



Transport for
New South Wales

Warrell Creek to Nambucca Heads

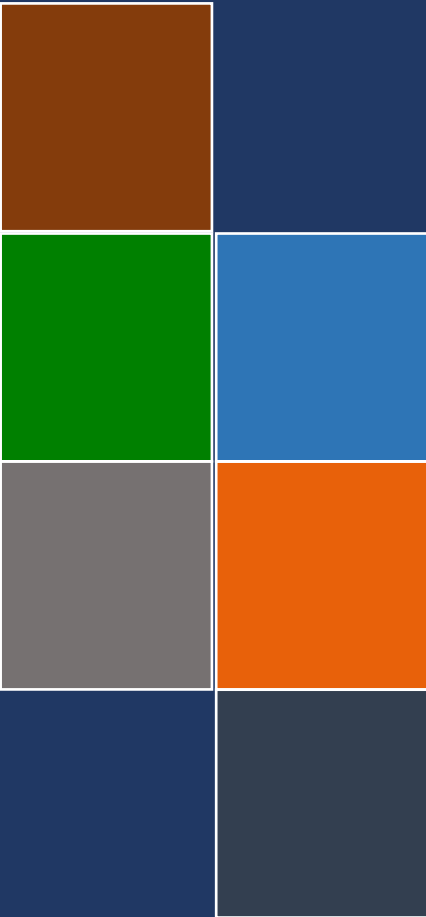
Interim Giant Barred Frog Monitoring Report – summer
year five operational phase (2022-2023)

Transport for New South Wales | September 2023 | Final Report



Pacific Highway upgrade: Warrell Creek to Nambucca Heads (WC2NH)

Giant Barred Frog – operational phase year
five summer interim report (2022-2023)



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1. Introduction

In 2015, Transport for New South Wales, in conjunction with Acciona Ferrovia 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 monitored include koala (*Phascolarctos cinereus*), yellow-bellied glider (*Petaurus australis*), giant barred frog (*Mixophyes iteratus*), green-thighed frog (*Litoria brevipalmata*), slender marsdenia (*Marsdenia longiloba*), rusty plum (*Niemeyera whitei*) and Floyd's grass (*Alexfloydia repens*). Mitigation measures monitored included green-thighed frog breeding ponds, fauna underpasses, vegetated median, and exclusion fence. Sandpiper Ecological Surveys (SES) has been contracted by Transport for NSW (TfNSW) to deliver the WC2NH operational ecological and water quality monitoring program in accordance with the Warrell Creek to Nambucca Heads Operational Ecological and Water Quality Monitoring Brief (the Brief).

The following interim report details the methods and results of the summer year five operational phase giant barred frog population monitoring. The objective of giant barred frog monitoring, as outlined in the Giant Barred Frog Management Strategy (GBFMS), is “to demonstrate through the life of the project that mitigation has maintained or improved population sizes and habitat of giant barred frog. The use of pre-construction, 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 2014b).

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 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 2014b).

Measures proposed to manage impacts on giant barred frogs included: population monitoring, pre-clearing surveys, temporary frog fencing during construction, clearing supervision, de-watering procedures (tadpole surveys) and permanent frog exclusion fence. Population monitoring was recommended to occur within a 1km transect, extending either side of the upgrade alignment, in spring, summer and autumn of Year 1 and 3 of the construction phase and years 1, 3 and 5 of the operational phase using the methods applied during preconstruction baseline surveys.

Preconstruction baseline surveys for giant barred frog were conducted between 20 September 2013 and 2 April 2014. The baseline surveys recorded 47 individuals, including 22 adults (11 females & 11 males), 8 sub-adults, and 8 juveniles. Based on these results, the population of giant barred frogs 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 construction phase 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).

2. Methodology

2.1 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. The two sample sites, Butchers Creek and Upper Warrell Creek, are situated near the southern end of the alignment (Figure 1). Following completion of the spring year 3 operational phase survey it was agreed with TfNSW that future monitoring at Butchers Creek be discontinued following refused entry from the landowner in response to severe flooding that had increased the risk of tree-fall at the site in combination with the absence of giant barred frog records during construction and operational surveys. As such, monitoring in year 5 focused on a 1km transect at Upper Warrell Creek. The transect extended either side of the upgrade alignment and was divided into 21 zones per baseline monitoring (Figure 2).

