Oxley Highway to Kempsey EPBC 2012/6518

Condition 8 Annual Report 2022

Transport for NSW (TfNSW) | October 2022

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1 Introduction

1.1. Purpose of this document

The purpose of this report is to address EPBC (2012/6518) Approval Condition 8, which requires the preparation of a report addressing compliance with each of the conditions of approval, including implementation of the:

- Biodiversity Offset Management Plan (BOMP)
- Flora and Fauna Management Plans (FFMP)
- Ecological Monitoring Plan (EMP).

This report covers the seventh period from 22 July 2021 to 21 July 2022.

The timing for compliance with certain approval conditions is linked to specific dates as follows:

- Date of the approval decision under sections 130(1) and 133 of the *Environment Protection and Biodiversity Conservation Act 1999* – 24 January 2015
- Commencement of the action – 22 July 2014
- Expiry of Commonwealth approval – 31 December 2063

1.2. Project staging

The Oxley Highway to Kempsey Pacific Highway Upgrade project has been constructed in three main stages:

- Stage 1: The Sancrox Traffic Arrangement works located about two kilometers north of the Oxley Highway / Pacific Highway intersection. Note that the construction of Stage 1 was completed in November 2015
- Stage 2: Kundabung to Kempsey (K2K) consisting of about 14 kilometers of dual carriageway, commencing north of Barry's Creek near Kundabung (chainage 24,000) and connecting to the Kempsey Bypass at Stumpy Creek (Chainage 37,800). Note that construction of Stage 2 was completed in October 2017
- Stage 3: Oxley Highway to Kundabung (OH2Ku) consisting of about 24 kilometres of dual carriageway, commencing just north of the Oxley Highway / Pacific Highway intersection (chainage 700), and connecting with the Kundabung to Kempsey stage just north of Barry's Creek (chainage 24,000). Note construction of Stage 3 was completed in March 2018.

In addition, there is an ultimate upgrade to the four lane Class M (motorway) standard highway. Due to estimated traffic volumes and availability of funding some sections of the Project will initially be constructed and operated as a Class A (arterial) standard highway. Upgrade of those sections of the Project from Class A to Class M standard will occur when it is warranted by an increase in traffic volumes, and when funding becomes available.

1.3. Modifications to the Conditions of Approval

No modifications to the Conditions of Approval were approved during this reporting period.

2 Conditions of Approval

2.1. Condition 1

Condition 1

The person taking the action must not clear more than 211 hectares of Koala (*Phascolarctos cinerea)* habitat, 232 hectares of Grey-headed Flying-fox (*Pteropus poliocephalus*) habitat, 215 hectares of Spotted-tail Quoll (*Dasyurus maculatus*) habitat and 7.7 hectares of Giant-Barred Frog (*Mixophyes iteratus*) habitat within the project corridor of the proposed action.

Clearing for the three initial stages of the project (refer Section 1.2) is now complete. The clearing quantities for the first three stages against the limits outlined in Condition 1 are detailed in Table 1.

Table 1 Clearing quantities for the first three stages of the project

EPBC Species	Total estimated clearing	Total clearing	EPBC Limit Condition 1
Koala	196.8284	196.7656	211
Grey-headed flying fox	206.9144	206.8258	232
Spotted-tail Quoll	197.0330	196.2896	215
Giant-barred Frog	2.8512	2.8512	7.7

2.2. Condition 2

Condition 2

To assist in mitigating the impacts of the proposal on the Koala, Grey-headed Flying-fox, Spotted-tail Quoll and the Giant-Barred Frog during construction, the person taking the action must prepare and submit a Flora and Fauna Management Plan for each **stage** of the action, for the **Minister**'s written approval prior to **commencement** of each **stage** of the action. The Flora and Fauna Management Plan for each **stage** must be approved by the **Minister** in writing prior to **commencement** of the relevant **stage**. These plans must include:

- **a.** Measures to be implemented to avoid, suppress and control the spread of weeds, plant pathogens and invasive species;
- **b.** Measures to avoid and minimise other indirect impacts that may result from the proposal during and after construction, including erosion and sedimentation;
- **c.** Measures to manage aquatic habitat on-site to at least maintain habitat values for the Giant Barred Frog;
- **d.** A detailed description of the pre-clearance surveys to be undertaken by a **suitably qualified expert** within all areas proposed for disturbance, including: hollow bearing trees, logs, existing culverts and bridges, no earlier than 48 hours prior to the removal of vegetation occurring in that area to ensure that the area is free of the Koala, Giant-Barred Frog, Grey-headed Flying-fox and Spotted-tail Quoll.

Condition 2

e. Measures to relocate and/or ensure the **appropriate care of** individuals of the Koala, Giant-Barred Frog, Grey-headed Flying-fox and Spotted-tail Quoll that are identified during searches referred to in condition 2d; and

f. Clear key milestones, monitoring, performance indicators, corrective actions and timeframes for the completion of all actions outlined in the plan.

A Flora and Fauna Management Plan has been prepared for each stage of the project. As at 21 July 2021, these plans were approved by the Minister on the following dates:

- Stage 1: Sancrox Interchange — 24 June 2014
- Stage 2: Kundabung to Kempsey — 22 October 2014 (Revision 1); 15 November 2016 (Revision 2); 22 August 2019 (Revision 3)
- Stage 3: Oxley Highway to Kundabung — 10 October 2014 (Revision 1); 15 November 2016 (Revision 2); 22 August 2019 (Revision 3)

Construction of these three stages was completed during the 2017/18 reporting period, along with a majority of requirements of each Flora and Fauna Management Plan. The Ecological Monitoring Program (Appendix to the Flora and Fauna Management Plan) continues to be implemented and is reported on below in Condition 4.

2.3. Condition 3

Condition 3

To assist in mitigating the impacts of the proposal on the Koala, Spotted-tail Quoll and the Giant-Barred Frog, the person taking the action must construct and maintain **fauna crossings** and **fencing** in all **areas that are likely to benefit** these species for the duration of the impact of the action.

a. The **fauna crossings** must:
   - **i.** be **effective** for the Koala, Spotted-tail Quoll and/or Giant Barred Frog (the relevant species targeted to use the **fauna crossing**);
   - **ii.** provide dry passage up to a 1 in 100 year Average Recurrence Interval (ARI) event for **dedicated fauna crossings** and up to a one in 1 year 72 hour ARI event for **combined fauna crossings**;
   - **iii.** include a minimum of 11 **dedicated fauna crossings** and 30 **combined fauna crossings** for the project;
   - **iv.** not increase in length more than 10 per cent from the lengths provided in Schedule 2 of this notice, and not reduce in width and height from the values provided in Schedule 2 of this notice without the written consent of the **Minister**;
   - **v.** be bridges in **areas that are likely to benefit** the Giant-Barred Frog.

b. If a change to the **fauna crossing** design is proposed that does not meet the parameters described in Condition 3a), the person taking the action must:
   - **i.** provide evidence to the **Minister** that these will remain **effective** for the Koala, Spotted-tail Quoll or Giant-Barred Frog

Condition 3

(as relevant for the **fauna crossing**) for the **Minister's** written approval prior to **commencement** of the **stage** relevant to that fauna crossing; or

ii. provide written evidence to the **Minister** detailing how the resulting loss in connectivity will be compensated for with increased connectivity for the impacted species. This must be approved in writing by the **Minister,** prior to **commencement** of **stage 2** and **stage 3**.

c. **Fencing** must be constructed at a minimum the locations identified in Schedule 3 of this notice.

The requirements of this condition were completed during the 2017/2018 reporting period. Please refer to the 2017/18 report for further detail on compliance with this condition.

2.4. Condition 4

Condition 4

Prior to **commencement of stage 2** and **stage 3** of the action**,** the **person taking the action** must submit an Ecological Monitoring Program for approval by the **Minister** that determines the effectiveness of the mitigation measures implemented as part of the project. The Ecological Monitoring Program must be approved in writing by the **Minister** prior to **commencement** of **stage 2** and **stage 3,** and must include:

a. The baseline data collected from surveys undertaken by a **suitably qualified expert** on the Koala, Spotted-tail Quoll and Giant-Barred Frog within all habitat areas outside areas to be cleared of vegetation for the proposed action, that are likely to contain these species and that are likely to be adversely impacted by the action (as determined by a **suitably qualified expert**).The data must address the densities, distribution, habitat use and movement patterns of these species;

b. The methodology to be implemented for the ongoing monitoring of road kill, the species densities, distribution, habitat use and movement patterns, and the use of **fauna crossing** during construction and operation of the action, including the timing, and duration of the methodology;

c. Goals and performance indicators to measure the success of proposed **fauna crossings**, which must be specific, measureable, achievable, realistic and timely (SMART), and be compared against baseline data described in condition 4a)

d. Details of contingency measures that would be implemented in the event of changes to densities, distribution, habitat use and movement patterns that are attributable to the construction or operation of the project.

Monitoring must continue until mitigation measures can be demonstrated to have been **effective** for the Koala, Spotted-tail Quoll, and Giant-Barred Frog.

Should monitoring associated with this condition demonstrate that the use of **fauna crossings** and/or **fencing** is not achieving its intended purpose or is having a detrimental effect upon Koala, Spotted-tail Quoll, and Giant-Barred Frog (as determined by **the Minister**), **the Minister** may require that the person taking the action implement alternative forms of mitigation and/or corrective actions to address the relevant impacts to Koala, Spotted-tail Quoll, and Giant-Barred Frog,. Such measures must be implemented as requested.

The Ecological Monitoring Program for the project was submitted to the Minister in a letter dated 29 April 2014 and approved by the Minister on 10 October 2014. Commencement dates for Stage 2 and Stage 3 were early to mid-November 2014.

An updated Ecological Monitoring Program for the project was submitted to the Minister on 3 May 2016 and approved by the Minister on 11 November 2016.

A third revision of the Ecological Monitoring Program for the project was submitted to the Minister on 3 April 2019 with a subsequent fourth revision submitted on 20 August 2019 and approved by the Minister on the 22 August 2019.

A fifth revision of the Ecological Monitoring Program was submitted to the Minister on 6 May 2022 and approved by the Minister on 30/05/2022.

The compliance status of the implementation of the Ecological Monitoring Program is detailed in Appendix A.

2.5. Condition 5

Condition 5

To compensate for the loss of 240 hectares of threatened species habitat the person taking the action must prepare and submit a Biodiversity Offset Management Plan (**BOMP**) for the **Minister's** written approval within 12 months of approval of the action. The BOMP must be approved in writing by the **Minister** within 12 months of approval of the action. The **BOMP** must include:

a. the identification of the portions of the lands described as the "Proposed Biodiversity Offset Areas" in the Map at Schedule 1 of this notice that are necessary to achieve the outcomes required by the *Environmental Offsets Policy 2012* (or subsequent published revisions). This must include **offset attributes**, **shapefiles**, textual descriptions and maps to clearly define the location and boundaries of the offset area(s);

b. the results of targeted field surveys within the offset sites (undertaken at any ecologically appropriate time of the year) to assess and describe habitat suitability and presence / absence of individuals in relation to the Koala, Grey-headed Flying-fox, Spotted-tail Quoll and Giant Barred frog;

c. an assessment of the baseline population for the Koala, Spotted-tail Quoll, Giant-Barred Frog, and Grey-headed Flying-fox which are detected within the offset area during field surveys;

d. a description of the current **quality** (prior to any management activities) of the offset area(s) identified in Condition 5a with reference to the Koala, Spotted-tail Quoll, Giant-Barred Frog, and Grey-headed Flying-fox;

e. an assessment demonstrating how the offset area(s) achieve the outcomes required by the *Environmental Offsets Policy 2012* (or subsequent published revisions) and user guide;

f. Should the offset sites identified in 5a not be sufficient to achieve the outcomes required by the *Environmental Offsets Policy 2012* (or subsequent published revisions) and user guide, as determined in writing by the **Minister**, the person taking the action must provide further suitable offset sites and include these as part of the **BOMP**;

g. information about the Koala, Grey-headed Flying-fox, Spotted-tail Quoll, Grey-headed Flying-fox, and Giant Barred frog (in relation to ecology, biology and conservation status) to inform appropriate management actions;

Condition 5

h. targeted management actions, regeneration and revegetation strategies to be undertaken on the offset area(s) to improve the ecological quality of these areas for the Koala, Grey-headed Flying-fox, Spotted-tail Quoll and Giant Barred frog

i. clear performance objectives for management actions that will enable maintenance and enhancement of habitat within the offset area, as well as contribute to the better protection of individuals and / or populations of Koala, Spotted-tail Quoll, Giant-Barred Frog, and Grey-headed Flying-fox onsite;

j. anticipated timeframes for achieving performance objectives.

k. performance and completion criteria for evaluating the management of the offset area, including contingency actions, criteria for triggering contingency actions and a commitment to the implementation of these actions in the event that performance objectives are not met;

l. a program to monitor and report on the effectiveness of these measures, and progress against the performance and completion criteria;

m. details of who would be responsible for monitoring, reviewing, and implementing the **BOMP**.

n. a description of funding arrangements or agreements including work programs and responsible entities;

The approved **BOMP** must be published on the NSW Roads and Maritime Services internet web site, within 1 month of the BOMP being approved.

The approved BOMP must be implemented.

The BOMP was first submitted to the Department of the Environment for the approval of the Minister in a letter dated 16 January 2015.

A revised version of the BOMP, taking into account comments received on the first version, was submitted on 14 April 2021 and again on 16 June 2021. The Department have advised TfNSW that they require the finalised management plan for the Paperbark Flora Reserve before they can approve the BOMP. TfNSW has received this from FCNSW and provided the plan to the Department on 27 June 2022. It was discussed and agreed that the Norton Site would be replaced by species credit for Giant Barred Frog from the Kalang Offset site. TfNSW has provided the final assessment report for Kalang Offset Site along with the EPBC Calculator for Giant Barred Frog.

TfNSW envisaged that the final BOMP with management plans as an appendix to be submitted to the Department by the end of October 2022.

Approval from the Minister remains outstanding.

2.6. Condition 6

Condition 6

If an offset site proposed as a part of Condition 5 is already required to be protected as a result of a separate EPBC Act approval, only the management actions which can be demonstrated to be additional to those required for the separate approval, can be considered as an offset for this project. The legal protection of the site and management measures required for a separate approval cannot be considered a part of the offset, in accordance with the *Environmental Offsets Policy 2012* (or subsequent published revisions).

This requirement has been noted as part of the preparation of the BOMP, required under Condition 5.

2.7. Condition 7

Condition 7

Within 12 months of approval of the Biodiversity Offset Management Plan (BOMP), the person taking the action must secure the offset area(s) identified in Condition 5a), under relevant conservation legislation. The legal instrument chosen must be registered on title, and must prevent any future development activities from occurring on the land protected, and ensure the active management of that land for the better protection of matters of national environmental significance for the duration of the impact of the action. Evidence of compliance with this condition must be provided to the **Department** within 30 days after the land(s) have been secured.

Approval from the Minister of the BOMP remains outstanding; as such compliance with this condition is not yet applicable.

2.8. Condition 8

Condition 8

Within three months of every 12 month anniversary of the **commencement** of the action, the person taking the action must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of the BOMP, Flora and Fauna Management Plans and Ecological Monitoring Plan as specified in the conditions. Documentary evidence providing proof of the date of publication must be provided to the **Department** at the same time as the compliance report is published. Noncompliance with any of the conditions of this approval must be reported to the **Department** within 2 business days of becoming aware of the non-compliance. At any time within the life of this approval the **Minister** may agree, in writing, that further reporting is not required if compliance with all requirements has been demonstrated to the **Minister's** satisfaction.

This report has been prepared to satisfy the requirements of this condition. Evidence of the date of publication will be provided to the Department when this report is published on the Transport for NSW project website.

The BOMP was first submitted to the Department of the Environment for the approval of the Minister in a letter dated 16 January 2015. The BOMP was re-submitted in April 2021 and June 2021. The Department advised TfNSW that they require the finalised management plan for the Paperbark Flora Reserve before they can approve the BOMP. TfNSW received this from FCNSW and provided the plan to the Department on 27 June 2022. It was discussed and agreed that the Norton Site would be replaced by species credit for Giant Barred Frog from the Kalang Offset site. TfNSW has provided the final assessment report for the Kalang Offset Site along with the EPBC Calculator for Giant Barred Frog.

Following recent consultation with the Department, TfNSW envisaged that the final BOMP to be submitted to the Department by the end of October 2022. Approval from the Minister remains outstanding.

A Flora and Fauna Management Plan has been prepared for each stage of the project. As at 21 July 2021, these plans were approved by the Minister on the following dates:

• Stage 1: Sancrox Interchange	24 June 2014
• Stage 2: Kundabung to Kempsey	22 October 2014 (Revision 1) 15 November 2016 (Revision 2) 22 August 2019 (Revision 3)
• Stage 3: Oxley Highway to Kundabung	10 October 2014 (Revision 1) 15 November 2016 (Revision 2) 22 August 2019 (Revision 3)

Construction of Stage 1 was completed in November 2015. Construction of Stage 2 and Stage 3 was completed in October 2017 and March 2018 respectively.

With the exception of the Ecological Monitoring Programs included as Appendices, the Flora and Fauna Management Plans are construction documents and were closed out in the Annual Report submitted to the July 2017 - July 2018 reporting period.

Details of the implementation of the Ecological Monitoring Plan is provided in Section 3.

All previous reports, and this report once published, can be found at the following link:

https://www.pacifichighway.nsw.gov.au/document-library/oxley-highway-to-kempsey-upgrade-epbc-compliance-reports

2.9. Condition 9

Condition 9

Within 30 days after the **commencement** of the action, the person taking the action must advise the **Department** in writing of the actual date of **commencement**.

In a letter to the Department, dated 19 August 2014, Transport for NSW advised the Department of the actual date of commencement, being 22 July 2014.

2.10. Condition 10

Condition 10

The person taking the action must maintain accurate records substantiating all activities associated with or relevant to these conditions of approval, including measures taken to implement the **BOMP,** Ecological Monitoring Plan and Flora and Fauna Management Plans, and make them available upon request to the **Department**. Such records may be subject to audit by the **Department** or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the **Department's** website. The results of audits may also be publicised through the general media.

TfNSW is maintaining accurate records for all activities relating to the conditions of approval, and the implementation of the BOMP, EMP and FFMPs. The potential audit by the Department is noted.

2.11. Condition 11

Condition 11

Upon the direction of the **Minister**, the person taking the action must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the **Minister**. The independent auditor must be approved by the **Minister** prior to the **commencement** of the audit. Audit criteria must be approved by the **Minister** and the audit report must address the criteria to the satisfaction of the **Minister**.

The requirements of this condition are noted. A direction from the Minister under Condition 11 has not been received by Transport for NSW during this reporting period.

2.12. Condition 12

Condition 12

1. If the person taking the action wishes to carry out any activity otherwise than in accordance with the **BOMP**, Ecological Monitoring Plan and Flora and Fauna Management Plans as specified in the conditions, the person taking the action must submit to the **Department** for the **Minister's** written approval a revised version of that Plan. The varied activity shall not commence until the **Minister** has approved the varied Plan in writing. The **Minister** will not approve a varied Plan unless the revised Plan would result in an equivalent or improved environmental outcome over time. If the **Minister** approves the revised Plan, that Plan must be implemented in place of the Plan originally approved.

Transport for NSW submitted an update to the Ecological Monitoring Plan to the Department for approval on 3 May 2016. The updated Ecological Monitoring Plan was also an appendix of the approved Kundabung to Kempsey and Oxley Highway to Kundabung Flora and Fauna Management plans. The EMP and FFMP updates were approved by the Minister on 15 November 2016.

A third revision of the Ecological Monitoring Program for the project was submitted to the Minister on 3 April 2019 with a subsequent fourth revision submitted on 20 August 2019 and approved by the Minister on the 22 August 2019.

