research for a sustainable future

Yanco Creek and tributaries:

Intensive frog surveys of creek and farm habitats 2019-20

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Acknowledgements

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The project team also thanks the landholders who granted us access to wetlands, the creek and their properties. We are grateful for their assistance in advising on suitable farm sites, their interest, cooperation and support. We would like to thank the volunteers who joined us late into the night on multiple frog surveys; Nella Smith, Keith Thompson, Amy Daeche and Emmalie Sanders.

All research methods were conducted in accordance with Charles Sturt University's Animal Care and Ethics Committee guidelines, approval number: A19044.

Contents

Summary

Limited ecological surveys have been conducted in the Yanco-billabong creek system, particularly for aquatic animals and plants. Information such as frog species and abundance, water quality and vegetation diversity is critical in making informed, evidence-based natural resource management decisions. This project has been developed in partnership with Charles Sturt University and Yanco Creek and Tributaries Advisory Council (YACTAC) to increase the knowledge of the ecology of this system. More specifically, these surveys aimed to increase understanding of the ecological value of constructed waterbodies such as farm dams and irrigation channels during dry years, when wetlands and billabongs are dry.

Seven properties were selected for the 2019-20 frog surveys across the Mid-Yanco, Colombo and Lower Billabong creek systems. Selection was based on previous surveys in the region during the 2017-18 water year (Walcott et al., 2018) and targeted detection of the endangered Southern Bell frog (*Litoria raniformis*). To better understand the value of refuge habitats during dry years, six survey sites were selected on each property; three natural sites (wetland or creek) and three constructed waterbodies (dams or irrigation channels). On "Sheepwash" only one of each site type was selected due to the sites available.

Intensive frog surveys were conducted on two occasions. First at the end of November 2019 and repeated during the second week of January 2020, the peak breeding season and therefore increased possibility for detection of the Southern Bell frog. Where wetlands surveyed during the 2017-18 surveys were found to be dry, nearby creek sites were selected.

Overall, seven species of frog were identified across the system: Spotted Marsh frog, Barking Marsh frog and Eastern Sign-bearing froglet, Eastern Banjo frog, Giant Banjo frog, Peron's tree frog and the Southern Bell frog. Despite

the dry season, an increase in water levels occurred prior to the January surveys due to a combination of inter valley transfer and environmental water. This increase in flow led to an increase in frog activity in the creek system observed during the January surveys. Most notably was the increase in calling and sightings of Southern Bell frogs at "Broome".

Based on the findings of this study, natural resource management actions which improve/ sustain aquatic vegetation diversity and provide aquatic habitats which persist during spring and summer could sustain and improve frog occupancy in this system. Farm dams and irrigation channels provide important alternative habitat for many of the frog species detected. Improving the diversity of aquatic vegetation in these structures by mechanisms such as restricting stock access may see an increase in vegetation and consequently in increase frog numbers, providing important refuge habitat during dryer years.

Introduction

Frogs are considered important ecological indicators and their life cycle depends on both aquatic, riparian and terrestrial habitat. They have a role as both a predator and a food source in the greater food chain. Their two stage life cycle; that in the water as tadpoles and moving between water and land as adults, means they are an important energy and nutrient transfer between the aquatic and terrestrial ecosystems. Different species have different habitat requirements, wetland inundation and duration is particularly influential as the timing of which can either support or prevent successful breeding outcomes for species, with tadpoles requiring water to persist for their complete development. Therefore, diversity and composition of frog species, including changes in these measures can provide important insight into wetland ecosystems.

The aim of this study was to conduct intensive frog surveys in follow-up to the base line surveys of 2017 (Walcott et al., 2018). As this 2019-20 season was drier than during previous surveys and wetlands in the creek system containing little to no water, the decision to survey constructed water bodies as part of farm infrastructure was made to determine their ecological value as drought refuge habitat for frogs. In particular, the endangered Southern Bell frog was targeted for these surveys, with site selection based on previous detection of this species.

Project objectives:

1. Undertake frog occupancy and diversity surveys on both constructed and natural waterbodies at selected sites between Morundah and Conargo.
2. Provide an assessment of habitat diversity at each site surveyed.
3. Provide an assessment of water quality at each selected site.
4. Provide an assessment of the ecological value of constructed waterbodies as refuge habitat for frogs.
5. Implications for natural resource management and farm management.

Survey methods

Seven properties between Morundah and Conargo were selected based on previous surveys conducted in 2017. Six survey sites were selected on each of the seven properties. These included three natural sites such as a wetland, anabranch, backwater, billabong or creek line and three constructed waterbodies such as farm dams and irrigation channels. Initial search for suitable sites was conducted using aerial maps on Google Earth. Constructed waterbodies in proximity to the natural water bodies were selected. After consultation with the landholder and initial inspection of potential sites, site were selected based on water levels and abundance/diversity of vegetation.

Habitat survey

Sites were surveyed twice over the 2019-20 summer season in order to detect all species present, variation in weather conditions can impact detectability of species. During the initial survey, wetland vegetation communities were evaluated through a rapid habitat assessment of 10 metre belt transects. Percentage cover of each structural component (e.g. submerged, free floating, attached floating or emergent) and dominant species were recorded. On both survey occasions water quality (temperature (°C), conductivity (mS/cm), dissolved oxygen (mg/L), pH and turbidity (NTU) was measured using a handheld multi-parameter water quality meter (U-50 Series, HORIBA Ltd., Kyoto, Japan) at a depth of at least 30cm, or wherever possible in shallow waters. The meter was calibrated according to manufacturer specifications.

Frog surveys

Frog surveys were conducted after dark along a 20 minute transect along the water's edge and through surrounding terrestrial vegetation within 10 meters of the water line, using a handheld spotlight. The total number of calling individuals for each species was recorded prior to commencing the visual search and any additional species heard during the visual search were added to the count.