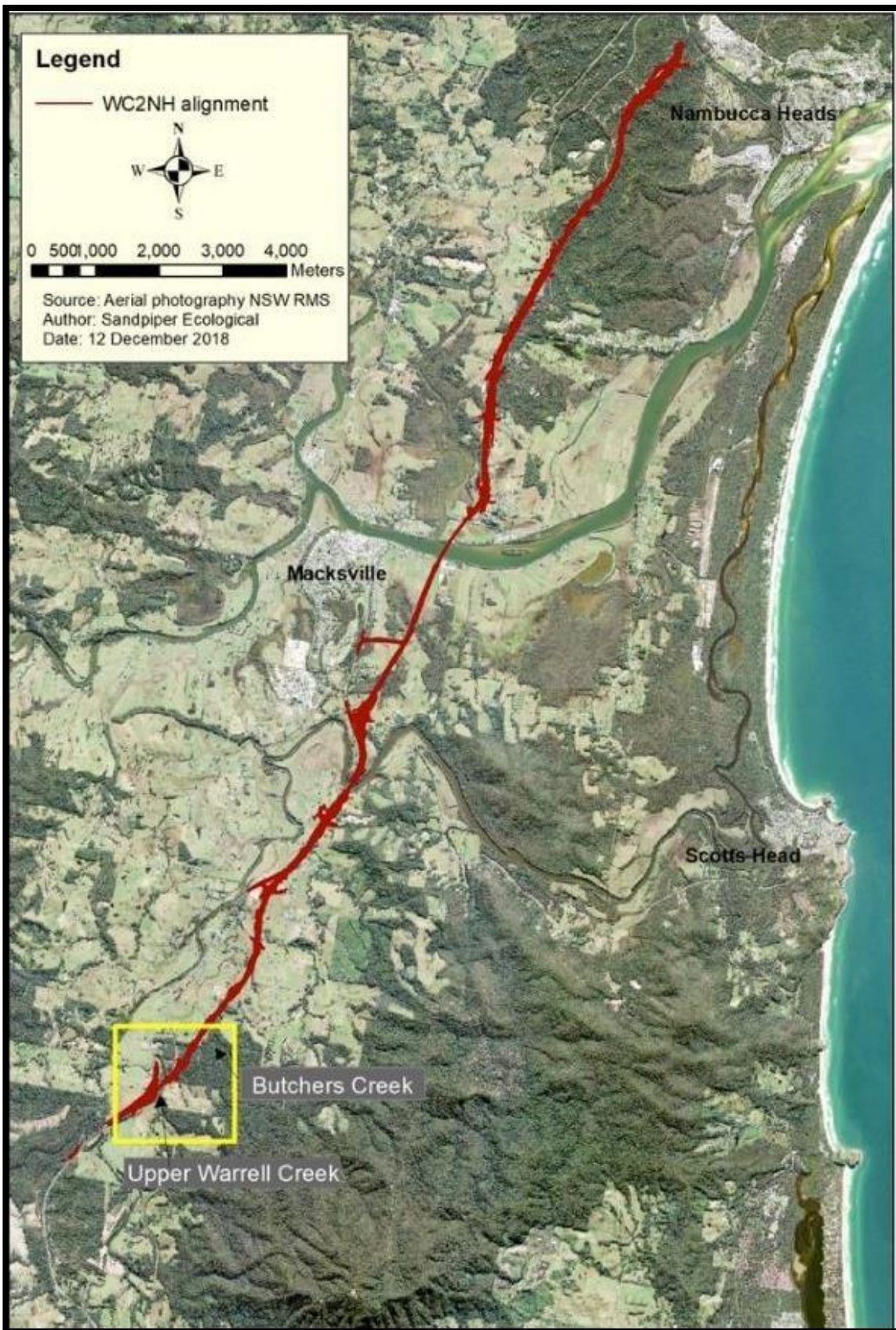


Figure 1: Location of giant barred frog sample sites in relation to the WC2NH alignment.

