PATH CO. PTY LTD

ACN 623 982 061

108 Shipton Lane Verona NSW 2550

SAM PATMORE - Director

email: sam.p@path-co.com.au

KARYN THOMPSON - Director

email: karyn@path-co.com.au

Frog Population Monitoring of Mulloon Creek

Report on November 2023 surveys

Report prepared for The Mulloon Institute



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Sam Patmore

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Client: The Mul	Client: The Mulloon Institute (TMI)										
Author(s):	Sam Patmore	Association:	PATH Co Pty Ltd								
Reviewed by:	Peter Hazell		The Mulloon Institute								

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Executive Summary

Frog monitoring surveys were undertaken at pre-determined sites along Mulloon Creek in November 2023. The surveys are being undertaken as part of a broader assessment of the biodiversity values of the Mulloon Creek catchment and assist with assessing the longer-term outcomes of the landscape rehydration pilot project being undertaken at degraded sections of Mulloon Creek. These surveys represent a fifth season of annual monitoring of frogs along the creek that commenced initially in 2017 and were undertaken again in 2020, 2021 and 2022 (although the number of sites surveyed has changed marginally over each of these years).

For this 2023 monitoring season, the surveys were conducted by a team of people using audio-recording techniques that were later analysed by an experienced herpetologist. A total of 61 stream sites along 29 pre-existing RARC monitoring transects as well as 8 farm dam/wetland sites were included in this 2023 season's surveys, occurring over a total of almost 20km of stream length between the upstream and downstream sites, as well as along tributaries of Mulloon Creek in the downstream, northern margins of the catchment.

The surveys found that the section of the Mulloon Creek catchment covered by this study continues to support a relatively healthy frog community along the creek as well as at select dams/wetland sites adjacent to the creek (restricted to within the Mulloon Creek Home Farm property only). This (2023) season, a total of 10 frog species were recorded during the study. This result represents an increase in the total number of species recorded in the study area from the previous 2022 of 9 species, but is one less than the earlier (2021) season's result of 11 species, while being two more than the earlier 2020 survey of 8 species and three more than the 2017 survey of 7 species.

The only previously recorded species that was not recorded this season was the Screaming Tree Frog, a species that has been infrequently recorded in the study area in past seasons. Two species not recorded in the 2017, 2020 and 2022 studies but recorded in the 2021 survey include Lesueur's Tree Frog and the Southern Leaf Green Tree Frog. Both of these species were recorded again this (2023) season and within the same small number of sites in the upper reaches of Mulloon Creek within Landtasia where a rocky streambed substrate occurs.

No species of frog had the highest detection frequency rate this season compared with all previous seasons. However, five species did record their (equal or) lowest detection rates this year compared with all previous seasons, including the Plains Froglet, Common Eastern Froglet, Spotted Grass Frog, Eastern Banjo Frog, and the Screaming Tree Frog. All of these species are relatively common and widespread in the region and have relatively secure populations. Two species of frog which had been mentioned specifically in previous seasons' survey reports (see Patmore, 2022 and 2023) as potentially being of concern due to low detection rates are the Peron's Tree Frog and Whistling Tree Frog. Both of these species had relatively high (but not the highest) detection rate this season, and up from the previous two years results. Consequently, the concern for these species within the catchment no longer appears warranted.

The overall average species richness of frogs at stream sites (and at transects) on Mulloon Creek as well as the dam/wetland sites on MCHF during the 2023 season was down on last (2022) season and all previous seasons. However, the maximum number of species observed at a single stream site this (2023) season (7 species) is the same as the previous 2022 and 2021 seasons (also 7 species), and an increase on the earlier 2020 season (maximum of 5 species at a single site) and the 2017 season (maximum of 6 species at a single site). The maximum number of species observed at a single dam/wetland site (6 species) was also equal to the 2021 and 2022 season's results and higher than the initial (2020) season's result of only 4 species (maximum) detected at a single site.

Overall, the results appear to show that most frog species present in the Mulloon Creek system have relatively stable local populations, being recorded regularly over the five years of survey. Importantly, no species of frog in this Mulloon Creek catchment appears to have a local population that may be declining, although some do appear to have populations that are moderate-highly fluctuating in distribution and abundance.

Note that habitat assessment variables were not collected for this 2023 season survey.

A number of both land management and further research recommendations have been made that are drawn out by the findings of this monitoring work and are described in detail in the full report.

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1 INTRODUCTION

1.1 Summary overview of project

This report provides a summary of the amphibian population surveys undertaken at Mulloon Creek near Bungendore NSW in November 2023.

The Mulloon Institute (TMI) has been working with landholders at a catchment scale to rehydrate the landscape and improve functionality and land use management along a section of Mulloon Creek near Bungendore, NSW. In 2006, the Mulloon Institute, with backing from the Southern Rivers Catchment Management Authority, and through the Mulloon Creek Natural Farms (MCNF) business, began a landscape rehydration pilot project at degraded sections of Mulloon Creek. The work has included the installation of numerous weirs within the creek to reinstate more natural 'pool and riffle' sequences.

The primary aim of this work was to slow the movement of water through the creek and to recharge the groundwater system within the floodplain. The targeted benefits of slowing the movement of water and recharging the groundwater was to reduce erosion and improve the productivity of the landscape, including the overall biodiversity values of the aquatic and terrestrial systems in the area.

Based on the success to date of the project at a property scale, a multi-faceted scientific research program to collect hydrological, soil, and biological data to assess the impact of the catchment scale approach, is being undertaken (Peel & Hazell *et. al.*, 2022).

Part of the biodiversity surveys has included assessing the existing amphibian populations in the area to determine how they might respond to or benefit from the rehydration project. A preliminary survey was completed by Luke Peel in November 2017 with analysis and reporting by Frogwatch (Hoefer 2017). Subsequent, follow-up surveys were completed in December 2020 (Patmore, 2021), December 2021 (Patmore, 2022) and November 2022 (Patmore, 2023). The recent survey completed in November 2023 (and which is the focus of this report) was undertaken to increase the extent of baseline data on the existing frog community present within the defined study area of Mulloon Creek.

The data from these frog surveys will facilitate part of a broader project to monitor the effectiveness of the Mulloon Rehydration Initiative to regenerate the waterways and associated riparian corridor and floodplains over time.

The study area, survey methods including dates and timing of the surveys, as well as survey conditions, and results of the 2023 frog surveys are provided below.

1.2 Aims and objectives of this assessment

The broad aim of this project is to provide baseline data on the frog populations present within the defined sections of Mulloon Creek to allow for future comparisons of population numbers and assemblages to aid in the assessment of the benefits and effectiveness of the rehydration project. Baseline data is an important tool to measure key conditions (indicators) and is commonly gathered before a project begins, to be used to monitor and evaluate a project's progress.