Results

Habitat assessment

Of the natural sites, Sheepwash, Coonong (Fig. 1 and 2), Bundure (Fig. 3) and Broome (Fig. 4) showed the highest diversity in vegetation structure. Sheepwash and Coonong had all five categories of aquatic vegetation: free floating, submerged, low growing, short emergent and tall emergent. Of the constructed sites, The Yanco (Fig. 5) and Sheepwash had the highest diversity of vegetation structure. The free floating species, azolla, was seen in small amounts across the natural sites but not in farm dams. Submerged aquatic vegetation included, milfoil, was observed at both natural and constructed sites. However, milfoil was only present in farm dams with restricted stock access such as at Quiamong and Broome (Fig. 6 and 7). Low growing aquatic vegetation, water primrose and common starwort, was observed in smaller amounts and less frequently. Low growing aquatic vegetation was more common in natural sites. Milfoil and water primrose provide important habitat for Southern Bell frogs as they are frequently observed calling from platforms created by this vegetation mat (see Fig. 8). Short emergent species such as short spike rush, *Eleocharis sp.*, water couch, juncus and slender knotweed were seen across all sites, short spike rush being the most common. Tall emergent species across the sites included cumbungi and occurred across all sites except constructed waterbodies on Broome and Bundure, this vegetation is often used by Peron’s tree frog who can be heard calling from up high on the cumbungi.

Figure 1- Coonong backwater

Figure 2- Coonong creek site

Figure 3- Bundure wetland site

Figure 4- Broome backwater where *L. raniformis* were detected

Figure 5- The Yanco waterhole where *L. raniformis* was heard calling

Figure 6- Quiamong farm dam

Figure 7- Broome farm dam

Diversity of vegetation between constructed and natural sites

Overall, there was similar average diversity in aquatic vegetation between constructed waterbodies and natural sites (Fig. 8). However abundance in each vegetation type varied between waterbody types, constructed waterbodies had a higher percentage of submerged aquatic vegetation than that of natural waterbodies, whereas natural waterbodies had higher percentage of short emergent vegetation, these differences can be seen in Fig. 8.

Similar to the 2017 frog surveys, it was found that diversity of frog species increased with the number of vegetation functional groups (Spearman's rank R= 0.353, p=0.028). As different frog species have different habitat requirements, the variety of vegetation groups, from free floating to tall emergent help provide for these needs.

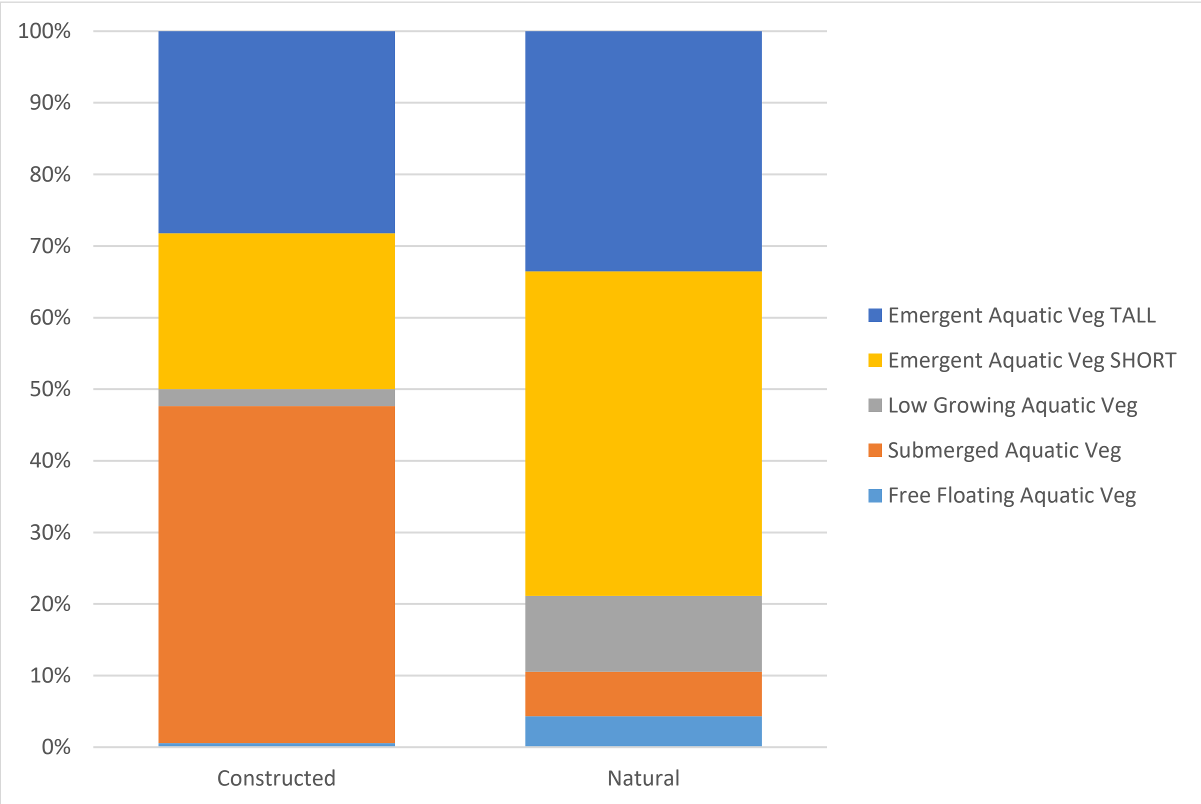

Figure 8- Average diversity of vegetation in constructed versus natural waterbodies

Water quality

Of the measured water quality, constructed and natural waterbodies had similar turbidity and temperature (°C). The pH (Fig. 9) and conductivity (Fig. 10) were significantly different in constructed waterbodies (pH: GLIM w=38.817, p= 0.000, Cond: GLIM w=22.538, p= 0.000) and probably reflects the difference in water source, bore water versus flow. Dissolved oxygen (DO%) was significantly different between sites (GLIM w= 21.225, p=0.000) with constructed waterbodies having higher dissolved oxygen, most probably due to algae.

