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Stratford Renewable Energy Hub *Mixophyes balbus* (Stuttering Frog) Expert Report

Yancoal/GHD

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Template 2.8.1

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Abbreviations

Abbreviation	Description
BC Act	NSW <i>Biodiversity Conservation Act 2016</i>
BAM	Biodiversity Assessment Method
BAMC	Biodiversity Assessment Method Calculator
BDAR	Biodiversity Development Assessment Report
DC	Direct current
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
NSW DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
DPI	Former NSW Department of Planning and Infrastructure
DPIE	Former NSW Department of Planning, Infrastructure and Environment
EIS	Environmental Impact Statement
ELA	Eco Logical Australia
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
ETL	Electricity Transmission Lines
IBRA	Interim Biogeographic Regionalisation for Australia
LGA	Local Government Area
NPWS	National Parks and Wildlife Service
NSW	New South Wales
PCT	Plant Community Type
PHES	Pumped Hydro Energy Storage
SED	Stratford East Dam
SMC	Stratford Mining Complex
SREH	Stratford Renewable Energy Hub

1. Introduction

1.1 Background

The Scoping Report for this project (Yancoal 2023) states that Yancoal proposes to develop the Stratford Renewable Energy Hub (SREH) at the site of the Stratford Mining Complex (SMC; Figure 1) following the scheduled completion of mining in 2024. This provides an opportunity to transition the site from a coal mine to a beneficial post-mining land use comprising a proposed Pumped Hydro Energy Storage (PHES) with an indicative capacity of 3.6 gigawatt-hours (GWh) (300 megawatts [MW] over 12 hours) alongside a photovoltaic solar farm facility (Solar Farm). The proposed Solar Farm would produce 330 MW direct current (DC) electricity to supply a portion of the energy requirements of the PHES.

A species of frog, *Mixophyes balbus* (Stuttering Barred Frog or just Stuttering Frog), is listed as a threatened species under both the NSW *Biodiversity Conservation Act 2016* (BC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). There are records of this species within a 10 km radius of the SMC (the locality) and the habitat is broadly suitable in the Project Area such that the species could be present and it has been listed as a candidate species for the site under the Biodiversity Assessment Method (BAM; DPIE 2020a). It is also listed as a species subject to Serious and Irreversible Impacts under the BAM.

It is noted that the species assessed here as the Stuttering Frog has been recommended to consist of two separate taxa (Mahony et al. 2023); the northern taxa of *Mixophyes balbus* (Stuttering Frog) that is found from the Tenterfield area of northern NSW down to northern side of the Macleay River and then the southern taxa of *Mixophyes australis* (Southern Stuttering Frog) that is found further south from the Carrai Plateau on the southern side of the Macleay River in New South Wales south to the Cann River catchment in East Gippsland Victoria. When both species are ultimately recognised, the species that would potentially occur in the Project Area would be the Southern Stuttering Frog. However, as this split has not yet been formally recognised under the BC Act, the species will remain being referred to and assessed in this expert report as *Mixophyes balbus* (Stuttering Frog). The similarities in behaviour and habitat requirements indicate that the assessment of potential presence would be the same regardless of the species of Stuttering Frog that is most likely present within the region.

Surveys as required under the BAM survey guidelines (DPIE 2020b) have not been completed for this species due to night land access restrictions. Therefore, the presence of this species and any need for offsets for impacts to this species' habitat have not been able to be established as part of the Biodiversity Development Assessment Report (BDAR) prepared by GHD.

This expert report has been written to be included as a component of the BDAR to adequately assess the likelihood of the Stuttering Frog being present in the Project Area and, if so, provide an assessment of where this species would be located. The Project Area covers the lands that are to be subject to direct impacts by the proposed works. The assessment also takes into consideration a 500 m buffer around those impacted areas where indirect impacts may occur. This information can be used to determine any final offset requirements, if needed, for the species.

1.2 Project infrastructure

The Project is proposed to include the following elements, based on the Scoping Report (Yancoal 2023):

- Construction of an upper reservoir.
- Construction of a tunneled waterway comprising a vertical shaft and inclined headrace tunnel between the upper reservoir intake and powerhouse, and a tailrace tunnel connecting the powerhouse to the lower reservoir.
- Augmentation of the existing Stratford East Dam (SED) to serve as the lower reservoir.
- Construction and operation of a “behind the meter” Solar Farm to supply up to 330 MW to the PHES, with optionality to export electricity to the grid in times of surplus solar generation.
- Re-alignment of the existing Electricity Transmission Lines (ETL) across previously disturbed mine areas.
- Construction of an on-site electrical substation, to connect the PHES and the Solar Farm to the TransGrid ETL.
- Minor works in the public road network, such as intersection upgrades and installation of an ETL.
- Other associated construction and operational activities.

The proposed location of this infrastructure is provided in Figure 2.

1.3 Purpose of the expert report

Section 6.5.2 of the BAM (DPIE 2020a) sets out the following essential requirements for the preparation of an expert report:

- Identify the relevant species or population.
- Justify the use of an expert report.
- Indicate and justify the likelihood of presence of the species or population.
- Estimate the number of individuals or area of habitat (whichever unit of measurement applies to the species/individual) for the biodiversity development assessment area, including a description of how the estimate was made.
- Demonstrate what information was considered, rejected and discounted in relation to the determination made in the expert report.
- Identify the expert and provide evidence of their expert credentials.

The report needs to determine whether:

- The target species is unlikely to be present, in which case no further assessment is required, or
- The target species is likely to be present in which case the expert report must provide estimates of habitat area within the impact assessment area.

1.4 Impact assessment area

The location in NSW of the proposed SREH is provided in Figure 1. The area potentially being impacted is referred to as the Project Area and comprises the Development Footprint and areas of the existing SMC within the Development Footprint (Excluded Areas), as shown in Figure 2. The available records of the Stuttering Frog for NSW and the broad region around the Project Area are depicted in Figure 3. The vegetation and water

bodies mapped within the Project Area are provided in Figure 4 and Figure 5 respectively. Information for the Project Area encompassed by this infrastructure and the locality of the SMC (10 km around the infrastructure) was obtained from a range of data layers including:

- Native vegetation: provided by GHD
- Waterbodies: NSW LPI
- Stuttering Frog Records: NSW BioNet and the Atlas of Living Australia (NSW DCCEEW 2024).

1.5 Reasons for use of an expert report

Section 5.2.3(2)(b) and 5.2.4(2)(c) of the Biodiversity Assessment Method (BAM) (DPIE 2020a) places two specific requirements for where an expert report can be used instead of surveys:

- An expert report can only be used instead of a survey for species to which species credits apply.
- An expert report may be obtained instead of undertaking a species survey at a development site, clearing site, land to be biodiversity certified or a biodiversity stewardship site.

The Stuttering Frog meets the first criteria, being a species credit species under the BC Act.

In this case, an expert report has been provided in relation to the Stuttering Frog, which is listed as vulnerable under the BC Act, and is a species credit species. An expert report has been prepared due to the difficulty in meeting the survey requirements set out in the BAM Survey Guidelines (DPIE 2020b). The area to be covered is inaccessible as a mine site area, especially during the necessary wet conditions for surveys, necessitating that an expert report be produced to consider the potential for this species to be present and extent of any possible occurrence.

1.6 Credentials of expert

Dr Frank Lemckert is an Ecologist who has been undertaking studies into the ecology and management of frogs since 1986 and has been an ecological consultant since 2011. His skills include survey design/ implementation/ targeted species surveys, data handling, analysis and interpretation and the production of high level reports including papers published in international peer-reviewed journals and technical reports and recovery plans for the Commonwealth and NSW Governments. He has also been an expert witness for the assessment of the impacts of alleged illegal clearing for the Commonwealth, NSW and Local Governments (Hornsby Council) and provided expert advice to NSW Department of Primary Industry for legal considerations over the potential for forestry operations to impact on rock outcrop dependent species.

Dr Lemckert represented Forests NSW (now Forestry Corporation NSW) as a reptile and amphibian expert in the Comprehensive Regional Assessments and Regional Forest Agreement Process carried out between 2000 and 2002 and as an expert in fauna management for negotiations over a new Threatened Species License for harvesting operations in 2014 that included consideration of this species.

Dr Lemckert is an acknowledged expert on eastern Australian frogs having completed his MSc and PhD on the ecology and management of frogs in this region and has published over 70 papers (or book chapters) in Australian and International peer-reviewed journals that relate specifically to frog conservation. He has been used by both the NSW and Commonwealth Governments as an expert witness in court cases assessing the impacts of land clearing on threatened frogs.