The key factors included in the baseline data collection are broadly in relation to the following:

- Habitat features and values including certain water variables and vegetation characteristics; and
- Frog species (and general estimates of abundance) present within the defined sections of Mulloon Creek in the study area.

The Frog surveys along Mulloon Creek will assist in identifying areas of high(er) diversity in frog species composition at sites which may also indicate the availability of high-quality habitat for various frog species. Identifying sites with higher quality habitat values will therefore assist in future decision-making, priority setting, planning and management of the area.

1.3 Study area - The Mulloon Creek

The study area is situated along Mulloon Creek which is situated in the Southern Tablelands of New South Wales between Braidwood and Bungendore (Figure 1). This November 2023 study includes a total of 29 monitoring transects. The 29 transects are located between the Landtasia property in the southern/upstream parts of the Mulloon Creek catchment, approximately 5.5km due south of the MCNF Home Farm property and the Duralla – Sandhills properties, including sites on Sandhills Creek that confluence with Mulloon Creek to where it becomes Reedy Creek, as well as sites in the far upper reaches of Sandhills Creek, about 3km north of the Kings Highway (see Figure 2 for the location of each site). This study area represents a total distance of almost 20km of stream length between the upstream and downstream sites (with an additional approx. 6km of stream length of Sandhills Creek from the most upstream sites to the confluence with Mulloon/Reedy Creek).



Figure 1. Location of study area on the Mulloon Creek, Southern Tablelands, NSW



Figure 2. Study area – Mulloon Creek 2022 Frog Monitoring Transects

(image courtesy the Mulloon Institute, 2021. Note: refer to results below for summary of which of the 29 RARC transects shown above were included in this 2023 season survey)



Figure 3. Location of (additional) farm dam/wetland monitoring sites at MCHF

2 Survey methods, effort, timing, and conditions

2.1 Survey locations, methods and effort

A total of 61 stream survey sites were included in the November 2023 frog surveys along Mulloon Creek as well as an additional eight (8) artificial farm dam and wetland sites located within the MCHF property (see Figures 2 and 3). The 61 stream survey sites were pre-established by TMI and involved 29 stream "transects" originally established for the RARC monitoring project (see Figure 2)¹. Each RARC transect is approximately 200m long with two survey sites located at each end of the transect (i.e. 200m apart). Each transect is spaced approximately 1km (in stream length) apart.

The 29 stream transects are located between the Landtasia property in the south of the catchment (starting at Transect No. 2) to Mount Fairy (on Shiel's Creek) in the northern parts of the catchment (Transect 50). Two additional transects (32 and 33) are also included in the 29 monitoring transects and are located towards the upper reaches of Sandhills Creek, more than 4km southwest of the confluence of Sandhills Creek and Mulloon/Reedy Creek. This represents a total distance of more than 20km of stream length between the furthest upstream and downstream monitoring transects/sites.

The frog surveys for this project involve primarily a call-based census of the frog species present in the catchment and includes completion of a timed (minimum) 5-minute audio recording at each stream site which is then uploaded and analysed by an experienced herpetologist (Sam Patmore). For the 8 dam/wetland sites, a direct audio-visual encounter surveys of frogs at the was undertaken *in-situ* by an experienced observer (Sam Patmore). Air, water (where possible), temperature, sky (i.e. cloud cover) and wind conditions were also recorded at each frog survey site/occasion.

Typically, and for the previous years' surveys, a habitat assessment was also undertaken at each stream survey site. This was usually (in the last two years) undertaken separately during the daytime and by a single observer for observer consistency, and usually on the same day as the nocturnal frog surveys. This year however, the daytime habitat assessment was unable to be completed at the stream sites, but was completed for the 8 farm dam/wetland sites at MCHF (see previous years reports for more detail on the habitat variables collected during the surveys).

The procedures described above are the same as for the previous three 2020-2022 surveys and which generally follow the ACT Frogwatch protocol. They are therefore very similar in manner to the 2017 survey (Hoefer 2017) (except for the increased overall survey area and effort, being extended call recording period). This repetition of methodology therefore allows for good comparison between the findings of this survey season and the previous 2017 and 2020-2022 seasons' survey findings.

¹ Note that there were more than 2 of the 4 sites on the transect surveyed with audio recordings for transects 32, 33 and 44. Additionally, two transects, 6 and 13 only had one functioning audio-recording uploaded.

2.2 Survey timing and conditions

All of the frog surveys were completed on a single night on the 23rd of November 2023. The surveys (audio-recordings) commenced after dusk (8pm) when most frog species had become active/started calling, and continued through in some locations till just after midnight.

The weather conditions on the night were generally suitable for frog surveys. The air temperature on the evening of 23/11/23 was mild, ranging from about 18°C at the start of the survey (8.30pm) and dropping to about 13°C at the end of the survey (about 12am in some circumstances). The sky conditions were (partly) cloudy to overcast and winds were mostly light to occasionally stronger gusts.

There was also some moderate rainfall in the days leading up to the surveys with about 3mm of rain the day/night before (22/11/2023) and about 13mm the night before that (21/11/2023). These conditions are regarded as being sufficiently warm and calm enough and with adequate recent rainfall and water levels in the system to encourage good frog activity (calling) levels, ensuring an adequate census of frog species was achieved on the night.

A full list of the sites completed for this 2023 Mulloon Creek frog survey, including timing and basic weather conditions is provided in the full results table at Appendix A.

3 RESULTS

3.1 Habitat Assessments

As noted above, a single, daytime assessment of stream habitat variables (on or about the same day as the frog surveys) was not able to be completed for this 2023 survey season. Accordingly, no summary of the stream habitat conditions is provided in this 2023 survey season summary report. Habitat conditions for the dam/wetland sites at MCHF were collected and are provided below.

3.1.1 Dam/Wetland Sites

Water levels within the eight dam/wetlands included in this study were mixed with some sites observed to be nearly full, while other dams had relatively low water levels and exposed banks. This was likely a consequence of the preceding (very) dry period through winter and early Spring 2023 when there was little rainfall and many sites would have had very low water levels. The earlier rain in November 2023 obviously had been insufficient to fully inundate some of these sites.

Most sites (6/8) recorded no emergent aquatic vegetation cover, while the two 'wetland' sites; W6 and W26, had full (entire pond) and 'just localised' emergent aquatic vegetation cover respectively. Most sites (6/8) had scores of either 1-10% or 11-25% fringing/edge vegetation cover values, while one site (D4) had 'just localised' edge vegetation cover and one site (W6) had between 50-75% edge vegetation cover.

Most sites (7/8) had little (with scores of either 0 or <10%) pond shading while site W26 had 10-25% pond shading levels. There was evidence of mowing around only one site (W26), although most other sites were subject to some grazing, while all sites had vegetated buffer widths of between 1-5m.