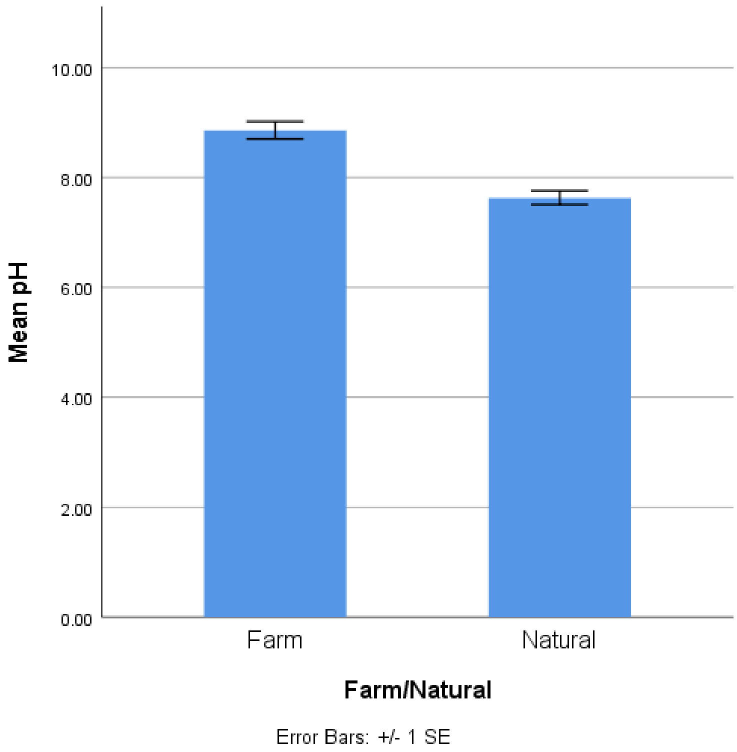

Figure 9- Significant difference was seen in pH between constructed (farm) waterbodies and natural waterbodies

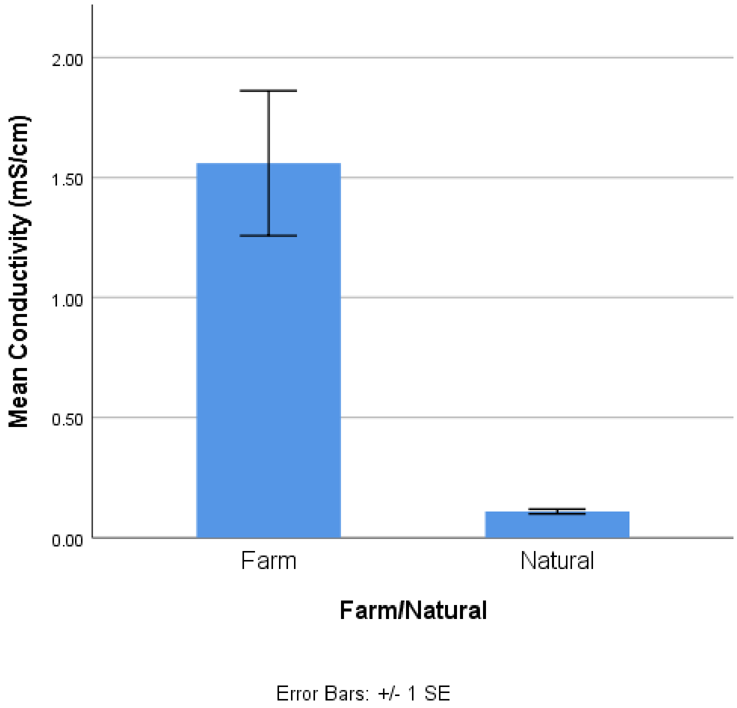

Figure 10- Conductivity was significantly higher in constructed (farm) waterbodies compared with natural waterbodies

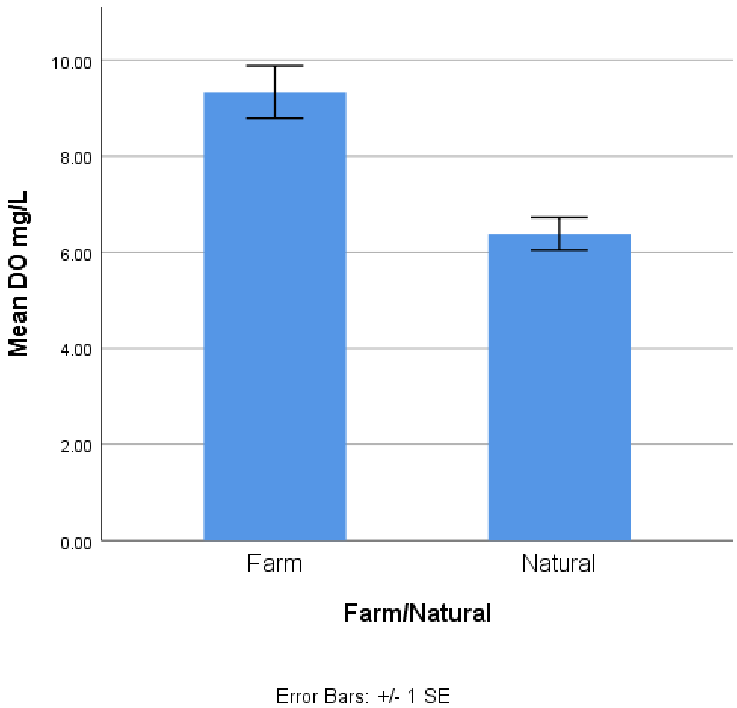

Figure 11- Dissolved oxygen levels were significantly higher in constructed (farm) waterbodies than natural waterbodies