A fifth revision of the Ecological Monitoring Program was submitted to the Minister on 6 May 2022 and approved by the Minister on 30/05/2022.

The BOMP has not yet been approved by the Department, and therefore the requirements of this condition are not yet applicable to this plan.

2.13. Condition 13

Condition 13

1. If the **Minister** believes that it is necessary or convenient for the better protection of listed threatened species and ecological communities to do so, the **Minister** may request that the person taking the action make specified revisions to the **BOMP**, Ecological Monitoring Plan and Flora and Fauna Management Plans, as specified in the conditions and submit the revised **BOMP**, Ecological Monitoring Plan and Flora and Fauna Management Plans for the **Minister's** written approval. The person taking the action

Condition 13

must comply with any such request. The revised approved **BOMP**, Ecological Monitoring Plan and Flora and Fauna Management Plans must be implemented. Unless the **Minister** has approved the revised **BOMP**, Ecological Monitoring Plan and Flora and Fauna Management Plans then the person taking the action must continue to implement the **BOMP**, Ecological Monitoring Plan and Flora and Fauna Management Plans originally approved.

Noted.

No requests from the Minister under Condition 13 were received by Transport for NSW in this reporting period.

2.14. Condition 14

Condition 14

If, at any time after 5 years from the date of this approval, the person taking the action has not **substantially commenced** the action, then the person taking the action must not substantially commence the action without the written agreement of the **Minister**.

Commencement of the action occurred on 22 July 2014.

2.15. Condition 15

Condition 15

Unless otherwise agreed to in writing by the **Minister**, the person taking the action must publish all plans referred to in these conditions of approval on their website. Each plan must be published on the website within 1 month of being approved.

The Flora and Fauna Management Plans for each stage are published at

- https://www.pacifichighway.nsw.gov.au/document-library/sancrox-traffic-arrangement-flora-and-fauna-management-sub-plan
- https://www.pacifichighway.nsw.gov.au/document-library/oxley-highway-to-kundabung-upgrade-construction-environmental-management-plan-0
- https://www.pacifichighway.nsw.gov.au/document-library/kundabung-to-kempsey-upgrade-construction-environmental-management-plan

The Ecological Monitoring Program and Annual compliance reports are published at

- https://www.pacifichighway.nsw.gov.au/document-library/oxley-highway-to-kempsey-upgrade-ecological-monitoring-program-and-reports
- https://www.pacifichighway.nsw.gov.au/document-library/oxley-highway-to-kempsey-upgrade-epbc-compliance-reports

3 Ecological Monitoring Plan

Table 2 outlines the monitoring requirements from the Ecological Monitoring Plan, relevant to matters of National Environmental Significance that were required to be conducted during the last reporting period.

This monitoring was conducted in accordance with the timing requirements outlined in Table 2. The reports including the results of these monitoring events and evaluation of the project's compliance with the performance indicators, have been included in Appendix A.

In some instances, monitoring of a particular species or mitigation measure requires several monitoring events throughout the year. In these instances, it is considered more informative to wait until all monitoring events have been conducted for that year, before reporting on the results. This allows analysis between seasons, further statistical analysis, etc to be conducted than if individual monitoring events are reported on.

Table 2 highlights monitoring completed to date, yet to be completed and the reports included as part of this Annual Compliance Report 2022.

Table 2 Ecological monitoring completed to date, yet to be completed and the reports included in Annual Compliance Report 2021.

Species monitored	Timing	Done/ yet to be done	Reporting
Koala	Spring/Summer	Year 3 monitoring (2017) completed. Year 4 monitoring (2018) completed. Year 5 monitoring spring 2019 and summer 2019/20 completed. Year 6 monitoring undertaken spring 2020 and summer 2020/21. Year 8 monitoring scheduled for spring 2022 and summer 2022/2023.	Year 8 monitoring scheduled for spring 2022 and summer 2022/2023.
Spotted-tail Quoll	Autumn/winter	Year 4 monitoring (2018) completed. Year 6 monitoring undertaken in autumn/winter 2020 completed. Year 8 monitoring scheduled for autumn/winter 2022.	Year 8 monitoring scheduled for autumn/winter 2022.
Giant Barred Frog	Spring, Summer and Autumn	Year 3 monitoring (2017/18) completed. Year 4 monitoring (2018/19) completed. Year 5 monitoring spring 2019, summer 2019/20 and autumn 2020 completed.	**Year 7 monitoring included in this report Appendix A.**

Species monitored	Timing	Done/ yet to be done	Reporting
		Year 6 monitoring undertaken spring 2020, summer 2020/21and autumn 2021. Year 7 monitoring scheduled for spring 2021, summer 2021/22 and autumn 2022 Year 8 monitoring scheduled for spring 2022, summer 2022/23.	
Road Kill	Weekly during October (spring), January (summer) and April (autumn) in Year 4, 5, 6 and 8	Construction / post opening – July 2017 – June 2018 completed. Year 4 monitoring (2018/19) completed. Year 5 monitoring October 2019, January 2020 and April 2020 completed Year 6 monitoring undertaken October 2020, January 2021 and April 2021 Year 8 monitoring scheduled for October 2022, January 2023 and April 2023	Year 8 monitoring is scheduled for October 2022, January 2023 and April 2023.
Fauna underpasses	Autumn and spring/summer year 4, 6 and 8	Year 4 monitoring (2018/19) completed. Year 6 monitoring undertaken late autumn 2020, late spring /early summer 2020 Year 8 monitoring scheduled for late autumn 2022, late spring /early summer 2022	Year 8 monitoring is scheduled for late autumn 2022, late spring /early summer 2022.
Fauna Fence		Year 4 monitoring autumn 2018 and spring/summer 2018/2019 completed. Year 6 monitoring undertaken autumn 2020 and spring/summer 2020/2021 Year 8 monitoring - autumn 2022 and spring/summer 2022/2023	Year 8 monitoring is scheduled for autumn 2022 and spring/summer 2022/2023.

Table 3 lists the title of each of the monitoring reports where each of the EPBC reporting requirements in Table 2 have been included in this annual report. These reports are available in Appendix A.

Table 3 EPBC monitoring reports in Appendix A

Species / aspects monitored	Report title in Appendix A
Giant Barred Frog (spring, summer and autumn) Year 7 monitoring	Giant Barred Frog Monitoring 2021/22

All the Ecological Monitoring Program performance measures for the monitoring events listed in Table 3 were met for the 2021/22 reporting period, except for the following, which were not found to be attributed to the project:

Giant Barred Frog: The performance measure relating to continued presence of Giant Barred Frogs during each survey event where it was identified during baseline surveys was met for one of the six sites. Giant Barred Frogs were not recorded at Smiths Creek impact, Maria River impact and Cooperabung reference sites during 2021/2022 surveys, where it was recorded during all three baseline surveys. Giant Barred Frogs were not recorded in spring at Cooperabung impact site or autumn at Pipers Creek impact site, where it was recorded during baseline surveys.

Due to extreme climatic conditions and reduced records at all sites (impact and reference) it is recommended that monitoring continue as per the EMP.

Giant Barred Frog: The performance measure relating to change to densities, distribution, habitat use and movement patterns compared to baseline data during monitoring in Year 1 – 8.

The number and location of Giant Barred Frogs recorded has varied between season and year at all sites. All sites show an overall decreasing trend in mean records and densities. However, as this decreasing trend is evident at both impact and reference sites, it is not possible to attribute these changes to the Project at this stage.

The high rainfall experience in 2020/2021 and 2021/2022 resulted in highly variable water levels, waterway flooding and expansive water flows across floodplains. The above-average rainfall conditions observed over the spring/summer periods of 2020/2021 and 2021/2022 follow the long-term drought conditions experienced across the Project area in 2019. It is possible that the population changes observed at all sites are in response to these changing conditions. Low capture rates may be a result of population impacts from drought conditions followed by waterway flooding, which is also likely to reduce capture and observation rates simply due to the likely dispersal of individuals across a broader wet area. A population response to improved waterway conditions after the 2020/2021 rainfall may be evidenced by the increased capture rates at some sites, but also hindered by difficult (flooding) survey conditions.

Within-year movement patterns that would permit comparison between baseline and subsequent monitoring events is not possible due to lack of data (surveys and captures are too infrequent), however, assessment of movement patterns of recaptured individuals over all surveys show that 24% of recaptured frogs have been found to traverse from one side of the carriageway to the other.

Appendix A: Ecological Monitoring Program Reports

Species / mitigation monitored	Report title
Giant Barred Frog	Giant Barred Frog Monitoring 2021/22

niche
Environment and Heritage

Giant Barred Frog Monitoring 2021/2022

Oxley Highway to Kempsey, Pacific Highway Upgrade

Prepared for Transport for NSW

September 2022

Document control

Project no.:	1702
Project client:	Transport for NSW
Project office:	Port Macquarie
Document description:	Giant Barred Frog Monitoring 2021/2022 Report
Project Director:	Lawrence Smith
Project Manager:	Radika Michniewicz
Authors:	Jodie Danvers, Radika Michniewicz
Internal review:	Radika Michniewicz
Document status:	R1
Local Government Area:	Kempsey and Port Macquarie-Hastings

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Cover photograph: Giant Barred Frog

Executive summary

Context

This report documents findings of the fourth of five operational monitoring periods for the Giant Barred Frog (*Mixophyes iteratus*), as required for the Oxley Highway to Kempsey (OH2K) Pacific Highway Upgrade Project (the Project), and specified in the Oxley Highway to Kempsey (OH2K) Ecological Monitoring Program (EMP, TfNSW 2022). Transport for NSW (TfNSW) is required to manage and monitor the effectiveness of biodiversity mitigation measures implemented as part of the Project. The Giant Barred Frog is one of the threatened species identified as requiring mitigation and monitoring throughout the course of the construction and operational periods of the Project.

Aims

The aim of the Giant Barred Frog monitoring program is to determine, through evaluation of the performance indicators outlined in the EMP, if the Project is having an impact on the species and whether corrective actions are required.

Methods

Six sites (two reference and four impact) were monitored in spring and summer and five sites (two reference and three impact) in autumn, due to access constraints. Each site consists of a one kilometre transect along the creek line, divided into 10 x 100 metre zones. At the impact sites, the transects cross beneath the carriageway, the carriageway being the midpoint of the transect. Each monitoring location was surveyed in accordance with the monitoring method and design specified in the EMP. Surveys were undertaken after a sufficient rainfall trigger event (> 10 millimetres within a 24 hour period) and involved passive listening, call playback (upon arrival and at intervals during searches), active searching (within 20 metres of each creek bank) and habitat surveys within each of the 100 metre zones.

Key results

Surveys were undertaken on the 11-14 October 2021 (spring), 7-9 December 2021 (summer) and 26-28 May 2022 (autumn) after suitable rainfall. A total of 28 Giant Barred Frogs were recorded during the 2021/2022 monitoring period and 27% (n = 6) of those captured were recaptures. Frogs were absent from Smiths Creek impact, Maria River impact and Cooperabung Creek reference site in all seasons. The highest mean number of Giant Barred Frogs was recorded at Pipers Creek reference site.

Evidence of breeding via the presence of juveniles or sub-adults, gravid females or reproductive males was observed at all sites where frogs were recorded during at least one survey event during 2021/2022.

Analysis of frog movement in relation to the highway found that 12 (24%) of the 50 recaptures from impact sites have been captured on both sides of the carriageway over successive monitoring events. At the reference sites, 11 (26%) of the 43 recaptures have been captured on both sides of the transect midpoint over successive monitoring events.

Conclusions

Performance measures relating to undertaking monitoring have been met to date.

The performance measure relating to continued presence of Giant Barred Frogs during each survey event where it was identified during baseline surveys was met for three of the six sites. Giant Barred Frogs were:

- Not recorded at Smiths Creek impact, Maria River impact and Cooperabung reference sites, where it was recorded during all three baseline surveys.
- Not recorded in spring at Cooperabung impact site or autumn at Pipers Creek impact site, where it was recorded during baseline surveys.

The performance measure relating to changes in density and mean records was not met. All sites appear to show an overall decreasing trend in mean records and densities. However, as this decreasing trend is evident at both impact and reference sites, it is not possible to attribute these changes to the Project.

Management implications

Given the variable nature of annual mean records among sites, the evidence of decreasing trends at reference sites and the lack of a distinct difference between impact and reference sites, it is not possible to attribute observed changes in frog numbers to the Project. As such, it is recommended that monitoring continue as per the EMP.

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1. Introduction

1.1 Context

The Oxley Highway to Kempsey (OH2K) section of the Pacific Highway Upgrade Project (the Project) was approved in 2012 subject to various Ministers Conditions of Approval (MCoA) and a Statement of Commitments (SoC). A subsequent approval with additional conditions of consent (CoA) was granted in 2014 by the Commonwealth Department of Climate Change, Energy the Environment and Water (DCCEEW, previously the Department of Environment (DoE)) for Matters of National Environmental Significance (MNES) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Ecological Monitoring Program (hereafter referred to as the EMP) (TfNSW 2022) combines these approval conditions and defines the mitigation and offsetting requirements for threatened species and ecological communities impacted by the Project.

Transport for NSW (TfNSW) is required to manage and monitor the effectiveness of biodiversity mitigation measures implemented as part of the Project. The Giant Barred Frog (*Mixophyes iteratus*) was one threatened species identified as requiring mitigation and monitoring through the course of the Project's construction and operational periods.

1.1.1 Legal status

The Giant Barred Frog is listed as endangered under the New South Wales *Biodiversity Conservation Act 2016* (BC Act) and Commonwealth EPBC Act. Monitoring of the species is required under the Project's approval.

1.1.2 Monitoring framework

The design, methods and performance indicators that define the Giant Barred Frog monitoring program are specified in the EMP and Giant Barred Frog Management Strategy (GBFMS, Lewis 2013). Where there are discrepancies between the EMP and the GBFMS, the EMP takes precedence (Section 1.2 TfNSW 2022).

The EMP required monitoring of the Giant Barred Frog three times a year (spring, summer and autumn) in years 1, 2 and 3 once substantial construction commenced. Following completion of the Project, surveys are to be undertaken for five consecutive years, in spring, summer and autumn of Year 4, 5, 6, 7 and 8 (operational phase) or until mitigation measures can be demonstrated to have been effective. To date, these monitoring events have been undertaken and reported as follows:

- Construction phase monitoring:
  - *Autumn 2015* (Year 1): Niche 2015a
  - *Spring 2015, summer and autumn 2016* (Year 1): Niche 2016
  - *Spring 2016, summer and autumn 2017* (Year 2): Niche 2017
  - *Spring 2017, summer 2018* (Year 3): Niche 2018.
- Operational phase monitoring:
  - *Autumn 2018* (Year 3)*:* Niche 2018
  - *Spring 2018, (summer 2019 insufficient rainfall) and autumn 2019* (Year 4): Niche 2019
  - *Spring 2019, summer and autumn 2020* (Year 5): Niche 2020
  - *Spring 2020, summer and autumn 2021* (Year 6): Niche 2021
  - *Spring 2021, summer and autumn 2022* (Year 7): Current report.

This report addresses the fourth round (Year 7) of operational phase monitoring for the Project and is the eighth of nine monitoring reports for the Giant Barred Frog. The next round of operational monitoring will commence in spring 2022.

Water quality monitoring was previously conducted within Giant Barred Frog habitat and potential habitat. Water quality monitoring commenced prior to construction, continued during construction and continued for three years during the operational phase, with the final monitoring occurring in March 2021 (Niche 2021). All water monitoring results for the Giant Barred Frog impact sites have been included previous reports.

1.1.3 Baseline data

The EMP specifies the following regarding the Giant Barred Frog:

"The Giant Barred Frog was recorded at Maria River and suitable habitat was identified at Smiths Creek, Pipers Creek and Cooperabung Creek during surveys undertaken to inform the Environmental Assessment (GHD 2010). Targeted surveys undertaken over eight nights between late November 2012 and late January 2013, involving spotlighting, call-playback and tadpole searches, identified the Giant Barred Frog at Cooperabung Creek (south), Cooperabung Creek downstream at Haydons Wharf Road, Smiths Creek, Pipers Creek and Maria River. Areas of suitable habitat for the Giant Barred Frog were also identified at both Stumpy Creek and Barrys Creek"

The EMP lists six sites to be monitored:

- Four impact sites: Cooperabung Creek, Smiths Creek, Pipers Creek, and Maria River.
- Two reference sites: Sun Valley Road (where it crosses Cooperabung Creek), and Old Coast Road (where it crosses Pipers Creek).

Baseline surveys (Niche 2015b) recorded a total of 152 Giant Barred Frogs, at all six monitoring sites in spring and summer and at four sites in autumn. Frogs were absent from the Maria River impact site and Pipers Creek reference site during the autumn 2014 baseline survey.

1.1.4 Purpose of this report

The purpose of this report is to summarise the methods and results of the 2021/2022 monitoring and determine if performance measures are being met, as per the EMP.

1.2 Performance Measures

The EMP specifies the following performance measures for the Giant Barred Frog:

- *Monitoring is undertaken during baseline surveys and Years 1 – 8 or until monitoring can demonstrate that mitigation measures are effective.*
- *Monitoring during Years 1 – 8 is undertaken at the Impact and Control sites where baseline monitoring was undertaken, subject to landowner agreement.*
- *Continued presence of Giant Barred Frogs during each survey event in Years 1 – 8 at sites where it was identified during baseline surveys, subject to access due to landowner agreement.*
- *Mitigation measures are effective as defined in the EPBC approval when all monitoring events are considered at Year 8.*
- *Median values of all downstream water quality monitoring at GBF habitat or potential habitat locations during construction and operation (Year 1 – 6) is less than the 80th percentile value of the upstream site (where 80th percentile is the value at which median values at the downstream site are above 80% of the recorded background water quality records), where this change is found to be attributable to construction or operation.*

- *At Year 8, no change to GBF densities, distribution, habitat use and movement patterns compared to baseline data.*

1.3 Monitoring Timing

Monitoring is to occur three times a year: spring, summer and autumn. Monitoring is to occur in the middle of the season, within one week of rainfall of 10 millimetres within a 24 hour period.

1.4 Reporting

As per the EMP, annual reporting of monitoring results will include:

- Detailed description of monitoring methodology
- Results of the monitoring period
- Discussion of results, including how the results compare against performance measures, if any modifications to timing or frequency of monitoring periods or monitoring methodology are required and any other recommendations
- If contingency measures should be implemented.

This report prepared under the EMP will be submitted to NSW Department of Planning and Environment (DPE), the NSW Environment Protection Authority (EPA) and DCCEEW.

1.5 Limitations

The following limitations to the monitoring procedure were encountered:

- As previously reported, Giant Barred Frogs have become difficult to detect and access in some areas along the transects due to the density of streamside vegetation including the growth of Lantana.
- Monitoring at Maria River Impact Site was not undertaken in autumn 2022 as access to the transect was not possible due to the growth of Lantana along the banks.

2. Methodology

2.1 Monitoring Sites

Monitoring was undertaken at the four impact and two reference sites in spring, summer and autumn. In autumn the Maria River Impact site was inaccessible due to excessive Lantana growth preventing access to the creek, therefore only five sites were monitored in autumn 2022. Each site consists of a one kilometre transect along the creek line.

Where possible, impact site transects extend 450 metres upstream and 450 metres downstream of the Project footprint (assumes Project boundary width of 100 metres) and are divided into 10 x 100 metre zones, resulting in four to five zones downstream of the Project footprint, one within the Project footprint, and four to five upstream of the Project footprint. As for previous monitoring events, the Cooperabung Creek impact site was not surveyed for the full kilometre as access agreements with landowners could not be obtained for the final downstream zone, and for the first two upstream zones.

The two reference sites are located several kilometres upstream of the Project footprint within Cooperabung Creek and Pipers Creek.

The location of all monitoring sites is shown in Figure 1, with detailed locations for each site transect provided in Figure 2 to Figure 7.