The full results of the habitat descriptions and water quality measurements are provided at Appendix B and separately as a Microsoft Excel spread sheet.

3.2 Frog species detected during the November 2023 Surveys

A total of 61 stream sites at 29² of the pre-established RARC Transects were successfully surveyed via a completed audio analysis of the five-minute call recording at each site on 23/11/2023. An additional 8 dam/wetland monitoring sites were also successfully surveyed on the same night by audio-visual analysis at the site by an experienced observer (Sam Patmore).

In summarising the results, a total of 10 species were detected across the total combined 69 monitoring sites during the November 2023 survey (Table 2). This included the following species:

- Crinia signifera, Common Eastern Froglet
- Crinia parinsignifera, Plains Froglet
- Limnodynastes dumerelli, Eastern Banjo Frog

² at some Transects, more than 2 of the 4 sites were surveyed and their results included here

- Limnodynastes peronii, Striped Marsh Frog
- Limnodynastes tasmaniensis, Spotted Grass Frog
- Litoria lesueuri, Lesueur's Tree Frog
- Litoria nudidigitus, Southern Leaf Green Tree Frog
- Litoria peronii, Peron's Treefrog
- Litoria verreauxii, Whistling Treefrog
- Uperoleia laevigata, Smooth Toadlet

Table 2 below shows the number/frequency of sites that each species was detected at (and includes the both the 61 stream sites and 8 dam/wetland sites; therefore, the total number of sites each species was recorded at and the detection frequency is out of 69 completed frog survey monitoring sites; results are also provided for the stream and dam/wetland sites separately).

Species Name	Common Name	Number of sites recorded at (n=69)	Detection Frequency (% of sites detected at)		
Crinia parinsignifera	Plains Froglet	24 (16/61 & 6/8)	35% (26% & 75%)		
Crinia signifera	Common Eastern Froglet	41 (37/61 & 4/8)	59% (60% & 50%)		
Limnodynastes dumerilii	Eastern Banjo Frog	9 (9/61 & 0/8)	13% (15% & 0%)		
Limnodynastes peronii	Striped Marsh Frog	13 (11/61 & 2/8)	19% (18% & 25%)		
Limnodynastes tasmaniensis	Spotted Grass Frog	6 (3/61 & 3/8)	9% (5% & 38%)		
Litoria lesueuri	Lesueur's Tree Frog	1 (1/61 & 0/8)	1% (2% & 0%)		
Litoria nudidigitus	Southern Leaf Green Tree Frog	1 (1/61 & 0/8)	1% (2% & 0%)		
Litoria peronii	Peron's Tree Frog	17 (15/61 & 2/8)	25% (25% & 25%)		
Litoria verreauxii	Whistling Tree Frog	52 (49/61 & 3/8)	75% (80% & 38%)		
Uperoleia laevigata	Smooth Toadlet	1 (1/61 & 0/8)	1% (2% & 0%)		

Table 1. Species recorded and detection rates during the November 2023 Mulloon Ck frog surveys

No species was detected at every single site in this survey. The Whistling Tree Frog was the most frequently detected species during the surveys, being detected at 52 of the 69 (or 75%) sites surveyed in total (including at 46/61, or 80%, of the creek sites). This species is common and widespread across much of eastern Australia, although in previous years, detection rates of this species in the study area were lower (see further below and report from the 2021 and 2022 seasons).

Other species recorded regularly (i.e. at more than 50% of the surveys sites) included only the Common Eastern Froglet, recorded at 41 of 69 (59%) sites. All other species were detected at or less than 35% of (all) sites.

Table 3 below provides a comparison of the detection frequency of species across the five survey seasons and for stream sites only. The detection frequency, being the percentage of sites that a species was recorded at, provides a basic surrogate measure of the overall extent of distribution of each species across the study area.

Common Name	2017 survey detection frequency	2020 survey detection frequency	2021 survey detection frequency	2022 survey detection frequency	2023 survey detection frequency
Plains Froglet	62%	47%	64%	52%	<u>35%</u>
Common Eastern Froglet	94 %	75%	84%	89%	<u>59%</u>
Eastern Banjo Frog	42%	14%	48%	56%	<u>13%</u>
Striped Marsh Frog	<u>0%</u>	28%	26%	11%	19%
Spotted Grass Frog	16%	19%	67%	59%	<u>9%</u>
Lesueur's Tree Frog	<u>0%</u>	<u>0%</u>	3%	<u>0%</u>	1%
Southern Leaf Green Tree Frog	<u>0%</u>	<u>0%</u>	2%	<u>0%</u>	1%
Peron's Tree Frog	50%	31%	<u>5%</u>	13%	25%
Screaming Tree Frog	<u>0%</u>	<u>0%</u>	40%	3%	<u>0%</u>
Whistling Tree Frog	100%	31%	<u>10%</u>	28%	75%
Smooth Toadlet	11%	0%	14%	13%	1%

Table 2. Comparison of detection frequency of species between survey seasons (stream sites only).

*Bold text represents year with highest recorded detection frequency; underlined text represents year with the lowest recorded detection frequency

In comparison with previous years' results for the stream site surveys, it is noted that 10 of the combined total 11 species recorded at the site since surveys commenced, were recorded in this 2023 season's survey. This result is up on last year's survey result of only nine (9) frog species recorded in the study area. The only species not recorded this season that had previously been recorded in the study area was the Screaming Tree Frog. No new species of frog were added to the total list of 11 species already/previously recorded.

Notable inclusions in this 2023 season's survey findings were Lesueur's Tree Frog and the Southern Leaf Green Tree Frog. Both of these species had been recorded only once previously, during the 2021 survey season. Both in 2021 and this season, the species were recorded in the upper reaches of Mulloon Creek (both at Transect 4 this season and in 2021 at Transects 2 and 4 for Lesueur's Tree Frog and Transect 6 for the Southern Leaf Green Tree Frog). In 2021, both records were made only *in-situ* by an experienced observer; they were not picked up in the audio call files. This season however, both species were detected via audio call file analysis.

In comparison with all four previous survey seasons, no species had a highest recorded frequency across all stream sites this (2023) season, while five (5) of the 10 species had their equal or lowest recorded frequency at sites this season since surveys began in 2017. This includes the Plains Froglet (2023 was lowest detection rate), Common Eastern Froglet (2023 was lowest detection rate), Eastern Banjo Frog (2023 was lowest detection rate), Spotted Grass Frog (2023 was lowest detection rate), and Screaming Tree Frog (2023 was

equal lowest detection rate - wasn't recorded at all and also not detected in 2017 and 2020 surveys).