Frog diversity

Seven species of frog were identified throughout the system including (Fig. 12): three ground dwelling species, Spotted Marsh frog (*Limnodynastes tasmaniensis*) (Fig. 13), Barking Marsh frog (*Limnodynastes fletcheri*)(Fig. 14), and Eastern Sign-bearing froglet (*Crinia parinsignifera*)(Fig.15); *two burrowing species, Eastern Banjo frog* (*L. dumerilii*) and Giant Banjo frog (*L. interioris*); one tree dwelling species, Peron's tree frog (*Litoria peronii*)(Fig. 16); and one endangered species, the Southern Bell frog (*Litoria raniformis*)(Fig. 17).

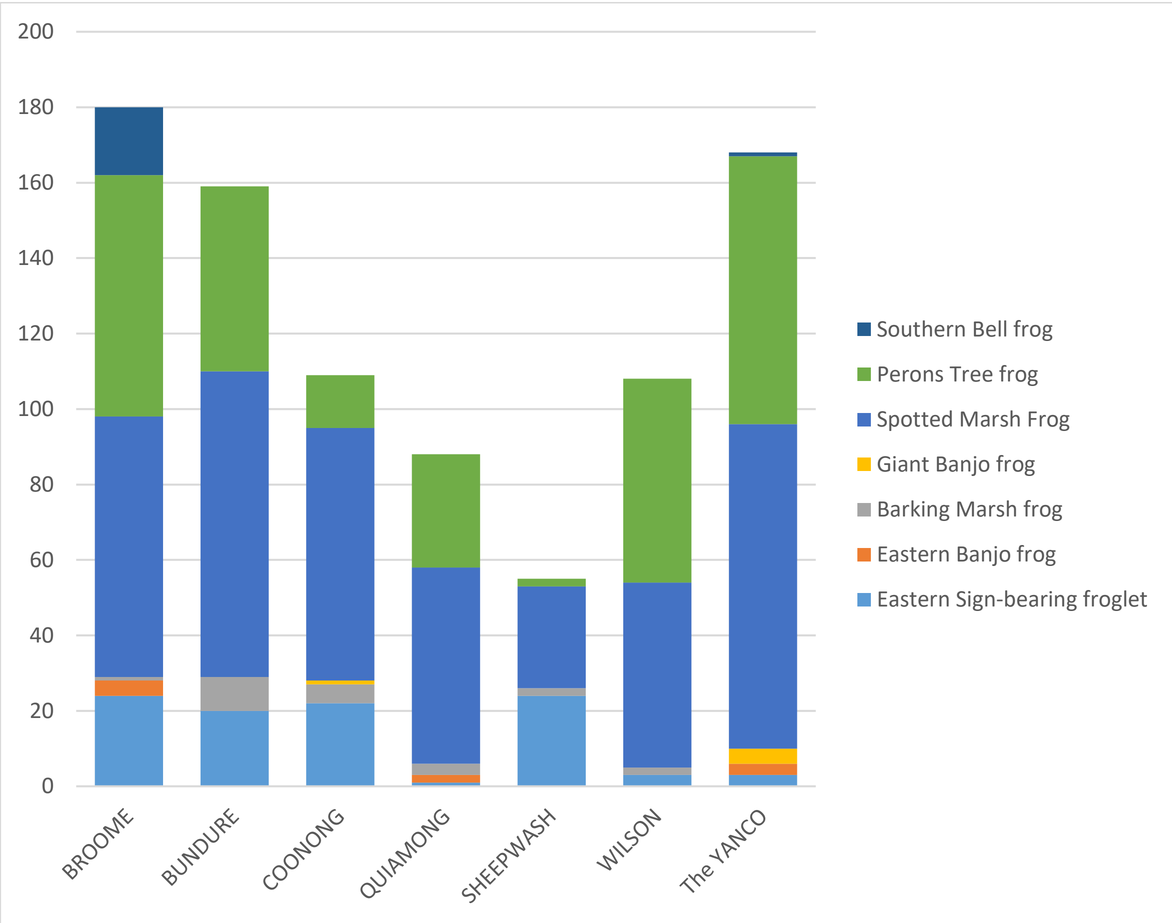

Figure 12- Frog species diversity across sites

Figure 13- Spotted Marsh frog (*Limnodynastes tasmaniensis*) at Bundure

Figure 14- Barking marsh frog (*Limnodynastes fletcheri*) at Coonong

Figure 15- Eastern Sign-bearing froglet (*Crinia parinsignifera*) on Water couch (*Paspalum distichum*)

Figure 16- Peron's Tree frog (Litoria peronii)

Figure 17- Southern Bell frog (Litoria raniformis) calling from Water Primrose.

Farm waterbodies as important drought refuge

The same diversity of frog species (7 species) were detected in constructed waterbodies such as farm dams and irrigation channels as in natural waterbodies, however the numbers were fewer for all species in the constructed waterbodies (Fig. 18). A similar number of Eastern Sign-bearing froglet and Spotted Marsh frog were detected across constructed waterbodies and natural waterbodies (48 and 49 eastern sign-bearing, 215 and 216 Spotted Marsh frog, constructed and natural respectively). More than double the number of Peron's Tree frogs were found in natural than constructed waterbodies (76 to 208). This coincides with a greater number of trees along creek lines, an important habitat for this tree-dwelling species. Giant Banjo frog and the Eastern Banjo frog are more likely to be detected after rains, they were detected in small numbers at both constructed and natural waterbodies during these surveys although numbers were slightly greater at the natural sites (1 vs 8 for Eastern Banjo frog, 1 vs 4 for Giant Banjo frog). One Southern Bell frog was heard calling from The Yanco waterhole (constructed waterbody, Fig. 5) but could not be visually spotted during the November surveys. In comparison, twenty Southern Bell frogs were detected at the backwater on Broome during the January surveys (natural waterbody).

