Warrell Creek to Nambucca Heads

Interim Giant barred Frog Monitoring Report – spring year one operational phase

Roads and Maritime Services | December 2018

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Table of contents

List of tables

List of figures

List of plates

1. Introduction

In 2015, Roads and Maritime Services (RMS) NSW, in conjunction with Acciona Ferrovial Joint Venture (AFJV), commenced the upgrade of the Pacific Highway between Warrell Creek and Nambucca Heads (WC2NH). The WC2NH project was opened to traffic in two stages: stage 2a - 13.5km section from Lower Warrell Creek Bridge to Nambucca Heads opened on 18 December 2017; and stage 2b 6.25km section from the southern end of the project to the Lower Warrell Creek bridge opened in late June 2018.

Approvals for the WC2NH upgrade required monitoring of several species and mitigation measures during the operational phase. Species and mitigation measures targeted include koala, yellow-bellied glider, giant barred frog, green-thighed frog ponds, underpasses, vegetated median, roadkill, exclusion fence, and threatened flora. Sandpiper Ecological Surveys (SES) has been contracted by RMS to deliver the WC2NH operational ecological and water quality monitoring program.

The following report details the methods and results of spring year 1 operational phase giant barred frog population monitoring. The objective of giant barred frog monitoring is “To demonstrate through the life of the Project that mitigation has maintained or improved population sizes and habitat of the Giant Barred Frog. The use of preconstruction, during construction and post construction monitoring to measure frog distribution, abundance and habitat quality with defined thresholds will be used to measure the overall performance of the mitigation” (Lewis 2014a).

The following report presents and methods and results of the spring 2018 giant barred frog survey more detailed analysis of the giant barred frog population and habitat within the study area will be provided in the annual giant barred frog monitoring report, which is due in May 2019.

1.1 Background

The giant barred frog is listed as ‘Endangered’ under both the NSW *Biodiversity Conservation Act 2016* (BC Act) and Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The impact of the upgrade on giant barred frog (*Mixophyes iteratus*) was assessed in the Project Environmental Assessment (Sinclair Knight Merz [SKM] 2010). Following identification of potential giant barred frog habitat during the Project environmental assessment Lewis Ecological conducted targeted surveys (in November 2011 and January/February 2013) (Lewis 2014a). A population of giant barred frog was subsequently confirmed at Upper Warrell Creek and a management strategy prepared (see Lewis 2014a).

Measures proposed to manage impacts on giant barred frogs included: population monitoring, pre-clearing surveys, temporary frog fencing during construction, clearing supervision, dewatering procedures (tadpoles surveys) and permanent frog exclusion fence. Population monitoring was recommended to occur within a 1km transect in spring, summer and autumn of Year 1 and 3 of the construction phase using the methods applied during pre-construction baseline surveys.

Pre-construction baseline surveys for giant barred frog were conducted between 20 September 2013 and 2 April 2014. The baseline surveys recorded 47 individuals within the 20 survey zones, including 22 adults (11 females & 11 males), 8 sub-adults, and 8 juveniles. Based on these results the population of giant barred frog at the Upper Warrell creek site was calculated as 45 adults (with a 1:1 sex ratio), 19 sub-adults, and 16 juveniles (Lewis Ecological 2014b). Geolink (2018) recalculated population size for baseline, year 1 and year 3 samples and obtained population estimates of 41 (2013/14), 7 (2015/16), and 8 (2017/18) respectively. The results suggest a substantial decline in population between 2013/14 and 2015/16.

During early construction work *Mixophyes* spp. tadpoles were recorded at Butchers Creek (Geolink 2015).

There was some conjecture about the identification of tadpoles and targeted surveys for adult frogs and further consultation with frog specialists was undertaken in an attempt to confirm the identification. The final consensus was that the tadpoles were great barred frog (*Mixophyes fasciolatus*) and the giant barred frog was unlikely to occur at Butchers Creek (see Geolink 2015; Lewis 2015). Nonetheless, a precautionary approach was adopted and the Butchers Creek site was included in population monitoring (Geolink 2016). No giant barred frogs were recorded at Butchers Creek during the construction phase (Geolink 2018).

1.2 Study area

The WC2NH project covers a total length of 19.75km and extends from Warrell Creek in the south to Nambucca Heads in the north (Figure 1). The alignment bypasses the town of Macksville and the northern section traverses Nambucca State Forest.