Despite the relatively overall low detection rates this season (compared with previous seasons), many of the frog species that had low detection rates are considered to be relatively common, widespread and abundant and none are (known to be) under any long-term decline or conservation threat. In particular, there were relatively large drops in the detection rates for the Spotted Marsh (recorded at only 9% of sites compared with 67% of sites in 2021 and 59% of sites in 2022) and the Smooth Toadlet (recorded at only 1% of sites compared with 14% of sites in 2021 and 13% of sites in 2022, but not recorded at all in 2020 and only 11% of sites in 2017; indicating consistently low detection rates). Despite these low detection rates, both of these species are considered to have secure populations and the low detection rate was more likely a result of the conditions/timing of the survey.

Also of note from previous seasons' findings, two frog species; Peron's Tree Frog and Whistling Tree Frog, both had (previously) relatively low detection rates particularly in the last two years. For the Peron's Tree Frog, this species was detected at 25% of sites this season, which is an increase on both of the previous two years' detection rates (2021: 5% and 2022: 13%). For the Whistling Tree Frog, this species was detected at 75% of sites this 2023 season (the highest of any species this season) and well up on the detection rates for the previous three survey seasons (2020: 31%, 2021: 10%, and 2022: 28%).

Overall, these results appear to show that, on the whole, despite the lower detection rate for a number of species compared to last season, when looked at over the five years of surveys (four conducted consecutively), the continued detection of 10 out of the 11 species ever recorded in the 5 years of surveys indicate that a relatively stable amphibian community persists in the Mulloon Creek system. The lower detection rates for some species, including lack of record of one species from last season, could potentially be explained by either/combination of seasonal conditions (including a preceding dry spell through winter and early summer) as well as lack of observer skill and/or low audio quality (in relation to frog calls over ambient noise such as the creek or wind). Of note, for the five species that had their lowest detection rate at stream sites this (2023) season, some of these (including notably the Plains Froglet, Common Eastern Froglet and Spotted Grass Frog) were all detected in at least 3/8 of the dam/wetland sites (with the former two species recorded at 6/8 and 4/8 sites respectively; see below). This might suggest that some frogs had used the recent rain to move away from the creek to occupy surrounding pond habitats for breeding.

Table 4 shows the detection frequency of species across the three survey seasons and for dam/wetland sites only.

Table 3. Comparison of detection frequency of species between survey seasons (dam/wetland site	2S
only).	

Common Name	2020 survey detection frequency	2021 survey detection frequency	2022 survey detection frequency	2023 survey detection frequency
Plains Froglet	<u>50%</u>	100%	100%	75%
Common Eastern Froglet	<u>38%</u>	50%	100%	50%
Eastern Banjo Frog	<u>0%</u>	13%	38%	<u>0%</u>
Striped Marsh Frog	<u>13%</u>	38%	<u>13%</u>	25%
Spotted Grass Frog	63%	100%	88%	<u>38%</u>
Peron's Tree Frog	63%	50%	38%	<u>25%</u>
Screaming Tree Frog	<u>0%</u>	75%	<u>0%</u>	<u>0%</u>
Whistling Tree Frog	38%	<u>13%</u>	50%	38%
Smooth Toadlet	38%	38%	38%	0%

*Bold text represents year with highest recorded detection frequency; underlined represents lowest year detection frequency

In comparison with previous years' results for the dam/wetland site surveys, it is noted that three previously detected species; the Eastern Banjo Frog, Screaming Tree Frog and Smooth Toadlet, were not recorded at any of the dam/wetland sites during this (2023) survey. The Eastern Banjo Frog was previously detected at 3/8 sites in the last (2022) and 1/8 sites in the 2021 season, but not recorded at any sites in the 2020 season. The Screaming Tree Frog was previously detected at 6/8 sites in the 2021 season but was not recorded at any site in the earlier 2020 or last 2022 seasons). The Smooth Toadlet was previously detected at 3/8 sites in all three of the previous surveys (2020-2022).

Combined, this (2023) season saw the lowest recorded detection frequency over the combined four consecutive years' survey of dam/wetland sites at MCH for five (5) species (including the previously mentioned three species that were not recorded at all, as well as the Spotted Grass Frog and Peron's Tree Frog). The Spotted Grass Frog was detected at 3/8 sites this (2023) season, but was detected at 7/8 sites in the last (2022) season, at all (8/8) sites in the 2021 season and at 5/8 sites in the 2020 season. The Peron's Tree Frog was detected at 2/8 sites this (2023) season, and was detected at 3/8 sites in the 2021 season and 5/8 sites in the 2020 season.

No species had their highest or equal highest detection frequency this season over the four combined seasons of survey at the dam/wetland sites at MCHF.

The apparent lower detection rate results this (2023) season was not (visually) attributable to any change in habitat conditions, which on the whole were quite good. Possible reasons for the lower detection rates may include the very dry early Spring period leading up to the surveys (although there was some recent rainfall in the two days prior). Despite the apparent lower detection rate results this 2023 season, there is no reason to indicate that a relatively robust local amphibian community does not continue to occur within the MCHF.

3.2.1 Species richness at sites

The species richness per site describes the total number of species detected at a single site. The average number of species detected per site/survey across all 69 sites in total (61 stream and 8 dam/wetland sites) was 2.42 species per site. This included an average of 2.33 species per stream site and an average of 2.5 species per dam/wetland site, discussed separately below.

For the (61) stream sites along Mulloon Creek, the greatest number of species found at any one site during the surveys was 7 species, recorded at only one site (T_26_1). No site recorded six (6) species, two sites recorded five (5) species, nine sites recorded four (4) species, 15 sites recorded three (3) species, 13 sites recorded two (2) species, 18 sites recorded only one (1) frog species and three sites did not record any frogs at all (0 species); see Figure 4 below.





The average species richness (2.33 species per site) at stream sites recorded this (2023) season represents a moderate decrease from the average species richness of stream sites compared to the previous 2022 season's survey result of 3.26 species per site. Compared to the earlier surveys, it is a further decrease on the earlier 2021 season's result of 3.66 species per site, comparable to the 2020 season's survey result of 2.44 species per site, and a decrease on the 2017 season's survey result of 3.68 species per site.

The maximum number of species observed at a single site this (2023) season was 7 species, the same as the previous 2022 and 2021 seasons, and an increase on the earlier 2020 season (maximum of 5 species at a single site) and the 2017 season (maximum of 6 species at a single site).

For the (8) dam/wetland sites, the greatest number of species found at a single site during the surveys was 6 species, recorded at only one of the dam/wetland sites (W26). Of the remaining seven dam/wetland sites, no sites recorded five (5) species, one site recorded four (4) species (site W6), two sites recorded three (3) species (sites D31 and D32), one site recorded two (2) species (site D27/28), two sites recorded only one (1) species (sites D3 and D4), and one site (D30) recorded no calling frogs (Figure 5).



Figure 5. Species richness at dam/wetland sites at MCHF during the 2023 frog surveys.