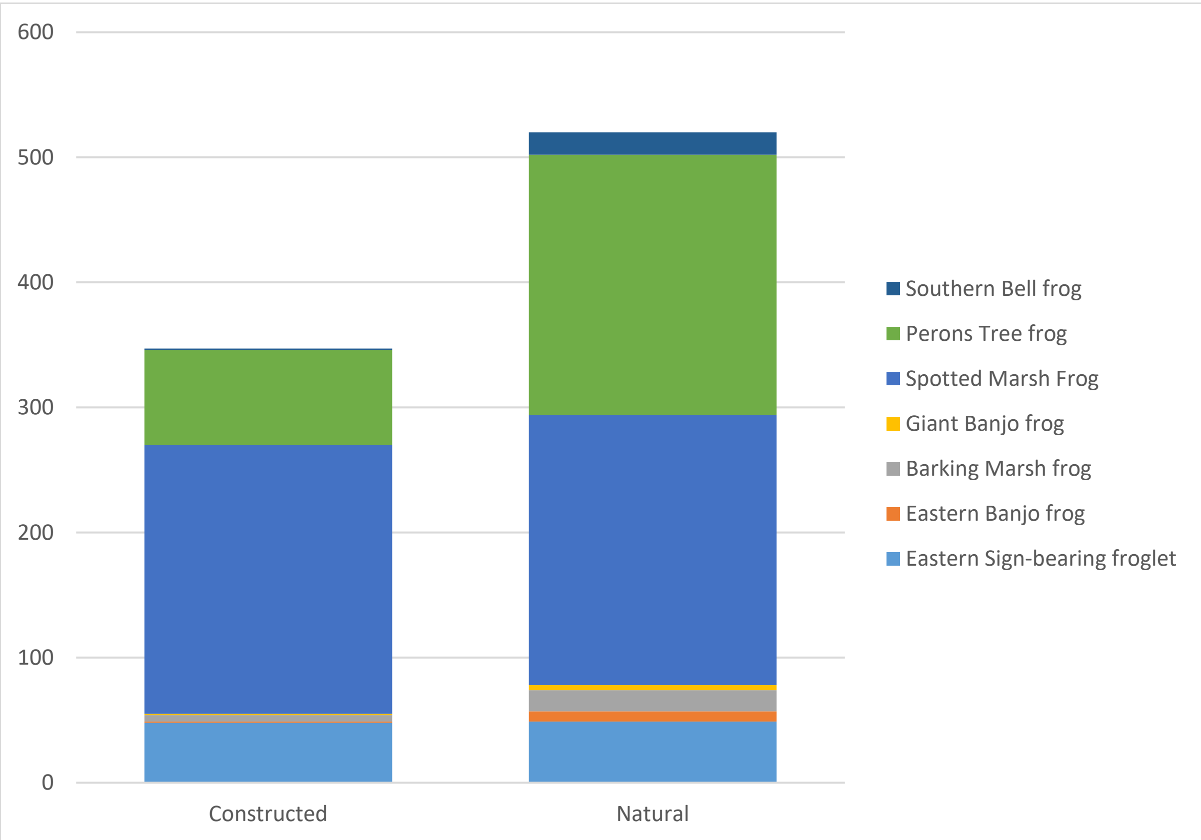

Figure 18- Frog species diversity in constructed versus natural waterbodies

The relationship found in this study between frog diversity and vegetation cover in farm dams is very complex. Frog diversity was seen to decrease with increasing vegetation cover but there is a positive association between frog diversity and vegetation complexity. As the number of different types of aquatic vegetation increases (i.e. submerged, low growing, emergent etc.) so too does the diversity of frog species. This emphasises the importance increasing diversity of aquatic vegetation in constructed waterbodies in order to provide a variety of habitat for a range of frog species, providing for their specific ecological niches.

Discussion and Conclusion

Frogs in Australia are well known to make farm dams and irrigation channels their home in an often dry and hostile landscape (Brainwood & Burgin, 2009). In the absence of such refugia, extended dry phases can lead to local declines and even extinctions (Mac Nally et al., 2014). Little research has been conducted on frogs in the Yanco-Billabong creek system. This study aimed to build on the preliminary surveys in 2017 (Walcott et al., 2018) to better understand the use of constructed waterbodies by frogs when wetlands along the creek system are dry, especially for the endangered Southern Bell frog.

Seven species of frog were detected, with all species utilizing both constructed and natural waterbodies. Aside from the Southern Bell frog, the species observed are known to be quite widespread and common in the broader, south east Australian landscape (Anstis, 2013). As habitat generalists, these species are known to live in a wide range of habitats within their distribution with numbers during this study being similar to nearby regions (MacNally et al., 2009; Wassens & Maher, 2011).

In this study, the diversity of frog species increased with the increase in vegetation diversity. The diversity of vegetation and its abundance plays an important role in providing frogs with suitable habitat, whatever the waterbody type, constructed or natural (Hazell et al., 2001). Vegetation plays an important role in providing protection from predators and climate, as well as scaffolding for egg masses.

A small increase in water flow down Yanco creek between the November and January survey, due to a combination of the delivery of inter-valley transfers between the Murrumbidgee and Murray valleys by Water NSW and environmental water, saw a response in Southern Bell frog activity. Over twenty Southern Bell frogs were recorded at "Broome" during the January surveys. This response is expected as breeding is triggered by flooding of ephemeral waterbodies during spring or summer (Schultz, 2007). Although constructed waterbodies neighbouring the creek, provide important alternative habitat for frogs in this region. The creek, its anabranches, backwaters and billabongs are vital for the longer term persistence of the Southern Bell frog in this region. The majority of Australian frogs require free standing water for their entire larval development period. Tadpole development time varies between species, with Southern Bell frogs requiring 4-6 months to fully metamorphose. Targeted watering of the Yanco-Billabong creek system which inundates backwaters such as that at Broome, could greatly benefit the Southern Bell frog populations.