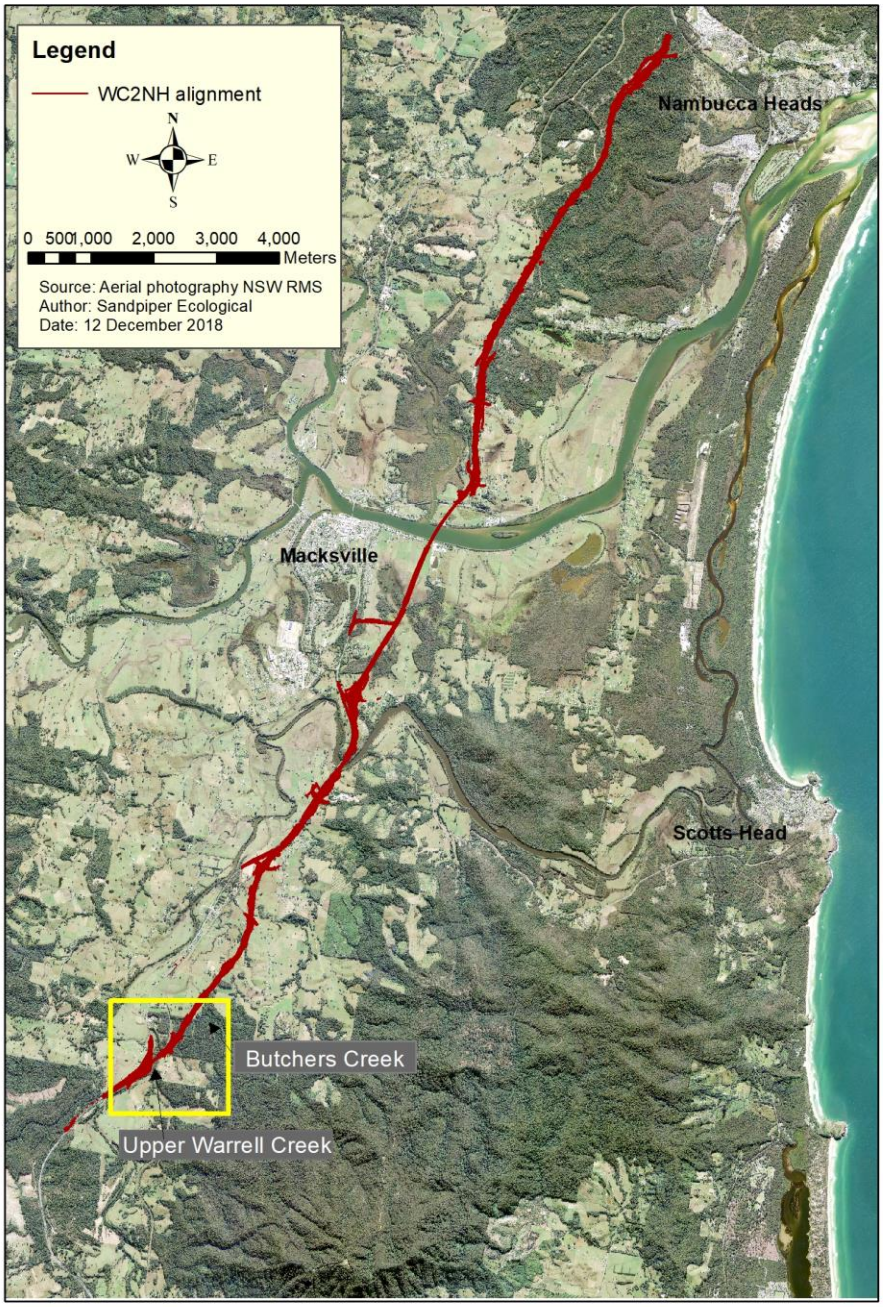

Figure 1: Location of giant barred frog sample sites in relation to the WC2NH alignment.

2. Methodology

2.1 Timing and weather conditions

The spring 2018 giant barred frog survey was conducted on 16 and 17 October 2018. The rainfall trigger of 10mm in a 24hr period measured at the WC2NH south compound project weather station was achieved. Rainfall continued after the initial trigger was achieved and a total of 142mm was recorded immediately prior to, and during, the survey. Rainfall resulted in elevated water levels at both sites and heavy rain during the later stage of the Upper Warrell Creek survey is likely to have reduced frog activity. The elevated water level at Upper Warrell Creek affected access to the creek bank. Relative humidity, air temperature, dew point and wind speed were all suitable for giant barred frog surveys (Table A1, Appendix A).

2.2 Frog survey

Frog surveys followed the method specified in the Brief and baseline population survey (Lewis 2014b). The method involved:

1. Two ecologists conducted a nocturnal meandering foot-based traverse of each 50m survey zone on each side of the watercourse i.e. 40 zones at Upper Warrell Creek (20/side; Figure 2); and 16 zones at Butchers Creek (8/side; Figure 3).
2. Each ecologist was equipped with a 200lumen spotlight and slowly traversed the riparian zone searching for frogs listening for calls. Giant barred frog calls were broadcast through a 5 watt megaphone for five minutes within each zone. Both ecologists listened for call responses during and immediately after call broadcast.
3. All captured giant barred frogs were scanned with a Trovan Nanotransponder to determine if that frog had been previously pit-tagged. If the captured individual had not been pit-tagged a tag was inserted beneath the skin on the right side and the insertion hole sealed with vetbond. The insertion point was swabbed with disinfectant prior to the tag being inserted.
4. Data collected on each captured frog included:
    a. Survey zone (20x50m).
    b. Distancefromthestreamedgemeasuredtothenearest0.1m.
    c. Position within the microhabitat (i.e. under litter, above litter, exposed, on rock/ log).
    d. Sex (male, female, unknown).
    e. Age class (adult=>60mm; sub-adult=40-60mm; juvenile=<40mm).
    f. Snout-vent length (mm).
    g. Weight (grams).
    h. Breeding condition:
        i. males assessed on the colouration of their nuptial pads (i.e. no colour, light, moderate, dark) in accordance with the classification developed by Lewis (2014);
        ii. females assessed based on whether they are gravid (i.e. egg bearing, with the typically adult weighing > 100 grams) or not gravid.
        iii. Frogs with a snout vent length of <60 mm were classified as immature.

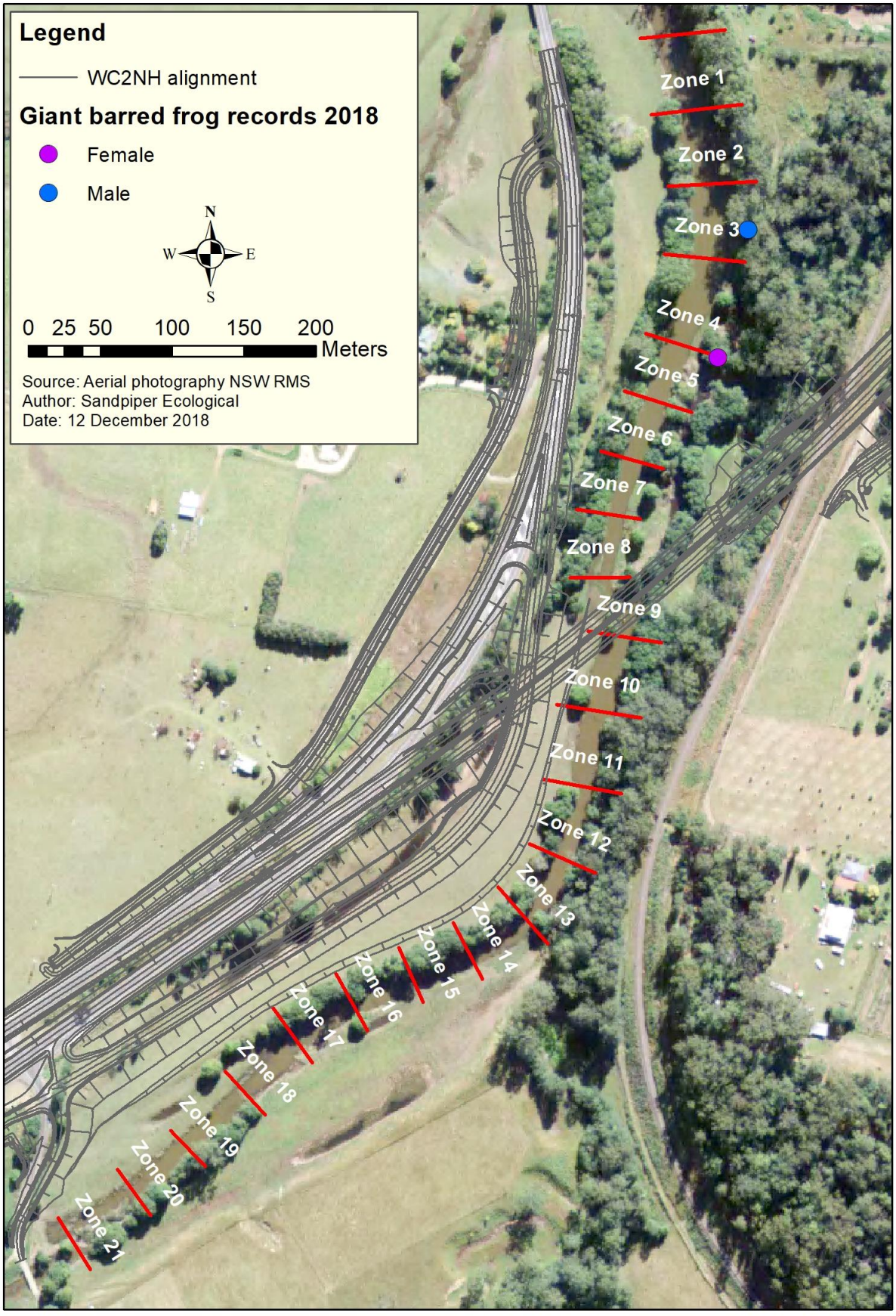

Figure 2: Survey zones within the Upper Warrell creek sample site and location of spring 2018 giant barred frog records.