This year's findings (of 2.5 species per dam/wetland site) is well down on the previous (2022) season's findings of 4.63 species per dam/wetland site (which also recorded a maximum of 6 species at a single site). It is also down on the earlier (2021) season's findings of 4.75 species per site (which also recorded a maximum of 6 species at a single site), and down slightly on the first (2020) season's findings of 3.0 species per site (but which recorded a maximum of only 4 species at a single site). The dam/wetland sites were not included in the original 2017 survey.

3.2.2 Species richness at transects

The species richness at transects describes the total number of species detected at each transect (i.e. total species recorded combined for both sites $T_r_1 \& T_r_4$). For this assessment, the dam/wetland sites were discounted as these sites did not involve a transect with two survey sites.

For the transects along Mulloon Creek, an average of 3.24 species per transect were detected across the 29 (full/completed) transects in this (2023) season's survey. The

greatest number of species found at any single transect this season however increased to 8 species; at Transect T_26 (an increase from the maximum 7 species found at a single site, T_26_1; the Plains Froglet was recorded at T_26_4 but not at T_26_1). No transects recorded a combined 7 or 6 species of frog, five transects recorded a total of both 5 and 4 species, 10 transects recorded 3 species, three transects recorded 2 species, five transects recorded a single species, while no transects failed to record at least one species at either site (see Figure 6).

A total of nine of the 29 transects had an increased combined number of species for the transect than that recorded for one of the individual (i.e. the highest) site species count on that transect. For example, each site on the transect may have recorded three species, but with a different composition of species at each site, the combined species count for the transect was higher at 4 (or more) species. The full results at Appendix A and in the electronic file show this information in detail).



Figure 6. Species richness at stream transects along Mulloon Creek during the 2023 frog surveys.

The average species richness recorded per transect (3.24) in this 2023 season's survey represents a moderate decrease in the average species richness of stream transects compared to the previous 2022 survey result of 4.63 species per transect. It is also lower that the earlier 2021 result of 4.9 species per transect, and comparable to the 2020 result of 3.56 species per transect. The 2017 survey obtained a result of 5 species per transect.

The maximum number of species at a single transect this 2023 season (8 species) is however higher than the previous 2022 season maximum of 7 species at a single transect, the same as the earlier 2021 season (of 8 species at a single transect) and higher than the 2020 result of only 5 species combined as the highest maximum number of species at a single transect.

4 DISCUSSION AND MANAGEMENT RECOMMENDATIONS

4.1 Discussion

The November 2023 frog surveys conducted at Mulloon Creek were undertaken at 61 stream sites being located within (at either end of) 29 existing RARC transects, as well as at 8 dam/wetland sites within the MCHF property. These are generally the same sites surveyed during the previous November 2022 and December 2021 and 2020 surveys.

For this 2023 season's survey, as with previous years, a 5-minute audio recording was undertaken at the 61 stream sites for later acoustic detection/identification of calling frogs. All calls were recorded on a single night; 23rd November 2023. The 8 dam/wetland sites were also surveyed on the same night by an experienced ecologist.

Conditions for the frog surveys were generally good. Temperatures were adequate for calling activity (starting at about 18°C at 8pm), with slightly cloudy to overcast conditions and some light to moderate winds. Water levels within the creek were generally good after some preceding rainfall in mid-late November 2023 (including a combined 17mm on the two days/nights before the surveys³), helping to stimulate frog activity. Water levels in the eight dams/wetlands of MCHF were however generally low, with only the two 'wetland' sites (W6 and W26) holding more than 75% water. Given this and several consecutive previous years of periodically good rainfall and relatively high stream levels, the observed aquatic habitat conditions for frogs within the study area on the whole were (likely to be) relatively good (despite the individual site-based daytime stream habitat assessments not being completed this 2023 season).

The acoustic-based frog monitoring surveys undertaken this 2023 season found that the Mulloon Creek study area continues to support a relatively healthy frog community within the stream habitats as well as at the additional dam/wetland sites within the MCHF property. This season, a total of 10 frog species recorded during the study. This is one more than the previous (2022) season's result, one less than the earlier (2021) season's result of 11 species, two more than the earlier 2020 survey of 8 species, and three more than the 2017 survey of 7 species. The only species not recorded this season was the Screaming Tree Frog, a species that has been infrequently recorded in the study area in past seasons.

Notable observations this season include Lesueur's Tree Frog and the Southern Leaf Green Tree Frog which were not recorded last year and recorded only once previously in 2021 by an experienced observer on site (in the same general area, between Transects 2-6).

When looking at individual species records this 2023 survey season, it was noted that no species was detected at every single site. The Whistling Tree Frog was the most frequently detected species during the surveys. This species is common and widespread across much of eastern Australia, although in previous years, detection rates of this species at sites were lower (see comments on this species included in the 2021 and 2022

³ BoM; Lockhart Bungendore readings

seasons' reports). Other species recorded regularly (i.e. at more than 50% of the surveys sites) included only the Common Eastern Froglet, while all other species were detected at or less than 35% of (all) sites.

When looking at patterns or changes of records over the seasons for each of the frog species individually to see if there are any potential patterns or trends in their occurrence, the 2023 season survey did not record a highest detection frequency rate for any species. It did however record the (equal or) lowest detection rate for five frog species over the five years of surveys completed thus far. This includes the Plains Froglet, Common Eastern Froglet, Spotted Grass Frog, Eastern Banjo Frog, and the Screaming Tree Frog. The first three of these species are all common and widespread in the region and often in very high numbers, and notably, the Common Eastern Froglet was still recorded at more than half of all sites. The latter two species, although not encountered as frequently, are also relatively common in southeastern NSW. The low numbers of these species this year do not present any obvious or immediate concerns and they are all considered to have a relatively secure conservation status in the region.

In contrast to the lower detection rates for the above five species, there was a notable increase in detection rates for two species which had been mentioned specifically in previous seasons' survey reports (see Patmore, 2022 and 2023) as potentially being of concern due to low detection rates. These include the Peron's Tree Frog and Whistling Tree Frog. For the Peron's Tree Frog, this species was detected at 25% of sites this season, which is an increase on both of the previous two years' detection rates, while for the Whistling Tree Frog, this species was detected at 75% of sites this 2023 season (the highest of any species this season) and well up on the detection rates for the previous three survey seasons.

When looking at frog species richness in the study area, all sites except three (T_32_3; T_39_1 and T_43_4) recorded at least one species of frog while the average number of species per site (as a measure of species richness) was 2.42; this included an average of 2.33 species per stream site and an average of 2.5 species per dam/wetland site. These numbers are down on the previous (2022) season's results of 3.26 species per stream site and the earlier 2021 season results of 3.66 species per stream site, and comparable to the 2020 season survey result of 2.44 species per stream site. All of these are less than the initial 2017 season survey result of 3.68 species per stream site. However, the maximum number of species observed at a single site this (2023) season (7 species) is the same as the previous 2022 and 2021 seasons (also 7 species), and an increase on the earlier 2020 season (maximum of 5 species at a single site) and the 2017 season (maximum of 6 species at a single site).