2.2 Giant Barred Frog Survey Method

Surveys were undertaken in accordance with the EMP after sufficient rainfall events.

A two hour minimum search time, using two ecologists, at each site was employed, however access and movement difficulties due to dense vegetation often resulted in increased survey time. Surveys involved passive listening, call playback (upon arrival and at intervals during searches), active searching (within 20 metres of creek bank) and habitat surveys. In accordance with the EMP, the following habitat data was collected within each of the 100 metre zones:

- Overstorey vegetation cover (OS, expressed as per cent cover)
- Shrub cover (expressed as per cent cover)
- Ground cover (expressed as per cent cover)
- Leaf litter cover (expressed as per cent cover)
- Bare soil/earth (expressed as per cent cover)
- Presence of cattle (based on hoof marks, manure and whether it is recent or aged evidence)
- Number of pools and riffles within the zone
- Approximate depth of the deepest pool within the zone
- Number of breaches in frog fencing, if applicable.

The location of all observed Giant Barred Frogs was recorded and, where possible, individuals were captured. Captured individuals were checked for recapture status and fitted with a Passive Integrated Transponder (PIT) tag if the individual was previously unknown. In accordance with the EMP, the following data were collected for captured individuals:

- Location according to demarcated survey zone
- Distance from stream edge
- Sex (male, female, unknown)

- Breeding condition with:
    - Males assessed on the colouration of their nuptial pads (i.e. no colour, light, moderate, dark)
    - Females based on whether they are gravid or not gravid (egg bearing).
- Snout-vent length (millimetres)
- Weight (grams).

Temperature and humidity, per cent cloud cover and broad wind level (scale of 0-3 where 0 = no wind) were recorded for each survey. Rainfall (millimetres) within the previous 24 hours was recorded from the Port Macquarie Airport (Station No. 060168) and Kempsey Airport (Station No. 059007) Bureau of Meterorology weather stations.

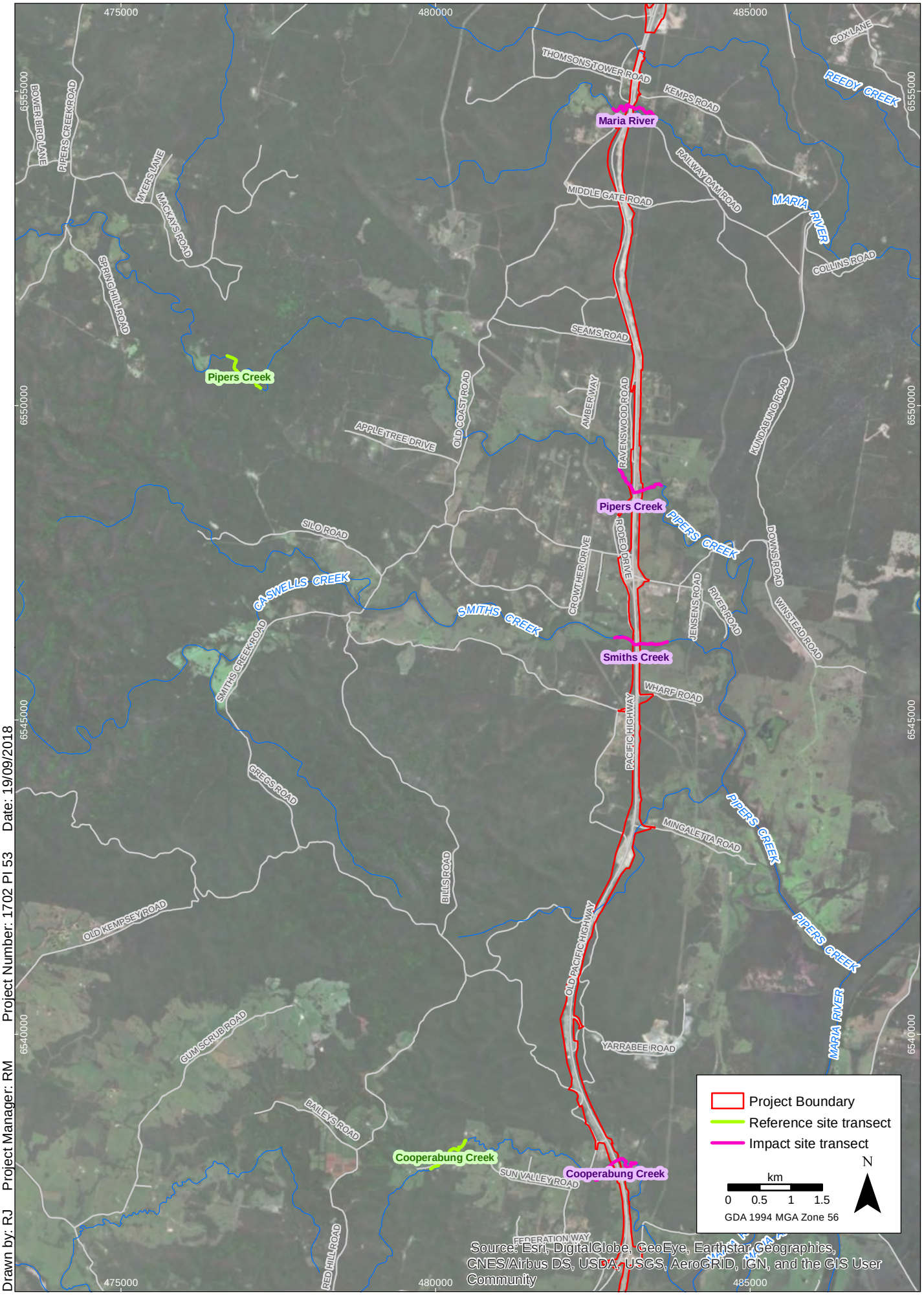
2.3 Water Quality

Water quality monitoring was not undertaken during the 2021/2022 monitoring period. The final operational water quality monitoring period and associated report was completed in 2021 (TfNSW 2021). A summary of the water quality data extracted from TfNSW (2021) from both upstream and downstream sites for Cooperabung Creek, Smiths Creek, Pipers Creek, and Maria River was included in the previous report (Niche 2021).

2.4 Analysis

For consistancy with Baseline analyses and previous reporting, the Minimum Number Known Alive (MNA) (see Sutherland 2006) was calculated for each of the sites. The MNA is based on the number of new individuals encountered over multiple visits, where any new animals are summed, providing an aggregate total. As this method does not account for any migration out of the population or any death, it may over-estimate the total population size if counts are completed over a long period of time. As baseline studies commenced in 2013 it is possible that considering cumulative records over the subsequent survey periods, which extend over a period of seven years, may result in overestimation of the actual population. Data is provided for the annual new captures and a cumulative MNA over the years is also provided, however this data should be approached with caution, as the lifespan of the Giant Barred Frog may not extend beyond four or five years (Michael Mahony unpublished data).

Changes in Giant Barred Frog density within the zones and distribution along transects across the years were investigated by considering mean annual records within each specific zone. In addition, movement of individuals between zones was examined for recaptured frogs.



Drawn by: RJ Project Manager: RM Project Number: 1702 PI 53 Date: 19/09/2018

Giant Barred Frog Monitoring Sites: overview

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 1

niche Environment and Heritage

Imagery: (c) LPI DigitalGlobe 2015

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Giant Barred Frog monitoring: Cooperabung Creek impact site

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 2

Imagery: (c) DigitalGlobe

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Giant Barred Frog monitoring: Smiths Creek impact site

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 3

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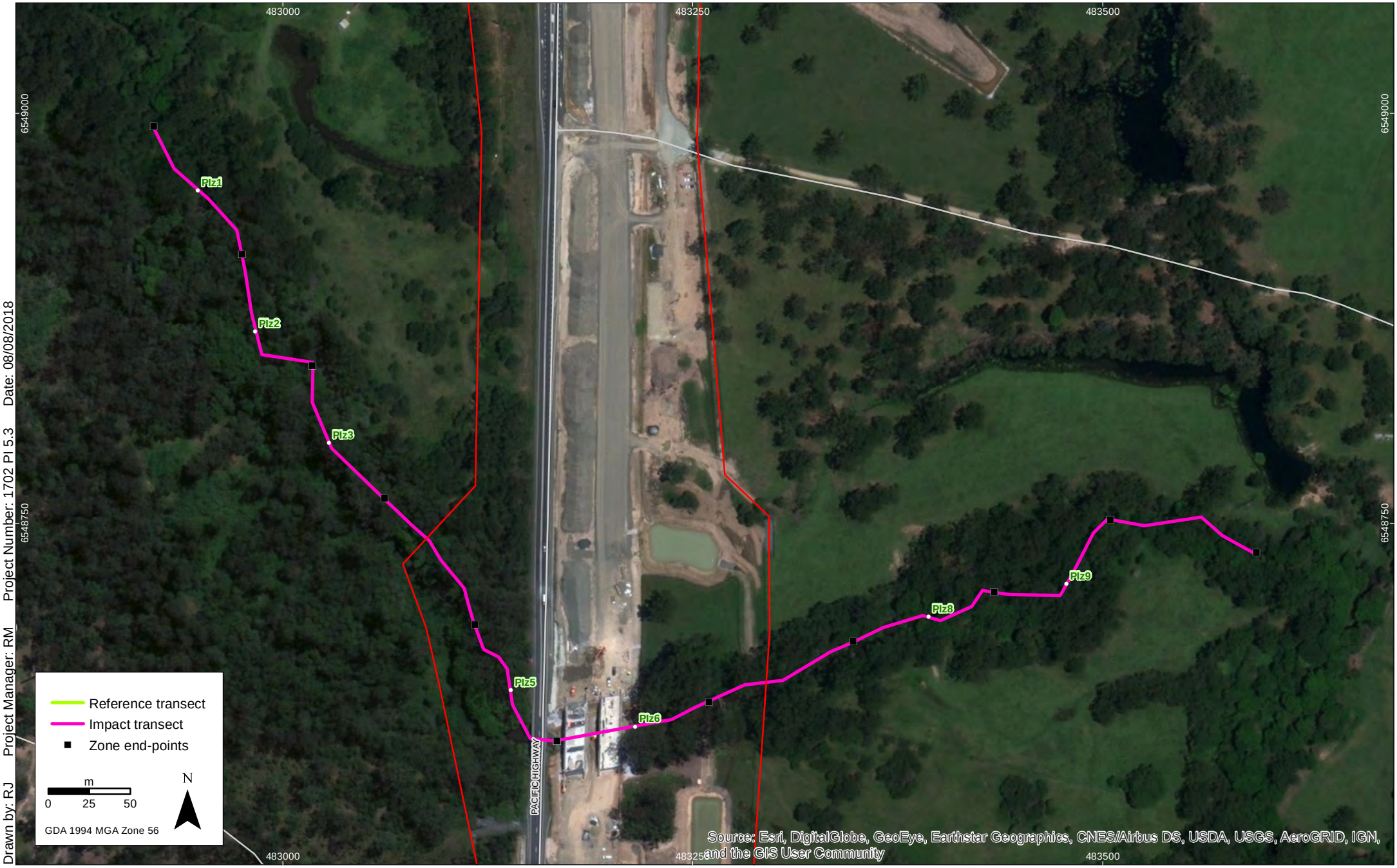

Giant Barred Frog monitoring: Pipers Creek impact site

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 4

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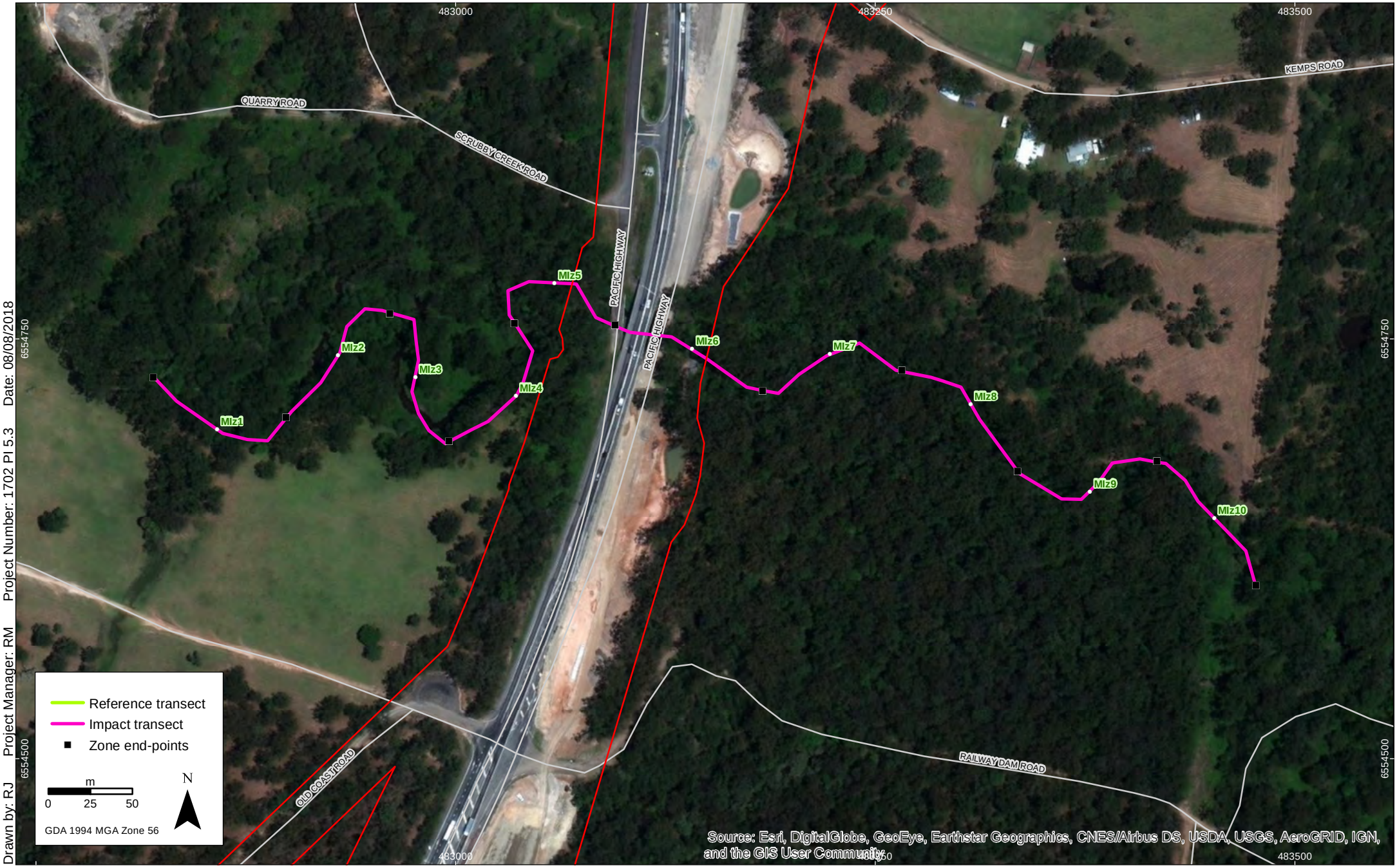

Drawn by: RJ Project Manager: RM Project Number: 1702 PI 5.3 Date: 08/08/2018

Giant Barred Frog monitoring: Maria River impact site

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 5

Imagery: (c) DigitalGlobe

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Giant Barred Frog monitoring: Cooperabung Creek reference site

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 6

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Imagery: (c) DigitalGlobe

Giant Barred Frog monitoring: Pipers Creek reference site

Pacific Highway Upgrade - Oxley Highway to Kempsey

FIGURE 7

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Imagery: (c) DigitalGlobe

3. Results

3.1 2021/2022 Giant Barred Frog Monitoring Results

Field data are presented in Annex 1 and Annex 2. Survey dates and trigger rainfall events measured at Port Macquarie Airport (Station No. 060168) weather station were as follows:

- 11 – 14 October 2021 (spring): 16.4 millimetres recorded on 11 October 2022 prior to surveys
- 7 - 9 December 2021 (summer): 44.6 millimetres recorded on 5 December 2022 prior to surveys
- 26 - 28 April 2022 (autumn): 18.6 millimetres recorded on 23 April 2022 prior to surveys.

3.1.1 Survey results

A total of 28 Giant Barred Frogs were recorded in spring, summer and autumn during the 2021/2022 monitoring surveys. Giant Barred Frogs were recorded at one of the six sites during spring surveys, at two sites during the summer and autumn surveys (Table 1). Of the 28 frogs recorded, 22 were captured, of which six were recaptures (27%). Frogs were absent from Smiths Creek impact, Maria River impact and Cooperabung Creek reference sites in all seasons. In spring,frogs were recorded at Pipers Creek impact site (1) and Pipers Creek reference site (6). In summer, frogs were recorded at Cooperabung Creek impact site (1), Pipers Creek imact site (3) and Pipers Creek reference site (10). In autumnr, frogs were recorded at Cooperabung Creek impact site (5), and Pipers Creek reference site (2). The Pipers Creek reference site recorded the highest mean number of Giant Barred Frogs, with frogs recorded in spring, summer and autumn.

The cumulative MNA (9 years) is highest at the Pipers Creek reference site (MNA = 201) and Smiths Creek impact site (MNA = 121). As mentioned in Section 2.4, this estimate of MNA is likely an overestimate of the population as calculation of the MNA does not take dispersal or deaths into account.

Table 1: Giant Barred Frogs recorded at each site during 2021/2022 surveys

Data set	Cooperabung Creek impact	Smiths Creek impact	Pipers Creek impact	Maria River impact	Cooperabung Creek reference	Pipers Creek reference
Spring (2021)	0	0	1	0	0	6
Summer (2021)	1	0	3	0	0	10
Autumn (2022)	5	0	0	No survey	0	2
Mean number of frogs over the monitoring period	2	0	1.3	0	0	6
Standard Error (SE)	2.6	0	1.5	0	0	4.0
Recaptures	0	0	1	0	0	5
New captures	4	0	2	0	0	10
Uncaptured	2	0	1	0	0	3
Total	6	0	4	0	0	18
Cumulative MNA	59	121	53	95	74	201

3.1.2 Evidence of breeding

Table 2 presents records of breeding evidence. Evidence of breeding via the presence of juveniles or sub-adults, gravid females or reproductive males was observed at all sites where frogs were recorded during at least one survey event during 2021/2022.

Table 2: Breeding evidence records 2021/2022

Monitoring site	Season	Juveniles	Sub-adults	Gravid females	Nuptial pads
Cooperabung Creek impact	Spring				
	Summer			1	
	Autumn			1	
Maria River impact	Spring				
	Summer				
	Autumn	No survey	No survey	No survey	No survey
Pipers Creeks impact	Spring			1	
	Summer		2		
	Autumn				
Smiths Creek impact	Spring				
	Summer				
	Autumn				
Cooperabung Creek reference	Spring				
	Summer				
	Autumn				
Pipers Creek reference	Spring		5	1	
	Summer		1		1
	Autumn				

3.1.3 Weather conditions

The prevailing weather conditions encountered during the field surveys are summarised in Table 3 (Port Macquarie Airport, Station No. 060168). Additional details of the prevailing micrometeorological conditions at the six sites during the field surveys are presented in Annex 1.

Table 3: Weather conditions: 2021/2022 surveys

Date	Min temp (˚C)	Max temp (˚C)	Humidity (%)	Rainfall 24 hours prior (mm)	Rainfall 7 days (mm)	Rainfall 30 days (mm)
11/10/2021	17.2	18.6	96	16.4	16.4	39.8
13/10/2021	14.7	21.1	65	31.0	81.2	104.6
14/10/2021	16.5	23.1	85	0.6	81.8	105.2
7/12/2021	17.6	26.1	80	0.4	67.0	298.6
8/12/2021	16.7	25.7	72	17.8	69.6	291.6
9/12/2021	17.3	26.1	74	12.8	78.6	304.4
26/04/2022	14.2	21.7	78	4.0	34.8	303.4
27/04/2022	15.3	24.2	75	2.4	37.2	281.8
28/04/2022	15.3	25.9	69	1.6	38.8	251.2

3.1.4 Habitat use

Habitat information collected for each site is presented in Annex 1. Microhabitat use was highly variable. Frogs were recorded on, and buried within, leaf litter, using flood debris as shelter, on bare ground or creek banks and under logs and vegetation. Most frogs were captured between 1-10 metres from the creeks, with the furthest frog being found 20 metres from the creek.