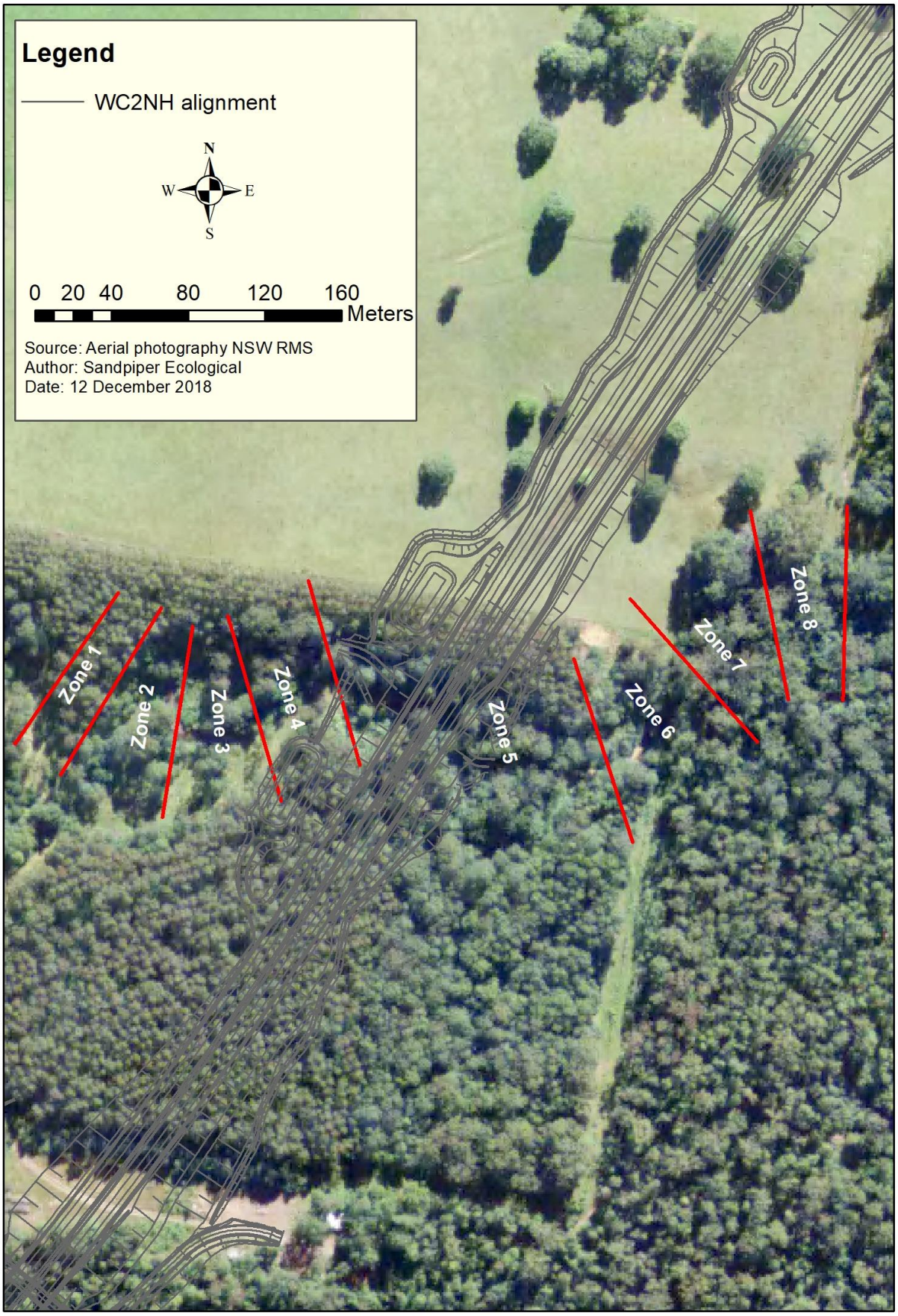

Figure 3: Survey zones within the Butchers Creek giant barred frog sample site.

2.3 Tadpole survey

Tadpole surveys were undertaken using the following procedure:

1. Dip-netting was undertaken by two ecologists within each survey zone. Dip-netting targeted areas of undercut bank and detritus.
2. One bait trap (~300 mm x 200 mm), baited with bread, was installed within each zone for a minimum of three hours. This equated to 20 bait traps in Upper Warrell Creek and eight bait traps in Butchers Creek.
3. The following information was collected for each tadpole:
    a. Survey zone (20x50m).
    b. Sex (male, female, unknown).
    c. Weight (grams).

2.4 Habitat assessment

Key habitat components in each survey zone are required to be sampled annually (i.e. once/year). Habitat assessment was abandoned during the spring survey due to the elevated water level at both Butchers Creek and Upper Warrell Creek.