The species richness at the 29 RARC survey transects (which includes the combined result of both sites on each transect) was recorded at 3.24 species per transect. Again, this is down from the previous 2022 season survey of 4.63 species per transect and the earlier 2021 result of 4.9 species per transect while being comparable to the 2020 result of 3.56 species per transect. The 2017 survey obtained a result of 5 species per transect.

The combined maximum number of species at a single transect this 2023 season (8 species at T_{26}) is however higher than the previous 2022 season maximum of 7 species at a single transect (but recorded at four different transects, not including T_{26}), the same as the earlier 2021 season of 8 species (but recorded at only one transect; T_4),

higher than the 2020 maximum result of only 5 species (but recorded at four different transects, including T_26), and higher also than the initial 2017 survey of 7 species as the highest combined maximum number of species at a single transect (in Palerang; RARC transect number to be confirmed).

Looking at the individual transect with the highest species richness this 2023 season (8 species at T_26 at Duralla; and included 7 species at T_26_1 and 3 species at T_26_4), in comparison with the previous seasons survey results, this transect had a combined total 6 species in 2022 (including 6 species at T_26_1 and 6 species at T_26_4), a total of 5 species in 2021 (including 3 species at T_26_1 and 5 species at T_26_4), and a total of 5 species in 2020 (including 1 species at T_26_1 and 5 species at T_26_4). It is also double the initial findings for this transect in the original 2017 survey (Peter Hazell, TMI, pers. *comms.*⁴).

At this stage, it is not known what factors may be contributing to the increased species richness at Transect T_26, (or increase/decreases in species richness at other specific sites/transects across the rest of the study area). Further detailed analysis of the data including assessment of habitat conditions at specific sites relative to frog species richness, as well as comparison of individual site-based conditions across the seasons relative to frog species is required (see recommendations below).

For the dam/wetland sites, a total of six (6) species were recorded across all of these (n=8) sites this 2023 survey season. Species richness at the dam/wetland sites this 2023 season was found to be only 2.55 species per site which is well down on the previous 2022 season's findings of 4.63 species per dam/wetland site, which also recorded a maximum of 6 species at a single site. It is also down on the earlier 2021 season's findings of 4.75 species per site, which also recorded a maximum of 6 species per site, which also recorded a maximum of 6 species per site, which also recorded a maximum of 6 species per site, which also recorded a maximum of 6 species at a single site. It is also down on the earlier 2021 season's findings of 4.75 species per site, which also recorded a maximum of 6 species at a single site, and down slightly on the first 2020 season's findings of 3.0 species per site, but which recorded a maximum of only 4 species at a single site.

Overall, these results appear to show that most frog species present in the Mulloon Creek system appear to have relatively stable local populations, being recorded regularly over the five years of survey. Importantly, no species of frog in this Mulloon Creek catchment appears to have a local population that may be declining, although some do appear to have populations that are moderate-highly fluctuating in occurrence, including local distribution and abundance.

The only species of any apparent concern or interest is the Screaming Tree Frog whose inconsistent recording is not well understood. It could be that there is no real decline in numbers but that activity levels of this species may be limited to or triggered by certain conditions and therefore its calling is less frequent, or more sporadic. Given this species has only had one season (2021) where it was regularly recorded, and wasn't recorded at all during the earlier 2017 or 2020 surveys and at only 3% of sites in the last 2022 season, there is no real pattern to indicate what the current status of the local population might be. At this stage, there is no real cause for concern or apparent requirement to undertake further species research into the population status of this species.

⁴ PATH Co have not yet reviewed the raw data for each site in the 2017 surveys by FrogWatch.

In summary, some possible reasons for the perceived declines in overall species richness as well as the detection rate of certain species this (2023) season could include a variety of factors, potentially acting independently or in conjunction with each other. These could include the following factors:

- Very dry winter and early Spring period leading up to the surveys.
- Very recent rainfall in the two days/nights immediately preceding the survey (which may have caused some frogs to move to alternate habitats such as dams/wetlands).
- Relatively high stream flow rates and or wind/conditions at some sites contributing to greater background noise in the audio recording. For some sites it was very hard to identify calling frogs over the background noise.
- Observer skill; previous seasons had some sites surveyed by relatively skilled staff that were able to identify frogs on-site that were not able to be identified from the call files.
- Local populations that fluctuate seasonally but overall, in the long-term are relatively stable (the Screaming Tree Frog, Striped Marsh Frog and Eastern Banjo Frog would appear to exist in this manner).

Importantly, there is no evidence for any actual declines in local population abundance and distribution for any species, with the Peron's Tree Frog in particular, recorded in good numbers this season, although the occurrence of the Screaming Tree Frog in the locality is not well understood.

Possible management and further research recommendations to ensure the ongoing health and future potential increase in the frog community within the catchment are discussed below.

4.2 Recommendations

4.2.1 Land and habitat management

The land/habitat management recommendations related to ensuring the maintenance of a viable (sustainable and diverse) frog community at Mulloon Creek are relatively unchanged from those proposed in the previous 2020-2022 survey season reports (Patmore, 2021, 2022 and 2023). As indicated in those reports, these are primarily for consideration (not mandatory or otherwise urgently required) and include the following:

- 1. Continue to maintain in good repair all existing fencing along the creek to exclude/control livestock access.
- 2. Consider constructing additional fencing along sections of the creek that are currently unfenced.
- 3. Reduce/manage degradation of in-stream and riparian habitat through addressing any active sediment and erosion inputs.

As also noted in the initial 2020 survey season report (Patmore 2021), a strategy for the longer-term management/removal of Blackberry along creek banks should be considered (such as in sections of MCHF). However, this removal needs to be balanced against its current role in maintaining bank stability, thus, some form of replacement

planting would be required. This combined with the difficulty of removal of the Blackberry could become a prohibitively costly exercise. Consequently, this factor is mentioned for consideration only, but not a specific recommendation for implementation.

As also noted in the 2020 survey report, it is recommended consideration be given to future possible longer-term habitat creation, enhancement, or expansion for frogs in the catchment. These include:

- Construction/establishment of further artificial wetlands within MCHF (as discussed and recommended in the Habitat Assessment & Translocation Strategy for the Green and Golden Bell Frog report prepared by PATH Co (2019). This could also extend to other properties as well. The general approach should be for creation of a more natural 'wetland' feature as opposed to standard farm dams (typically used for stock watering etc). Additionally, ensuring connectivity and proximity to the creek is important for new wetland habitats to function as suitable amphibian habitats.
- Consider further riparian revegetation along sections of the creek where natural/native riparian vegetation species are limited.