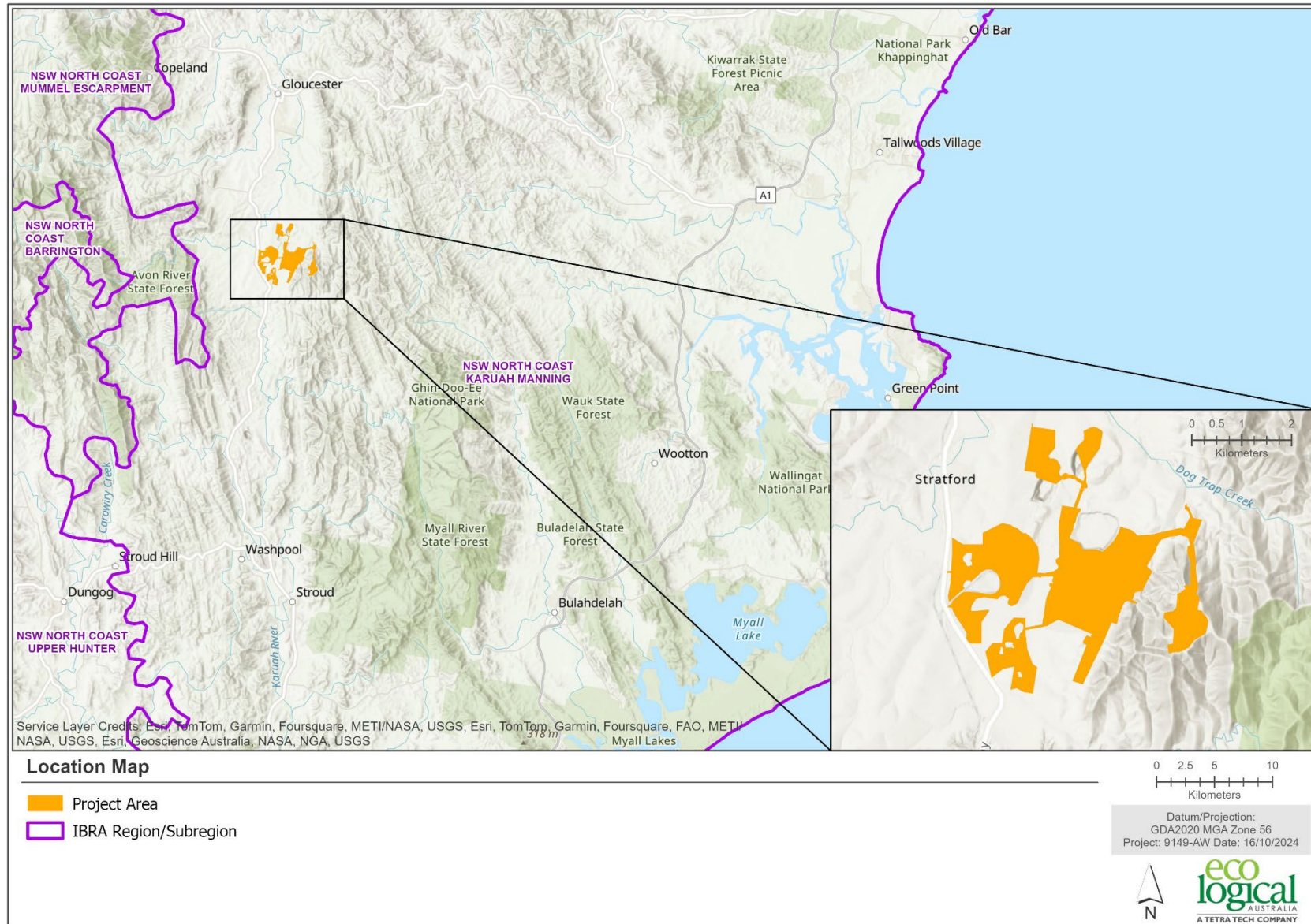


Figure 1. Location of the Project Area within the region

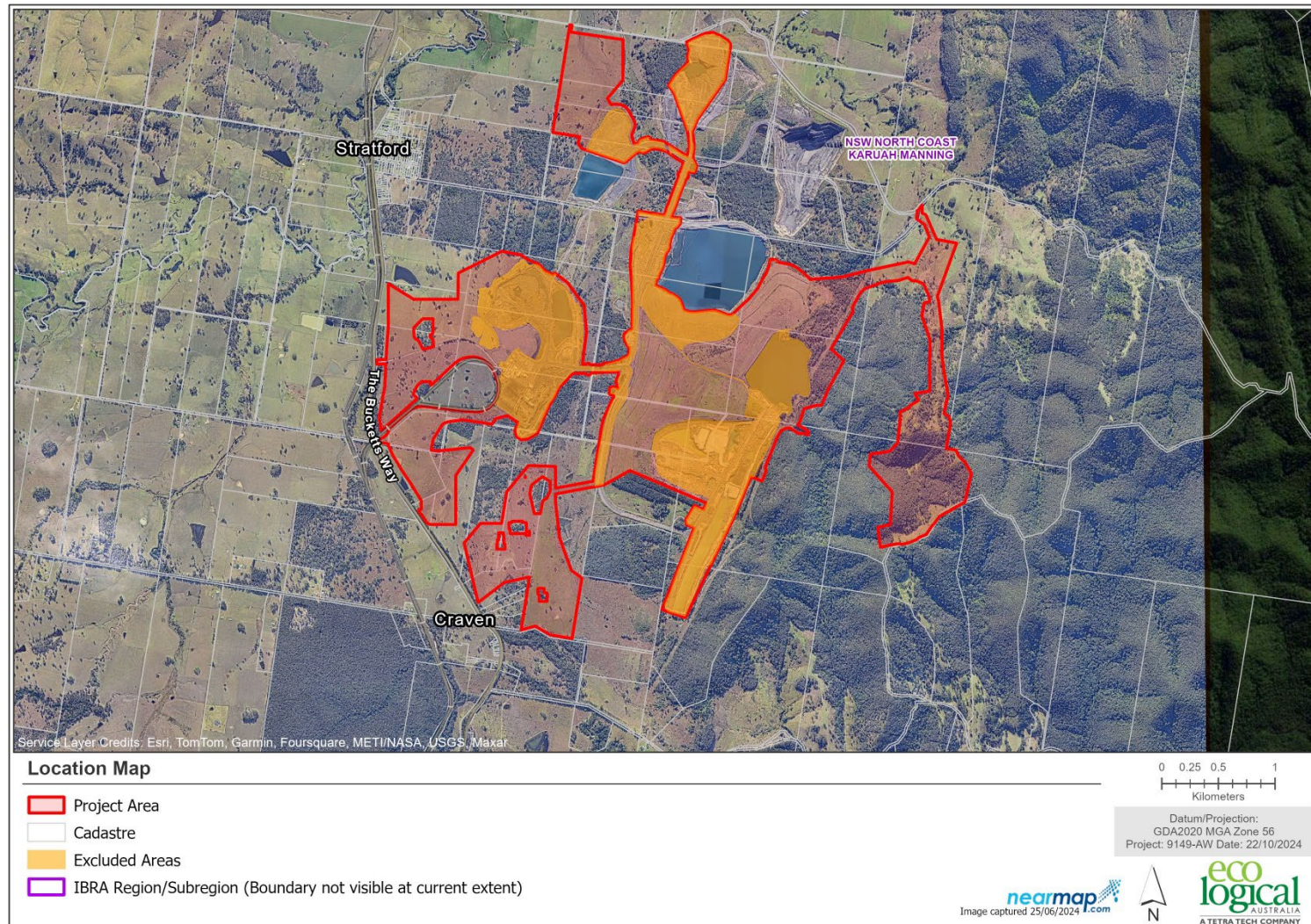


Figure 2. Detailed map of the Project Area

Dr Lemckert is a member of the Amphibian Specialist Group of the IUCN, secretary of the NSW Declining Frog Working Group of NSW and past president of the Australian Society of Herpetologists. He co-supervised two PhD students, a Master of Applied Science Student and three Bachelor of Science (Honours) students who completed theses addressing issues of frog biology and conservation. He is listed as an accredited expert by the NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW) to provide expert reports for the Stuttering Frog under the BAM. Dr Lemckert wrote the survey guidelines for NSW threatened frog species to be used in assessments under the BAM (DPIE 2020b).

1.6.1 *Mixophyes balbus* (Stuttering Frog)

In regards to the Stuttering Frog (*Mixophyes balbus*), Dr Lemckert can demonstrate his expertise through the following publications that include this species:

- Mahony, M., Gould, J., Beranek, C., Callen, A., Clulow, J., Clulow, S., Klop-Toker, K., Mahony, S., Wallace, S., Stock, S., Garnham, J., Lemckert, F., Thumm, K., Moses, B. & Pickett, E. (2022). A trait-based analysis for predicting impact of wildfires on frogs. *Australian Zoologist* 42:326-351. <https://doi.org/10.7882/AZ.2022.021>.
- Geyle, H.M., Hoskin, C.J., Bower, D.S., Catullo, R., Clulow, S., Driessen, M., Daniels, K., Garnett, S., Gilbert, D., Heard, G.W., Hero, J.-M., Hines, H.B., Hoffmann, E.P., Hollis, G. Hunter, D.A. Lemckert, F.L., Mahony, M., Marantelli, G., McDonald, K.R., Mitchell, N.J., Newell, D., Roberts, J.D., Scheele, B.C., Scroggie, M., Vanderduys, E., Wassens, S., West, M., Woinarski, J.S.C. & Gillespie, G.R. (2021). Red hot frogs: identifying the Australian frogs most at risk of extinction. *Pacific Conservation Biology*. <https://doi.org/10.1071/PC21019>.
- Gillespie, G.R., Roberts, J.D., Hunter, D., Hoskin, C.J., Alford, R.A., Heard, G.W., Hines, H., Lemckert, F., Newell, D. & Scheele, B.C. 2020. Status and Priority Conservation Actions for Australian Frog Species. *Biological Conservation* 247: 108543. <https://doi.org/10.1016/j.biocon.2020.108543>.
- Lemckert, F.L., & Mahony, M.J. 2018. The status of Decline and Conservation of Frogs in Temperate Coastal South-eastern Australia. Pp 59-72 In *Amphibian Biology Volume 11 - Conservation and Decline of Amphibians: Eastern Hemisphere (Australia, New Zealand and Pacific Islands)*. H. Heatwole and J. Rowley (Eds.). CSIRO Publishing, Melbourne.
- Roberts, D., Hines, H., Gillespie, G., Robertson, P., Lemckert, F. & Hero, J.-M. 2009. *Mixophyes balbus*. The IUCN Red List of Threatened Species 2009: e.T13595A4220629. <http://dx.doi.org/10.2305/IUCN.UK.2004.RLTS.T13595A4220629.en>.
- Gillespie, G., Robertson, P., Hines, H., Lemckert, F. & Hero, J.-M. 2008. *Mixophyes balbus*. Pp 422 In: *Threatened Amphibians of the World*. S. N. Stuart, M. Hoffman, J. S., Chanson, N. A. Cox, R. J. Berridge, P. J. Ramani & B. E. Young (Eds.). Lynx Edicions, Barcelona, Spain.
- Lemckert, F.L. & Mahony, M.J. 2008. Core calling periods of the frogs of temperate New South Wales, Australia. *Herpetological Conservation and Biology* 3:71-76.
- Slatyer, C., Rosauer, D. & Lemckert, F. 2007. An assessment of endemism and species richness patterns in the Australian Anura. *Journal of Biogeography* 34:583-596.
- Hero, J.-M., Morrison, C., Gillespie, G., Roberts, J.D., Newell, D., Meyer, E., McDonald, K., Lemckert, F., Mahony, M., Osborne, W., Hines, H., Richards, S., Hoskin, C., Clarke, J., Doak, N. & Shoo, L. 2006. Overview of the conservation status of Australian Frogs. *Pacific Conservation Biology* 12:313-320.
- Green, M., Thompson, M.B. & Lemckert, F.L. 2004. The effects of suspended sediments on the tadpoles of two stream-breeding and forest dwelling frogs, *Mixophyes balbus* and *Heleioporus*

australiacus. Pp 713-720 In: Conservation of Australia's Forest Fauna II. D. Lunney (Ed). Royal Zoological Society of NSW, Sydney.

- Lemckert, F.L. 1999. Impacts of selective logging on frogs in a forested area of northern New South Wales. *Biological Conservation* 89:321-328.
- Lemckert, F. and Morse, R. (1999). Frogs of the timber production forests of the Dorrigo escarpment in northern New South Wales: an inventory of species present and the conservation of threatened species. In: A. Campbell, ed. *Declines and Disappearances of Australian Frogs*. Pages 72-80. Environment Australia, Canberra.

Dr Lemckert has also undertaken the following actions as a result of his recognised expertise in this species:

- Was invited to provide a profile for this species for the Arkive online fauna database: See <http://www.arkive.org/species/GES/amphibians>
- Was asked to advise in the preparation of the recovery plan for stream frogs of south-east Queensland 2001-2005 (Hines et al. 2002).
- Provided expert opinion on the habitat requirements, sub-population status and reservation requirements for the Stuttering Frog during the NSW Government's Comprehensive Regional Assessment program completed in 2000-2001.

2. Species information

2.1 *Mixophyes balbus* (Stuttering Frog)

2.1.1 Species Description

The Stuttering Frog is a relatively large species of ground dwelling frog of the Australian frog family Myobatrachidae. Females can grow up to 100 cm snout-vent length, with males being slightly smaller (Clemann and Swan 2023). Individuals have vertical pupils, well developed webbing on the feet, broad barring on the hind legs (the trait the species group draws its common name from) and a black line from the snout, through the eye and above the 'ear'. The colour on the dorsum is brown to olive-green and may be broken into irregular blotches. The underside is creamy-white and the upper lip is also creamy, but with interruptions of darker markings. Adults have a pale-blue crescent across the upper half of the eye (visible only when pupil is closed), whereas juveniles have orange gold upper eyes (Anstis 2013).