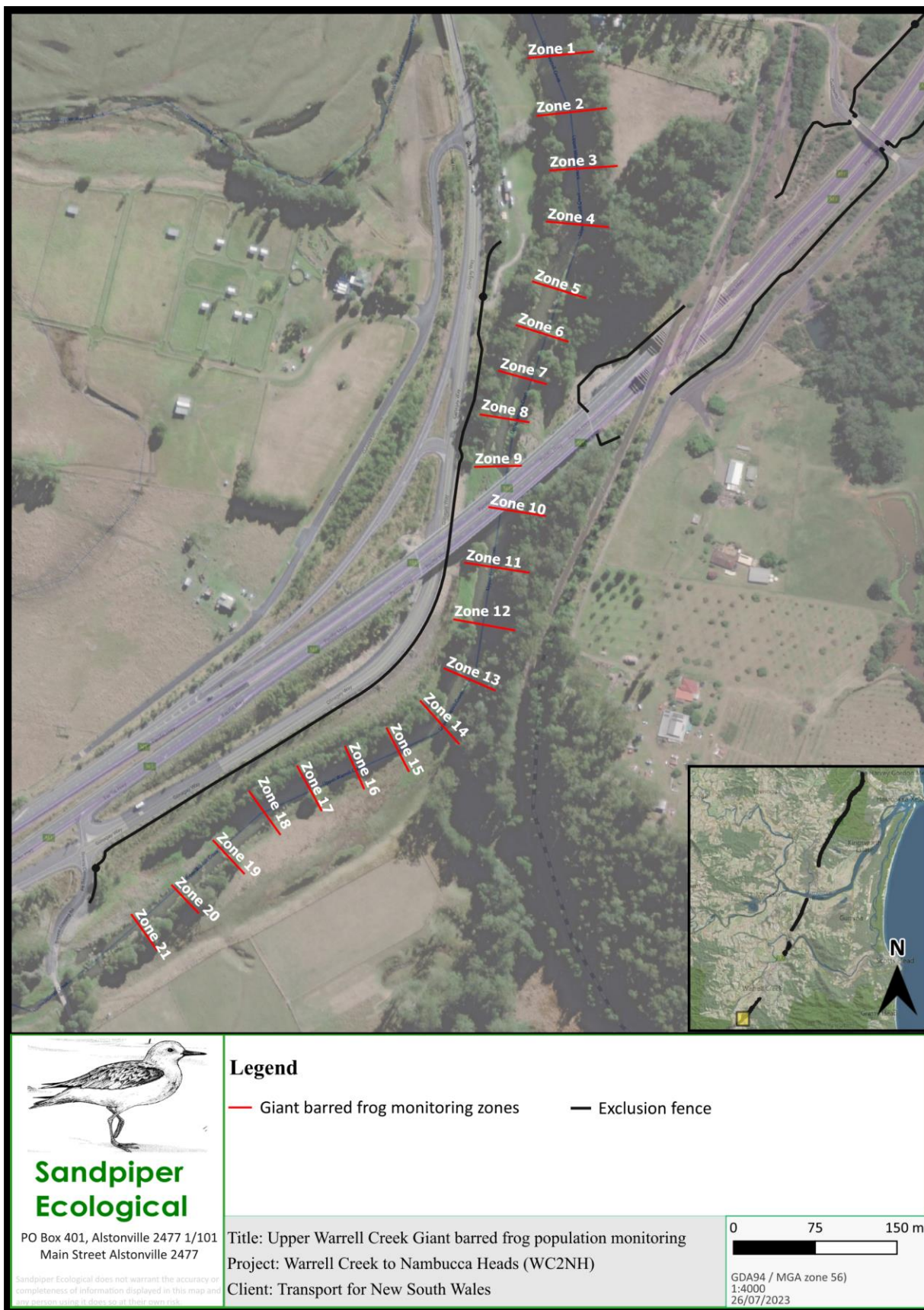


Figure 2: Survey monitoring zones at Upper Warrell Creek.

2.2 Frog surveys

Frog surveys followed the method specified in the Brief and baseline population survey (Lewis 2014). Surveys were conducted on 6, 7 and 24 March 2023. The method involved:

1. Two to three ecologists carried out nocturnal, foot-based surveys across 21 designated sample zones. These zones spanned a riparian area extending 25 meters on either side of Upper Warrell Creek (Figure 2).
2. Each ecologist was equipped with a 200-700 lumen spotlight and slowly traversed the riparian zone searching for frogs and listening for calls. Giant barred frog calls were broadcast through a 2-watt bluetooth speaker 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 and was deemed a sub-adult or older (i.e. >40mm snout-vent length) a tag was inserted beneath the skin on the left side and the insertion hole sealed with vet bond. The insertion point was swabbed with disinfectant (Betadine) before the tag was inserted. During operational surveys prior to autumn 2021, only frogs with a SV length greater than 60mm were PIT tagged. In autumn 2021, the size limit was reduced to 40mm to ensure consistency with baseline and construction phase surveys.
4. The dorsal pattern of all captured frogs was photographed. A comparison of dorsal pattern is a way to distinguish individual frogs and was done to identify untagged frogs captured in autumn 2021 and March 2022.
5. Data collected on each captured frog included: Survey zone (20x50m); Distance from the stream edge measured to the nearest 0.1m; Position within the microhabitat (i.e. under litter, above litter, exposed, on rock/log); Sex (male, female, unknown); Age class (adult=>60mm; sub-adult=40-60mm; juvenile=<40mm); Snout-vent length (mm); Weight (grams); 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 (2014b);
 - ii. females assessed 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.

2.3 Tadpole survey

Tadpole surveys were undertaken on 7 February 2023 using the following procedure:

1. Dip-netting by two ecologists within each survey zone. Dip-netting targeting areas of undercut bank and detritus.
2. One bait trap (~300 mm x 200 mm), baited with bread, was installed within each zone for 2 -3 hours.
3. In the event of a tadpole capture the following information was recorded:
 - a. Species
 - b. Survey zone (20x50m).
 - c. Sex (male, female, unknown).
 - d. Weight (grams).

Tadpoles were identified with reference to Anstis (2001, 2017).

2.4 Habitat assessment

Habitat sampling was conducted on 7 February 2023. Habitat data recorded in each zone included:

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 (>100 mm); Moderate (20-100 mm); Shallow (>0-20 mm); or Absent (0 mm).

2.5 Water quality sampling

Water samples and field measurements were taken within the sample transect at Upper Warrell Creek in zone 8 on the southern bank on 25 January 2023 (Figure 3). Due to a change in property ownership, the sample collection site was moved approximately 100m upstream during the summer sample. Field physicochemical measurements, including Conductivity, pH, Temperature, dissolved oxygen and turbidity, were measured using a Horiba U-52 multiparameter probe.

Water quality parameters analysed include:

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. 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.

