Pennay, M., Law, B., and Reinhold, L. 2004. Bat calls of New South Wales: Region based guide to echolocation calls of Microchiropteran bats. NSW Department of Environment and Conservation, Hurstville.

Reardon, T.B., McKenzie, N.L., Cooper, S.J.B., Appleton, B., Carthew, S. and Adams, M. 2014. A molecular and morphological investigation of species boundaries and phylogenetic relationships in Australian free-tailed bats Mormopterus (Chiroptera: Molossidae). Australian Journal of Zoology 62: 109 – 136.

Reardon, T.B., Kutt, A. S., Richards, G. C., and Hoye, G. 2008. Inland Forest Bat. Vespadelus baverstocki (Kitchener, Jones and Caputi, 1987). In van Dyck, S. and Strahan, R. (eds). The Mammals of Australia. Third Edition. Reed New Holland, Sydney.

Reinhold, L., Law, B., Ford, G., and Pennay, M. 2001. Key to the bat calls of south-east Queensland and north-east New South Wales. 2001. Queensland, DNR.

Turbill, C., Lumsden, L. F., and Ford, G. I. 2008. South-eastern and Tasmanian Long-eared Bats. Nyctophilus spp. In van Dyck, S. and Strahan, R. (eds). The Mammals of Australia. Third Edition. Reed New Holland, Sydney.

eco logical AUSTRALIA
A TETRA TECH COMPANY

1300 646 131
www.ecoaus.com.au