The following habitat data were recorded in each zone at each site:

1. Land use: Description of existing land uses e.g. grazing, dairy, horticulture, conservation, private native forestry.
2. Broad vegetation type within the immediate riparian zone (primary stream bank): Riparian Rainforest, Dry Sclerophyll, Wet Sclerophyll, Sedgeland, Grassland or Cleared Land.
3. In stream physical characteristics including: stream width and depth(metres), presence of pools and/or riffles, bed composition (sand, clay, rock, organic or other to be specified), and type of emergent vegetation, if present.
4. Stream bank characteristics including bank profile expressed as steep, benched or a gradual incline from the water's edge.
5. Foliage projective cover of overstorey, midstorey and ground layer vegetation on the stream bank.
6. Groundcover expressed as a percentage of vegetation, leaf litter, soil, and exposed rock.
7. Litter depth - Deep (>10 mm); Moderate (20-100 mm); Shallow (>0-20 mm); or Absent (0 mm).

2.5 Water quality

Water samples and field measurements were taken at approximate locations E 489301 N 6594447 at Upper Warrell Creek and E 489642 N 6594927 at Butchers Creek. Single one-litre samples were collected at each site and placed immediately into an esky. Samples were analysed by the Environmental Analysis Laboratory (EAL), a NATA accredited laboratory, at Southern Cross University. Water quality parameters measured included:

1. Heavy Metals including arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc.
2. Nutrients including Nitrogen (as N), Suspended Solids and Total Phosphorus.
3. Turbidity and dissolved oxygen.
4. Hydrocarbons from the following groups:
    a. Naphthalene group including TRH>C10-C16, TRH>C10-C16 less Naphthalene (F2),

TRH>C16-C34, TRH>34-C40, TRH C6-C10 and TRH C6-C10 LESS BTEX (F1).

b. BTEX group including Benzene, Ethylbenzene, m&p-Xylenes, o-Xylene, Toluene and Xylenes – total.

Field physicochemical measurements including Conductivity, pH, and Temperature, were measured using a Horiba Laqua PC110 portable water quality meter.

3. Results and discussion

3.1 Frog survey

A total of 14 person hours were spent conducting nocturnal frog surveys, 11 hours at Upper Warrell Creek and 5 hours at Butchers Creek. No giant barred frogs were recorded at Butchers Creek. Two adult giant barred frogs, one male and one female, were recorded at Upper Warrell Creek (Table 1). The male frog was a recapture that was originally captured and micro-chipped on 7 February 2018. The captured female was the largest recorded over the monitoring period with a weight of 173 grams and snout-vent length of 101.5mm (Plate 1). The female was considered gravid based on weight, size and shape.

Both captures occurred on the north bank downstream of the alignment, with the male captures in zone six and the female in zone eight. Both individuals were initially observed on top of the leaf litter. The male was recorded near a small flooded tributary close to its original point of capture. The female was recorded on the main creek bank.

Table 1: Giant barred frogs captured during the spring 2018 survey at Upper Warrell creek.

Upper Warrell Creek	Frog 1	Frog 2
Capture date	17/10/18	17/10/18
Zone	4/5	3
Creek side	N	N
GPS location	489351, 6594448	489372, 6594537
Distance from stream edge (nearest 0.1m)	3.4	4.05
Position in micro-habitat*	On leaf litter	On leaf litter
Sex**	Female	Male
Age***	Adult	Adult
S/V length	101.5mm	77.1mm
Weight	173g	67g
Breeding condition[#]	Gravid	Moderate
Microchip ID (new or re-capture)	New: 991001000620130	Recapture: 00078ABB9B

*Microhabitat: under leaf litter, under veg, on leaf litter, exposed, on a log/rock etc.
**Sex: Frogs >78mm were deemed female unless heard calling.
***Age: >60mm = adult, 40-60mm = sub, <40mm = Juv.
[#]Breeding: Males: colour of nuptial pads; light/moderate/dark/no colour. Females: Gravid, typically weighing >100g. Immature: SV length <60mm.

3.2 Tadpole survey

No tadpoles were recorded during the spring 2018 survey.

Plate 1: Female giant barred frog recorded at Upper Warrell Creek during the spring 2018 survey.

3.3 Habitat

3.3.1 Upper Warrell creek

High water level at Upper Warrell Creek affected the habitat assessment at that site as the immediate bank and bank vegetation was inundated. Habitat at Upper Warrell Creek ranges from grassland to moderate quality riparian and wet sclerophyll forest with a dense litter layer (Appendix B). Parts of the Upper Warrell Creek study area contained fragmented riparian forest that is grazed. The width of riparian vegetation varied throughout the site but in virtually all zones was restricted to the bank. Leaf litter cover ranged from high (>75%) in areas with an intact riparian zone to low (<40%) in cleared and grazed areas. One notable aspect of concern was growth of pigeon grass (*Setaria sphacelata*) and broad-leaved paspalum (*Paspalum mandiocanum*) on the north bank in zones 4 and 5. Whilst giant barred frogs have been recorded in broad-leaved paspalum, pigeon grass may create a barrier to movement when it occurs in dense clumps.