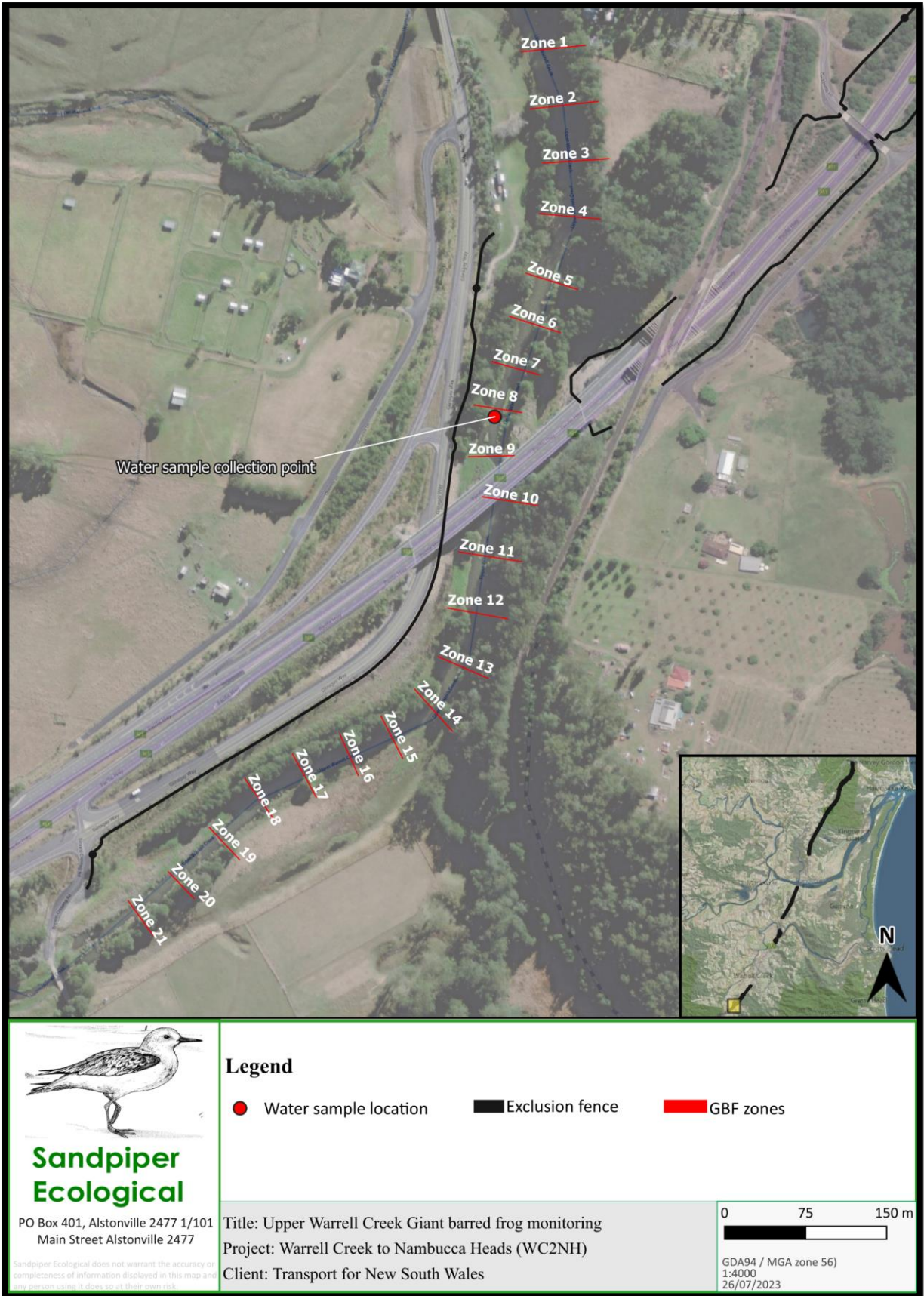


Figure 3: Location of water sampling site in relation to the survey zones at Upper Warrell Creek.

3. Results and discussion

3.1 Survey timing, effort and weather conditions

During the summer survey, the rainfall in the 30 days preceding the study was below average, with a total of 51 mm recorded (Table 1). Of this, 21 mm fell in the week prior the survey (Table 1 – rainfall prior). Moreover, rain occurred during the third summer survey, which may have influenced frog activity and detectability (Table 1).

The air temperature ranged between 20.7°C and 22.4°C across all surveys (Table 1), which was favorable for detecting giant barred frogs, particularly calling males (Koch & Hero 2009). The relative humidity was notably high, reaching 92% on 24 February (Table 1), and the dew point was consistently high during most nights (Table 1). Wind conditions remained calm, with no wind record across all surveys (Table 1).

Overall, the weather conditions were drier and warmer during the first two surveys, while the third survey took place under wet conditions (Table 1). The combined survey effort at Upper Warrell Creek during the summer sample amounted to 21.5 person-hours and exceeded the minimum requirement of 18 person-hours.

Table 1: Weather conditions and survey effort recorded during the year five summer giant barred frog survey at Upper Warrell Creek. Rainfall data were sourced from the Bellwood weather station. PH = person hours; Wind categories = 0 - no wind, 1 - rustles leaves, 2 - branches moving, 3 - canopy moving; RH = relative humidity (%); Rainfall = mm; Temp = °C; Dew Point = °C. Rainfall prior = rainfall totals (mm) recorded in 24hours/7 days/30 days prior to the survey recorded from the Bellwood weather station.

Date	Observers	Survey	PH	Effort	Rain	Rainfall prior	Temp	RH	Dew point	Wind
6/2/23	LA/AE	1	2	9.00	Nil	0/21/51	22.4	61	15.9	0
7/3/23	LA/AE	2	2	8.50	Nil	0/9/51	21.9	74	16.1	0
24/3/23	LA/AE	3	2	4.00	Showers	22/88/110	20.7	92	20.1	0

3.2 Tadpole surveys

No giant barred frog tadpoles were detected at Upper Warrell Creek during the year five summer dip-netting and bait trap surveys. The only vertebrate species captured were various freshwater fish. These included empire gudgeons (*Hypseleotris compressa*), striped gudgeons (*Gobiomorphus australis*), and australian smelt (*Retropinna semoni*). Notably, these species were recorded through both dip-netting and bait-trapping methods.