Plate 1. Typical adult Stuttering Frog

2.1.2 Life cycle

The Stuttering Frog is a species that is known to breed along streams with permanent or near permanent water flows located within areas of wetter forests. Breeding streams are most typically 3rd-4th order streams that may not flow permanently, but will at least have permanent ponds and will have flowing water much of the time. The core calling period for the species is September to March (Lemckert and Mahony 2008). Breeding activity is triggered by heavy rain and can

potentially occur at any time. Breeding does not occur directly in conjunction with rainfall, but rather several days afterwards when creek flows have returned to a steady normal flow (Knowles et al. 2015). This presumably provides a relatively certain water level and flow during egg development.

Males call from close by to slow flowing pools, often buried under leaf litter or under logs or low vegetation, but also in exposed positions when the environment is warm and wet. The call is a relatively soft grating 'wuh uh uh uh'. In the southern species that is the entire call, but north of the Barrington Region they include multiple 'o, o, o' sounds as a second part of the call, which may be the obvious distinguishing feature between the two putative species. The stuttering call gives the species its common name.

Females construct a nest in an area of shallow running water that occurs between pools in relatively wide, flat sections of mountain streams (Knowles et al. 2015). They create a nest by rotating in loose material to excavate out a circular cavity where approximately 500 to 550 pigmented eggs (2.8 mm diameter) are deposited as a single layer either onto the loose substrate or directly onto bed rock (Knowles et al. 2015; Watson & Martin 1973). The eggs hatch after several days and the tadpoles stay within the nest until they are either strong enough to swim free or are washed out by water flows. Laying eggs into shallow areas of water is likely an adaptation to keep tadpoles away from fish until they have developed further and are more capable swimmers. However, tadpoles do occur with several species of native fish (Mahony et al. 1997), but the effects of introduced fish such as trout, whilst potentially serious, are not clear (Hunter and Gillespie 2011). The development period is relatively long and may take up to 12 months with overwintering, but is more likely to be around 3 months (Anstis 2013). The tadpoles are dark in colouration with obvious spotting along the dorsal surface and particularly the tail fins.

Males and females are likely to be able to breed at 2 years in age, although this has never been confirmed. The life expectancy of frogs in the wild is not known.

2.1.3 Diet

Adult frogs feed on a wide range of invertebrates and small vertebrates (Lemckert and Shoulder 2007) and do not appear to have any specific dietary requirements. Tadpoles are thought to feed on any organic material present in the stream bed.

2.1.4 Distribution and Abundance

The Stuttering Frog has a historic distribution that includes the plateaus and eastern slopes of the Great Dividing Range from the Cann River catchment in far East Gippsland, Victoria, to tributaries of the Timbarra River near Drake, NSW (Figure 1). There appears to be altitude related cline in its distribution with the species found at lower altitudes in the south (down to as low as 20 m above sea level) to being only located at higher altitudes (up to 1400 m) in the far north. This may indicate it has a preferred specific temperature range that limits the areas it inhabits. The historic extent of occurrence for the Stuttering Frog is approximately 110,000 km² (Mahony et al. 1997).

The majority of more recent records for this species are from the northern half of NSW and particularly north of the Hunter River. The species was never apparently common in the southern

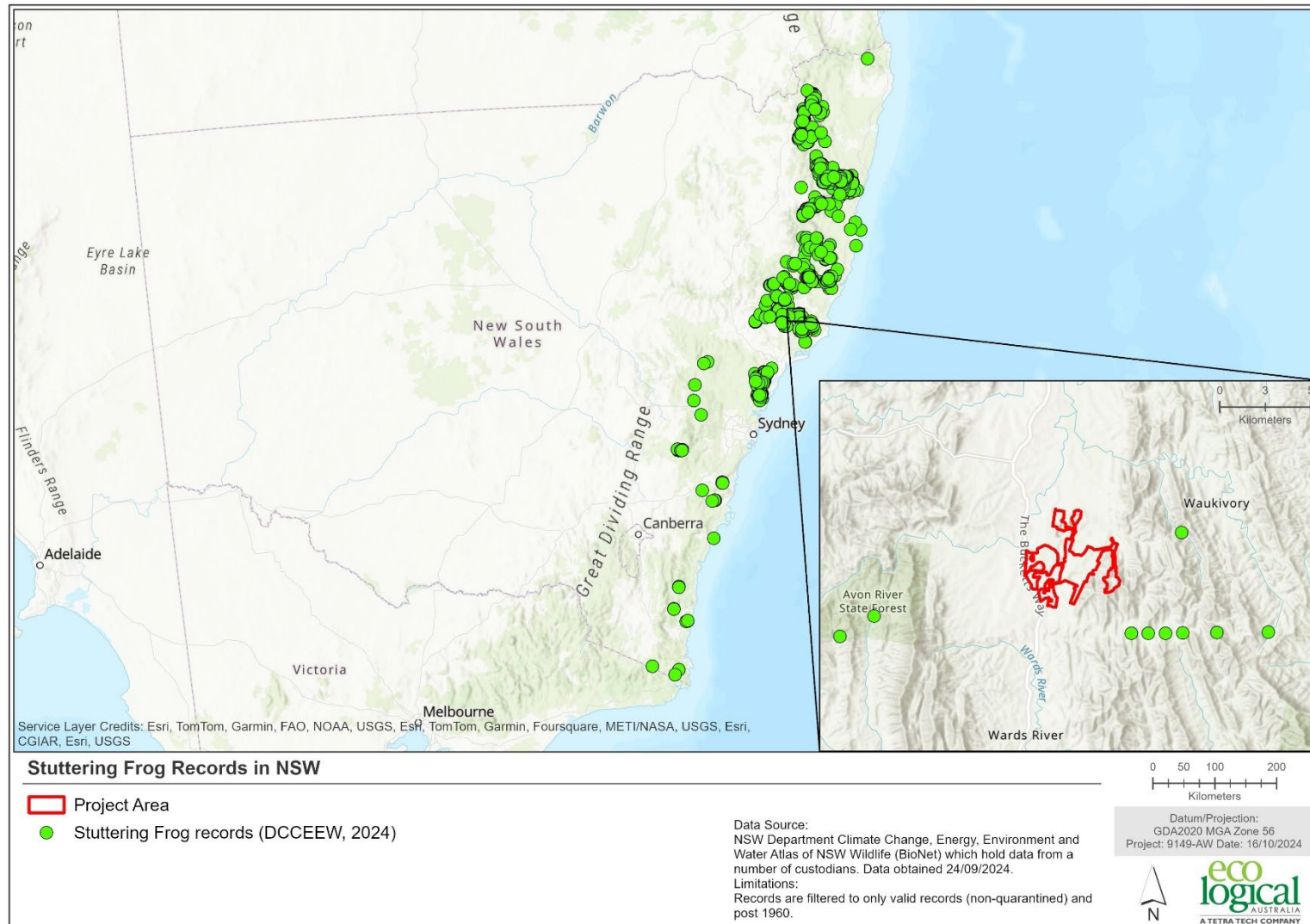


Figure 3. Denatured BioNet records of the Stuttering Frog in NSW and in broad relation to the Project Area

half of its range and has only been found in Victoria on three occasions (Tennyson Creek, Cann River and Jones Creek). It is now thought to be extinct in that state (Gillespie & Hines 1999). The species has been recorded to also have declined and disappeared from a number of locations in NSW where it was once considered to be common (Anstis 2013; Mahony 1993). Records from the southern half of NSW have declined notably since the 1970s and surveys in south-east NSW after 1990 located individuals at only a few sites (Daly 1998; Lemckert et al. 1997), all of which have subsequently disappeared. The last population known south of Sydney was discovered in 2000 at Macquarie Pass National Park. Recent efforts to re-introduce the species into an area south of Sydney appear to have had some success to date (G. Daly Pers. Comm.).

The only records of the species from the Blue Mountains are to the west with a population at Ruby Creek being recorded into the early 2000s (M. Mahony Pers. Comm.), but there are no sightings in the last 10 years and the current status of that population is not known. Hence, over the last 20 years there are no confirmed records south of the Hawkesbury River.

North of the Hawkesbury there are records from the Watagan Mountains including in Ourimbah and Olney State Forests (Mahony 1993) and the Stuttering Frog remains present at these sites with apparently stable populations. Further north past the Hunter River the Stuttering Frog has maintained or recovered to relatively normal numbers and can usually be easily detected.

This information indicates that the identified southern population nominated as the Southern Stuttering Frog has gone through much more significant declines and is very likely extinct across at least two thirds of its historic range, although numbers north of the Hawkesbury appear to be stable. In contrast, the northern Stuttering Frog population appears to still be present through its historic range. The Project Area falls within the range of the potential Southern Stuttering Frog, although it is noted again that there is not yet an official recognition that there are two different species.

2.1.5 Habitat Requirements

The Stuttering Frog is typically found in association with streams located in temperate and sub-tropical rainforest and wet sclerophyll forest, but has also been recorded in tableland riparian vegetation and moist gullies in dryer forests (Mahony et al. 1997; Gillespie & Hines 1999; Lemckert and Morse 1999). In north-east NSW, statistical modelling investigating (Gillespie & Hines 1999) showed the Stuttering Frog to have a preference for the interiors of large forest tracts in areas with relatively cool mean annual temperatures. These sites are typically free from any disturbance with a thick canopy and relatively simple understorey. The species is not associated with isolated ponds (e.g., forest dams) or ephemeral pools.

During periods of breeding activity adults typically shelter under leaf litter and logs close to the breeding streams that have been detailed above. Outside of breeding times individuals have often been found on roads at more than 100 m away from the nearest waterbody indicating that individuals move widely through the forest when moist conditions prevail (Mahony 1993; Lemckert & Morse 1999). A limited radio-tracking study of individuals of both sexes conducted near Dorrigo found frogs regularly sheltering in deep (often >10 cm) leaf litter immediately adjacent to the roads that they were caught on (F. Lemckert Unpublished Data). This contrasts strongly with the behaviour of the Giant Barred Frog that has consistently been found to rarely move more than 30 m from its breeding stream (Lemckert and Brassil 2000).

2.2 Listed vegetation associations

In this NSW North Coast Bioregion, NSW DCCEE lists in their profile (NSW OEH 2018) that the Stuttering Frog is associated with the following vegetation formations and classes:

1. Dry sclerophyll forests (shrub/grass sub-formation)

- Central Gorge Dry Sclerophyll Forests
- Clarence Dry Sclerophyll Forests
- Hunter-Macleay Dry Sclerophyll Forests
- New England Dry Sclerophyll Forests
- Northern Gorge Dry Sclerophyll Forests
- Upper Riverina Dry Sclerophyll Forests

2. Dry sclerophyll forests (shrubby sub-formation)

- North Coast Dry Sclerophyll Forests
- Northern Escarpment Dry Sclerophyll Forests
- South Coast Wet Sclerophyll Forests
- South East Dry Sclerophyll Forests
- Southern Tableland Dry Sclerophyll Forests
- Sydney Coastal Dry Sclerophyll Forests
- Sydney Hinterland Dry Sclerophyll Forests
- Sydney Montane Dry Sclerophyll Forests
- Sydney Sand Flats Dry Sclerophyll Forests
- Western Slopes Dry Sclerophyll Forests

3. Forested wetlands

- Coastal Floodplain Wetlands
- Eastern Riverine Forests
- Inland Riverine Forests

4. Freshwater wetlands

- Coastal Freshwater Lagoons
- Coastal Heath Swamps
- Montane Bogs and Fens

5. Grasslands

- Temperate Montane Grasslands

6. Grassy woodlands

- Coastal Valley Grassy Woodlands
- New England Grassy Woodlands
- Southern Tableland Grassy Woodlands
- Subalpine Woodlands
- Tableland Clay Grassy Woodlands

7. Heathlands

- Southern Montane Heaths
- Sydney Coastal Heaths
- Sydney Montane Heaths

8. Miscellaneous ecosystems
 - Water bodies, rivers, lakes, streams (not wetlands)
9. Rainforests
 - Cool Temperate Rainforests
 - Dry Rainforests
 - Littoral Rainforests
 - Northern Warm Temperate Rainforests
 - Southern Warm Temperate Rainforests
 - Subtropical Rainforests
 - Western Vine Thickets
10. Wet sclerophyll forests (grassy sub-formation)
 - Montane Wet Sclerophyll Forests
 - Northern Hinterland Wet Sclerophyll Forests
 - Northern Tableland Wet Sclerophyll Forests
 - Southern Lowland Wet Sclerophyll Forests
 - Southern Tableland Wet Sclerophyll Forests
11. Wet sclerophyll forests (shrubby sub-formation)
 - North Coast Wet Sclerophyll Forests
 - Northern Escarpment Wet Sclerophyll Forests
 - Southern Escarpment Wet Sclerophyll Forests.