3.3.2 Butchers Creek

Habitat at Butchers Creek varied substantially across the transect. West of the alignment habitat was dominated by a narrow degraded riparian zone was predominantly cleared immediately prior to the survey commencing. East of the alignment habitat was characterised by wet sclerophyll forest that extended well beyond the riparian zone. The substrate consisted of rock and gravel with a steep bank and gravel bars. Leaf litter cover varied from 25 to 80% and ground vegetation cover from 10 to 60%. Habitat at Butchers

Creek did not contain the moist micro-climate that is typical of many giant barred frog habitats. The site lacked continuous overhanging riparian vegetation and thick dense leaf litter required to create moist ground conditions.

3.4 Water quality

Most water quality parameters were within the ANZECC trigger values for freshwater ecosystems in south eastern Australia (Table 2). Exceptions were Total phosphorus and Total nitrogen, and dissolved oxygen at Warrell Creek. Phosphorus and nitrogen levels exceeded the ANZECC threshold and dissolved oxygen was below the ANZECC threshold. Nitrogen and phosphorus values exceeded thresholds during the 2017/18 sample period. Elevated nutrients recorded in spring 2018 are attributed to recent run-off from adjoining farmland after a period of dry weather and the result is not of concern.

Table 2: Results of water sample analysis for Upper Warrell creek and Butchers Creek. ID = insufficient data to derive a reliable trigger value (ANZECC 2000).

Parameter	Warrell Creek	Butchers Creek	ANZECC/ARMCANZ Trigger value for freshwater (95% species level of protection)
Temperature (^{0}C)	19.6	18.5	
pH	6.7	6.9	6.5-8.0
Conductivity (us/cm)	256	110	125-2200
Dissolved oxygen (mg/L O_2)	8.4	9.0	9-10.5
Total Suspended Solids (mg/L)	9	1	
Turbidity (NTU)	18	17	6-50
Total Phosphorus (mg/L P)	0.04	0.02	0.025
Total Nitrogen (mg/L N)	0.49	0.19	0.35
BTEX			
Benzene (µg/L or ppb)	<0.5	<0.5	950
Toluene (µg/L or ppb)	<0.5	<0.5	ID
Ethylbenzene (µg/L or ppb)	<0.5	<0.5	ID
m+p-Xylene (µg/L or ppb)	<1	<1	200
o-Xylene (µg/L or ppb)	<0.5	<0.5	350
Naphthalene (µg/L or ppb)	<0.5	<0.5	16
Total Recoverable Hydrocarbons (TRH)			
C6-C9 Fraction (µg/L or ppb)	<40	<40	ID
C10-C14 Fraction (µg/L or ppb)	<50	<50	ID
C15-C28 Fraction (µg/L or ppb)	<200	<200	ID
C29-C36 Fraction (µg/L or ppb)	<200	<200	ID
C10-C16 Fraction (µg/L or ppb)	<60	<60	ID
C10-C16 less Naphthalene Fraction (µg/L or ppb)	<60	<60	ID
C16-C34 Fraction (µg/L or ppb)	<500	<500	ID
C34-C40 Fraction (µg/L or ppb)	<500	<500	ID

4. References

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Appendix A – Weather conditions

Table A1: Weather during and immediately prior to the spring 2018 giant barred frog survey.

Site	Date	Start/ Finish	Time	Rainfall (present)	Rainfall (prev 24hr)	Rainfall (prev 7 days)	Rainfall (prev 30 days)	RH	Temp	Dew point	Wind (0=no wind, 1= rustles leaves, 2 = branches moving, 3 - canopy moving)
Butchers Creek	16/10/18	Start	2010	Nil	30	142.2	181.4	94.5	19.5	18.5	0
		Finish	2210	Moderate				100	18.9	19.4	0
Warrell Creek	17/10/18	Start	1949	Nil				100	20.7	21.3	2
		Finish	0049	Moderate				100	20.2	21.8	2