3.3 Habitat assessment

The Upper Warrell Creek study area included a diverse range of habitats, ranging from grassland to moderate quality riparian and wet sclerophyll forest with a dense litter layer. The riparian forest was fragmented and grazed in some parts, while the rest consisted of a narrow strip of vegetation along the creek, surrounded by agricultural land. The riparian vegetation width varied, but it was mostly confined to the bank and did not exceed 30m. Leaf litter cover was high (>75%) in intact riparian zones, but low (<40%) in cleared and grazed areas. The creek bank topography also varied, with steep banks on both sides downstream of the alignment (Zones 1-6), and on the north bank upstream of the alignment (Zones 11-13). A flatter bank profile occurred on the north bank near the alignment (Zones 7-11), and upstream (Zones 14-21).

During the 2021-2022 period, severe floods had a substantial impact on the microhabitat. Numerous trees in the riparian zone were uprooted, and areas of grass and regrowth were either eroded or flattened. The floods also washed away leaf litter, leaving the soil exposed. Consequently, there was a decrease in litter cover, and a drastic increase in woody debris and scoured ground cover.

However, the February 2023 survey revealed some changes in microhabitat. There was a noticeable improvement in leaf litter cover, and scouring was less prominent. Flood debris was still present, particularly around the southern banks of Zones 4-8 and Zones 13-11, creating potential refuge areas for giant barred frogs.

Weeds, predominantly pigeon grass (*Setaria geniculata*) and tall knotweed (*Persicaria orientalis*), dominated the vegetation on the northern and southern banks in Zones 8 and 9. Broad leaf paspalum (*Paspalum mandiocanum*) declined in areas where it was previously problematic (Zones 7-9). Remediation works, including the planting of weeping lilly pilly (*Waterhousia floribunda*) on the northern bank in Zones 7-9, remained in good condition. More time is required for the weeping lilly pilly to form a canopy with the existing vegetation and prevent further weed proliferation.

3.4 Water quality

The surface water sample collected from Upper Warrell Creek displayed a slightly low pH, reduced dissolved oxygen, and low levels of heavy metals (Table 5). Notably, there were no indications of hydrocarbon contamination (Table 5). Stagnation during low flow periods, as observed in the January sample (per obs), can significantly affect water quality during sampling. The stagnant conditions arise due to reduced flow, which may lead to lower levels of dissolved oxygen and pH. This could be attributed to increased water temperature and higher biochemical oxygen demand (BOD) resulting from the breakdown of organic material. However, it is essential to acknowledge the limitations of the water quality sampling approach. The approach involves taking isolated samples, sometimes months or even years apart, and only from a single location. Relying on sporadic and localised sampling might not fully represent the actual water quality conditions across the entire sample area at Upper Warrell Creek (Leigh *et al.*, 2019).

Table 2: Results of water sample analysis for Upper Warrell creek. ID = insufficient data to derive a reliable trigger value (ANZECC 2000). N/A = not value provided/ not applicable.

Parameter	Units	Measurement	ANZECC/ARMCANZ Trigger value for freshwater (95% species level of protection)
General parameters			
Temperature	Celsius degrees	27.91	N/A
pH	pH units	6.23	6.5-8.0
ORP	mV	125	N/A
Conductivity	dS/m	0.247	125-2200
Turbidity	Nephelometric Turbidity Units (NTU)	8.3	N/A
Dissolved Oxygen	mg/L	0.9	9-10.5
DO% Saturation	percentage (%)	11.7	80-110
TDS	g/l	0.161	N/A
Salinity	parts per thousand (ppt)	0.1	N/A
Hydrocarbons			
Benzene	µg/L	<1	ID
Toluene	µg/L	<1	ID
Ethylbenzene	µg/L	<1	ID
m+p-xylene	µg/L	<2	ID
o-xylene	µg/L	<1	ID
Naphthalene	µg/L	<1	ID
TRH C6 - C9	µg/L	<10	ID
TRH C6 - C10	µg/L	<10	ID
TRH C6 - C10 less BTEX (F1)	µg/L	<10	ID
TRH C10 - C14	µg/L	<50	ID
TRH C15 - C28	µg/L	<100	ID
TRH C29 - C36	µg/L	<100	ID
TRH >C10 - C16	µg/L	<50	ID
TRH >C10 - C16 less Naphthalene (F2)	µg/L	<50	ID
TRH >C16 - C34	µg/L	<100	ID
TRH >C34 - C40	µg/L	<100	ID
Surrogates			
Surrogate Dibromofluoromethane	%	110	No guideline
Surrogate toluene-d8	%	104	No guideline
Surrogate 4-BFB	%	98	No guideline
Surrogate o-Terphenyl	%	61	No guideline
Heavy metals			
Silver-Total	µg/L	<1	0.012
Aluminium-Total	µg/L	50	552
Arsenic-Total	µg/L	2	132
Cadmium-Total	µg/L	<0.1	0.22
Chromium-Total	µg/L	<1	12
Copper-Total	µg/L	<1	1.42
Iron-Total	µg/L	1200	10002
Manganese-Total	µg/L	410	19002
Nickel-Total	µg/L	1	112
Lead-Total	µg/L	<1	3.42
Selenium-Total	µg/L	<1	112
Zinc-Total	µg/L	1	82
Mercury-Total	µg/L	<0.05	0.062
Nutrients			
Phosphorus - Total	mg/L	<0.05	0.05
Total Suspended Solids	mg/L	14	6
Phosphate	mg/L	<0.005	0.025
Nitrite	mg/L	<0.005	0.01
Nitrate	mg/L	0.006	1
Ammonia	mg/L	0.036	Dependent on ph
Total Nitrogen in water	mg/L	0.2	0.5