This broad range of vegetation types indicates, as for most Australian frogs, the typical lack of finer scale relationships with particular vegetation types beyond that of dry vs wetter forests. This species is predominantly associated with wetter forest types, but can breed in wetter riparian areas located within what look to be more open forests (Lemckert and Morse 1999).

2.3 Status and threats

The Stuttering Frog is currently listed as Endangered under the BC Act and Vulnerable under the EPBC Act and also as Vulnerable under the IUCN red list.

The NSW DCCEEW profile for this species lists the following threats to the Stuttering Frog:

- Modification and loss of habitat.
- Disease - chytrid fungus.
- Changes to natural water flows and water quality.
- Predation of eggs and tadpoles by introduced fish.
- Damage to habitat and impacts on water quality from forestry activities.
- Damage (vegetation removal, disturbance, turbidity) to habitat by domestic stock, feral cattle and pigs.
- Poor knowledge of the species' distribution, taxonomy and history of local extinction.

The Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) provides the following on its profile (DCCEEW 2019) in regards to threats for this species:

Several potentially threatening processes have operated upstream of, or at, sites where the Stuttering Frog was formerly found, but, as populations of this species have also disappeared in catchments with

seemingly minimal disturbance, it is not clear how much influence these processes have had. Logging and associated forest management practices have been carried out in some catchments where the Stuttering Frog historically occurred or currently occurs. The health and stability of extant populations in these disturbed catchments is unknown. Upstream forest grazing and land clearance for pasture have also occurred in some catchments. The species is not known from any localities with disturbed riparian vegetation or significant human impacts upstream, which may indicate that the species is highly sensitive to perturbations in the environment (Mahony et al. 1997).

The role of chytrid fungus in the decline of the Stuttering Frog has not been explicitly demonstrated, but it is highly likely that this is the primary cause of the major declines of this species south of Sydney and in the western Sydney Basin given that many historic areas appear to be unaffected by other factors.

Other impacts noted by DCCEEW include:

- Trampling by domestic stock (Knowles et al. 1998, 2015).
- Introduced fish, such as Eastern Gambusia (*Gambusia holbrooki*), Carp (*Cyprinus spp.*) and salmonids (Gillespie & Hines 1999).
- Sustained increased levels of sedimentation and changes to water pH (Green et al. 2004).

The IUCN has classified this species as Vulnerable because of “a population decline, estimated to be more than 30% over the last ten years, inferred from an observed decline in numbers, and from habitat destruction and degradation”. It lists the following in regards to threats to the Stuttering Frog:

Several potentially threatening processes have operated at sites where this species has been found, or up-stream in catchments. Logging and associated forest management practices have been carried out in some catchments where M. balbus historically occurred, or currently occurs (Mahony et al. 1997). The health and stability of extant populations in these disturbed catchments is unknown. Forest grazing and land clearance for pasture upstream have also occurred in some catchments (Mahony et al. 1997). Mahony et al. (1997) report that the species is not known from any localities with disturbed riparian vegetation or significant human impacts upstream. This might indicate that the species is highly sensitive to perturbations in the environment. However, populations of this species have also disappeared in catchments with seemingly minimal human disturbance (Mahony et al. 1997). Also, Lemckert (1999) was unable to detect a negative impact of selective logging on this species. Trampling by domestic stock is likely to have deleterious impacts on oviposition sites of the species (Knowles et al. 1998). However, different degrees of suspended sediments have not been found to affect growth and survivorship of tadpoles (Green et al. 2004). Mixophyes balbus tadpoles have been found in sympatry with native fish, and probably have survival strategies to avoid predation by them (Gillespie and Hines 1999). However, the impact of introduced fish, such as Eastern Gambusia (Gambusia holbrooki), carp (Cyprinus spp.) and salmonids is unknown (Gillespie and Hines 1999). Mahony et al. (1997) did not observe introduced fish at any sites where they found M. balbus. In other reports though, introduced fish (salmonids) have been recorded at sites where M. balbus has declined (Anstis 1997). However, M. balbus has also disappeared from many streams that do not contain introduced fish species (Gillespie and Hines 1999), and so disease, such as chytridiomycosis, might also be a factor in its decline.

Of the above potential threats, the ones likely to be of significant consideration to the SREH Project Area are:

- the presence of the amphibian Chytrid Fungus
- modification and loss of habitat
- changes to natural water flows and water quality
- predation of eggs and tadpoles by introduced fish.

2.4 Variables likely determining Stuttering Frog presence

This information provides the following important points when trying to assess the potential presence of the Stuttering Frog in any area:

- There needs to be suitable breeding streams of typically 3rd to 4th order, but that have permanent larger pools (>5 m long and at least 50 cm depth) and that have semi-permanent to permanent water flows.
- The streams must also have areas where shallow water (no more than 1-2 cm) flows over sand, gravel or debris that can allow females to create nests for their eggs.
- Have intact native forest in the catchment upstream from the site, presumably to protect hydrology.
- The forest areas adjacent to the stream should be shaded by the canopy and have a good cover of leaf litter to allow the frogs to seek shelter.
- The Stuttering Frog is less likely to be present within areas containing introduced fish such as *Gambusia holbrooki* sp. (Plague Minnow) and *Oncorhynchus mykiss* (Rainbow Trout) and *Salmo trutta* (Brown Trout).

3. Description of the Project Area

The Stratford REH is situated within the existing SMC, located approximately 95 km north of Newcastle (Figure 1). The SMC is an open cut coal mine owned by Yancoal that is scheduled to complete mining operations in 2024. It is roughly bounded by the North Coast Railway line in the west, Wenham Cox Road in the north and Glen Road to the south. The Glen Nature Reserve is located to the east, but does not directly adjoin the Project Area.

The Project Disturbance Footprint is currently approximately 870 ha, comprising approximately 468 ha (54%) within the SMC. The final Project disturbance footprint will be confirmed following the completion of environmental studies and described in the Environmental Impact Statement (EIS). All of this land is owned by Yancoal. These lands are zoned as either RU1, Primary Production Zone, or IN3, Heavy Industrial Zone under the Gloucester Local Environment Plan (LEP).

Key infrastructure components of the Stratford REH include:

- Upper reservoir.
- Powerhouse area.
- Lower reservoir (at the location of the existing SED).
- Solar Farm.
- Electrical substation.
- Relocated existing 132 kV ETL around the powerhouse and lower reservoir.
- Upgraded access roads to the upper reservoir.
- Existing and new internal roads and infrastructure corridors to be used for the Project, particularly to connect the Solar Farm to the electrical substation.
- Enhanced or new vegetation screens along The Bucketts Way.
- Other ancillary infrastructure such as offices, carparks, laydown areas and water treatment facilities, to be located within the extent of the Project Area and/or final EIS disturbance footprint.
- Water stored in existing SMC voids would be used to supply the PHES. Some of the existing SMC voids would also be used to emplace excess spoil material from the Project (e.g. from the tunnel and powerhouse excavations). These voids do not currently form part of the Project.

The Project Area is located between just over 100 m above sea level at ground level in western sections around the pit (lower in the pit) to over 460 m above sea level in the area proposed for the upper reservoir.

The Avon River is located downstream to the west of the Project Area (Figure 5), with Avondale Creek, Dog Trap Creek and a number of unnamed ephemeral drainage lines and creeks flowing west and north-west across the Project Area towards the Avon River. The drainage lines within the Project Area itself have small catchments, they typically exhibit low to zero flow for extended periods during dry weather, while heavy rainfall events result in short duration, high flow events. The Project Area also includes a number of artificial water bodies including the several large dams created as part of the SMC and there are also a number of smaller farm style dams located in the Project Area (Figure 5). These all provide relatively permanent areas of water.

The Project Area is located within the Mid-Coast Local Government Area (LGA). The land in and around the Project Area is mainly designated RU1 Primary Production (e.g. Plate 2), in keeping with the rural landuse for

farming. Other land uses within the area surrounding the Project Area include RU5 – Village, RE1 Public Recreation, SP1 Special Activities associated with a cemetery, C1 National Parks and Nature Reserves, C3 Environmental Management and E5 Heavy Industrial (the existing coal mine).



Plate 2. Partially cleared hillside grazing area in the eastern section of the Project Area



Plate 3. Swampy habitat in the southwest of the Project Area

3.1 Landscape features

The following landscape features, as defined by the BAM, are relevant to the project.

3.1.1 Bioregions

The Project Area is located within the NSW North Coast Interim Biogeographic Regionalisation for Australia (IBRA) Region. The following description for the region is taken directly from NSW NPWS (2003) “The Bioregions of New South Wales: their biodiversity, conservation and history”:

The North Coast Bioregion runs up the east coast of NSW from just north of Newcastle to just inside the Qld border. The total area of the bioregion is 5,924,130 ha (IBRA 5.1) and the NSW portion is 5,692,351.6 ha or 96.1% of the bioregion. The NSW portion of North Coast Bioregion occupies 7.11% of the state.

The North Coast Bioregion covers northern NSW from the shoreline to the Great Escarpment. Typically, there is a sequence from coastal sand barrier, through low foothills and ranges, to the steep slopes and gorges of the Escarpment itself, with rainfall increasing inland along this transect.

3.1.2 IBRA Subregions

The Project Area is located within the Karuah-Manning IBRA subregion (Figure 1). Details on this subregion are also taken from NSW NPWS (2003) and provided in Table 1.

Table 1. Description of the subregion covering the Project Area (from NSW NPWS 2003)

Subregion	Geology	Characteristic landforms	Typical Soils	Vegetation
Karuah-Manning	Extremely complex faulted terrain where the New England Fold belt over-thrusts the Sydney Basin. Main rocks present are: Silurian and Devonian slates, quartzites and acid volcanics, Carboniferous mudstones and lithic sandstones, and less deformed Permian shales and sandstones. Small areas of granite and plateaus of Tertiary basalt on Barrington and Comboyne Plateaus. Quaternary coastal sands.	Complex pattern of ridges and valleys running to the Great Escarpment, strong structural control along fault lines. Coastal beach, dune and lagoon barrier systems reach their maximum development at Myall Lakes.	Red brown structured loams on basalt. A range of other soil types relating to geology but poorly known. Deep siliceous sands and very well developed podsols in dunes, particularly the older high dunes. Organic sands in estuaries..	Wet sclerophyll forest with white mahogany, small-fruited grey gum, Sydney blue gum, blackbutt, tallowwood and brush box. White gum, blackbutt, forest red gum and grey box on dry open flats. Dense Antarctic beech on Barrington tops and patches of mixed cool temperate and warm temperate rainforest on Comboyne Plateau on basalt. Coastal complex of banksia, paperbark, smooth-barked apple, and blackbutt with numerous shrubs and areas of heath and swamp on dunes. Mangroves in estuaries.