Appendix B – Habitat data

Table B1: Habitat data collected in 21 zones at Upper Warrell Creek

Zone	Landuse (E&W)	Broad veg community (E&W)	In-stream physical characteristics (logs, boulders etc)	Stream width	Stream depth	Presence of pools or riffles	Bed composition	Emergent veg
1	Agriculture	Wet sclerophyll	Silt & sand; occ logs	40m	>1m	P	Uk	Absent
2	Agriculture	Wet sclerophyll	Silt & sand; occ logs	40m	>1m	P	Uk	Absent
3	Agriculture	Riparian/ wet sclerophyll	Silt & sand; occ logs	40m	>1m	P	Uk	Absent
4	Agriculture	Riparian/ wet sclerophyll	Silt & sand; occ logs	40m	>1m	P	Uk	Absent
5	Agriculture	Riparian	Silt & sand; occ logs	40m	>1m	P	Uk	Absent
6	Road reserve/ conservation	Riparian	Lateral vegetated bar; occ logs o/h vegt	35m	>1m	P	Uk	Absent
7	Road reserve	Riparian	Occ logs; overhanging veg;	40m	>1m	P	Uk	Absent
8	Road reserve	Riparian/ cleared	Boulders; occ logs	25-40m	>1m	P/R	Uk	Absent
9	Road reserve	Cleared land	Boulders; occ logs	25-40m	>1m	P/R	Uk	Absent
10	Agriculture / road reserve	Riparian / cleared	Occ logs	45m	>1m	P	Uk	Absent
11	Utility corridor	Wet sclerophyll/ grassland	Occ logs & fallen trees; prob silty substrate	25m	>1m	P	Uk	Present
12	Utility corridor	Wet sclerophyll/ grassland	Freq logs & fallen trees; prob silty substrate	25m	>1m	P	Uk	Present
13	Utility corridor	Riparian	Occ logs & fallen trees; prob silty substrate	20m	>1m	P	Uk	Present
14	Utility corridor	Riparian	Logs, fallen trees, mat rush on bank, bank slumping,	20m	>1m	P	Uk	Absent
15	Agriculture / road reserve	Riparian / grassland	Rare logs; persicaria & grasses & mat rush on bank;	25-30m	>1m	P	Uk	Absent
16	Agriculture / road reserve	Riparian / grassland	Rare logs; persicaria & grasses & mat rush on bank;	25-30m	>1m	P	Uk	Absent
17	Agriculture / road reserve	Riparian / grassland	Rare logs; persicaria & grasses & mat rush on bank;	25-30m	>1m	P	Uk	Absent
18	Agriculture / road reserve	Riparian / grassland	Occ logs; persicaria & grasses on bank; back channel	30m	>1m	P	Uk	Absent
19	Agriculture / road reserve	Riparian / grassland	Occ logs; persicaria & grasses on bank; back channel	20m	>1m	P	Uk	Absent
20	Agriculture / road reserve	Riparian / grassland	Occ logs; persicaria & grasses on bank; back channel	20m	>1m	P	Uk	Absent
21	Agriculture / road reserve	Riparian / grassland	Occ logs; occ mat rush clumps; back channel	20m	>1m	P	Uk	Absent

Table B2: Habitat data collected in 21 zones at Upper Warrell Creek.

Zone	Stream bank characteristics	Bank profile	Bank vegetation cover	Groundcover composition	Depth of leaf litter	Tadpoles (trap) weight, sex, location.	Tadpoles (dip net) weight, sex, location.
1	High bank on nth; clumping vegt ; undercuts; cleared south bank	Steep	40.0%	30% vegt; 50% litter; 20% bare	30mm	Nil	Nil
2	High bank on nth; clumping vegt ; undercuts	Steep	60.0%	25% vegt; 50% litter; 25% bare	30mm	Nil	Nil
3	High bank on nth; clumping vegt ; undercuts	Steep both banks	60.0%	25% vegt; 70% litter; 5% bare	20mm	Nil	Nil
4	Grassy patches with leaf litter	Sloping - moderate	60.0%	60% litter; 20% vegt; 20% bare	30mm	Nil	Nil
5	Grassy patch; established riparian vegt	Benched on nth; steep on Sth	75%	30% veg; 55% litter; 15% bare	30mm	Nil	Nil
6	Clumps of lomandra, logs, grasses and litter, lantana	Steep; gentle on central bar		60% veg; 35% litter; 5% logs	30mm	Nil	Nil
7	Clumps of lomandra, logs, grasses and litter	Steep; central island = gentle slope	75%%	50% veg; 40% litter; 10% logs	40mm	Nil	Nil
8	Rock, grasses,	Gentle to mod slope	10.0%	50% veg; 50% rock	10mm	Nil	Nil
9	Rock & grasses	Gentle slope	10.0%	50% veg; 50% rock	Nil	Nil	Nil
10	Undercuts; clumping vegt	Steep & short on Sth; sloping (mod) & tall on nth	50.0%	30% veg; 50% litter; 20% bare	10mm	Nil	Nil
11	Undercuts; clumping vegt; artificial rock	Steep east, benched west	50.0%	55% vegt; 30% litter; 15% bare	10mm	Nil	Nil
12	Silty, undercuts, mat rush; some erosion of inside bank	Vertical on west, steep slope on east	40.0%	60% vegt; 30% litter; 10% bare	20mm	Nil	Nil
13	Silty, undercuts, mat rush, woody debris	Verticals & steep slope	75%	40% vegt; 50% litter; 10% bare	40mm	Nil	Nil
14	Silty, undercuts, mat rush, o/h vegt	Vertical on west, steep slope on east	90.0%	30% vegt; 50% litter; 20% bare	50mm	Nil	Nil
15	Silty, o/h vegt, narrow rip zone, one bank cleared; cleared bank benched	Steep; cleared bank benched	35%	60% vegt; 25% litter; 15% bare	20mm	Nil	Nil
16	Silty, o/h vegt, narrow rip zone, one bank cleared; cleared bank benched	Steep; cleared bank benched	30.0%	60% vegt; 25% litter; 15% bare	20mm	Nil	Nil
17	Silty, o/h vegt, narrow rip zone, one bank cleared; cleared bank benched	Steep; cleared bank benched	40.0%	60% vegt; 20% litter; 20% bare	20mm	Nil	Nil
18	Silty, o/h vegt, narrow rip zone, one bank cleared	Steep; cleared bank benched	40.0%	60% vegt; 20% litter; 20% bare	20mm	Nil	Nil
19	Silty, o/h vegt, narrow rip zone, one bank cleared	Steep; cleared bank benched	35%	50% vegt; 20% litter; 30% bare	<10mm	Nil	Nil
20	Silty, o/h vegt, narrow rip zone, one bank cleared	Steep; cleared bank benched	35%	50% vegt; 20% litter; 30% bare	<10mm	Nil	Nil
21	Silty, sparse vegt	Steep; cleared bank benched	25%	55% vegt; 20% litter; 25% bare	<10mm	Nil	Nil