This study not only highlighted the importance of within channel rises and the inundation of backwater and swamp habitats but also of the diversity in aquatic vegetation. Measures to increase vegetation and therefore frog habitat in constructed waterbodies would greatly benefit frog populations not only in this region but in all agricultural landscapes. Hazell et al. (2001) found that there were several characteristics of the terrestrial/aquatic farm dam interface which were useful predictors of species presence and diversity. All five frog species which she studied in south eastern Australia were influenced by the extent of bare ground in the riparian zone or the percentage of emergent vegetation in the water margin.

Due to the complex nature of the frogs lifecycle the terrestrial/aquatic zone, or the edge of the dam, plays several different roles in proving habitat. As metamorphs, when the tadpoles have grown legs and are emerging from the water, vegetation on the water's edge is vital for protection from predators such as snakes, scorpions and leeches which are commonly observed along the waterline during metamorphosis (Hazell et al., 2001). Emergent vegetation on the waterline also provides important habitat for adult breeding activity, with many species vocalising for their mates in this zone. Emergent vegetation in the shallow water zone also provides import oviposition sites for eggs to attach and be protected from predators. When stock use such sites for their water source, it is this terrestrial/aquatic zone which is mostly impacted due to trampling and grazing. Appropriate fencing, restricting stock to water from a specific portion of the dam can greatly increase aquatic vegetation and benefit the frog abundance and diversity.