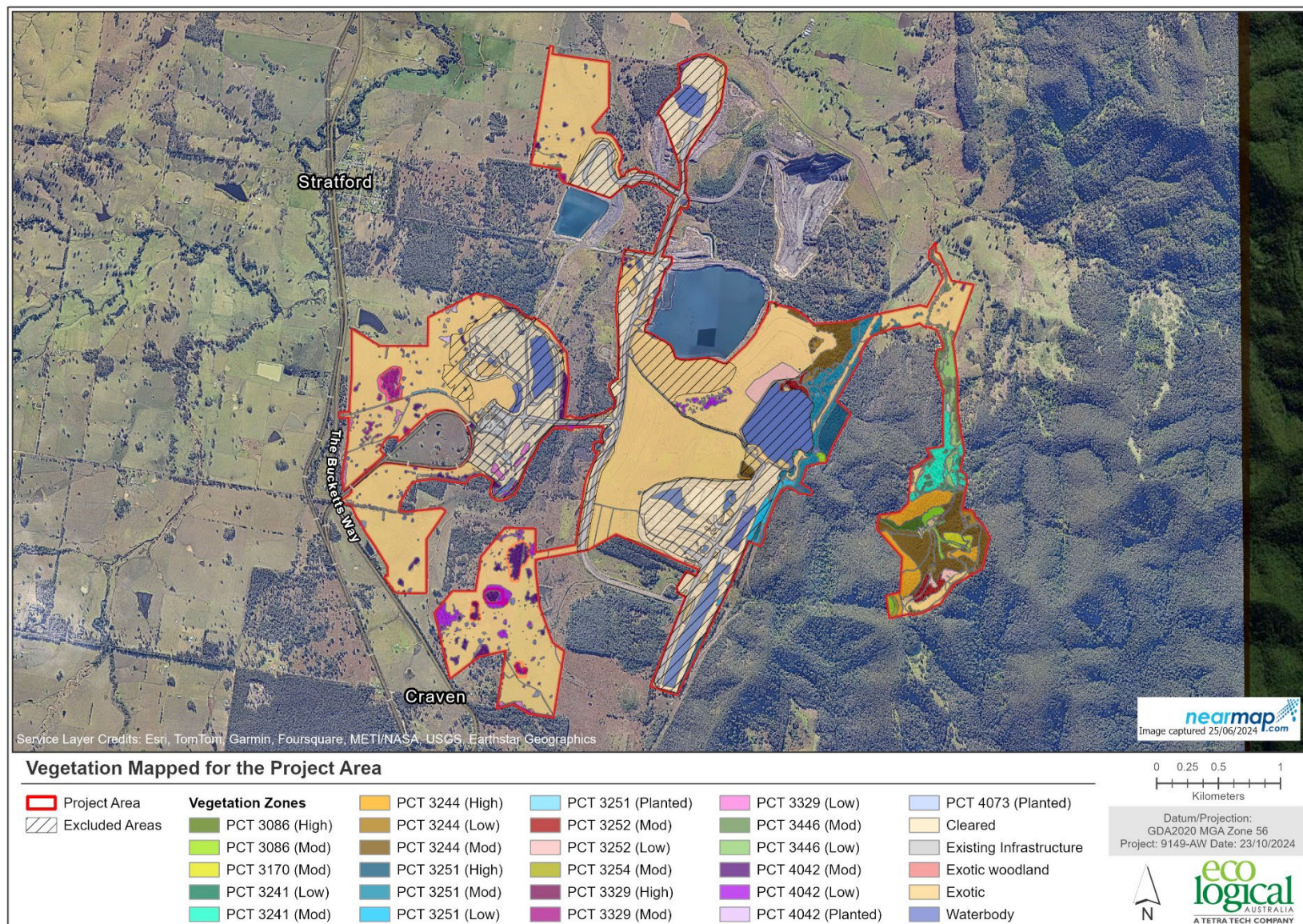


Figure 4. Vegetation mapped for the Project Area (data provided by GHD)

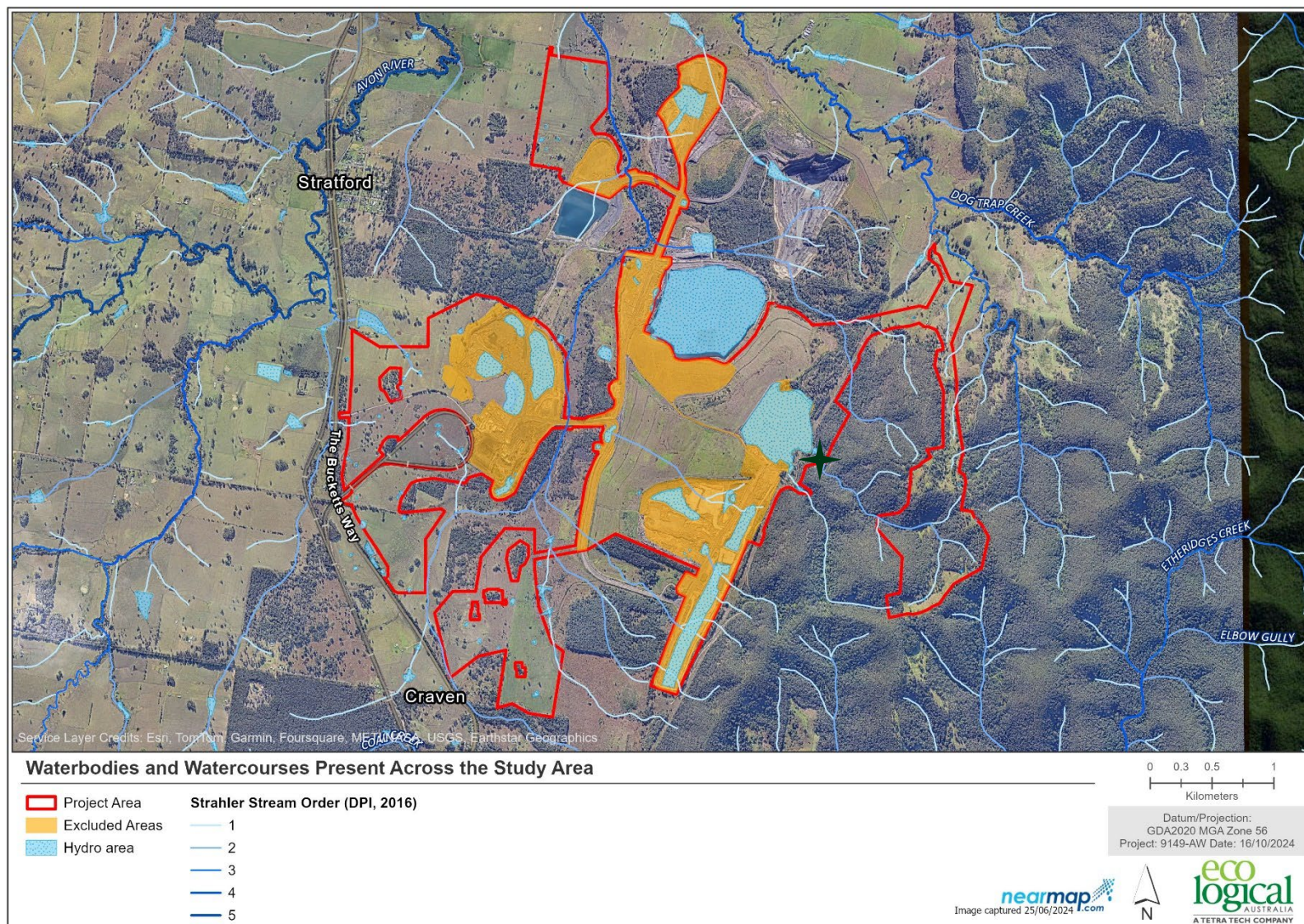


Figure 5. Mapped water courses and water bodies relative to the Project Area. The star represents the location of Plate 6.

3.1.3 NSW (Mitchell) Landscape

The Project Area covers two NSW Mitchell Landscape Types, the Manning - Macleay Channels and Floodplains and Stroud Mountains. The following description of each is taken directly from DECC (2002).

Manning-Macleay Channels Mitchell Landscape

Beaches, dunes, swamps and lagoons on Quaternary coastal sands, with inner and outer barrier dune sequences, general elevation 0 to 25 m, local relief 10 to 20 m. Yellow or white single grain quartz sand on destabilised dunes, well developed iron and humic podsols with depth to pan varying with position in the dune sequence, topography and depth to groundwater. Outer barrier; foredune with coast Spinifex coast wattle (Acacia sophorae), and coast tea tree (Leptospermum laevigatum). Hind dunes with blackbutt (Eucalyptus pilularis), pink bloodwood (Corymbia intermedia), old man banksia (Banksia serrata) and rainforest elements including blue lilly pilly (Syzygium oleosum), green tamarind (Elattostachys nervosa), native guava (Rhodomyrtus psidioides), plum pine (Podocarpus elatus), tuckeroo (Cupaniopsis anacardioides), bauerella (Sarcomelicope simplicifolia) and vines. Swampy lagoon zone of wet heath and swamp forest between the barriers with; dense tea tree (Leptospermum spp.), paperbark (Melaleuca quinquenervia), swamp oak (Casuarina glauca), and swamp mahogany (Eucalyptus robusta). Inner barrier dunes tall forest of; blackbutt, northern scribbly gum (Eucalyptus signata), needlebark stringybark (Eucalyptus planchoniana) and red bloodwood (Corymbia gummifera). Wet heath with lemon scented tea tree (Leptospermum petersonii), prickly tea tree (Leptospermum continentale), swamp banksia (Banksia robur) rushes and sedges.

Stroud Mountains Mitchell Landscape

Northwest oriented ranges with high peaks and parallel valleys on extensively faulted and folded middle Devonian lithic sandstones, mudstone, chert and minor volcanics, Carboniferous conglomerate, lithic sandstone, mudstone, interbedded dacite and ignimbrite, Permian pebbly lithic sandstone, with interbedded rhyolite, dacite and basalt. Strong structural control, general elevation 50 to 680m, local relief 400m. Higher slopes with gradational structured loams merging to red-brown to yellow texture-contrast soils on lower slopes and in valleys. Mixtures of moist and dry forests and rainforest understorey with; brush box (Lophostemon confertus), flooded gum (Eucalyptus grandis), turpentine (Syncarpia glomulifera), scentless rosewood (Synoum glandulosum), lilly pilly (Acmena spp.), rose maple (Cryptocarya erythroxylon), narrow-leaved palm lily (Cordyline stricta), southern mahogany (Eucalyptus botryoides), spotted gum (Corymbia maculata) and grey ironbark (Eucalyptus paniculata). River oak (Casuarina cunninghamiana) along all major streams.

3.1.4 Native vegetation

The Scoping Report indicates that approximately 110 ha of the Project Area that is located outside the SMC approved disturbance area comprises native vegetation (Yancoal 2023). The most contiguous intact native vegetation is located in the higher elevation eastern parts of the Project Area around the proposed upper reservoir.