Table B3: Habitat data collected in 8 zones at Butchers Creek.

Site	Zone	Landuse (E&W)	Broad veg community (E&W)	In-stream physical characteristics (logs, boulders etc)	Stream width	Stream depth	Presence of pools or riffles	Bed composition	Emergent veg
Butchers Creek	1	Agriculture / cleared (imm prior to survey	Wet sclerophyll / cleared	Rock/ gravel / silt	1-4m	1M	P/R	Rock & sand	Absent
Butchers Creek	2	Agriculture / cleared (imm prior to survey	Wet sclerophyll / cleared	Rock/ gravel / silt	2-7m	0.8M	P/R	Rock & sand	Absent
Butchers Creek	3	Agriculture	Wet sclerophyll / cleared	Rock/ gravel / silt	2-7m	>1.5m	P/R	Rock / gravel	Absent
Butchers Creek	4	Road reserve / conservation	Grassland & wet sclerophyll	Rock/ gravel; occ logs	1-6m	0.6M	P/R	Rock	Absent (mat rush due to higher water level)
Butchers Creek	5	Conservation/ forestry	Wet sclerophyll	Rock/gravel bed; occ logs	1-4.5m	0.4M	P/R	Rock/coarse gravel	Absent
Butchers Creek	6	Conservation/ forestry	Wet sclerophyll (flooded gum)	Rock/ coarse gravel bed; rare log	1-7m	0.4M	P/R	Rock/ coarse gravel	Absent
Butchers Creek	7	Conservation/ forestry	Wet sclerophyll (flooded gum)	Rock/ coarse gravel bed; rare log	1.5-5m	0.75M	P/R	Rock/ coarse gravel	Absent
Butchers Creek	8	Agriculture/ forestry	Wet sclerophyll	Rock / coarse gravel	1.5-6m	>1m	P/R	Rock/ coarse gravel	Absent

Table B4: Habitat data collected at 8 zones at Butchers Creek.

Zone	Stream bank characteristics	Bank profile	Bank vegetation cover	Groundcover composition	Depth of leaf litter	Tadpoles (trap) weight, sex, location.	Tadpoles (dip net) weight, sex, location.
1	Benched with steep sections	NR	20.0%	10% veg; 80% litter; 10% soil	10mm	Nil	Nil
2	Benched with gentle slope in places	NR	40.0%	25% veg; 25% rock; 25% litter; 25% soil	10mm patchy	Nil	Nil
3	Steep	NR	60.0%	20% veg; 60% litter; 15% bare; 5% rock	20mm	Nil	Nil
4	Steep	NR	45%	60% veg; 40% litter	20mm patchy	Nil	Nil
5	Benched with gravel bars	NR	50.0%	40% veg; 10% rock; 15% sand; 35% litter	10mm	Nil	Nil
6	Benched with gravel bars	NR	40.0%	10% veg; 20% rock; 70% litter	10mm	Nil	Nil
7	Benched with gravel bars	NR	70.0%	15% veg; 20% rock; 25% leaf; 40% bare	10mm	Nil	Nil
8	Benched with gravel bars	NR	45%	20% veg; 20% rock; 45% litter; 15% soil		Nil	Nil

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Customer feedback
Roads and Maritime
Locked Bag 928,
North Sydney NSW 2059

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