No frogs were found to have breached the frog fences at any sites (i.e. observed on the wrong side of the fence).

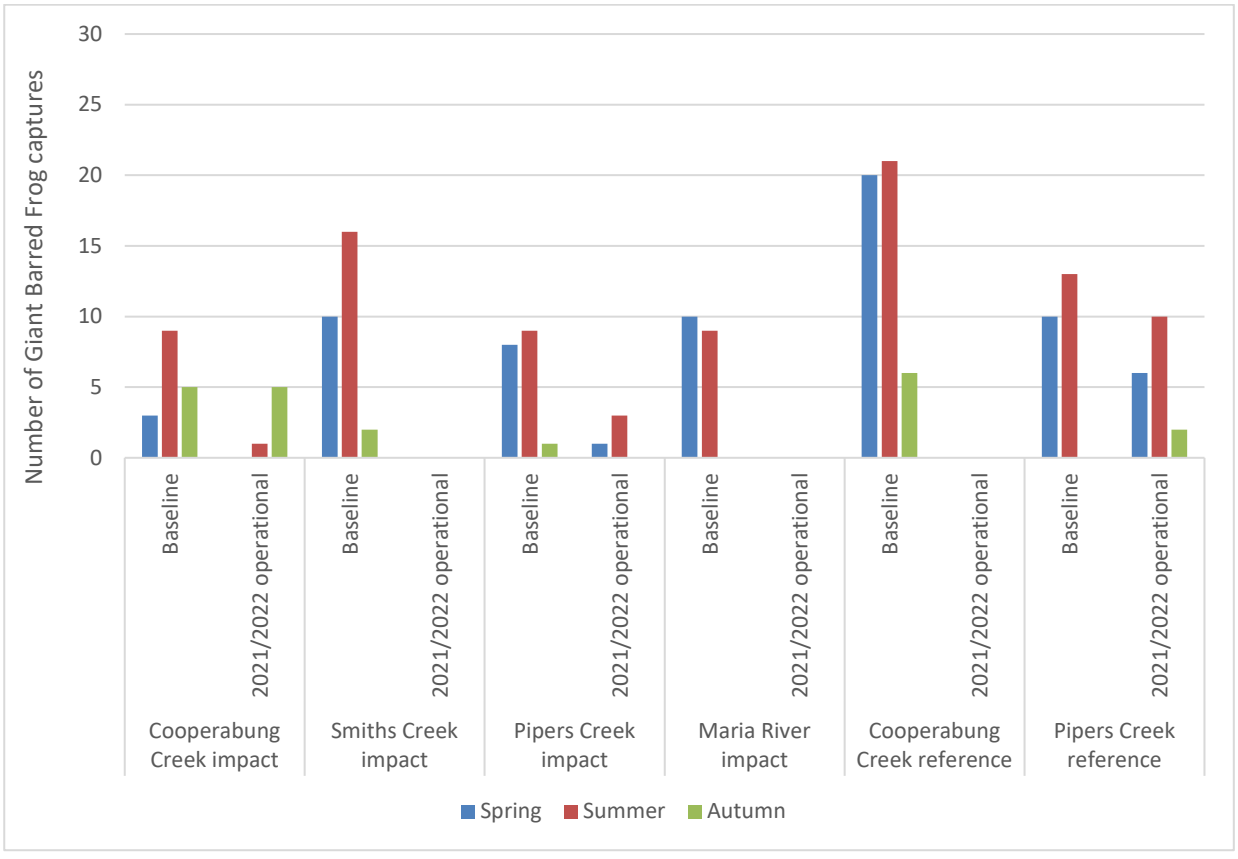
3.2 Comparison with Previous Surveys

3.2.1 Baseline and 2021/2022 surveys

Graph 1 presents the Giant Barred Frog records for baseline and the 2021/2022 operational monitoring surveys.

The Giant Barred Frog was recorded at all six monitoring sites in spring and summer and at four sites in autumn during baseline surveys. Giant Barred Frogs were not recorded at the Maria River impact site and Pipers Creek reference site during the autumn 2014 baseline survey.

Giant Barred Frogs were recorded at two of the six sites during spring and autumn and three sites during summer 2021/2022 surveys. Giant Barred Frogs were not recorded at Cooperabung Creek reference site, Smiths Creek impact site or Maria River impact site during the 2021/2022 surveys, where it was recorded during baseline surveys. Giant Barred Frogs were not recorded at Pipers Creek impact site in autumn or Cooperabung Creek impact site in spring where it was recorded during baseline surveys.



Graph 1: Giant Barred Frog records: baseline and 2021/2022 monitoring

3.2.2 Annual mean records

The mean number of records each year for each site is shown in Graph 2. All sites have demonstrated a general decreasing trend in the average number of captures at each montoring event since 2018/2019.

The mean number of Giant Barred Frogs recorded at Cooperabung Creek impact site and Cooperabung Creek reference site has decreased annually since 2015/2016. However, frogs were recorded at the Cooperabung Creek impact site for the first time since autumn 2019. Frogs were again not detected at Cooperabung Creek reference site and have not been detected there since summer 2020.

A similar annual decrease is evident at Pipers Creek impact site, however the mean number of frogs captured increased during the current monitoring period.

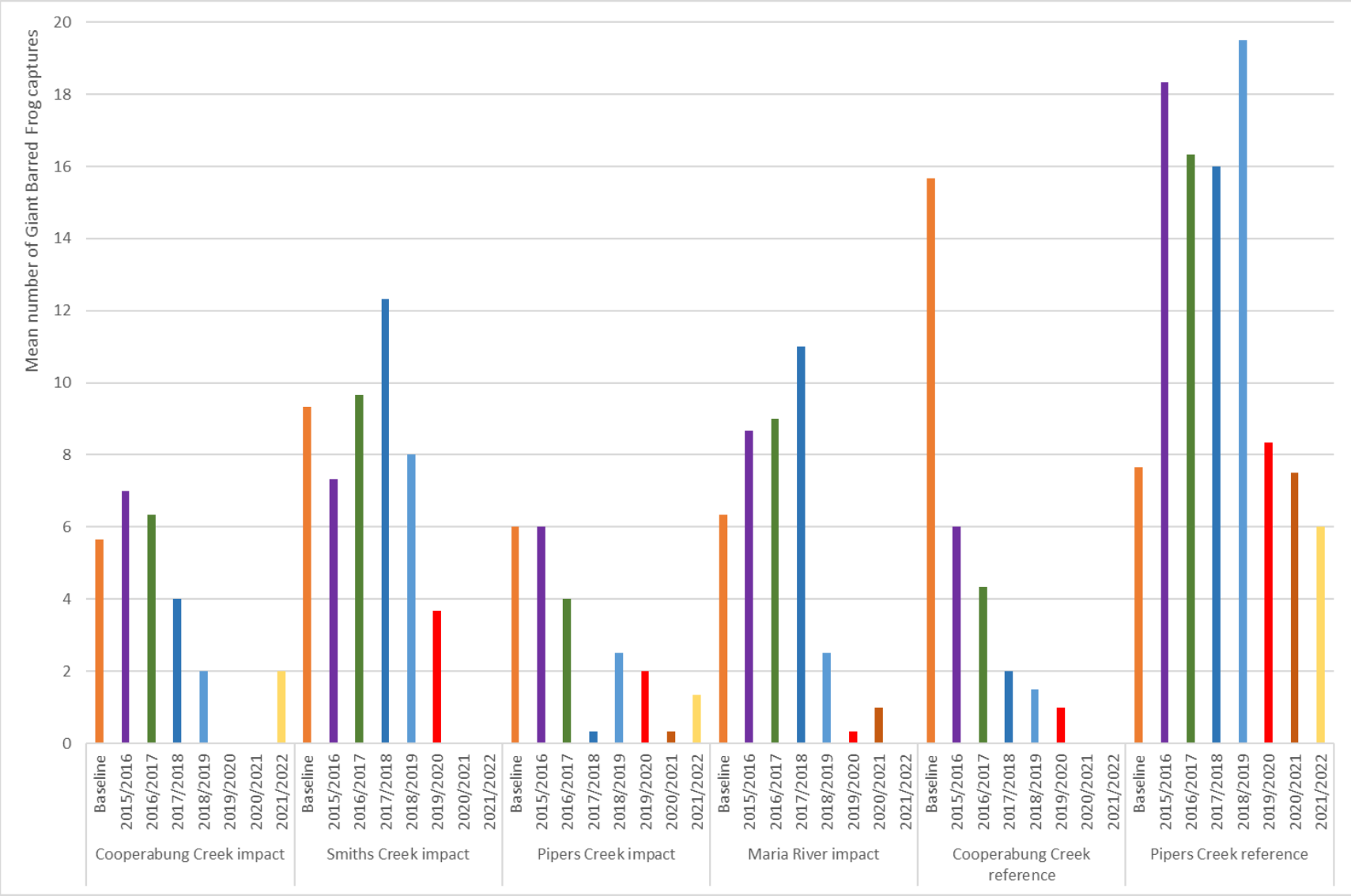
The mean number of Giant Barred Frogs recorded at Pipers Creek reference site increased substantially above baseline during the 2015/2016 monitoring period, where it remained stable, until decreasing back to baseline levels in 2019/2020 and subsequently below baseline in 2020/2021 and 2021/2022 monitoring periods.

The mean number of Giant Barred Frogs recorded at Smiths Creek impact site and Maria River impact site increased annually from 2015/2016 until 2018/2019. After this time the mean decreased substantially at both these sites and has continued to decrease, such that no frogs were recorded at Simths Creek impact and Maria River impact sites during the current monitoring period.

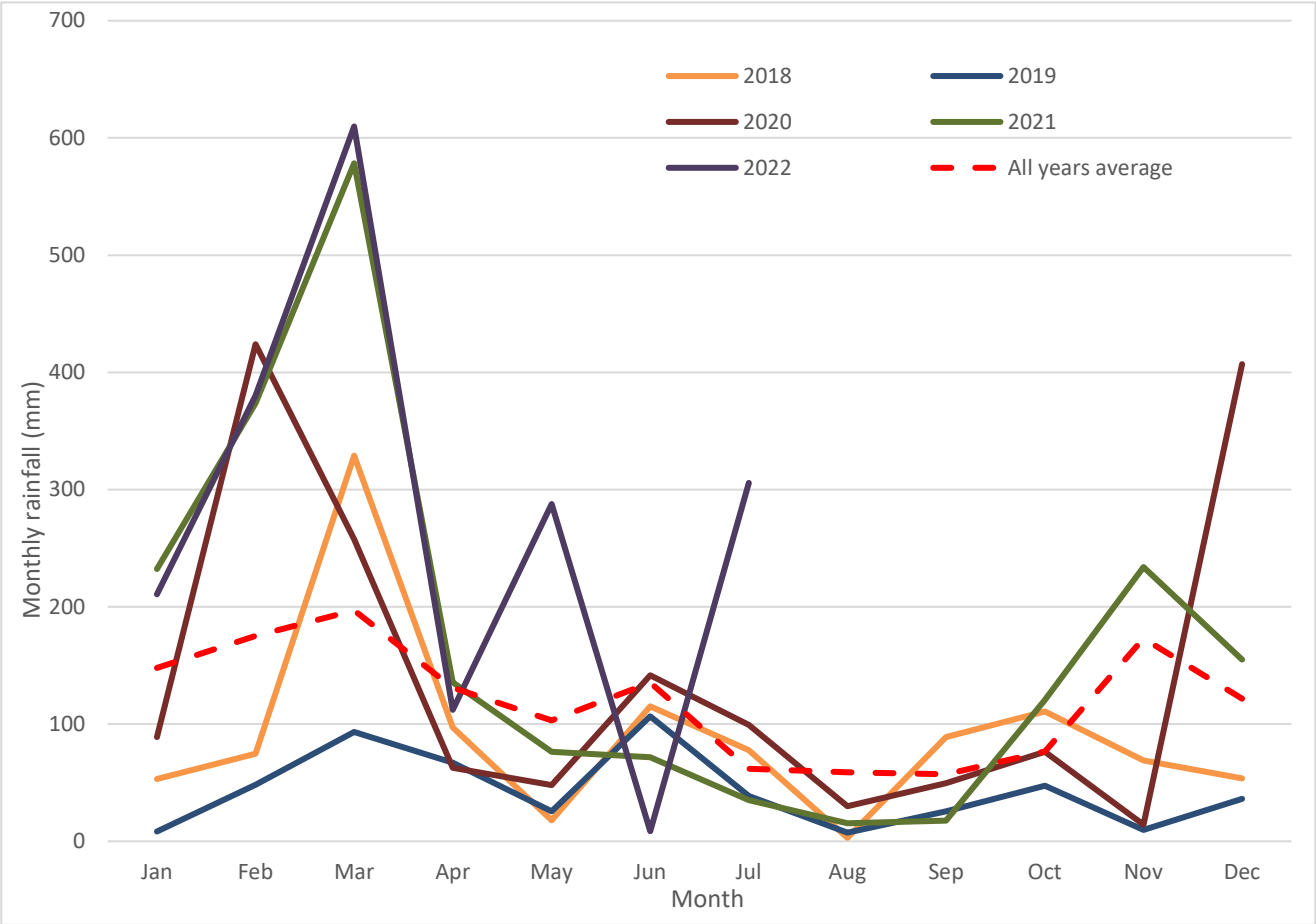
The mean number of Giant Barred Frogs recorded during the current monitoring period increased from the previous monitoring event at two of the six sites, Cooperabung impact and Pipers Creek impact. The remaining four sites decreased or remained the same. Mean records at all sites are currently lower than baseline and decreasing trends are evident at both reference and impact sites.

As during the 2020/2021 monitoring period, 2021/2022 experienced higher than average rainfall from October 2021 to May 2022 (Graph 3). This resulted in highly variable water levels, waterway flooding and expansive water flows across floodplains. The above-average rainfall conditions observed over the spring/summer periods of 2020/2021 and 2021/2022 follow the long-term drought conditions experienced across the Project area in 2019. It is possible that the population changes observed at all sites are in response to these changing conditions. Low capture rates may be a result of population impacts from drought conditions followed by waterway flooding, which is also likely to reduce capture and observation rates simply due to the likely dispersal of individuals across a broader wet area. A population response to improved waterway conditions after the 2020/2021 rainfall may be evidenced by the increased capture rates at some somes, but also hindered by difficult (flooding) survey conditions.

Given the lack of a distinct difference in population trends between impact and reference sites, it is not possible to attribute observed changes in frog numbers to the Project.



Graph 2: Mean annual Giant Barred Frog records by site



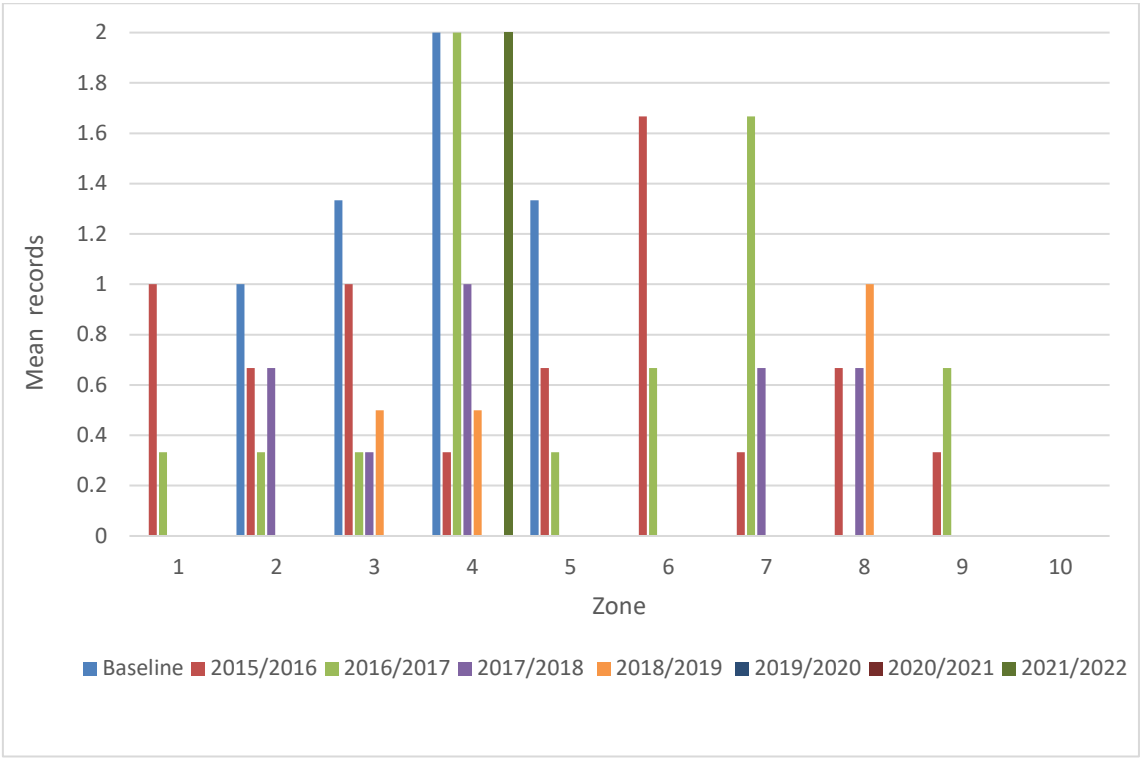
Graph 3: Monthly rainfall – All years monthly average and 2018-2022 monthly total rainfall

3.3 Density and Distribution

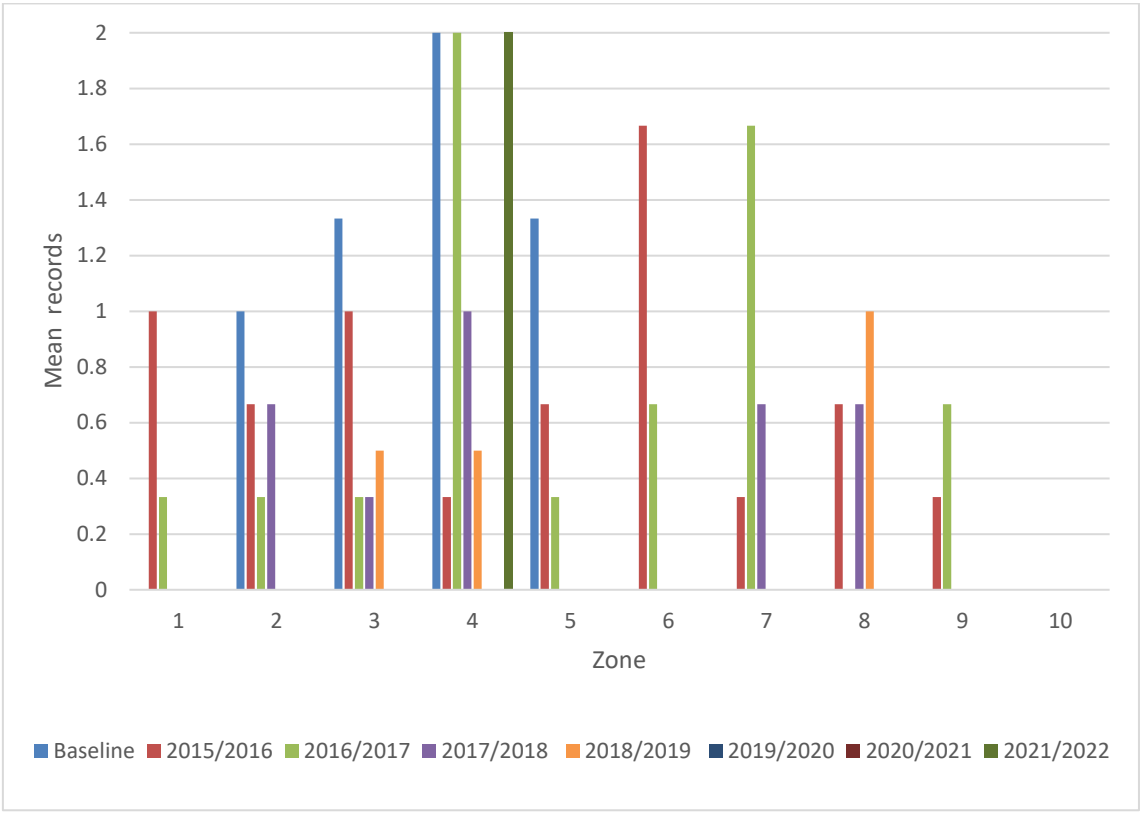
Graph 4 - Graph 9 present the density (*annual mean number of Giant Barred Frog records per zone*) and distribution of Giant Barred Frog records along the survey transect for each site and each monitoring period. Figure 8 - Figure 13 show the total number of captures within each zone over all monitoring periods.