3.5 Giant barred frog records and distribution

Three giant barred frog individuals were recorded at Upper Warrell Creek during the year five summer survey (Table 3). This included two juveniles (Frog 5 and 6), neither of which were recaptures and were deemed too small for pit-tagging (snout-vent length <40mm) (Table 3; Plate 1). An additional male giant barred frog (Frog 7) was heard calling on the southern bank and was unable to be found following a thorough inspection of the area (Table 3). The record of a calling male and two juveniles is encouraging as it provides positive indication of breeding activity in the current population at Upper Warrell Creek.

Giant barred frogs were recorded both downstream (1 adult male) and upstream of the alignment (2 juveniles) (Figure 4). The detections were between zones 5 and 13 (Figure 4) and tended to be within 200m of the alignment, consistent with recent operational monitoring surveys (Sandpiper, 2021 and 2022). Upstream of the alignment, two individuals were captured on the north bank, whilst downstream, one was recorded on the south bank. All captured individuals were positioned within 10m of the stream sitting on leaf litter (Table 3). No recaptures were recorded; hence, no individuals were found to have crossed the alignment.

Table 3: Data recorded for giant barred frogs captured or heard calling during the year 5 summer operational phase monitoring survey at Upper Warrell Creek. SI = Saw individual HC = Heard call. UK= unknown. S/V = snout-vent length; g = grams; mm = millimetres. New = new individual recorded no previous matching tags or dorsal photos. Recapture = previously tagged individual or matching dorsal photos from previous sample. N/A = not applicable.

Frog ID	Date	Zone	Creek side	Easting	Northing	Sex*	Age*	S/V length (mm)	Weight (g)	Detection	New or recapture	Microchip ID
Frog 5	6/2/23	13	North	489245	6594087	UK	Juvenile	33.2	8	SI	New	N/A
Frog 6	6/2/23	13	North	489248	6594087	UK	Juvenile	26.9	6	SI	New	N/A
Frog 7	7/6/23	5	South	489320	6594421	M	Adult	UK	UK	HC	UK	UK



Plate 1: Dorsal comparison of the two juvenile giant barred frogs captured on the southern bank during the summer surveys at Upper Warrell Creek. Individual on left is frog 5 and individual on right is frog 6.