4.2.2 Further research

Recommendations for further/ongoing research and monitoring to assist with managing the site for the benefit and maintenance of frog communities include mainly the recommendation for the continuation of this current monitoring program, acknowledging that future funding and budgets may not permit this. Some possible additions/alterations to the monitoring program (if continued) include:

- Consideration of reducing the frequency of future surveys now that 5 years of survey have been completed, the last 4 of which were consecutive. Going forward the monitoring program could be conducted at a 3-5 year interval (this may help with budget funding and also allow for an increase in other aspects of the surveys effort/scope; see below)
- If time/budgets permit, consider increasing the survey period to include two separate nights of Spring-Summer survey; ideally in early November and mid-late December. This will not only improve the overall chances of detection of species (and is more in-line with amphibian survey guidelines for many species) but will allow the surveys to be spread out which can help account for potential inclement weather. This may help ensure surveys during warmer weather with high calling activity levels (and may help to better ascertain overall status of species such as the Screaming Tree Frog whose numbers were well-down this season compared to last season which was undertaken during warmer weather).
- In addition, or as an alternative to the above, if budget permits consider an Autumn survey to detect other species (such as *Pseudophyne sp.*).
- If/where possible, seek more experienced field staff to conduct surveys to help identify/confirm on site all species calling (or even seen visually). This may help confirm the occurrence of certain species such as Lesueur's Tree Frog, Southern Leaf Green Tree Frog and the Screaming Tree Frog. If not possible, seek to ensure

better quality audio-recording of frogs over stream noise. This may involve having the recorder positioned further away from the stream. A longer recording time (of 10mins) may also be considered for these sites.

- Ensure that the habitat assessment component of the study continue to be undertaken diurnally (and separate to the nocturnal frog survey) and completed either by a single observer (as was the case for the 2021 and 2022 surveys), or, if undertaken by multiple observers, that some initial training be held to 'calibrate' their estimates. This is necessary to ensure consistency of data collection to enable more effective comparisons between sites and between seasons.
- If time/budgets permit, consider undertaking additional surveys of other nonstream habitats (i.e. additional dams/wetlands) within not only MCHF, but other properties within the study area.
- Consider also adding some additional parameters such as more water chemistry variables (e.g. pH, Conductivity etc). Note that water chemistry variables along a continuous aquatic system like Mulloon Creek may only need to be assessed at a smaller sub-set of sites/transects.
- Finally, although it is beyond the current scope of this study and reporting, it is recommended that a final report be prepared. This report would be a conclusion of the (current 5-year) annual monitoring survey program, but also should provide some further detailed analysis, including (but not limited to) site-specific assessments to identify which sites have greater frog species richness and to compare the habitat features of these sites against other sites of low(er) species richness. This would include a comparison of other factors not included in the current habitat assessment, including distance to in-stream interventions/structures (i.e. leaky weirs), stream morphology and a greater, indepth assessment of vegetation values (as mentioned above). The aim of this would be to identify and better understand which habitat parameters may/are likely to be important in determining overall habitat quality for frogs. Consequently, this information could help to inform any future targeted land management activities/stream interventions to improve habitat quality for frogs and overall biodiversity values within the catchment.

5 REFERENCES

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Appendix A. Frog Survey Records

The table below provides the species recorded as present (i.e. heard calling) at each site as well as the estimated number of individuals of each species present at the site. The estimated number of individuals present at a site has been grouped into size class categories as per the Frogwatch survey data sheet and as follows:

- 1-5 frogs
- 6-20 frogs
- 21-50 frogs
- > 50 frogs

Table A1. Frog species records at 61 frog survey sites (31 RARC Transects) along Mulloon Creek during the November 2023 Frog Surveys

SITE	TIME			Line aleree	1:	Line have	1:11	1 it is a set	1:1		1.11		Sp.	Sp. Total/
T O 1	00.25	Cri. par	Cri. sig	LIM. dUM	Lim. per	Lim. tas	Lities	Lif. nua	Lit. per	Lit. qui	Lif. Ver x (1-5)	upe. Ide		Iransect
I_2_1 T_0_0*	20.35		x (1-5)										1	
_1_2_3*	20.44		x (1 0)					x (1-5)			x (1-5)			2
<u> </u> 4_			x (1-5)		x (1-5)		x (1-5)	X (1 0)			x (1-5)		2	
I_4_4	21.17		X (1 0)		X (1 0)		x (1 0)				x (6-20)		4	5
T_6_1	21.42										× (1-5)		1	1
T_10_1	20.10										× (1-5)		1	-
	20.25		× (1-5)								× (1-5)		1	1
T_11_1	22.07		× (1-5)	× (1-5)					× (1-5)		× (4-20)		2	-
_T_11_4	22.16		× (1-5)	× (1-5)					× (1-3)		× (4 20)		4	4
_T_12_1	20.19	× (1 5)	X (1-5)						× (1 5)		× (4.20)		2	-
_T_12_4	20.10	x (1-5)							× (1-5)		x (6-20)		3	4
T_13_1	21.05	X (1-5)	× (1 5)			× (1.5)			x (1-5)		x (6-20)		3	3
T_14_1	22.52	x (1-5)	X (1-5)			X (1-5)			X (0-20)		X (0-20)		5	-
_T_14_4	23.02								X (1-5)		× (1 5)		1	5
T_15_1	22.20										X (1-5)		1	-
_T_15_4	22.08		× (1 5)						× (1 5)		x (1-5)		1	1
T_16_1	21.25		X (1-5)						X (1-5)		x (6-20)		3	
T_16_4	21.40		X (1-5)		(1,5)						x (6-20)		2	3
T_17-1	20.27		x (6-20)		x (1-5)						x (6-20)		3	-
T_17_4	20.43		x (1-5)		(1,5)						x (1-5)		2	3
T_18_1	0.10	X (1-5)	x (6-20)		X (1-5)				X (1-5)		x (6-20)		5	_
T_18_4	23.59	x (1-5)	x (6-20)						x (1-5)		x (6-20)		4	5
T_19_1	23.43	x (1-5)	x (6-20)								x (6-20)		3	-
T_19_4	23.26		x (1-5)								X (1-5)		2	3
T_21_1	22.28		x (6-20)	X (1-5)					x (1-5)		x (6-20)		4	_
T_21_4	22.39	x (6-20)	x (6-20)	× (1 E)	x (1-5)	× // 20)					x (6-20)		4	5
T_22_1	22.10		x (6-20)	X (1-5)		X (6-20)					x (6-20)		4	_
T_22_4	21.55	x (1-5)	x (6-20)	X (1-5)							x (6-20)		4	5
T_23_1	21.32		x (6-20)	X (1-5)							X (6-20)		3	-
T_23_4	21.21		x (6-20)	X (1-5)					X (1-5)		X (1-5)		4	4
T_24_1	21.04	x (6-20)	x (6-20)						X (1-5)		x (6-20)		4	_
T_24_4	20.53	x (6-20)	x (6-20)								x (6-20)		3	4
T_25_1	20.26	x (1-5)	x (6-20)								x (6-20)		3	_
T_25_4	20.13		x (1-5)	(1.5)	()	(1.5)			(2.5)		x (1-5)	(2.5)	2	3
T_26_1	20.29	(1.5)	x (6-20)	X (1-5)	x (1-5)	X (1-5)			x (1-5)		x (6-20)	x (1-5)	7	_
T_26_4	20.39	x (1-5)	x (6-20)								x (6-20)		3	8
T_27_1	21.55	x (1-5)	x (6-20)								x (6-20)		3	_
T_27_4	22.05	x (1-5)	x (6-20)								x (6-20)		3	3
T_28_1	21.16		x (1-5)	(1.5)							x (6-20)		2	_
T_28_4	21.27		x (6-20)	x (1-5)							x (6-20)		3	3
T_32_1	20.03				x(1-5)						(4.5)		1	-
T_32_2	20.12										x (1-5)		1	_
T_32_3	20.19				(1) =								0	
T_32_4	20.26				x (1-5)								1	2
_T_33_1	20.44										x (1-5)		1	
T_33_2	20.54				x (1-5)								1	
T_33_3	20.01	X (1-5)							X (1-5)				2	4
T_39_1	20.40		V /1 E										0	-
T_39_4	20.28		x (1-5)		(1.5)								1	1
T_42_1	22.00				x (1-5)						x (1-5)		2	
T_42_4	22.04			x (1-5)							x (1-5)		2	3
_T_43_1	22.15										x (1-5)		1	-
_T_43_4	22.16										V /1 E		0	1
_T_44_1	22.30										x (1-5)		1	-
T_44_1	22.30										x (1-5)		1	
T_44_4	22.21		x (1-5)		X (1-5)						x (6-20)		3	
T_44_4	22.40		x (1-5)		x (1-5)						x (6-20)		3	3
T_50_1	21.22	x (1-5)	x (1-5)										2	