The density of Giant Barred Frogs has been considered as the *mean number of records per year per zone* (Graph 4 to Graph 9). While the zones may vary in size slightly due to the nature of the creek's bank formation and the non-linear nature of the creek line, the zones themselves are consistent between years. As such comparisons can be made within the same zone between years to help identify trends in changing frog numbers. There is no consistent trend evident at any site for frogs to be found in any particular zone. Density appears to be highly variable across the years and along the transect and there is no evidence of lower frog densities within zones 5 and 6, i.e. under the carriageway and immediately adjacent.

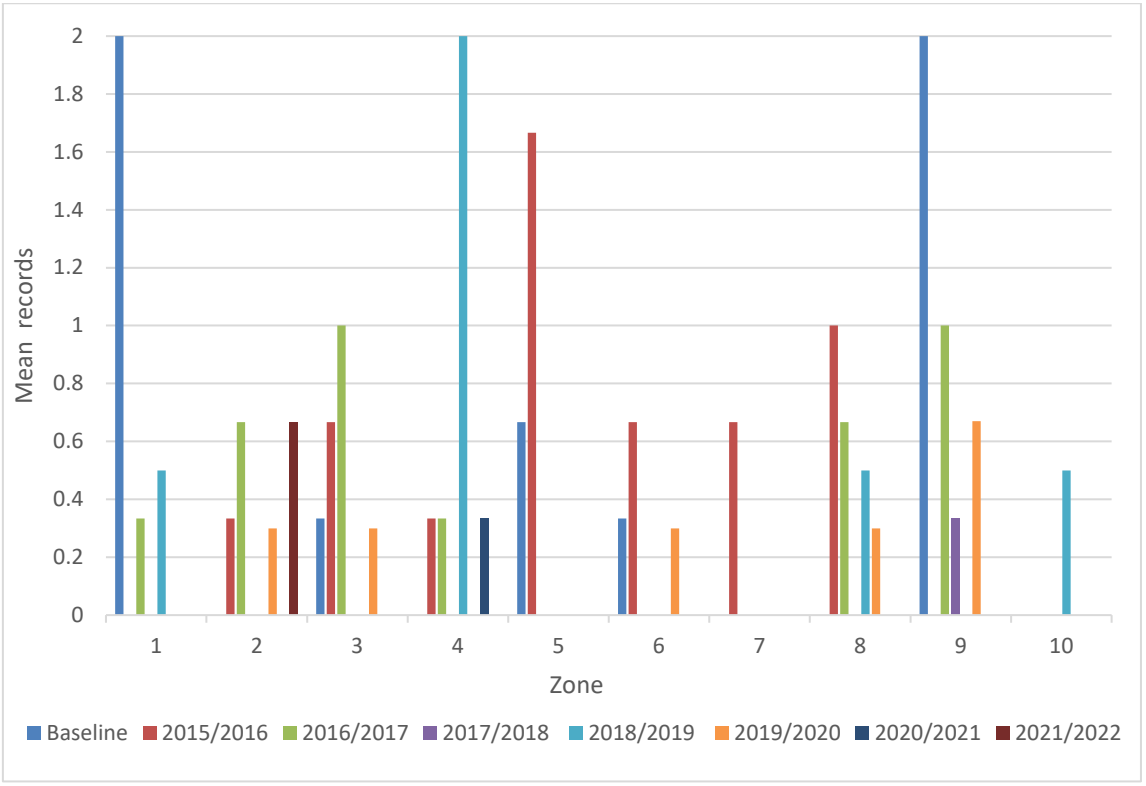
Figure 8 - Figure 13 show all capture records (i.e. cumulative records), whereby capture records (including recaptures) are shown as count ranges, where larger circles indicate larger frog counts. While density data indicates that frog distribution along the transects varies from year to year, when considering all years, frogs mostly appear to be using the entire length of the transect and there is no evidence of frogs being recorded only in one particular zone. In addition, there is no evidence of frogs being absent from zones 5 and 6. While capture frequencies within zones directly under the carriageway consistently fall into the lower range category (1-7 frogs), the low capture frequency range occurs regularly along the transects and at all sites.



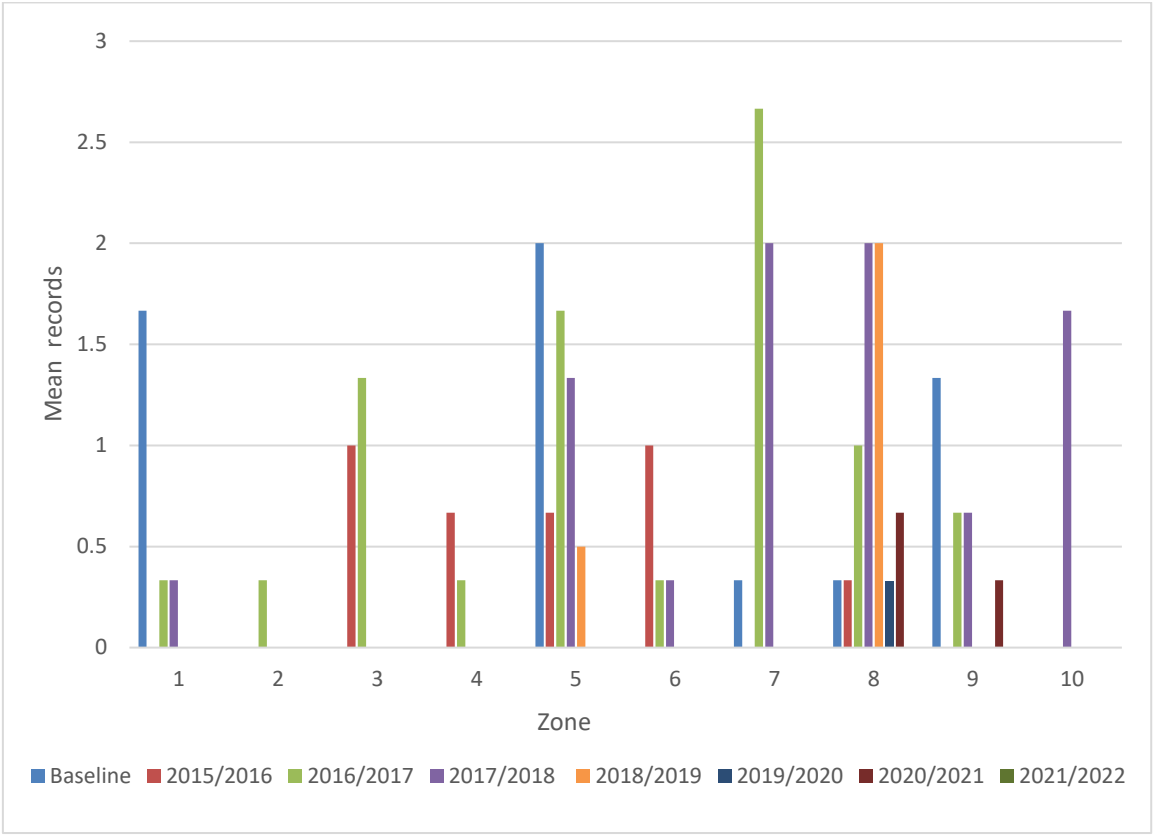
Graph 4: Cooperabung Creek impact site: mean number of Giant Barred Frogs per zone



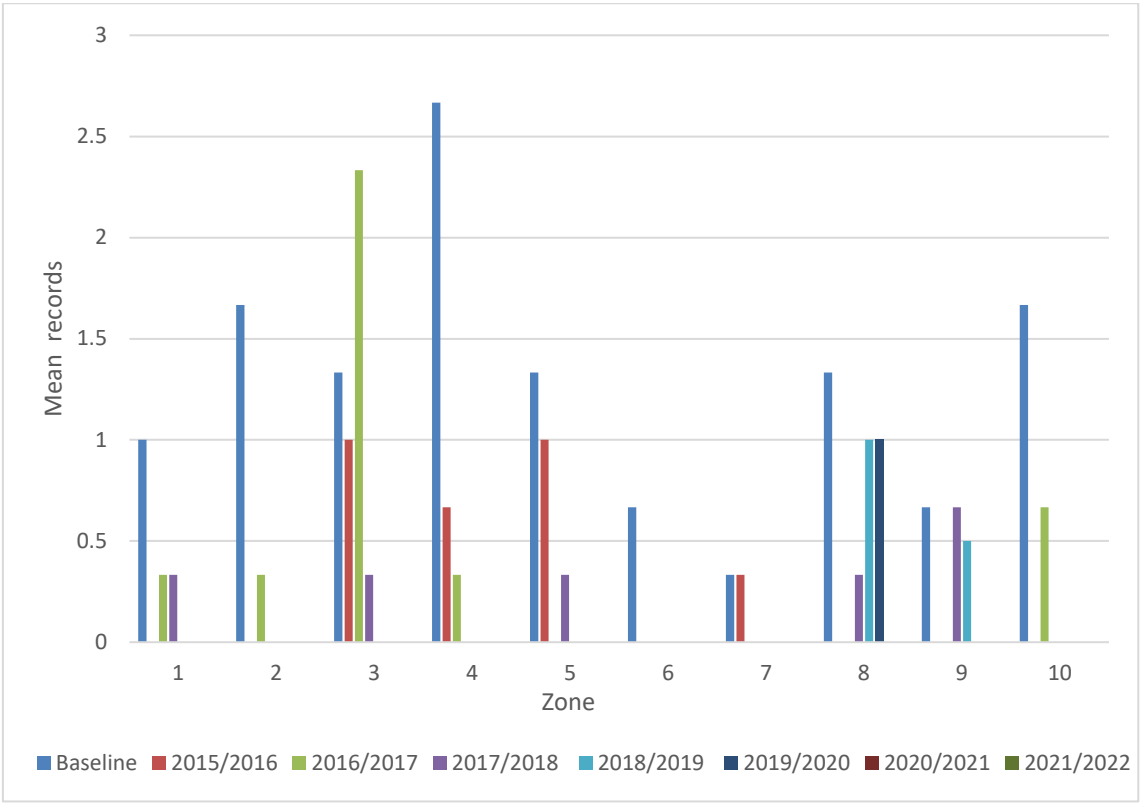
Graph 5: Smiths Creek impact site: mean number of Giant Barred Frogs per zone



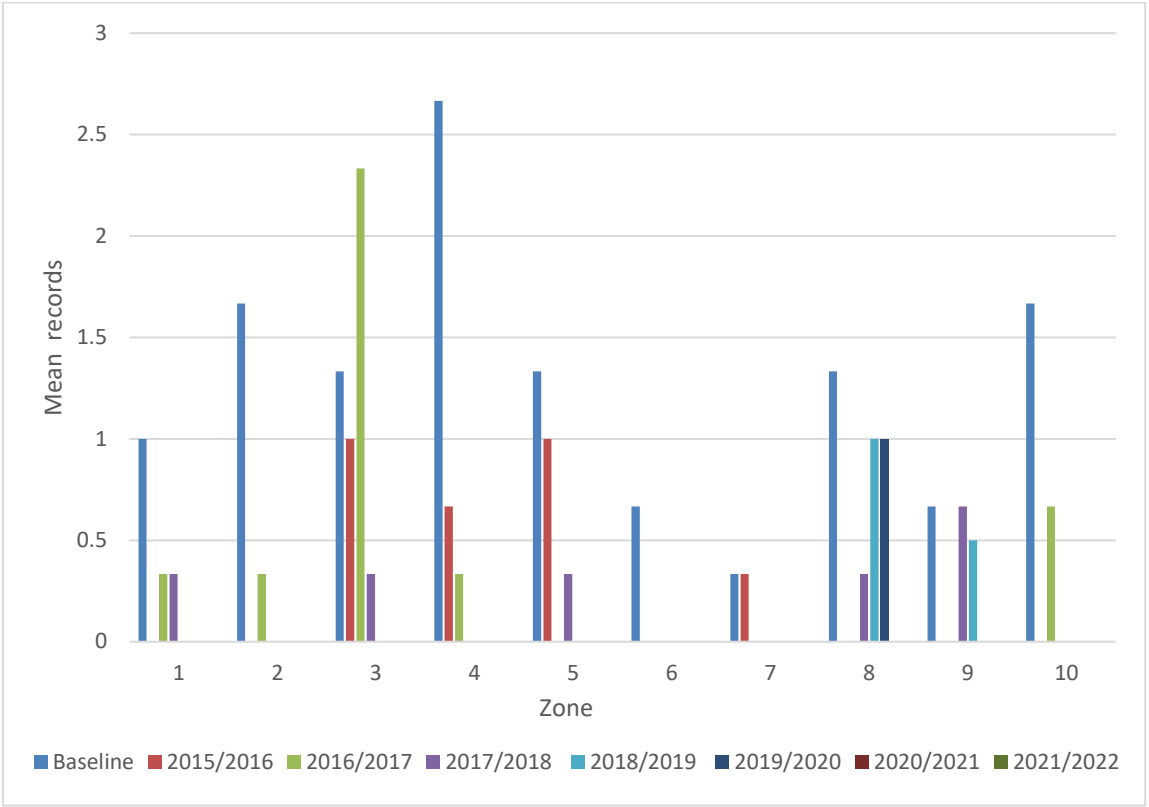
Graph 6: Pipers Creek impact site: mean number of Giant Barred Frogs per zone



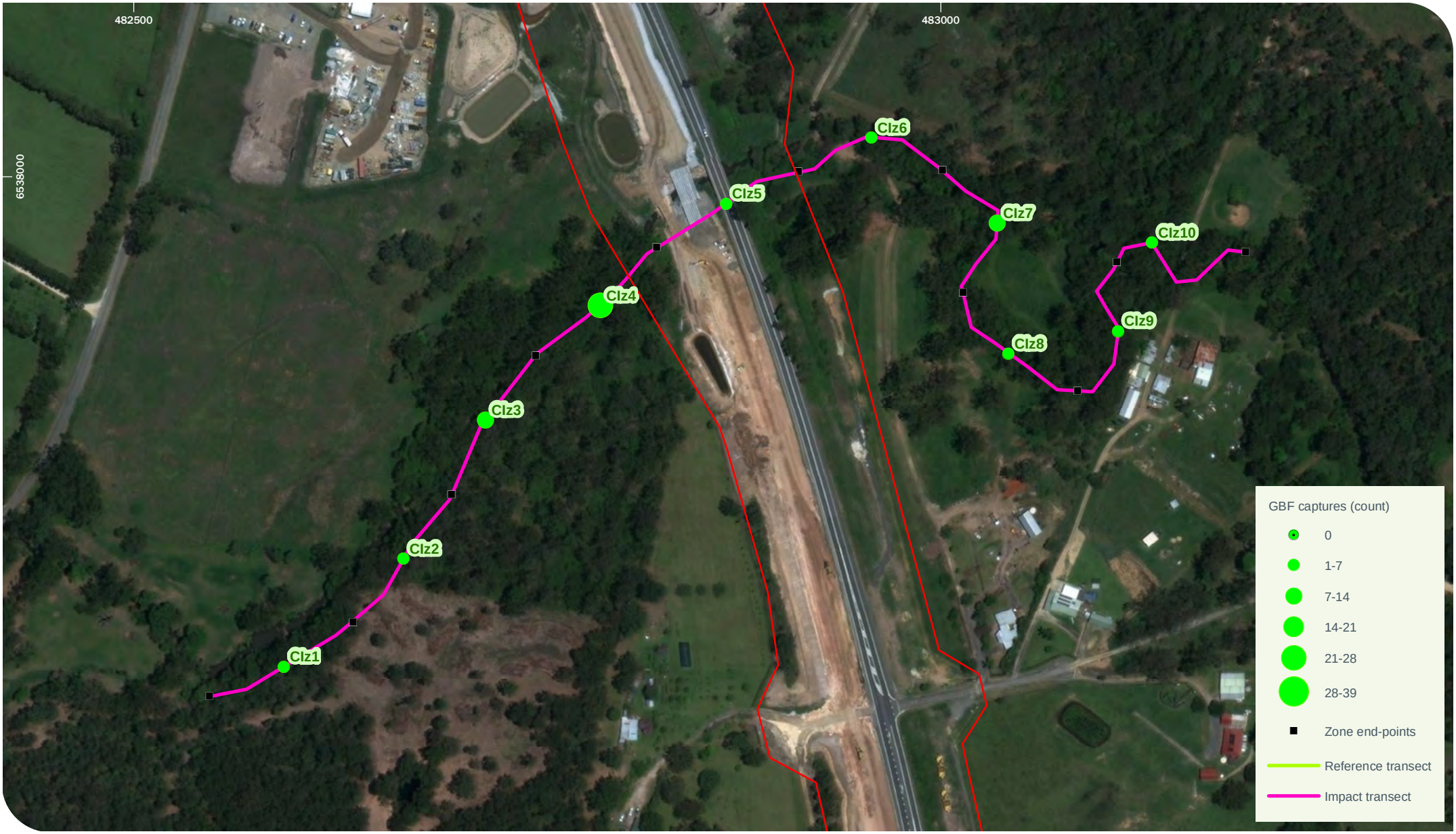
Graph 7: Maria River impact site: mean number of Giant Barred Frogs per zone



Graph 8: Cooperabung Creek reference site: mean number of Giant Barred Frogs per zone



Graph 9: Pipers Creek reference site: mean number of Giant Barred Frogs per zone



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Giant Barred Frog capture distribution: Cooperabung Creek impact site

Pacific Highway Upgrade - Oxley Highway to Kempsey

Niche PM: Jodie Danvers
Niche Proj. #: 1702 PI 5.3
Client: Transport for NSW

Figure 8

Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Niche PM: Jodie Danvers
Niche Proj. #: 1702 PI 5.3
Client: Transport for NSW