GHD have identified 24 different vegetation zones within the Project Area, consisting of 11 different plant community types (PCTs) in various states of condition (Figure 4). They also identify other vegetation zones that include exotic woodland and exotic. Nine of these PCTs (highlighted in bold) are listed as being associated with the Stuttering Frog:

- **PCT 3086 - Lower North Hinterland Riparian Dry Rainforest (6.14 ha)**

- **PCT 3170 - Northern Hinterland White Mahogany Moist Grassy Forest (2.02 ha)**
- **PCT 3241 - Lower North White Mahogany-Spotted Gum Moist Forest (12.42 ha)**
- **PCT 3244 - Lower North Spotted Gum-Mahogany-Ironbark Sheltered Forest (50.15 ha)**
- **PCT 3251 - Northern Gorges Diverse Grassy Forest (30.14 ha)**
- **PCT 3252 - Northern Hinterland Grey Gum-Mahogany Grassy Forest (11.08 ha)**
- **PCT 3254 - Northern Hinterland Tallowwood-Forest Oak Grassy Forest (0.75 ha)**
- PCT 3329 - Northern Hinterland Valleys Red Gum Grassy Forest (9.21 ha)
- PCT 3446 - Lower North Foothills Ironbark-Box-Gum Grassy Forest (10.69 ha)
- **PCT 4042 - Lower North Riverflat Eucalypt-Paperbark Forest (23.95 ha)**
- **PCT 4073 - Lower North Hinterland River Oak Forest (0.08 ha).**

This indicates that the majority of the native vegetation present in the Project Area is considered to be potentially suitable for use by the Stuttering Frog. The main area of relevance however is the elevated mountainous area in the east of the Project Area where the upper reservoir is planned to be located. This area, although partially cleared, contains mostly intact native vegetation that is listed as being suitable for the Stuttering Barred Frog. The mostly cleared and otherwise broadly disturbed vegetation located through the existing SMC is generally covered by vegetation that is not listed as being used by the Stuttering Frog and does not represent suitable habitat.

3.1.5 Rivers and streams

The Stuttering Frog is restricted to streams and so the various ponds and reservoirs present in the Project Area are of no consideration in assessing the presence of the species. As previously noted, the major river associated with the Project Area is the Avon River, which is located off the Project Area to the west and so is also not a consideration. In this area it also flows through areas that are in the majority cleared and otherwise disturbed, which is vegetation this species does not use. Avondale Creek and Dog Trap Creek as well as a number of unnamed drainage lines do flow through the Project Area (Figure 5), but they broadly also flow through relatively cleared landscapes within the Project Area and so are not suitable for use by the Stuttering Frog.

The area of most relevance is the higher elevation eastern part of the Project Area that retains relatively intact native vegetation. However, as noted in the Scoping Report (Yancoal 2023), and as was evident through the site inspection, the streams that flow through this area are highly ephemeral in nature and there was water flow at the time of inspection (e.g. Plate 4) and no evidence of any even semi-permanent pooling along those creeklines. The only water present was that located in dams created for stock, which are not used by this species (e.g. Plate 5). The slopes are steep and of an unsuitable topography to provide more permanent pools where tadpoles can develop. Even at the lowest point of the streams dropping down from the hill, there was no water flow present and no evident stream bed until water pooled at the base of the mountain in a human-created dam, as evident in Plate 6 (location of photo marked with a star in Figure 5).

The Project Area does not contain any water bodies listed on the Directory of Important Wetlands in Australia or that are classified as a Ramsar wetland (see (<https://www.awe.gov.au/water/wetlands/australian-wetlands-database/directory-important-wetlands>)).



Plate 4. Typical shallow and dry drainage line present at the eastern end of the Project Area



Plate 5. Dammed drainage line in eastern section of Project Area. Note no stream body evident flowing into dam



Plate 6. Water pooling at base of mountain in eastern section of the Project Area. Note the absence of a stream flowing in at the far end of the pool

3.2 Connectivity features

Habitat connectivity across the project area is very limited due to the clearing undertaken for the operation of the Stratford Coal Mine and the historic use of the area for agricultural purposes. There is no clear corridor of retained vegetation across the Project Area that would link the better vegetated landscape in the eastern end to the Avon River. However, Figure 2 shows that there is high connectivity with contiguous areas of native vegetation to the east including The Glen Nature Reserve. There are no obvious larger streams providing a connective corridor in this area, again a result of the topography, but the retained native vegetation may still allow for migration of the Stuttering Barred Frog that is known to move long distances away from water.

The absence of an extensive road network in the Project Areas is a positive for maintaining connectivity and it appears unlikely that this will change in any significant way even with the proposed infrastructure for the Stratford REH, which is unlikely to be more than lightly trafficked.

3.3 Areas of geological significance

No important karsts or other geological formations are located within the Project Area.

3.4 Climate

Key climate statistics for the two closest available Bureau of Meteorology stations located for the Project Area are provided in Table 2. The Project Area receives moderate rainfall and has a relatively temperate climate.

Table 2. Climatic statistics for nearby (< 50 km) weather stations (data from the Bureau of Meteorology)

Rainfall station	Mean total rainfall (mm)	Mean January maximum (°C)	Mean January minimum (°C)	Mean July maximum (°C)	Mean July minimum (°C)
Lostock	972.6	29.3	17.2	16.4	6.5
Scone	636.0	30.9	16.9	16.3	4.6

3.5 Land use history

The original inhabitants of the Stratford area were the Kabook and Watoo First Nations People of the Gringai Barrington River Gloucester, NSW. Prior to European settlement, the local area would have been covered in native forests and woodlands and managed using traditional methods.

The changes that followed after the arrival of European settlement of the Stroud-Gloucester Valley, encompassing the Project Area, are summarised by Smith (2016). He reports the original settling of the area was undertaken by the Australian Agricultural Company (AAC), that received a grant of 1,000,000 acres of Crown Land in 1824 to breed livestock, establish a fine wool industry and cultivate crops. Extensive land clearing started in 1827 and the Booral and Stroud areas were developed for agriculture including wheat. Stroud was established in 1832 as the centre of AAC's activities during the 1830s. The AAC closed its Agricultural Department in 1843, letting out large parts of its land to tenant farmers before selling off land in small packages in 1860. A large portion was purchased and subdivided by the Gloucester Estate Syndicate in 1902 and dairy farming expanded. A railway was completed in 1913, allowing the expansion of dairy operations and the hardwood timber industry, which both further increased after World War 2. In the 1970s there was a decline in both the dairy and timber industries and an increase in tourism and people settling for lifestyle reasons.

3.6 Site inspection

A site inspection was undertaken of the Project Area on Tuesday the 17th of September, 2024. This inspection allowed for me to traverse the Project Area to visually assess the landscape and confirm the broad environmental mapping available, confirming the quality of extent of both breeding and non-breeding habitats that were present for the Stuttering Frog. The inspection started at the eastern end of the Project Area to check on the most likely suitable habitat, based on mapped vegetation features with potentially suitable creek lines and then continued further west to assess the lower lying and highly modified areas found through the majority of the SMC.

The inspection allowed for the confirmation of the size and suitability of streams to provide suitable breeding habitat for the Stuttering Frog, also including checks on water bodies to search for the presence of introduced fish. The inspection also targeted the adjacent forest environment to assess if there were adequate levels of shelter present (leaf litter and ground logs) and to determine if the forest showed significant signs of disturbance through human activities that may have made it unsuitable for the Stuttering Frog. This revolved around the presence of a suitable level of canopy and ground cover to produce a suitable microclimate for the species as well as to provide suitable food sources. The location of the survey track and various specific visual inspection points are provided in Figure 6.

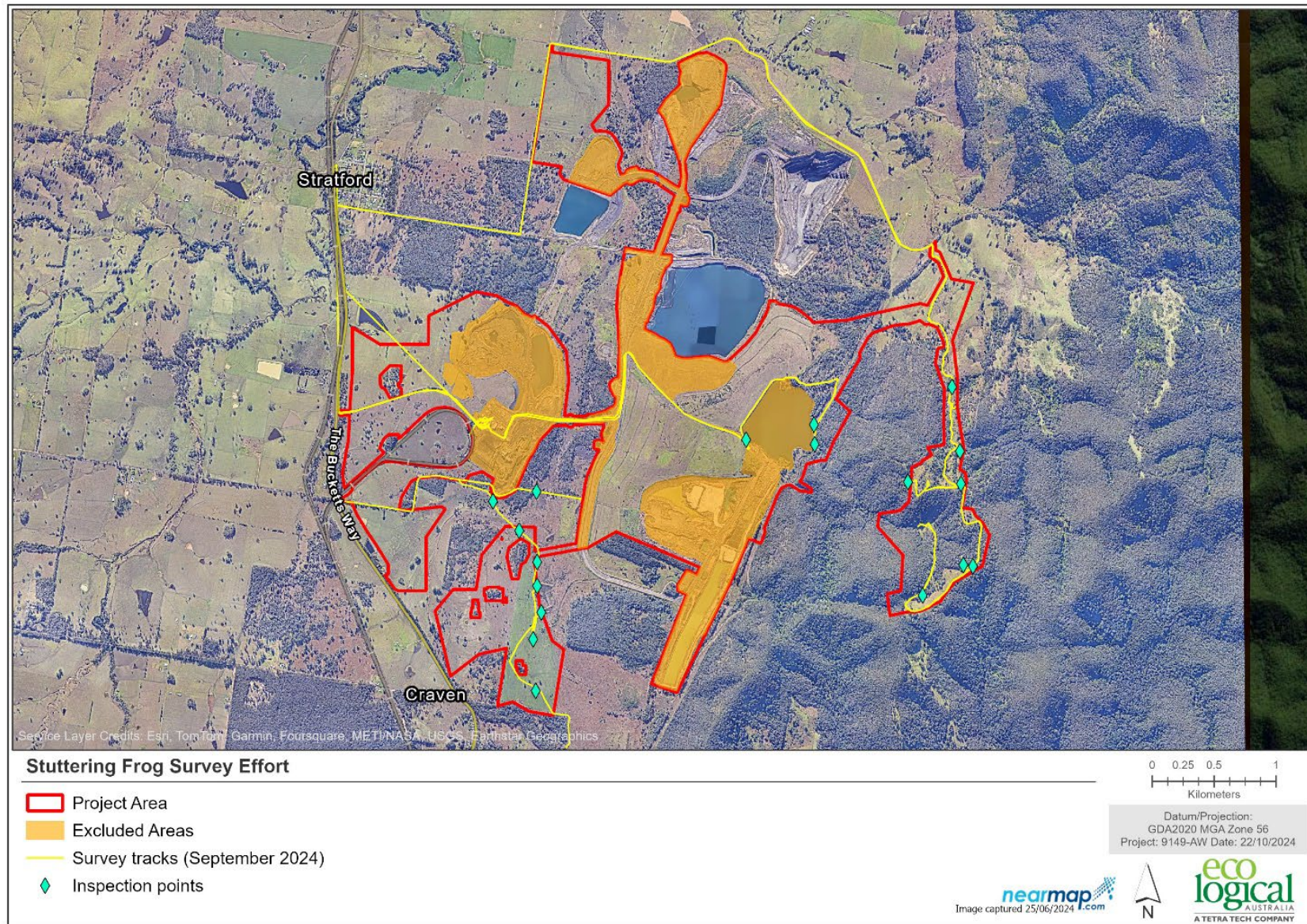


Figure 6. Survey track and location of inspection points completed for the Project Area