T_50_4	21.34		x (1-5)										1	2
T_55_1	23.07		x (1-5)						x (1-5)		x (1-5)		3	
T_55_4	22.54								x (1-5)		x (1-5)		2	3
	N=61													Max sp/site
Total Sites		16	37	9	11	3	1	1	15	NR	49	1		= 7 Total sp = 10
% Sites		26	61	15	18	5	2	2	25	0	80	2		Avg sp/site = 2.33

For Transect totals; bold number indicates an increase in number of species/transect from number species/site

Table A2. Frog species records at the (8) dam and wetland sites at MCHF during the November 2023 Frog Surveys

			Lim.									
Site	Cri. par	Cri. sig	dum	Lim. per	Lim. tas	Lit les	Lit. nud	Lit. per	Lit. qui	Lit. ver	Upe. lae	Sp. Total/ Site
D3	x (1-5)											1
D4	x (1-5)											1
W6		x (6-20)		x (6-20)	x (1-5)					x (6-20)		4
D26	x (1-5)	x (6-20)		x (1-5)	x (1-5)			x (6-20)		x (6-20)		6
D27/28	x (6-20)	x (1-5)										2
D30												0
D31	x (1-5)				x (1-5)					x (1-5)		3
D32	x (1-5)	x (1-5)						x (1-5)				3
Total												Max sp/site = 6
Sites/8	6	4	0	2	3	0	0	2	0	3	0	Total sp = 6
% Sites	75	50	0	25	38	0	0	25	0	38	0	Avg sp/site = 2.5

<u>Species Code:</u>

C. par = Crinia parinsignifera

C. sig. = Crinia signifera

Lim. dum = Limnodynastes dumerilii

Lim. per. = Limnodynastes peronii

Lim. tas. = Limnodynastes tasmaniensis

Lit. per. = Litoria peronii

Lit. qui. = Litoria quiritatus

Lit. ver. = Litoria verreauxii

U. lae. = Uperoleia laevigata

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Appendix B. Habitat Survey Data

Note: Habitat data was completed only for the dam/wetland sites this (2023) season

Table B1. Habitat Survey Details at (8) Dam/Wetland sites at MCHF during the November 2023 Frog Surveys

Site Ref	Sky	Wind	Air Temp	Water Temp	Water Depth	Pond Level	Water Flow	Vertical Water Level Drop (m)	Area Exposed Soil (m)		Emergent Aquatic	Fringe/Edge	Pond	Mowing?	Width of
No									Min	Max	Veg Cover	Veg Cover	Shading	(Y/N)	buffer
D3	3	3	17	20.1	2	3	1	1	1.5	1.5	1	4	1	n	2
D4	3	3	17	19.9	2	3	1	1	1.5	1.5	1	2	1	n	2
W6	3	3	16	18.3	1	2	1	0	0	0	7	6	2	n	2
D26	5	3	18	20.1	2	2	1	0.3	0	0	2	4	3	у	2
D27/28	5	3	18	19.8	2	3	1	0.8	0.5	0.8	1	4	2	n	2
D30	3	3	18	20.4	3	3	1	1.5	1	2	1	3	2	n	2
D31	3	3	18	20.3	2	2	1	0.3	0.1	0.2	1	4	1	n	3
D32	3	3	17	20.2	2	3	1	0.8	0.5	1.5	1	3	2	n	2

Table B3. Description of score categories for habitat variables in Tables B.1 and B.2

Sky (1 to 6)	Wind (1 to 4)	Water Depth	Pond Level	Water Flow	Emergent Aquatic	Fringe/Edge	Pond	Width of
		(1 to 4)		(1 to 4)	Veg Cover	Veg Cover	Shading	buffer
1= clear/few clouds	1 = Still	1 = <30	1 = Full	1 = Still	1 = none	1 = none	1 = none	1 = <1m
2 = Partly cloudy/variable	2 = Light Breeze	2 = >30	2 = Nearly Full	2 = Slow	2 = just localised	2 = just localised	2 = <10%	2 = 1-5m
3 = Cloudy/overcast	3 = Light Wind	3 = unknown	3 = Bank V. Exposed	3 = Moderate	3 = <25%	3 = <10% edge	3 = <25%	3 = >5m
4 = Fog	4 = Windy	4 = Dry	4 = Nearly Dry	4 = Fast	4 = <50%	4 = <25% edge	4 = <50%	
5 = Drizzle			5 = Dry		5 = <75%	5 = <50% edge	5 = <75%	
6 = Showers					6 = <100%	6 = <75% edge	6 = <100%	
					7 = entire pond	7 = <100% edge		
						8 = entire edge		