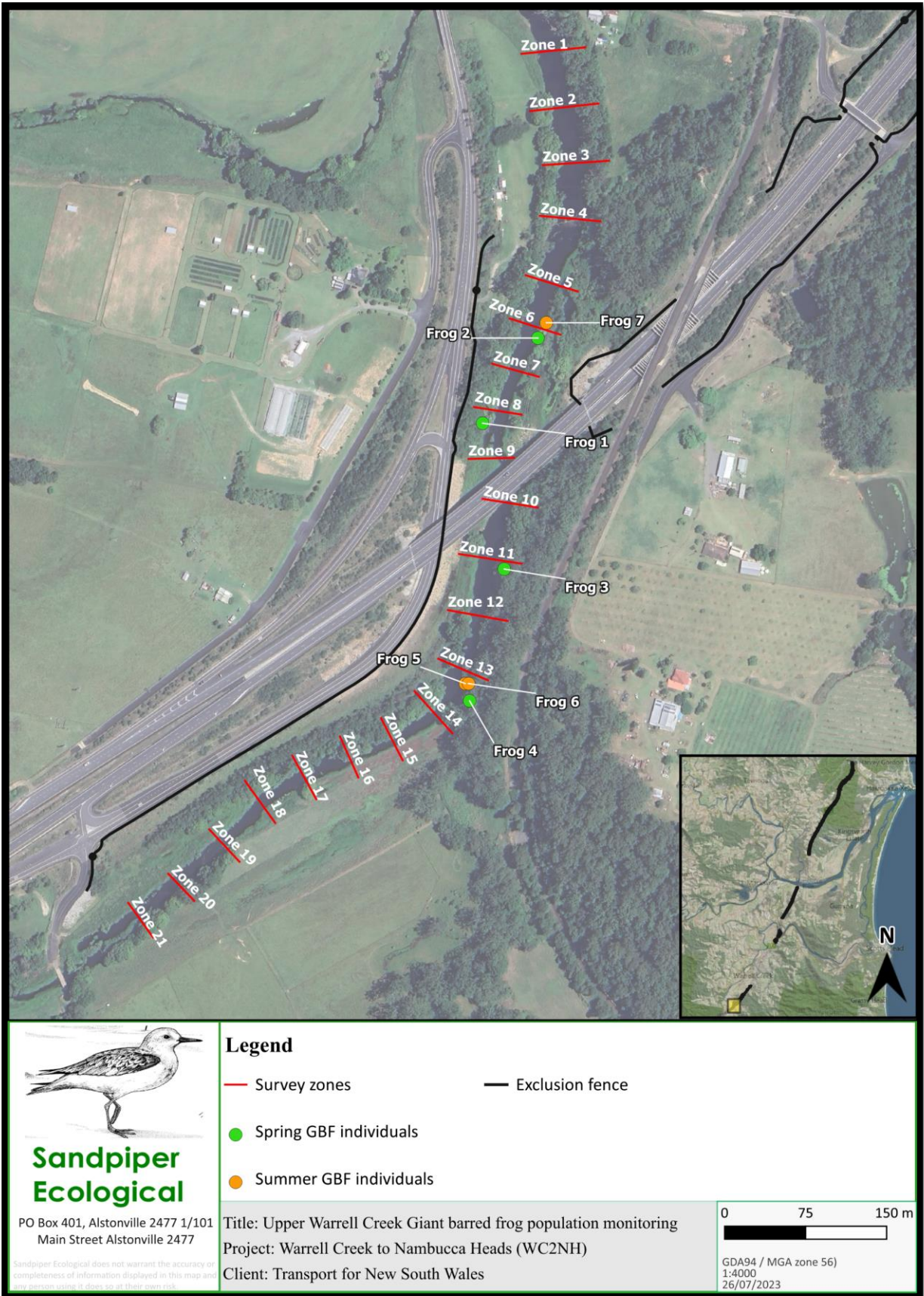


Figure 4: Location of GBF individuals recorded during spring and summer surveys at Upper Warrell Creek, WC2NH, 2023.

3.6 Giant barred frog abundance

Five years after the completion of construction, Upper Warrell Creek continues to support a population of giant barred frogs. A total of three frogs were recorded in summer of year 5, including two juveniles and one adult. The origin of the juvenile frogs remains unknown due to uncertainty about whether they are breeding locally or migrating from upstream. Notably, no recaptures were recorded in the recent summer survey, but the calling male (Frog 7) is likely to be the same individual as recorded in a similar location during the spring surveys (Frog 2).

The lack of recaptures in the fifth year cannot be solely attributed to the highway or other factors identified in the year 4 monitoring report. Therefore, it is crucial to consider other possible factors, including flood movements and threats like the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*), noting that these factors are outside the requirements of the Ecological Monitoring Program. These could potentially impact the giant barred frog population and contribute to explaining the absence of recaptures. Nonetheless, the record of a calling male and two juveniles is encouraging as it provides a positive indication of breeding activity. Further monitoring in autumn will assist in determining the status of the adult frog population at Upper Warrell Creek.

4. Recommendations

Table 4: Recommendations based on findings of the summer year five operational phase giant barred frog monitoring program.

Number	Recommendation	Transport for NSW Response
1.	Continue monitoring in autumn to determine the status of the GBF population at WC2NH	Agree.

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