Giant Barred Frog capture distribution: Smiths Creek impact site

Pacific Highway Upgrade - Oxley Highway to Kempsey

Figure 9

Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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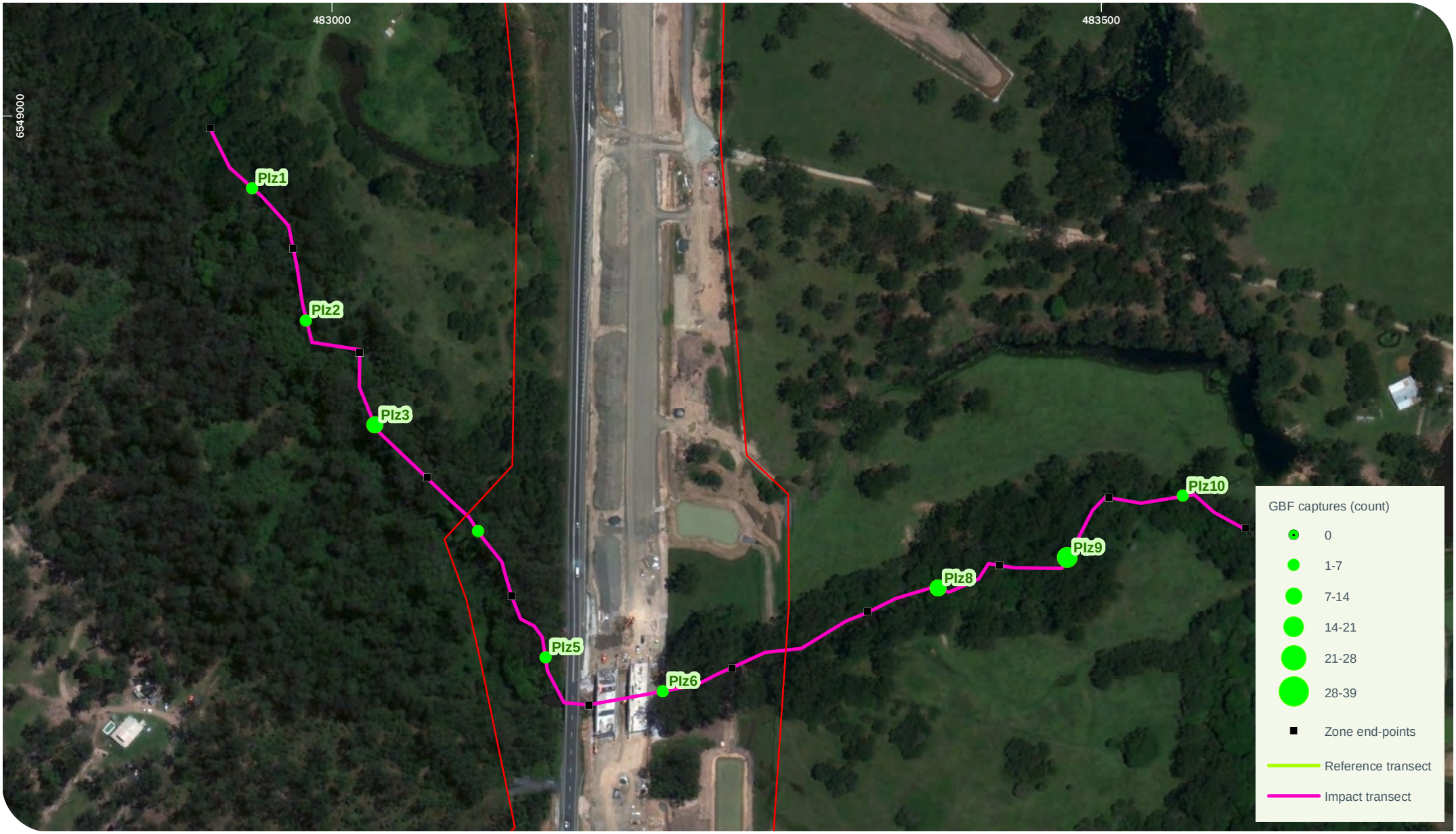

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Niche PM: Jodie Danvers
Niche Proj. #: 1702 PI 5.3
Client: Transport for NSW

Giant Barred Frog capture distribution: Pipers Creek impact site

Pacific Highway Upgrade - Oxley Highway to Kempsey

Figure 10

Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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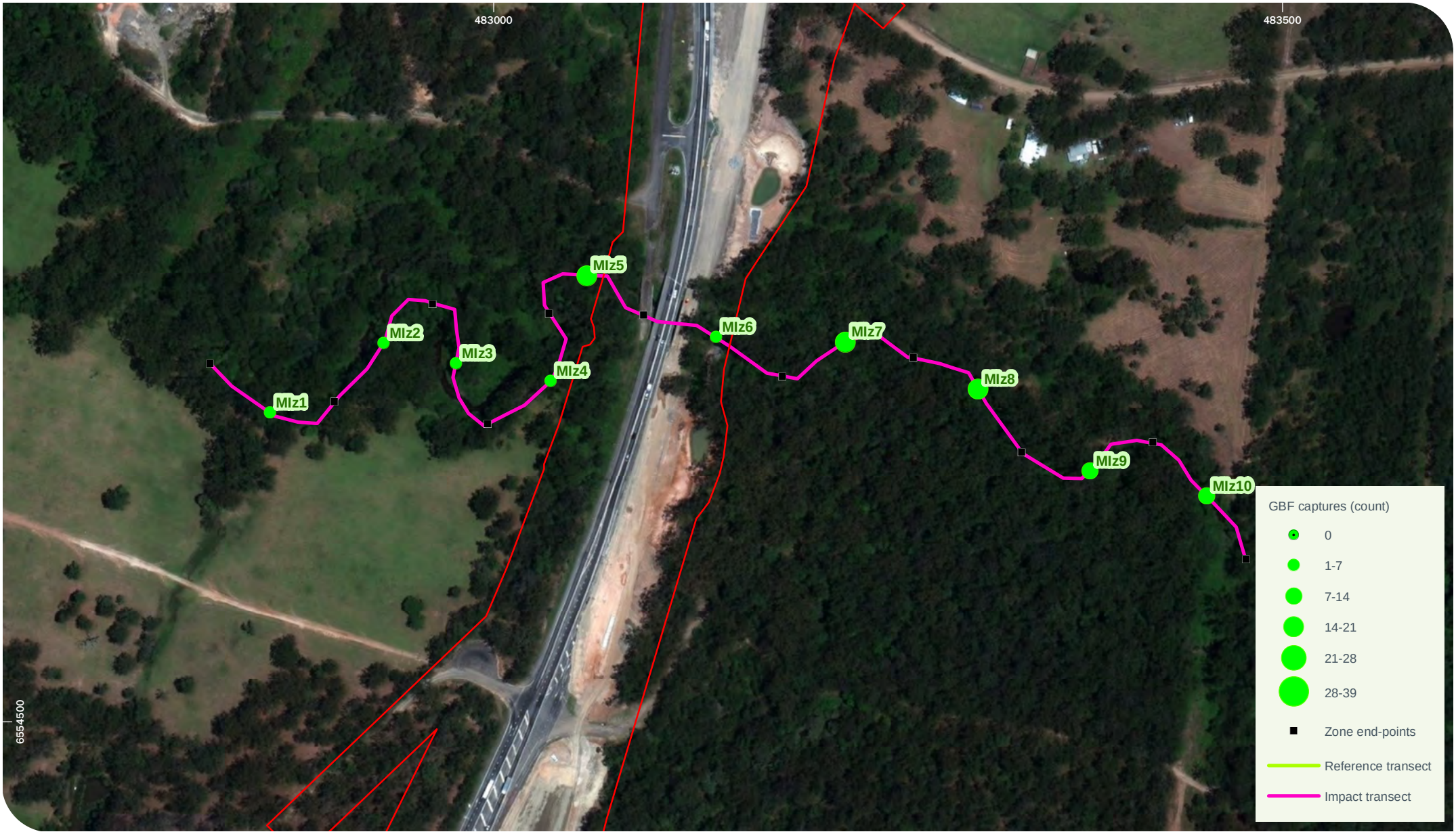

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Niche PM: Jodie Danvers
Niche Proj. #: 1702 PI 5.3
Client: Transport for NSW

Giant Barred Frog capture distribution: Maria River impact site

Pacific Highway Upgrade - Oxley Highway to Kempsey

Figure 11

Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Giant Barred Frog capture distribution: Cooperabung Creek reference site

Pacific Highway Upgrade - Oxley Highway to Kempsey

Niche PM: Jodie Danvers
Niche Proj. #: 1702 PI 5.3
Client: Transport for NSW

Figure 12

Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Niche PM: Jodie Danvers
Niche Proj. #: 1702 PI 5.3
Client: Transport for NSW

Giant Barred Frog capture distribution: Pipers Creek reference site

Pacific Highway Upgrade - Oxley Highway to Kempsey

Figure 13

Imagery: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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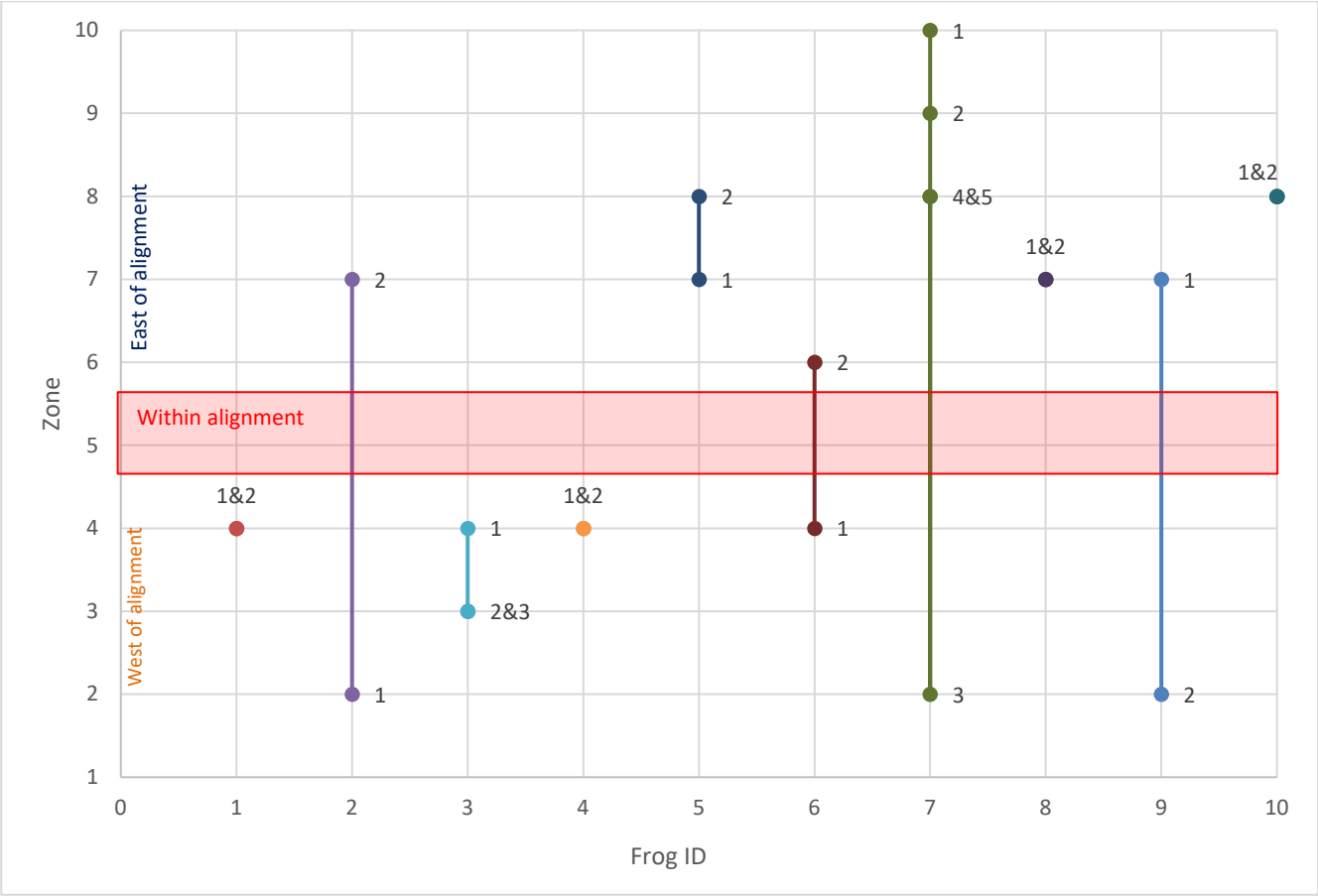
3.4 Movement

Recapture data of PIT-tagged individuals was used to determine movements along the transects, and notably, past the midpoint of the transect i.e. from one side of the carriageway to the other at the impact sites. It should be noted that this analysis does not imply that individuals that have not been found on opposite sides of the carriageway have not traversed at some time. Graph 10 - Graph 15 show the movement patterns of individual recaptured Giant Barred Frogs at each site and the data is summarised for each site below. As reference sites by their nature do not traverse the carriageway, a transect midpoint has been included to provide an indication of movements along the transects and permit comparison between reference and impact sites. The reference transect midpoint was chosen as the arbitrary location by which to assess movement along the transect (i.e. equal zones on either side). It should be noted that comparisons made between impact and reference sites do not take into account other potentially confounding factors such as site specific population ecology. Capture order is indicated by the numbers beside each capture point and a single capture point indicates recaptures within the same zone.

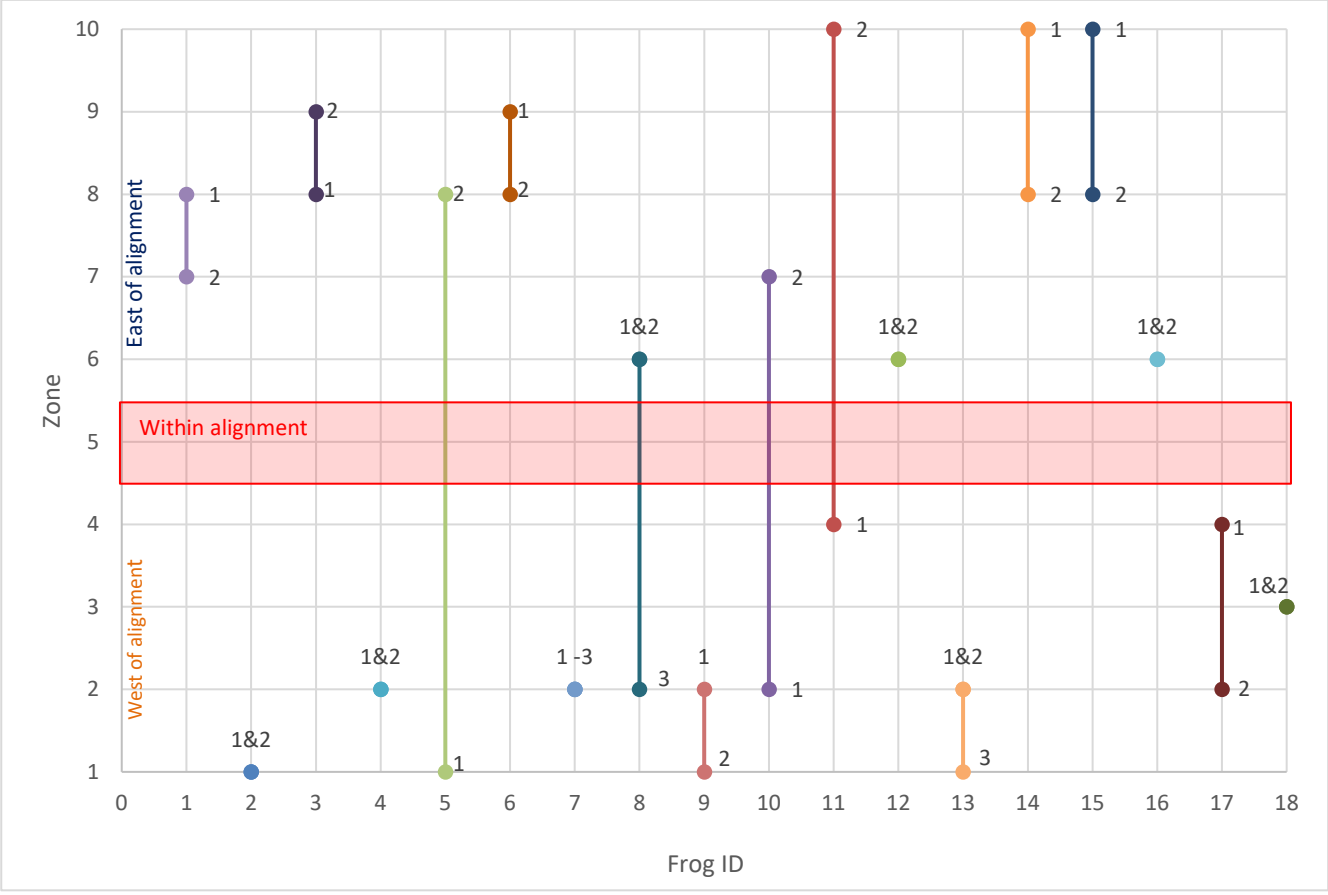
A total of 93 individuals have been recaptured on at least one occasion over all monitoring events. Of these, 50 recaptures have occurred at the impact sites. Twelve (24%) of these individuals from impact sites have been captured on both sides of the carriageway over successive monitoring events, demonstrating retained connectivity for this species under the carrageway. Of the 43 recaptures at the reference sites, 11 (26%) have been captured on both sides of the midpoint over successive monitoring events. The results at each of the monitoring sites are as follows:

- *Cooperabung Creek impact site*: Ten Giant Barred Frogs have been recaptured over all monitoring periods. Of these individuals, four (40%) have been captured on both sides of the carriageway, including one individual (ID#7) that traversed on at least two occasions.
- *Smiths Creek impact site*: Eighteen Giant Barred Frogs have been recaptured over all monitoring periods. Of these individuals, four (22%) have been captured on both sides of the carriageway.
- *Pipers Creek impact site*: Thirteen Giant Barred Frogs have been recaptured over all monitoring periods. Of these individuals, three (23%) have been captured on both sides of the carriageway.
- *Maria River impact site*: Nine Giant Barred Frogs have been recaptured over all monitoring periods. Of these individuals, one (11%) has been captured on both sides of the carriageway.
- *Cooperabung Creek reference site*: Nine Giant Barred Frogs have been recaptured over all monitoring periods. Of these individuals, two (22%) have been captured on both sides of the transect midpoint.
- *Pipers Creek reference site*: Thirty-four Giant Barred Frogs have been recaptured over all monitoring periods. Of these individuals, nine (26%) have been captured on both sides of the transect midpoint. including three individuals (ID#18, 19 and 23) that have traversed on at least two occasions.