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Appendices

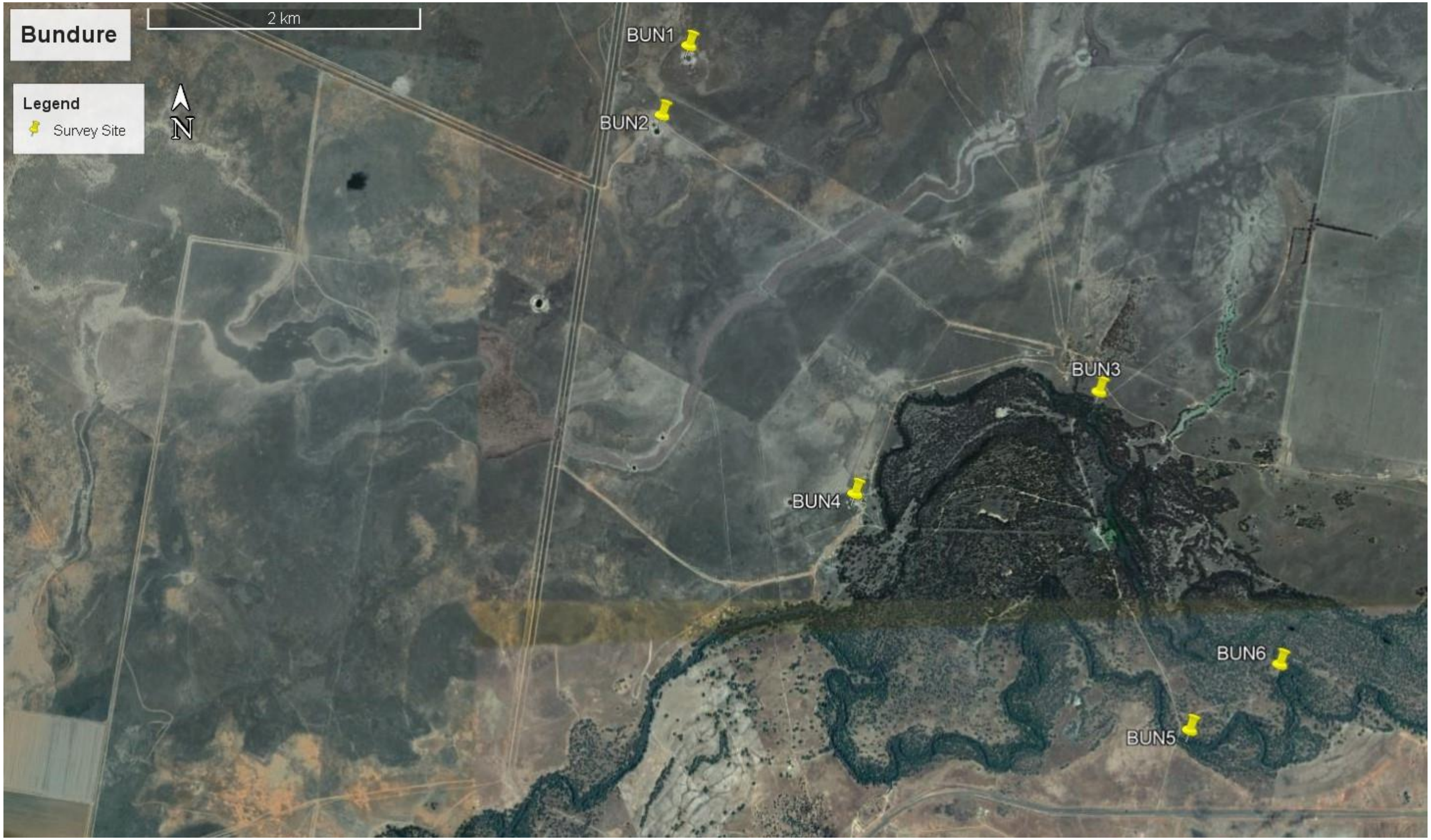
Appendix 1: Site details

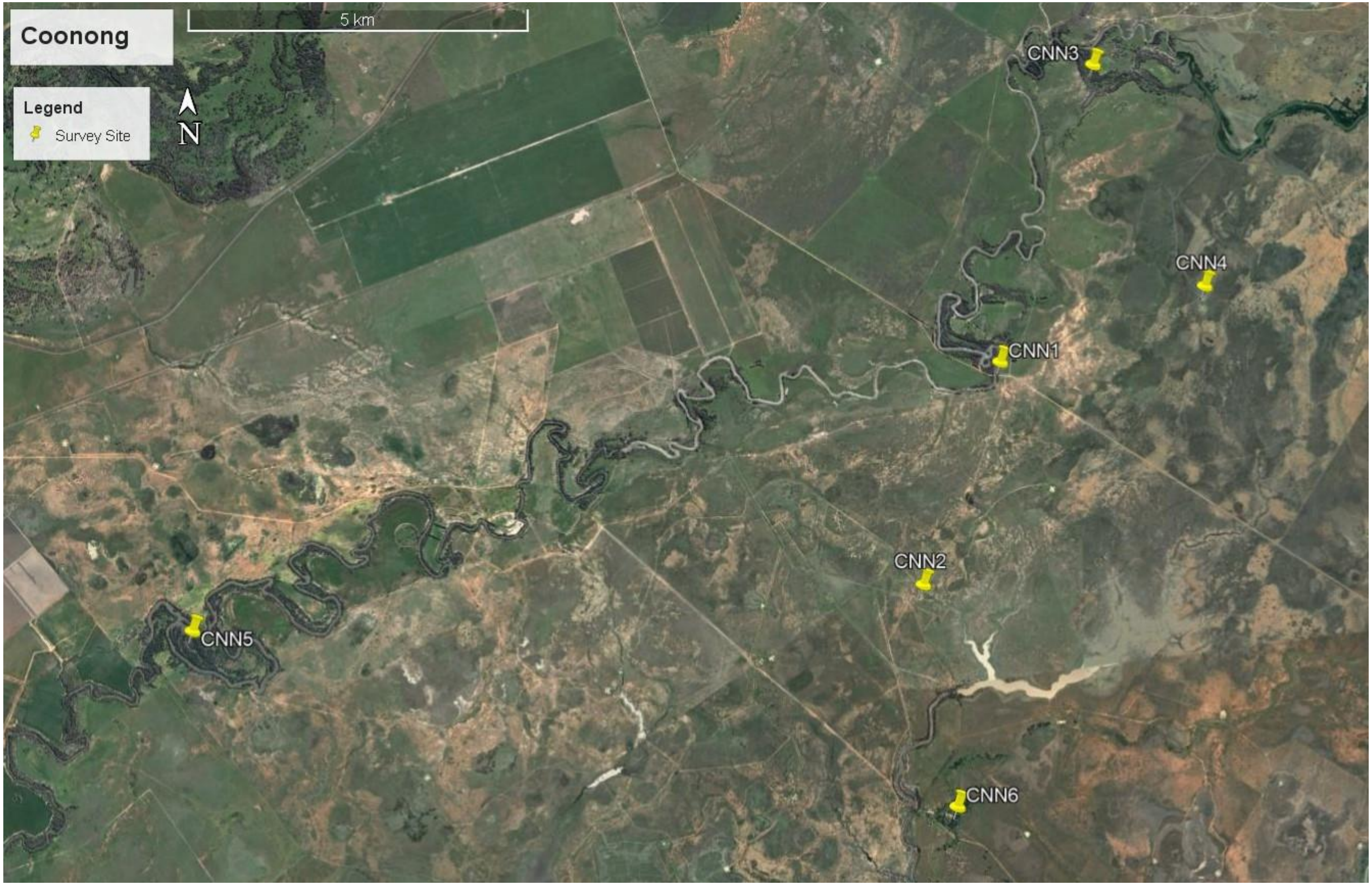
Property name	Site code	Latitude	Longitude
Broome	BRO1	-35.13788	146.79662
	BRO2	-35.13998	146.79651
	BRO3	-35.1401	145.79675
	BRO4	-35.13856	145.77854
	BRO5	-35.12505	145.79483
	BRO6	-35.12456	145.79421
	BRO7	-35.12458	145.79454
Bundure	BUN1	-35.1003	145.94161
	BUN2	-35.10489	145.93946
	BUN3	-35.12302	145.97432
	BUN4	-35.12966	145.95487
	BUN5	-35.14495	145.98134
	BUN6	-35.1407	145.98851
Coonong	CNN1	-35.15737	146.1761
	CNN2	-35.1863	146.16367
	CNN3	-35.11813	146.19136
	CNN4	-35.14742	146.20889
	CNN5	-35.192121	146.047873
	CNN6	-35.214777	146.1689
Quiamong	QUI1	-35.29015	145.21181
	QUI2	-35.28593	145.22588
	QUI3	-35.29644	145.187
	QUI4	-35.294462	145.183284
	QUI5	-35.33483	145.16783
	QUI6	-35.34106	145.17992
	QUI7	-35.214683	146.168912
	QUI8	-35.19154	146.04634
Sheepwash	SHE1	-35.07318	146.2838
	SHE2	-35.06747	146.27502
Wilson	WIL1	-35.29275	145.45409
	WIL2	-35.29356	145.45338
	WIL3	-35.29616	145.4769
	WIL4	-35.28811	145.485
	WIL5	-35.29541	145.49796
	WIL6	-35.29501	145.49449
The Yanco	YAN1	-35.16451	145.77614
	YAN2	-35.16169	145.7657
	YAN3	-35.15979	145.76227