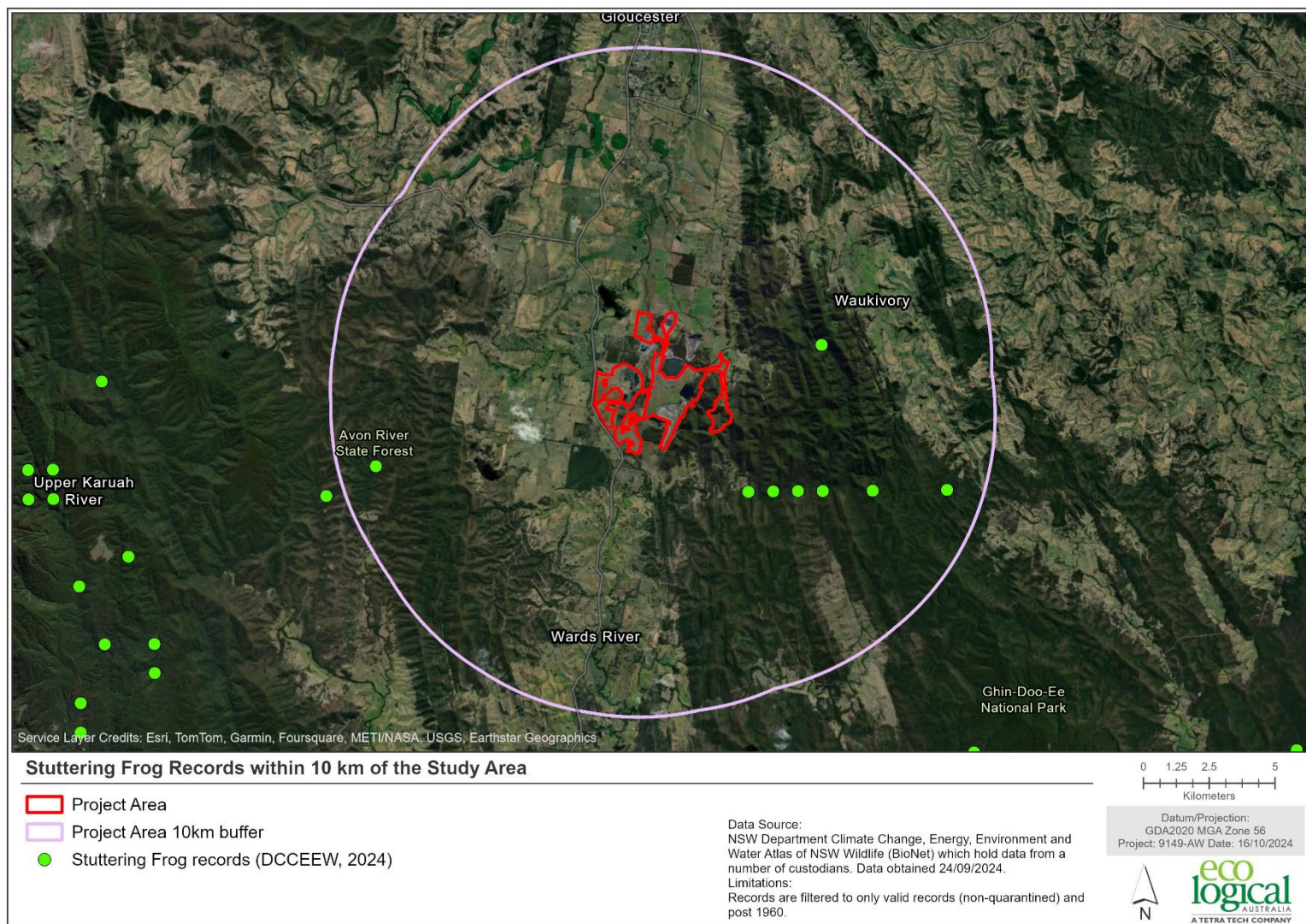


Figure 7. Location of Stuttering Frog records in the locality of the Project Area. Note, the records are denatured as per the BioNet sensitive species data policy

4. Potential for Stuttering Frog presence in the Project Area

4.1 Stuttering Frog in the region

The NSW DCCEEW species profile for the Stuttering Frog indicates that the species is predicted to occur within the locality of the Project Area and there are records of the species in tracts of retained vegetation both to the east and to the west that fall within 10 km. This includes records within the last 10 years and the species is considered to have a healthy extant population in the region.

4.2 Subject land as potential habitat

4.2.1 Breeding habitats

Whilst there are numerous semi-permanent and permanent water bodies present within the Project Area, these are almost all represented by artificial ponds created through human activities. The Stuttering Frog is dependent on semi-permanent and permanently flowing streams (typically 2nd to 4th order) as breeding habitat. As seen in Figure 5, there are essentially no 3rd or 4th order streams flowing within the Project Area, with the larger Dog Trap and Avondale Creeks and Avon River broadly falling outside of the Project Area Boundary, although Avondale Creek (3rd order) does cross over narrow sections of the Project Area in parts of the SMC (Figure 5). However, at these points the landscape has been highly modified and does not contain vegetation suitable for use by the Stuttering Frog. There are numerous 2nd order creeks present within the Project Area. Some of these in the western side of the Project Area do have some pooling of water and maybe at least provide semi-permanent water bodies (Plate 7), but they are highly variable in water quality, all suffer significant and ongoing disturbance from grazing by stock and are not present in suitable PCTs. Therefore they will not be used by the Stuttering Frog. The 2nd order streams in the east are all ephemeral and unable to support tadpole development.

Gambusia holbrooki (Plague Minnow) were present in all of the water bodies inspected in the lower areas of the Project Area around the SMC. They were not evident in the ponds inspected in the eastern elevated area. However, none of these water bodies appear to represent potential breeding habitat for the Stuttering Frog and so the Plague Minnow is not of further consideration.

4.2.2 Sheltering and foraging habitat

The majority of the Project Area has been cleared or highly disturbed and so does not contain vegetation that the Stuttering Frog would use, even if it represents a PCT that the species is considered to be associated with. This includes essentially the western and central sections of the Project Area wherever there has been mining related disturbance or agricultural activities (e.g. Plate 7) that the species has been identified as being intolerant of (Gillespie and Hines 1999). The only significant area of generally intact native vegetation is that present at the eastern end of the Project Area amongst the elevated lands where the upper reservoir is to be situated (Figure 4; Plate 8). The vegetation in this area is sufficiently continuous to provide enough “undisturbed” habitat to expect the Stuttering Frog to be present. The Stuttering Frog is listed as being associated with PCTs mapped as present in the Project Area by GHD (BioNet Threatened Species to Plant Community Type Data) and there is suitable leaf litter cover and low vegetation in the gullies (e.g. area above pond in Plate 6) that can provide suitable shelter habitat. It would be expected that there is a suitable diversity of food sources present to allow individuals to be able to use the site as non-breeding habitat.



Plate 7. Second order stream in western end of Project Area, flowing in a paddock



Plate 8. Eastward view over Stratford East Dam looking towards the vegetated mountain top area

4.2.3 Dispersal habitat

As previously noted, there are no streams and no continuous native vegetation strips running through the Project Area from the east to the west and/or then westwards to link the Project Area to the vegetated areas further west where there are records of this species (Figure 7). Hence there is no connectivity in this direction through the rural landscape. However, the eastern end of the Project Area is in direct contact with intact lands further to the east including The Glen Nature Reserve and this vegetation could be used for movements by Stuttering Frogs, although there are no direct larger more permanent creeks flowing directly through to the east from the Project Area. However, Etheridge's Creek, Dog Trap Creek and Wards River are all larger streams that are sufficiently close that it could be reasonably expected that the species would ultimately be able to maintain a broad connection across the landscape through occasionally dispersing individuals using the available smaller drainage lines in wetter periods.

5. Assessment of offset requirements under the BAM

5.1 Suitability of habitat on the Project Area

The information in Sections 2 and 4 demonstrates that there is suitable vegetation available for Stuttering Frogs within the Project Area. However, there are no suitable breeding streams within or even close to the Project Area that would allow a population of the species to permanently reside within the Project Area and use the area as important habitat. The presence of both breeding and complementary suitable non-breeding habitat is essential for the maintenance of a population within a given location. This view is further supported by the lack of records for the species actually in or within closer proximity of the Project Area. The available records are all in broader areas of retained native vegetation to the east and west.

5.2 Importance of the Project Area to the Stuttering Frog

It is concluded that the Stuttering Frog is not present within the Project Area or its immediate surrounds. Given the lack of suitable semi-permanent or permanent streams present within the Project Area it is likely that the Project Area never supported a population of this species, even before the site was subject to disturbance by European settlers. The more intact areas of vegetation in the east are potentially suitable for use for dispersing individuals from further east, but the overall disturbed and cleared nature of the land on the SMC means there is not connectivity to potential habitat and populations to the west that could even possibly make this area part of a broader dispersal corridor.

Based on the BAM survey guidelines for threatened frogs (DPIE 2020b) the following applies when assigning any species polygon for the Stuttering Frog:

The species polygon boundary should align with aquatic habitats linked directly to the record and a buffer, incorporating the PCTs with which the species is associated, of 500 metres radius from the top of bank.

As there are no records for the species in the Project Area and as it is considered that there is not suitable breeding habitat for the Stuttering Frog to have ever been present within the locality, there is no reason to produce a polygon to calculate credits as part of an offset obligation for this species.

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7. Appendix A Dr Frank Lemckert CV



Frank Lemckert PRINCIPAL SCIENTIFIC ECOLOGIST

Frank has been a professional scientist since 1992, specialising in understanding and managing the ecology and management of threatened species. Frank has conducted ecological work throughout eastern Australia (NSW, Victoria, Queensland), establishing long-term research and monitoring programs into the management of fauna and developing strategies to mitigate the impacts of human disturbances. He has worked extensively with the NSW state and federal Governments on varying issues of fauna and flora management including the preparation of a draft NSW/National recovery plan for the Giant Burrowing Frog (*Heleioporus australiacus*) and recent expert review roles on fauna management plans and monitoring strategies for the NSW Natural Resources Commission. Frank is an accredited expert under the NSW Biodiversity Assessment Method (BAM) for a range of threatened frogs and wrote the BAM survey guidelines for NSW's threatened frogs. Frank has prepared reports on endemism and representation in reserves of flora and fauna for the Commonwealth, represented the NSW Forestry Commission in license negotiations for the Comprehensive Regional Assessment process (2000), been a member of a state regulators advisory group for the management of Cane Toads across Australia and the Taren Point Cane Toad Advisory Group, and provided expert ecological advice on illegal land clearing for the NSW and Commonwealth Governments. He has authored over 90 peer-reviewed publications. Frank is a research associate with the Australian Museum and University of Newcastle and convenor of the NSW Declining Frog Working Group. He is a recognised expert in frog ecology and management, but has completed management related projects and works on a range of terrestrial vertebrate fauna.