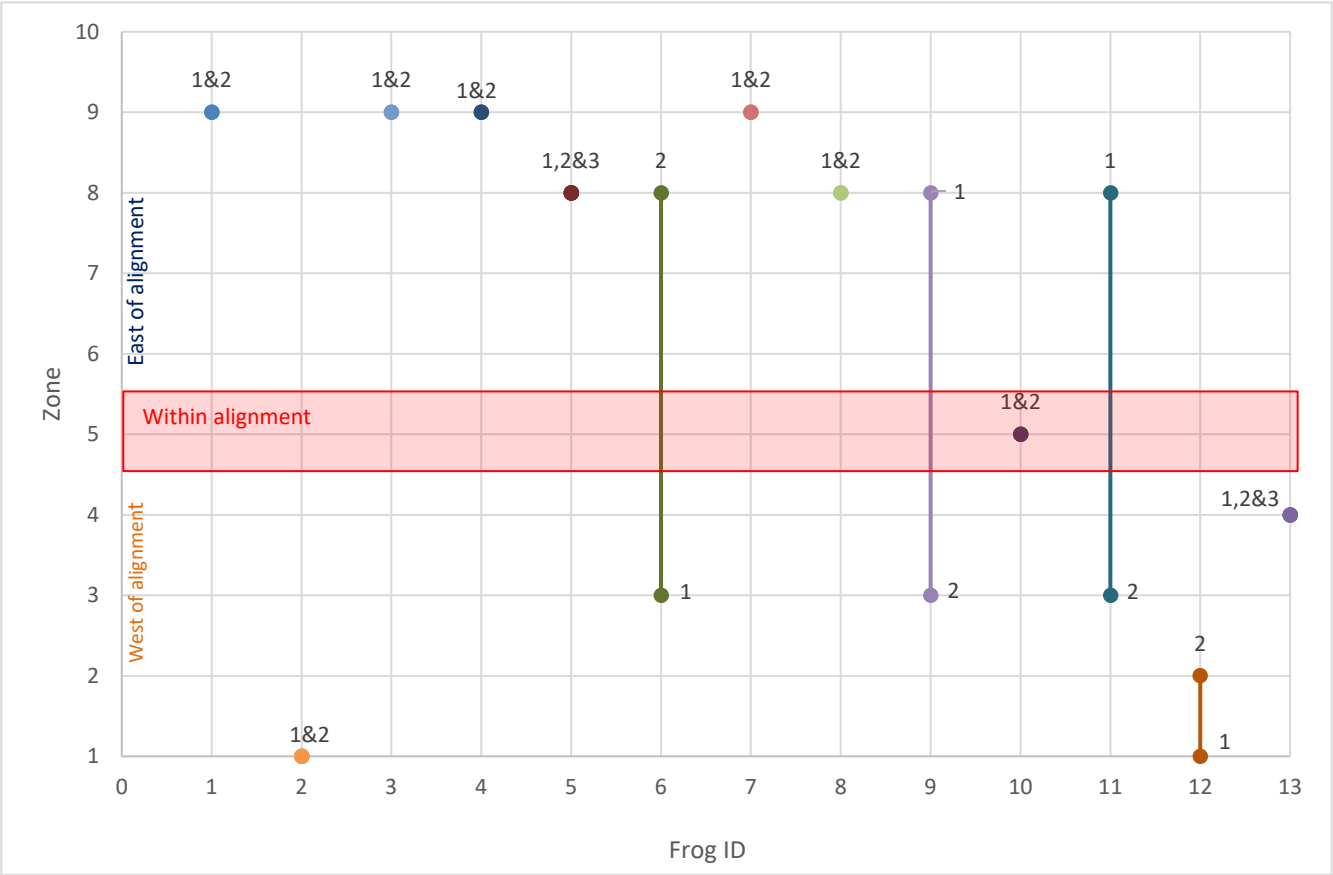
At the impact sites, while the monitored waterways continue uninterrupted under the carriageway, there is a distinct change in streamside vegetation within the area immediately under the carriageway. Under the carriageway at all impact sites, streamside vegetation ranges from limited to moderately dense, represented by patches of shrubs and/or *Lomandra* spp. The streamside habitat in these areas consists of native vegtation,large rocks and boulders or bare ground. Despite changes in streamside habitat immediately under the carriageway, a number of Giant Barred Frogs have been recorded traversing the carriageway. The percentage of Giant Barred Frogs found to have traversed the impact site midpoints do not appear to differ substantially from the percentage of Giant Barred Frogs found to have traversed the reference site midpoints.



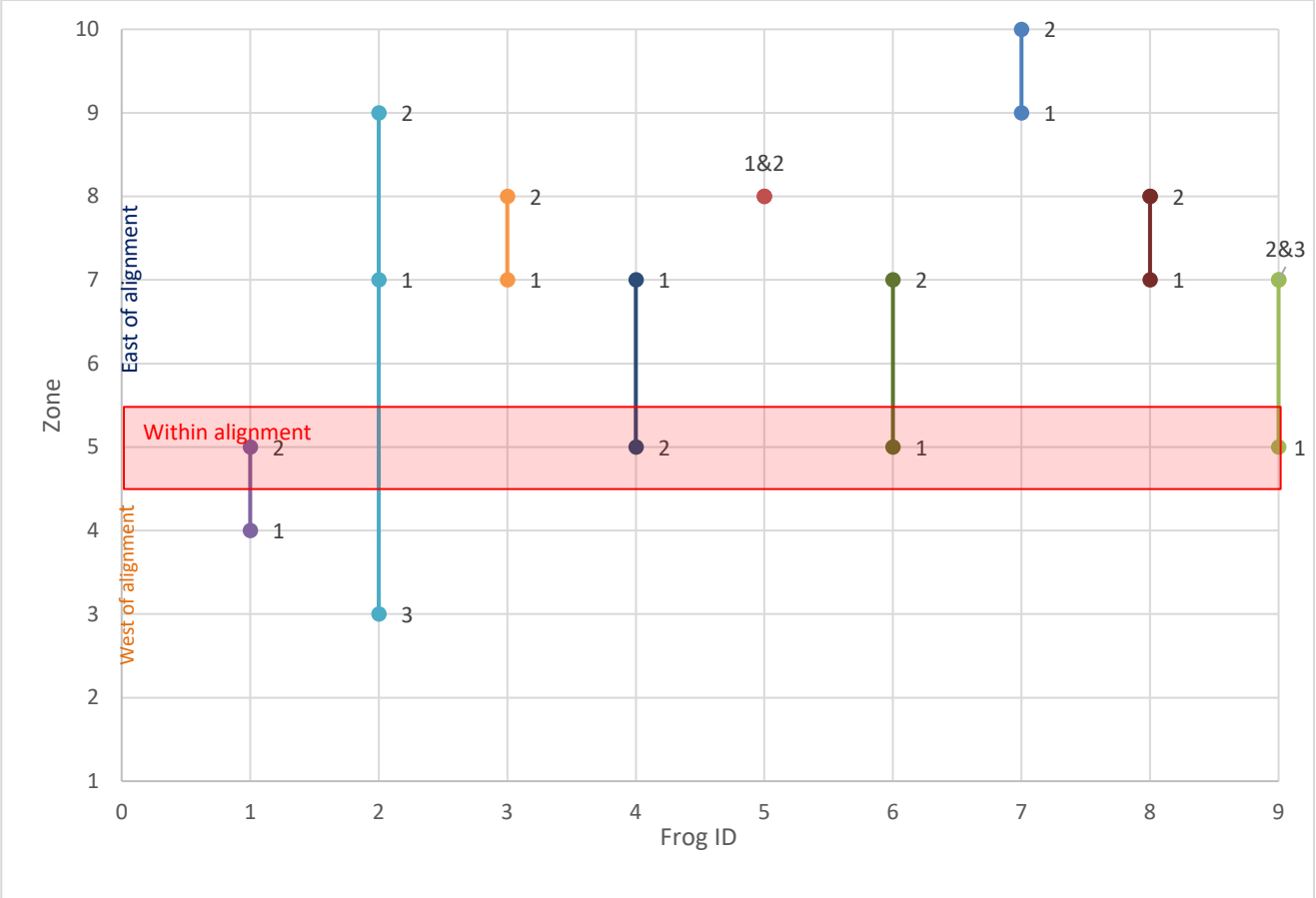
Graph 10: Cooperabung Creek impact site: recapture movement patterns



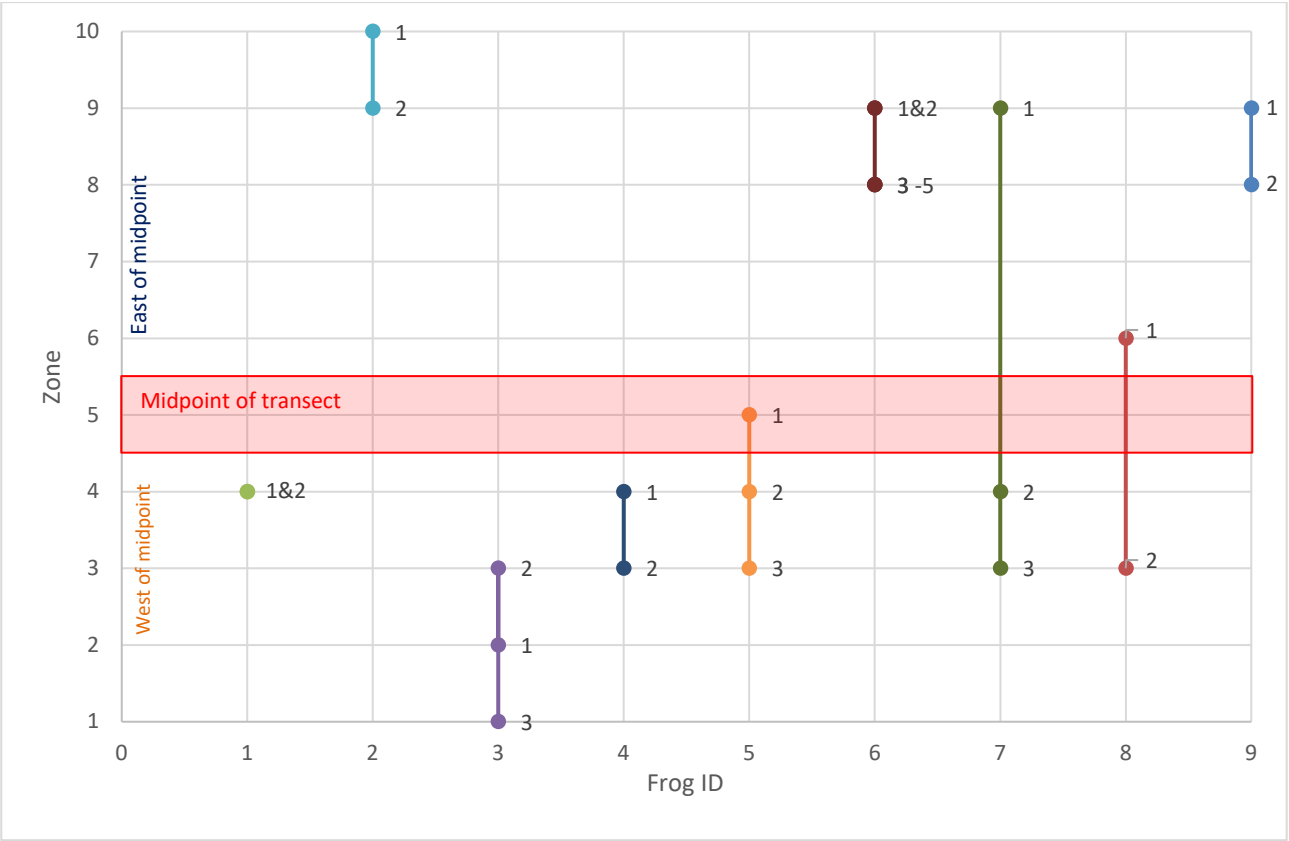
Graph 11: Smiths Creek impact site: recapture movement patterns



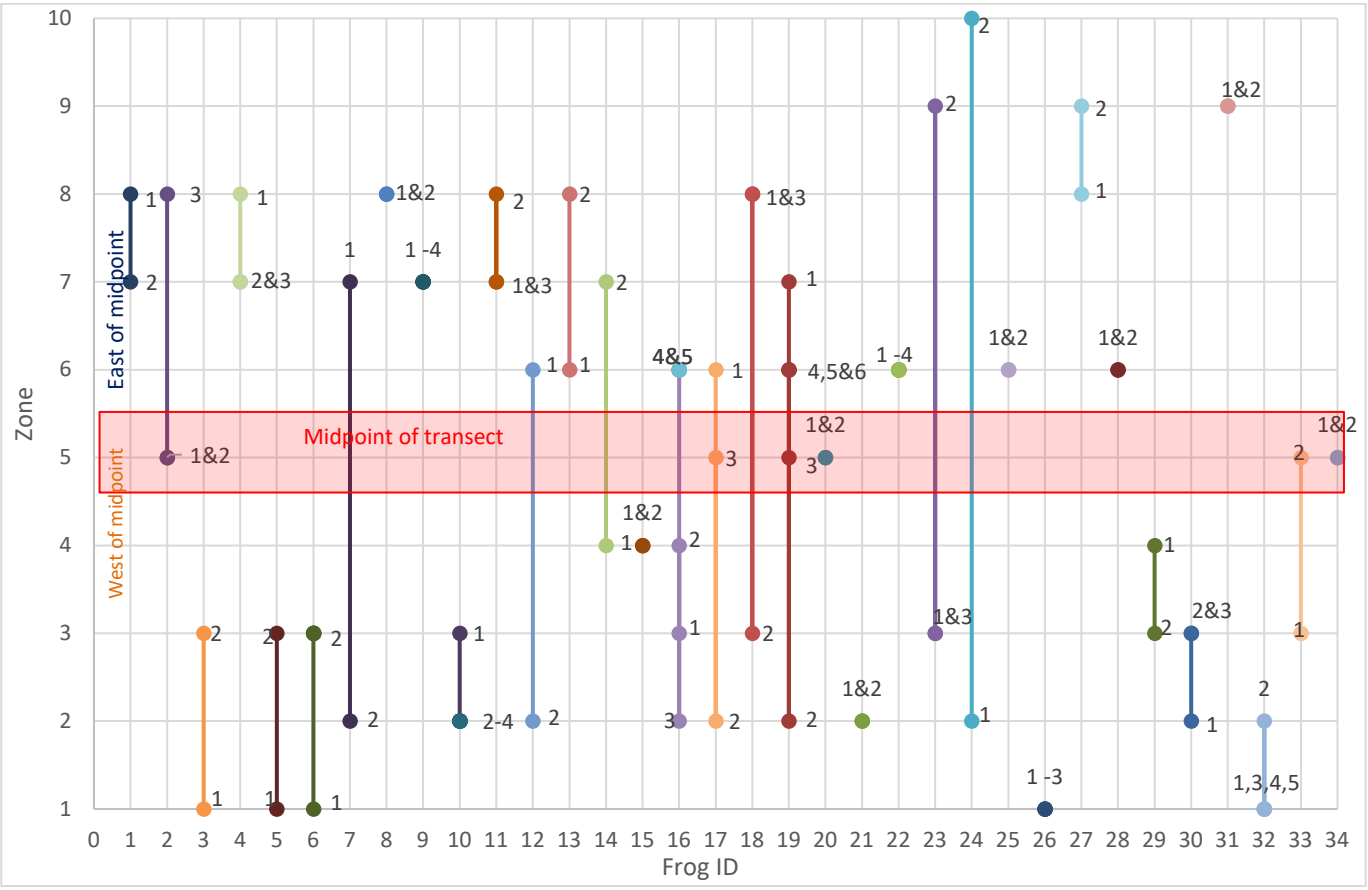
Graph 12: Pipers Creek impact site: recapture movement patterns



Graph 13: Maria River impact site: recapture movement patterns



Graph 14: Cooperabung Creek reference site: recapture movement patterns



Graph 15: Pipers Creek reference site: recapture movement patterns

4. Discussion

4.1 Performance Measures

A summary of Year 1 (2015/2016), Year 2 (2016/2017), Year 3 (2017/2018), Year 4 (2018/2019), Year 5 (2019/2020), Year 6 (2020/2021) and Year 7 (2021/2022) survey results in relation to the performance measures is provided in Table 5.

Table 4: Performance measures and discussion of results.

Performance measure	Discussion
Monitoring is undertaken during baseline surveys and Years 1 – 8 or until monitoring can demonstrate that mitigation measures are effective.	**This performance measure has been met for all years**. Giant Barred Frog monitoring has been undertaken at all six baseline sites at least twice during the monitoring period according to the EMP to date. Autumn 2021/2022 surveys were not undertaken at the Maria River impact site due to inaccessiblility after an increase in the growth of Lantana along the bank.
Monitoring during Year 1 – 8 is undertaken at the Impact and Control sites where baseline monitoring was undertaken, subject to landowner agreement.	**This performance measure has been met for all years**. Giant Barred Frog monitoring has been undertaken at all six baseline sites at least twice during the monitoring period, where landowner agreement permitted. Autumn 2021/2022 surveys were not undertaken at the Maria River impact site due to inaccessiblility after an increase in the growth of lantana along the bank.
Continued presence of Giant Barred Frogs during each survey event in Year 1 – 8 at sites where it was identified during baseline surveys, subject to access due to landowner agreement.	**This performance measure has been met for all sites in Year 1 (2015/2016), 5 of 6 sites in Year 2 (2016/2017), Year 3 (2017/2018), Year 4 (2018/2019), 3 of 6 sites in Year 5 (2019/2020), 2 of 6 sites in Year 6 (2020/2021) and 1 of 6 sites in Year 7 (2021/2022).** Baseline: Giant Barred Frogs were recorded at all six monitoring sites in spring and summer and at four sites in autumn. Giant Barred Frogs were not recorded at the Maria River impact site and Pipers Creek reference site during the autumn 2014 baseline survey. Year 1 (2015/2016): Giant Barred Frogs were detected at all six sites during all surveys. Year 2 (2016/2017): Giant Barred Frogs were detected at all six sites in spring and summer and five sites in autumn. Not recorded at Pipers Creek impact site during the autumn 2017 survey where it was detected during baseline surveys. Year 3 (2017/2018): Giant Barred Frogs were detected at all six sites in spring and five sites in summer and autumn. Not recorded at Pipers Creek impact site during summer and autumn 2018 where it was detected during baseline surveys. Year 4 (2018/2019): Giant Barred Frogs were detected at five sites in spring and all six sites in autumn. Not recorded at Cooperabung Creek reference site during spring 2018 where it was detected during baseline surveys. Year 5 (2019/2020): Giant Barred Frogs were not recorded at Cooperabung Creek impact site, where it was recorded during all three baseline surveys. Not recorded at Maria River impact during summer 2020, where it was recorded during baseline surveys and not recorded at Cooperabung Creek reference site during spring 2019, where it was detected during baseline surveys. Year 6 (2020/2021): Giant Barred Frogs were not recorded at Cooperabung Creek impact, Smiths Creek impact and Cooperabung reference sites during 2020/2021 surveys. Giant Barred Frogs were not recorded during autumn surveys (Pipers Creek reference site was not surveyed). Giant Barred Frogs were detected in summer at Maria River impact, Pipers Creek impact and Pipers Creek reference sites. Giant Barred Frogs were detected during spring surveys only at Maria River impact and Pipers Creek reference sites. Year 7 (2021/2022): Giant Barred Frogs were not recorded at Smiths Creek impact, Maria River impact and Cooperabung reference sites during 2021/2022 surveys. Giant

Performance measure	Discussion
	Barred Frogs were not recorded in spring at Cooperabung impact site or autumn at Pipers Creek impact site.
Mitigation measures are effective as defined in the EPBC approval when all monitoring events are considered at Year 8.	This performance measure is not yet applicable. Mitigation measures for the Giant Barred Frog include protection of habitat during clearing and construction, pre-clearing surveys, installation of Giant Barred Frog fence and an unexpected finds procedure (Lewis 2013). Construction related mitigation measures were successfully implemented and may be deemed to have been effective as frogs observed during works were captured and released safely, and no threatened fauna mortaliites due to clearing operations were reported. The effectiveness of the Giant Barred Frog Frence is assessed using the outcomes of road kill surveys and targeted threatened frog searches. To date, Giant Barred Frogs have not been identified as road kill. Results (review of movement patterns of re-captured individuals showing records along the creek on either side of the carriageway) indicate that Giant Barred Frogs are moving underneath the road. It is unknown if they used the underpasses, however, no breaches of the frog fencing were observed during surveys.
Median values of all downstream water quality monitoring at GBF habitat or potential habitat locations during construction and operation (Year 1 – 6) is less than the 80th percentile value of the upstream site (where 80th percentile is the value at which median values at the downstream site are above 80% of the recorded background water quality records), where this change is found to be attributable to construction or operation.	This performance measure is not applicable for Year 7.
No change to densities, distribution, habitat use and movement patterns compared to baseline data during monitoring in Year 1 – 8, and then when all monitoring events are considered at Year 8.	**This performance measure has not been met.** The number and location of Giant Barred Frogs recorded has varied between season and year at all sites. All sites show an overall decreasing trend in mean records and densities. However, as this decreasing trend is evident at both impact and reference sites, it is not possible to attribute these changes to the Project at this stage. As discussed, the high rainfall experience in 2020/2021 and 2021/2022 resulted in highly variable water levels, waterway flooding and expansive water flows across floodplains. The above-average rainfall conditions observed over the spring/summer periods of 2020/2021 and 2021/2022 follow the long-term drought conditions experienced across the Project area in 2019. It is possible that the population changes observed at all sites are in response to these changing conditions. Low capture rates may be a result of population impacts from drought conditions followed by waterway flooding, which is also likely to reduce capture and observation rates simply due to the likely dispersal of individuals across a broader wet area. A population response to improved waterway conditions after the 2020/2021 rainfall may be evidenced by the increased capture rates at some somes, but also hindered by difficult (flooding) survey conditions. Within-year movement patterns that would permit comparison between baseline and subsequent monitoring events is not possible due to lack of data (surveys and captures are too infrequent), however, assessment of movement patterns of recaptured individuals over all surveys show that 24% of recaptured frogs have been found to traverse from one side of the carriageway to the other.