YAN4	-35.14892	145.768876
YAN5	-35.14368	145.76403
YAN6	-35.163807	145.747057

Appendix 2: Wetland maps


Broome
1 km
N
Legend
Survey Site
BRO6
BRO7
BRO5
BRO1
BRO4
BRO2
BRO3


Bundure
2 km
Legend
Survey Site
N
BUN1
BUN2
BUN3
BUN4
BUN5
BUN6


Coonong
5 km
Legend
Survey Site
N
CNN3
CNN4
CNN1
CNN2
CNN5
CNN6


Quiamong
3 km
Legend
Survey Site
N
QUI2
QUI1
QUI4
QUI3
QUI5
QUI6


Sheepwash
700 m
Legend
Survey Site
N
SHE2
SHE1


The Yanco
1 km
N
Legend
Survey Site
YAN5
YAN4
YAN3
YAN2
YAN6
YAN1

Wilson
1 km
Legend
Survey Site
N
WIL1
WIL2
WIL3
WIL4
WIL5
WIL6

Appendix 3- Water Quality

Property name	**Site Name**	**Temperature (C)**	**pH**	**Conductivity (mS/cm)**	**Turbidity (NTU)**	**Dissolved Oxygen (DO mg/L)**	**Dissolved Oxygen (DO%)**
Broome	BRO1	29.45	8.47	0.14	220.0	8.46	111.7
	BRO2	24.04	7.44	0.09	163.5	6.48	78.15
	BRO3	23.51	7.41	0.09	152.0	6.45	76.85
	BRO4	25.74	8.41	0.06	210.0	8.03	99.95
	BRO5	24.91	10.11	5.18	45.0	15.88	198.95
	BRO6	23.52	9.64	3.65	22.8	9.13	111.9
	BRO7	24.18	9.73	5.28	54.9	12.82	157.95
Bundure	BUN1	26.07	8.87	4.52	87.9	9.22	118
	BUN2	25.82	9.95	3.30	31.1	11.98	151.6
	BUN3	25.74	7.33	0.12	80.3	5.03	63
	BUN4	25.31	9.04	1.17	738.5	6.82	84.6
	BUN5	25.18	7.61	0.07	230.0	6.38	78.8
	BUN6	25.49	8.17	0.09	176.5	6.01	74.7
Coonong	CNN1	23.45	7.05	0.08	67.5	6.16	74.3
	CNN2	20.47	8.43	0.39	173.3	9.82	111.9
	CNN3	22.72	7.64	0.11	79.4	7.51	89.2
	CNN4	20.61	8.49	0.16	54.5	8.01	91.8
	CNN5	22.45	7.25	0.09	76.2	6.47	76.4
	CNN6	20.86	8.99	0.23	28.2	8.74	100.5
Quiamong	QUI1	23.53	7.49	0.09	163.0	7.51	90.4
	QUI2	23.78	7.36	0.09	157.5	7.14	86.2
	QUI3	25.54	7.92	0.32	668.0	6.68	85.2
	QUI4	23.58	7.42	0.09	164.0	4.40	89.1
	QUI5	23.19	8.79	0.47	163.5	8.18	98.15

	QUI6	22.40	8.23	0.38	101.0	7.99	94.75
Sheepwash	SHE1	23.13	7.36	0.06	112.6	8.06	96.65
	SHE2	26.29	6.77	0.10	39.5	5.18	65.05
Wilson	WIL1	27.48	9.17	0.55	142.5	8.25	105.8
	WIL2	24.93	7.86	0.14	173.0	6.00	73.65
	WIL3	25.27	8.28	0.88	193.9	5.73	70.35
	WIL4	27.13	8.06	0.31	28.0	7.34	93.6
	WIL5	21.92	8.03	0.26	164.5	8.36	97.9
	WIL6	25.50	7.84	0.13	185.5	5.38	66.7
The Yanco	YAN1	29.16	10.45	2.20	19.1	16.22	213.8
	YAN2	28.77	9.82	0.27	13.7	11.77	153.1
	YAN3	25.69	7.59	0.09	158.0	6.14	76.05
	YAN4	25.49	7.71	0.09	212.0	6.18	76.3
	YAN5	27.27	8.03	0.47	37.4	7.02	89.1
	YAN6	26.03	7.75	0.09	144.3	4.92	61.15

Appendix 4- Frog numbers

Property	Site names	Eastern Sign bearing froglet	Eastern Banjo Frog	Barking Marsh Frog	Giant Banjo Frog	Spotted Marsh Frog	Peron's Tree Frog	Southern Bell Frog	Grand Total
Broome	BRO1	3	2			24	30	15	74
	BRO2	8	2	1			8	3	22
	BRO3	4				8	13		25
	BRO4	8				17	2		27
	BRO5					10	7		17
	BRO6					9	4		13
	BRO7	1				1			2
Bundure	BUN1					2			2
	BUN2					22			22
	BUN3	11		9		10	25		55
	BUN4	1				33			34
	BUN5	6				7	15		28
	BUN6	2				7	9		18
Coonong	CNN1			3		15	4		22
	CNN2	15				19			34
	CNN4	4			1	9			14
	CNN5	3		2		24	4		33
	CNN6						6		6
Quiamong	QUI1					2	2		4
	QUI2		1	2		8	6		17
	QUI3		1				1		2
	QUI4						7		7
	QUI5	1				8			9
	QUI6			1		34	14		49
Sheepwash	SHE1	12				15	2		29

	SHE2	12		2		12			26
Wilson	WIL1	2				5	7		14
	WIL2					1			1
	WIL3					3	14		17
	WIL4					22	23		45
	WIL5	1		2		11	5		19
	WIL6					7	5		12
The Yanco	YAN1					3			3
	YAN2	3				6	14	1	24
	YAN3					25	26		51
	YAN4					9	8		17
	YAN5					11	2		13
	YAN6		3		4	32	21		60
	Grand Total	**97**	**9**	**22**	**5**	**431**	**284**	**19**	**867**