5. Recommendations

5.1 Contingency Measures

The EMP lists potential problems and contingency measures for various components of the monitoring program. Those that are considered relevant to the Giant Barred Frog monitoring program are listed and discussed in Table 6.

Table 5: Contingency measures

Potential problem	Contingency measure proposed in EMP	Discussion of proposed measure
Decline in presence of target species recorded at Impact sites after the upgrade has been completed, when compared to change in Control sites.	The cause of the decline in populations at impacts sites will be investigated in consultation with EPA and DoTE within two weeks of results reported by ecologist. If the cause of decline is considered most likely attributed to the upgrade of the highway (and not another event such as bushfire), mitigation measures, such as the location and types of fauna crossings and fauna fencing will be reviewed within two months of the above consultation being completed.	All sites show an overall decreasing trend in mean records. However, as this decreasing trend is evident at both impact and reference sites, it is not possible to attribute these changes to the Project. The potential influence of environmental variables, such as drought and widespread flooding, may have contributed to the decreasing trend in records/observations. The apparent reduction in Giant Barred Frog numbers, however, is noted and will be considered in future monitoring events. **This contingency measure is not yet considered relevant**.

5.2 Recommendations

A summary of those performance indicators that were not met in the 2021/2022 monitoring period, recommended corrective actions and general recommendations are provided in Table 7.

Table 6: Recommendations

Performance measure	Action
Continued presence of Giant Barred Frogs during each survey event in Year 1 – 8 at sites where it was identified during baseline surveys, subject to access due to landowner agreement.	**This performance measure has been met for 1 of 6 sites in Year 7 (2021/2022).** Giant Barred Frogs were • Not recorded at Smiths Creek impacts site, Maria River impact site and Cooperabung Creek reference site, where it was recorded during all three baseline surveys. • Not recorded at Cooperabung Creek impact site in spring 2021 and Pipers Creek impact site in autumn 2021, where it was recorded during baseline surveys. Due to extreme climatic conditions and reduced records at all sites (impact and reference) it is recommended that monitoring continue as per the EMP. It should be noted that Giant Barred Frogs have become difficult to detect and access in some areas along the transects due to the density of stream-side vegetation.
No change to densities, distribution, habitat use and movement patterns compared to baseline data during monitoring in Year 1 – 8, and then when all monitoring events are considered at Year 8.	**This performance measure has not been met.** As discussed in Table 6, all sites show an overall decreasing trend in mean records and densities. However, as this decreasing trend is evident at both impact and reference sites, it is not possible to attribute these changes to the Project. It is recommended that monitoring continue as per the EMP. Due to extreme climatic conditions and reduced records at all sites (impact and reference) it is recommended that monitoring continue as per the EMP.

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Annex 1 – 2021/2022 data summary for each monitoring site

Cooperabung Creek impact site

Table 7: Summary of surveys and prevailing abiotic variables: Cooperabung Creek impact site

Date	Time		Air temp. °C	Water temp. °C	Humidity %	Stream depth (cm)	Wind (0-3, 0= no wind)	Cloud cover %	Rain (0-3, 0= no rain)
13/10/2021	Start	23:31	17.1	16	89	200	0	100	0
	Finish	01:00	17.1	16	89	200	0	100	0
9/12/2021	Start	22:17	20	21	80	50	0	15	0
	Finish	23:45	19.6	21	80	60	0	20	0
27/04/2022	Start	20:00	20.4	22	90	35	0	100	1
	Finish	21:45	18.9	21	93	50	0	100	1

Table 8: Habitat details: Cooperabung Creek impact site

Zone	OS %	Sh %	G %	LL %	BE %	Cattle	Pools	Riffles	DoP (cm)	EF	Frogs detected	FB
4	90	5	5	100	0	no	2	0	150	yes	no	Unk
3	80	50	58	30	25	yes	3	3	50	yes	no	Unk
5	10	15	50	15	10	yes	2	2	40	yes	no	Unk
6	90	28	50	20	10	yes	2	2	40	yes	no	Unk
7	40	20	5	60	15	yes	3	2	50	yes	no	Unk
8	50	30	50	50	5	no	3	2	40	yes	no	Unk

OS = overstorey cover, Sh = Shrub cover, G = Ground cover, LL = leaf litter cover, BE = bare earth, DoP = depth of deepest pool, FB = fence breach, EF = exotic fish

Table 9: Summary of captures: Cooperabung Creek impact site

	Spring 2021	Summer 2021	Autumn 2022
Number of frogs recorded	0	1	5
Number of adult males	0	0	2
Number of adult females	0	1	1
Number of sub-adults	0	0	0
Number of juveniles	0	0	0
Number of recaptures	0	0	0

Habitat: Microhabitat within these zones included flood debris as overhang shelter, lomandra and leaf litter.

Smiths Creek impact site

Table 10: Summary of surveys and prevailing abiotic variables: Smiths Creek impact site

Date	Time		Air temp. °C	Water temp. °C	Humidity %	Stream depth (cm)	Wind (0-3, 0= no wind)	Cloud cover %	Rain (0-3, 0= no rain)
14/10/2021	Start	21:14	15.8	17	98	30	3	0	0
	Finish	23:00	15	17	86	40	3	0	0
7/12/2021	Start	22:51	19.6	21	80	60	1	10	0
	Finish	22:51	19.6	21	80	100	0	2	0
28/04/2022	Start	19:55	18.5	21	98	40	0	0	0
	Finish	21:55	17.9	21	100	40	0	0	0

Table 11: Habitat details: Smiths Creek impact site

Zone	OS %	Sh %	G %	LL %	BE %	Cattle	Pools	Riffles	DoP (cm)	EF	Frogs detected	FB
3	90	5	5	60	20	no	2	0	100	yes	no	Unk
4	75	15	10	25	50	no	1	0	150	yes	no	Unk
2	85	2	5	60	10	no	2	0	100	yes	no	Unk
1	95	5	90	10	0	no	2	0	150	yes	no	Unk
5	15	5	10	5	50	no	91	0	100	yes	no	Unk
6	50	5	2	50	50	yes	1	0	100	yes	no	Unk
7	50	5	80	15	10	yes	2	0	100	yes	no	Unk
8	50	2	5	10	68	yes	2	0	150	yes	no	Unk
9	50	5	0	80	20	yes	0	0	150	yes	no	Unk
10	50	15	50	25	10	yes	1	0	200	yes	no	Unk

OS = overstorey cover, Sh = Shrub cover, G = Ground cover, LL = leaf litter cover, BE = bare earth, DoP = depth of deepest pool, FB = fence breach, EF = exotic fish

Table 12: Summary of captures: Smiths Creek impact site

	Spring 2021	Summer 2021	Autumn 2022
Number of frogs recorded	0	0	0
Number of adult males	0	0	0
Number of adult females	0	0	0
Number of sub-adults	0	0	0
Number of juveniles	0	0	0
Number of recaptures	0	0	0

Habitat: Microhabitat within these zones included leaf litter, flood debri under log and on bare ground.

Pipers Creek impact site

Table 13: Summary of surveys and prevailing abiotic variables: Pipers Creek impact site

Date	Time		Air temp. °C	Water temp. °C	Humidity %	Stream depth (cm)	Wind (0-3, 0= no wind)	Cloud cover %	Rain (0-3, 0= no rain)
11/10/2021	Start	19:36	15	17	90	40	0	100	0
	Finish	21:50	14.8	17	86	180	1	100	0
7/12/2021	Start	20:02	21.4	21	92	50	1	5	0
	Finish	22:51	19.7	21	80	50	1	50	0
27/04/2022	Start	20:00	20.4	22	90	35	0	100	1
	Finish	21:45	18.9	21	93	50	0	100	1

Table 14: Habitat details: Pipers Creek impact site

Zone	OS %	Sh %	G %	LL %	BE %	Cattle	Pools	Riffles	DoP (cm)	EF	Frogs detected	FB
5	50	20	2	100	0	no	1	0	150	yes	no	Unk
4	20	50	60	10	2	no	1	0	150	yes	yes	Unk
3	80	30	0	25	80	yes	1	1	100	yes	no	Unk
2	75	45	80	25	10	no	3	2	30	yes	no	Unk
1	80	55	30	50	15	no	2	1	50	yes	no	Unk
6	10	0	20	5	80	yes	1	0	200	yes	no	Unk
7	50	2	5	5	90	yes	2	2	150	yes	no	Unk

OS = overstorey cover, Sh = Shrub cover, G = Ground cover, LL = leaf litter cover, BE = bare earth, DoP = depth of deepest pool, FB = fence breach, EF = exotic fish, - = unknown

Table 15: Summary of captures: Pipers Creek impact site

	Spring 2021	Summer 2022	Autumn 2022
Number of frogs recorded	0	3	0
Number of adult males	0	0	0
Number of adult females	1	1	0
Number of sub-adults	0	2	0
Number of juveniles	0	0	0
Number of recaptures	0	0	0

Habitat: Microhabitat use included leaf litter and on bare ground at tree base.

Maria River impact site

Table 16: Summary of surveys and prevailing abiotic variables: Maria River impact site

Date	Time		Air temp. °C	Water temp. °C	Humidity %	Stream depth (cm)	Wind (0-3, 0= no wind)	Cloud cover %	Rain (0-3, 0= no rain)
11/10/2021	Start	22:11	14.6	17	86	0	1	100	0
	Finish	24:10	14	17	86	50	2	100	1
9/12/2021	Start	0:12	20	21	100	40	0	100	2
	Finish	2:06	19	21	100	50	0	100	3
26/04/2022	Start	22:49	16.7	21	100	40	0	100	0
	Finish	Not surveyed							

Table 17: Habitat details: Maria River impact site

Zone	OS %	Sh %	G %	LL %	BE %	Cattle	Pools	Riffles	DoP (cm)	FB	EF	Frogs detected
6	70	80	85	60	5	no	2	0	100		yes	no
10	75	80	80	90	0	no	1	0	150		yes	
9	90	50	10	100	0	no	2	0	100		yes	
5	85	80	70	28	10	no	1	0	200		yes	no
1	60	100										no
2	50	100										
3	50	100				no					yes	no
4	70	100				no					yes	no
7	75	60	100	30	15	no	3	0	100		yes	no
8	75	80	25	70	0	no	2	0	100		yes	no

OS = overstorey cover, Sh = Shrub cover, G = Ground cover, LL = leaf litter cover, BE = bare earth, DoP = depth of deepest pool, FB = fence breach, EF = exotic fish

Table 18: Summary of captures: Maria River impact site

	Spring 2021	Summer 2021	Autumn 2022
Number of frogs recorded	0	0	0
Number of adult males	0	0	0
Number of adult females	0	0	0
Number of sub-adults	0	0	0
Number of juveniles	0	0	0
Number of recaptures	0	0	0

Habitat: Microhabitat within these zones included under grass and leaf litter. Lantana is very abundant along both side of the river banks and is the dominant vegetation from MIz1 to MIz5. Lantana has also increased it's dominance of the downstream side throughout all zones. Access in Autumn 2022 was not possible due to increased lantana.

Cooperabung Creek reference site

Table 19: Summary of surveys and prevailing abiotic variables: Cooperabung Creek reference site

Date	Time		Air temp. °C	Water temp. °C	Humidity %	Stream depth (cm)	Wind (0-3, 0= no wind)	Cloud cover %	Rain (0-3, 0= no rain)
14/10/2021	Start	19:20	20	17	89	50	3	5	0
	Finish	21:00	20	17	80	40	3	0	0
9/12/2021	Start	20:01	21.2	21	96	60	0	80	0
	Finish	20:01	20.2	21	80	50	0	20	0
28/04/2022	Start	17:53	21.7	23	85	20	1	15	0
	Finish	19:35	21	23	88	25	0	5	0

Table 20: Habitat details: Cooperabung Creek reference site

Zone	OS %	Sh %	G %	LL %	BE %	Cattle	Pools	Riffles	DoP (cm)	Frogs detected	EF	FB
2	20	15	70	10	5	no	3	4	60	yes	no	2
3	30	15	60	15	10	no	2	4	40	yes	no	3
4	95	5	10	40	20	no	2	6	50	yes	no	4
5	20	50	25	50	10	no	2	2	40	yes	no	5
6	50	5	90	5	0	no	1	5	40	yes	no	6
7	95	45	10	55	5	no	1	6	60	yes	no	7
5	55	20	15	55	5	no	2	3	50	yes	no	5
8	95	15	10	70	20	no	1	5	50	yes	no	8

OS = overstorey cover, Sh = Shrub cover, G = Ground cover, LL = leaf litter cover, BE = bare earth, DoP = depth of deepest pool, FB = fence breach, EF = exotic fish

Table 21: Summary of captures: Cooperabung Creek reference site

	Spring 2021	Summer 2021	Autumn 2022
Number of frogs recorded	0	0	0
Number of adult males	0	0	0
Number of adult females	0	0	0
Number of sub-adults	0	0	0
Number of juveniles	0	0	0
Number of recaptures	0	0	0

Habitat: Microhabitat found being used included grass and *Lomandra longifolia*.

Pipers Creek reference site

Table 22: Summary of surveys and prevailing abiotic variables: Pipers Creek reference site

Date	Time		Air temp. °C	Water temp. °C	Humidity %	Stream depth (cm)	Wind (0-3, 0= no wind)	Cloud cover %	Rain (0-3, 0= no rain)
13/10/2021	Start	19:41	16.3	16	100	30	0	100	1
	Finish	23:00	15.9	16	100	20	0	100	2
8/12/2021	Start	20:23	20.6	21	90	20	0	50	0
	Finish	24:00	20	21	100	40	1	100	3
26/04/2022	Start	18:24	18	21	94	20	0	100	0
	Finish	22:00	16.8	21	100	50	0	100	0

Table 23: Habitat details: Pipers Creek reference site

Zone	OS %	Sh %	G %	LL %	BE %	Cattle	Pools	Riffles	DoP (cm)	EF	Frogs detected	FB
5	90	30	10	10	70	no	3	2	40	yes	no	
4		30	2	50	40	no	10	5	100	yes	yes	
3	60	15	1	90	10	no	5	4	100	yes	yes	
2	90	10	50	35	5	no	4	4	50	yes	yes	
1	85	10	10	25	30	no	4	3	40	yes	no	
6	95	45	5	10	40	no	3	2	100	yes	no	
7	30	10	90	10	2	no	2	2	100	yes	no	

OS = overstorey cover, Sh = Shrub cover, G = Ground cover, LL = leaf litter cover, BE = bare earth, DoP = depth of deepest pool, FB = fence breach, EF = exotic fish

Table 24: Summary of captures: Pipers Creek reference site

	Spring 2021	Summer 2021	Autumn 2022
Number of frogs recorded	6	10	2
Number of adult males	0	8	0
Number of adult females	1	0	1
Number of sub-adults	5	0	0
Number of juveniles	0	0	0
Number of recaptures	1	3	1

Habitat: Microhabitat within these zones included within leaf litter, sheltering under *Lomandra longifolia*, and on the creek bed, bank or bare ground.

Annex 2 - Giant Barred Frog individual capture data

L = length (mm); W = weight (g); DW = distance to water (m); Z = Zone; U = unknown; M = male; F = female; J = juvenile

Table 25: Giant Barred Frog capture data

Site	Location	Season	Sex	Age	Reproductive status	L	W	DW	pit_tag_code	Capture status	Z	Activity	Microhabitat
Impact	Piper's Creek	Spring	Female	Adult	Potential Gravid	102	250	3	007A0D205	Recapture	4	Sitting	under log
Reference	Piper's Creek	Spring	Unk	Sub Adult	Immature	43	25	10	NA	Immature	4	Jumping	leaf litter
Reference	Piper's Creek	Spring	Unk	Sub Adult	Immature	44	25	3	NA	Immature	3	Jumping	bare ground
Reference	Piper's Creek	Spring	Unk	Sub Adult	Light Nuptials	51		4	007A0B105	First time	3	Sitting	bare ground
Reference	Piper's Creek	Spring	Unk	Sub Adult	Immature	50	30	10	007A11BBE	First time	2	Sitting	leaf litter
Reference	Piper's Creek	Spring	Female	Adult	Potential Gravid	82	120	5	00791EB93	Recapture	3	Sitting	leaf litter
Reference	Piper's Creek	Spring	Unk	Sub Adult	Immature	52	35	5	007A3A948	First time	7	Sitting	leaf litter
Impact	Piper's Creek	Summer	Unk	Sub Adult		53	28	5	007A0E349	First time	5	Sitting	tree base
Impact	Piper's Creek	Summer	Unk	Sub Adult	Immature	64	47	4	0007E034F4	First time	2	Sitting	leaf litter
Impact	Piper's Creek	Summer	Female	Adult	n/a			3.5	NA	Uncaptured	2	Sitting	leaf litter
Reference	Piper's Creek	Summer	Male	Adult	Dark Nuptial Pads	63.5	55	5	0007E032CF	First time	5	Sitting	bank
Reference	Piper's Creek	Summer	Male	Adult	Light Nuptial Pads	74	80	1.5	007A0ECDD	Recapture	5	Sitting	lomandra
Reference	Piper's Creek	Summer	Male	Adult	Moderate Nuptial Pads	86	100	3	0007A3F00E	Recapture	1	Sitting	bank,leaf litter
Reference	Piper's Creek	Summer	Male	Sub Adult	Moderate Nuptial Pads	71	55	2	007A3E78F	First time	1	Sitting	bank
Reference	Piper's Creek	Summer	Male	Adult	Light Nuptial Pads	75	73	2	00079206C4	Recapture	6	Sitting	lomandra
Reference	Piper's Creek	Summer	Male	Adult	Moderate Nuptial Pads	65	58	3	0007E0319C	First time	6	Jumping	leaf litter
Reference	Piper's Creek	Summer	Unk	Adult	n/a			2	NA	Uncaptured	7	Sitting	bank
Reference	Piper's Creek	Summer	Male	Adult		69	65	1	0007A0F51A	First time	9	Sitting	
Reference	Piper's Creek	Summer	Male	Adult	Light Nuptial Pads	68	63	5	0007A0CB98	First time	9	Sitting	lomandra
Reference	Piper's Creek	Summer	Unk						NA	Uncaptured	7	Sitting	
Impact	Cooperabung Creek	Summer	Female	Adult	Gravid	101	235	1	0007E0342B	First time	4	Sitting	flood debri

Site	Location	Season	Sex	Age	Reproductive status	L	W	DW	pit_tag_code	Capture status	Z	Activity	Microhabitat
Reference	Piper's Creek	Autumn	Female	Adult	Not Gravid	79	90	10	0007A3F00E	Recapture	1	Sitting	leaf litter
Reference	Piper's Creek	Autumn	Unk	Adult	n/a	70		8	NA	Uncaptured	8	Jumping	flood debri
Impact	Cooperabung Creek	Autumn	Female	Adult	Gravid	95	200	2.5	00079EA6E1	First time capture	4	Sitting	leaf litter
Impact	Cooperabung Creek	Autumn	Male	Adult	Moderate Nuptial Pads	56	55	3	0007A3CC7F	First time capture	4	Jumping	flood debri
Impact	Cooperabung Creek	Autumn	Unk	Adult	n/a			0.3	NA	Uncaptured	4	Sitting	lomandra
Impact	Cooperabung Creek	Autumn	Male	Adult	Light Nuptial Pads	59	50	20	0007A2F05A	First time capture	4	Sitting	leaf litter
Impact	Cooperabung Creek	Autumn	Unk	Adult	n/a			1	NA	Uncaptured	4	Sitting	bare ground

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