Frank's primary role as a consultant has been to use his expertise and experience in technical writing and threatened species legislation to develop and maintain quality assurance in project reporting including:

- Species Impact Statements.
- >100 flora and fauna reports and assessments of significance using the EP&A Act and EPBC Act.
- Biodiversity Assessment Reports for Warragamba Dam Raising, Nowra Bridge, Golden Highway and Eurobodalla Dam.
- Manager for the Oxley Highway to Kempsey and Frederickton to Eungai ecological monitoring program.
- Lead fauna survey design for the Humelink transmission line project for Snowy Hydro 2.0.
- Complete targeted survey and monitoring works for threatened frog species including Giant Barred Frogs, Wallum Froglets, Green-thighed Frog and Green and Golden Bell Frogs.
- Construction and Environmental Management Plans, Monitoring Plans and Vegetation Management Plans for roads at Port Macquarie, Berry to Bomaderry and South Nowra.
- Nest Box, microbat and Green and Golden Bell Frog management plans for the Berry to Bomaderry and Oxley Highway to Kempsey Highway Upgrades.
- Review of monitoring strategies for the Woolgoolga to Ballina and Warrell Creek to Nambucca Heads programs for the Pacific Highway Upgrade.
- Review of two proposed Coal Seam Gas Impact Assessment methods for Matters of National Environmental Significance (contracted by the Commonwealth Government).
- Provision of species credit species expert reports for the Warragamba Dam raising project and Western Sydney Growth Centres Biocertification.

- Roadside mapping, survey and management strategies for the Wallum Froglet and Mahony's Toadlet.
- Develop frog and reptile survey guidelines and impact offset guidelines for the Biodiversity Assessment Method.

QUALIFICATIONS

- Bachelor of Science, University of Sydney, 1984 (Terrestrial Ecology and Marine Management)
- Master of Science, University of Sydney, 1991 (Population biology of the Common Froglet)
- PhD, University of Newcastle, 2009 (Management of forest frogs in timber production forests of NSW).

PROJECT EXPERIENCE

ECOLOGICAL IMPACT ASSESSMENT

- MONITORING OF BAT POPULATIONS AND ASSESSMENT OF POTENTIAL IMPACTS OF THE PROPOSED JEREMIAH WIND FARM AT ADJUNGBILLY, NSW (2019-PRESENT).
- MANAGEMENT OF IMPACTS ON GREEN AND GOLDEN BELL FROGS FOR THE KIWEF PROJECT AT KOORAGANG ISLAND, NSW FOR DARACON (2019-PRESENT).
- IMPACT ASSESSMENTS FOR HOUSING DEVELOPMENTS ON KOALAS IN THE CAMPBELLTOWN AREA (PRIVATE DEVELOPMENT AND CAMPBELLTOWN COUNCIL (2019)
- EXPERT REPORT ON THE GREEN AND GOLDEN BELL FROG FOR TWO WESTERN SYDNEY GROWTH AREAS BIOCERTIFICATION PROJECT (2018-PRESENT)
- WARRAGAMBA DAM RAISING PROJECT TARGET SURVEYS, IMPACT ASSESSMENTS, EXPERT REPORTING (SIX SPECIES) AND Q/A FOR WATER NSW (2018-19)
- GRANITE HILLS WIND FARM BIRD AND BAT STRIKE MODELLING AND ECOLOGICAL IMPACT ASSESSMENT, NIMMITABEL, AKUO ENERGY (2018) AND ELYSIAN WIND FARM, NIMMITABEL, AKUO ENERGY (2018)
- VEGETATION REMOVAL AND THREATENED FROG MANAGEMENT STRATEGIES, NEW INTERCITY FLEET MANAGEMENT FACILITY, JOHN HOLLAND GROUP (2018-PRESENT)
- NOWRA BRIDGE EIS ECOLOGICAL ASSESSMENTS, NSW RMS (2018)
- HEATHCOTE ROAD UPGRADE IMPACT ASSESSMENT AND REVIEW OF MITIGATION MEASURES, NSW RMS (2018-2019)
- EUROBODALLA DAM BIODIVERSITY ASSESSMENT REPORT, EUROBODALLA SHIRE COUNCIL (2017-18).

GOVERNMENT REVIEWS/REPORTS

- BIODIVERSITY ASSESSMENT METHOD FROG SURVEY GUIDELINES FOR SPECIES CREDIT SPECIES (2020)
- EXPERT WORKSHOP TO DEVELOP A NSW-WIDE NIL-TENURE FAUNA MONITORING PROGRAM, NSW NATURAL RESOURCES COMMISSION (2020)
- REVIEW OF SPECIES MANAGEMENT PLANS FOR THE YELLOW-BELLIED GLIDER, GIANT BURROWING FROG, EASTERN BRISTLEBIRD AND SOUTHERN BROWN BANDICOOT PREPARED UNDER THE NSW THREATENED SPECIES LICENSE FOR FORESTRY OPERATIONS, NSW NATURAL RESOURCES COMMISSION (2019)
- PROVISION OF INFORMATION AS THE BASIS FOR THE DEVELOPMENT OF SIX THREATENED FLORA SPECIES MANAGEMENT PLANS TO BE PREPARED UNDER THE NSW THREATENED SPECIES LICENSE FOR FORESTRY OPERATIONS, NSW NATURAL RESOURCES COMMISSION (2019)
- EXPERT REVIEW OF BIODIVERSITY IMPACT ASSESSMENT REPORT FOR THE HORNSBY QUARRY REHABILITATION PROJECT (2019)
- HORNSBY COUNCIL EXPERT WITNESS FOR DEVELOPMENT IMPACTS AT DURAL, HORNSBY SHIRE COUNCIL (2016)

- EXPERT ADVICE ON IMPACTS OF ILLEGAL LAND CLEARING AT EVANS HEAD, NSW STATE GOVERNMENT (2016)
- EXPERT ADVICE ON IMPACTS OF ILLEGAL LAND CLEARING AT SOMERSBY, COMMONWEALTH GOVERNMENT (2015)
- REVIEW OF MONITORING STRATEGIES FOR THE WOOLGOOLGA TO BALLINA AND WARRELL CREEK TO NAMBUCCA HEADS PROGRAMS FOR THE PACIFIC HIGHWAY UPGRADE, NSW RMS (2014)
- REVIEW OF IMPACT ASSESSMENT PATHWAYS FOR TWO LPNG PROJECTS, COMMONWEALTH GOVERNMENT (2013)
- REVIEW OF THREATENED SPECIES MODELLING IN FORESTRY AREAS, VIC FORESTS (2012)
- FLORA AND FAUNA REPRESENTATION IN THE AUSTRALIAN RESERVE SYSTEM, COMMONWEALTH GOVERNMENT (2010)
- FLORA AND FAUNA ENDEMISM PATTERNS ACROSS AUSTRALIA, COMMONWEALTH GOVERNMENT (2009)
- REVIEW IMPACTS TO THREATENED REPTILES AND AMPHIBIANS IN THE SOUTHERN BRIGALOW BELT, FOR WPS (2008)
- EXPERT REPRESENTING FORESTS NSW IN THE COMPREHENSIVE REGIONAL ASSESSMENT PROGRAM FOR THE REGIONAL FOREST AGREEMENT PROGRAM (1999-2001)
- EXPERT REVIEW OF FAUNA AND FLORA IMPACTS FOR 13 NSW FORESTRY COMMISSION EIS REPORTS (1992-94).

EPBC REFERRALS

- AUSTEN QUARRY (*EUCALYPTUS PULVERULENTA*), HARTLEY, HY-TEC INDUSTRIES (2014-15)
- MARYS MOUNT KOALA (*PHASCOLARCTOS CINEREUS*) REFERRAL, GUNNDAH QUARRY PRODUCTS (2015)
- GREEN AND GOLDEN BELL FROG (*LITORIA AUREA*) REFERRALS FOR THE PRINCES HIGHWAY UPGRADE AT SOUTH NOWRA, NSW RMS (2011-2012).

MONITORING PROGRAMS

- NIL-TENURE FERAL MANAGEMENT AND MONITORING STRATEGY FOR THE NARRABRI COAL SEAM GAS PROJECT, SANTOS (2019).
- THREATENED FAUNA MONITORING HUME HIGHWAY, KAPOOKA, NSW RMS (2018)
- GREEN AND GOLDEN BELL FROG BASELINE MONITORING PROGRAM AT MEROO LAKES, NSW OEH (2016-17)
- OXLEY HIGHWAY TO KEMPSEY THREATENED BIODIVERSITY MONITORING, NSW RMS (2013-2017)
- FCNSW STATE-WIDE ECOLOGICAL MONITORING PROGRAM, FORESTRY CORPORATION OF NSW (2009-10)

PLANS OF MANAGEMENT / STRATEGIES

- GREEN AND GOLDEN BELL FROG PRE-CLEARING WORKS KOORAGANG ISLAND (DARACON 2016 & CURRENT)
- REVIEW OF SPECIES MANAGEMENT PLANS FOR THE YELLOW-BELLIED GLIDER, GIANT BURROWING FROG, EASTERN BRISTLEBIRD AND SOUTHERN BROWN BANDICOOT PREPARED UNDER THE NSW THREATENED SPECIES LICENSE FOR FORESTRY OPERATIONS, NSW NATURAL RESOURCES COMMISSION (2019)
- PROVISION OF INFORMATION AS THE BASIS FOR THE DEVELOPMENT OF SIX THREATENED FLORA SPECIES MANAGEMENT PLANS TO BE PREPARED UNDER THE NSW THREATENED SPECIES LICENSE FOR FORESTRY OPERATIONS, NSW NATURAL RESOURCES COMMISSION (2019)
- NESTBOX, MICROBAT AND GREEN AND GOLDEN BELL FROG MANAGEMENT PLANS, BERRY TO BOMADERRY UPGRADE OF THE PRINCES HIGHWAY, NSW RMS (2017)
- GREEN AND GOLDEN BELL FROG SURVEYS AND MONITORING, PRINCES HIGHWAY UPGRADES AT SOUTH NOWRA AND BERRY TO BOMADERRY, NSW RMS (2012-2017)
- THREATENED FROG MODELLED HABITAT REQUIREMENTS, HORNSBY SHIRE COUNCIL (2016)
- MICROBAT MANAGEMENT PLAN FOR CLARENCETOWN BRIDGE, NSW RMS (2016)

- EASTERN BENTWING-BAT MANAGEMENT PLAN, GERRINGONG, NSW RMS (2014)
- GREEN AND GOLDEN BELL FROG MANAGEMENT STRATEGY, PRINCES HIGHWAY UPGRADE, NSW RMS (2012-2014)
- EXPERT REVIEW OF THREATENED FROG MANAGEMENT PLAN - WOOLGOOLGA TO BALLINA UPGRADE, NSW RMS (2014)
- THREATENED MICROBAT MANAGEMENT PLAN FOR WARRINGAH MALL, NORTHERN BEACHES COUNCIL (2014)
- COMMONWEALTH/NSW GIANT BURROWING FROG RECOVERY PLAN, DEWHA/DECC (2012)
- NSW DPI REPRESENTATIVE FOR THE NATIONAL ADVISORY GROUP ON CANE TOAD MANAGEMENT (2009-2011)
- TAREN POINT CANE TOAD MANAGEMENT ADVISORY GROUP (2007-2008).

TRAINING

- LEAD INSTRUCTOR > 50 WILDLIFE TRAINING SCHOOLS RUN IN NSW, ACT AND VICTORIA PROVIDING PRESENTATIONS ON THE SURVEY, IDENTIFICATION AND MANAGEMENT OF ALL FLORA AND FAUNA. THIS INCLUDED DETAILED INSTRUCTION ON THE MANAGEMENT OF THREATENED WADING AND AQUATIC BIRDS AND OTHER AQUATIC SPECIES PRESENTED TO QUEENSLAND, VICTORIAN, NSW AND COMMONWEALTH GOVERNMENT STAFF (1993-2017)
- PRIVATE FORESTRY SURVEY REQUIREMENTS, VICTORIAN TIMBER (2016).

PUBLICATIONS

Book Chapters

Hecnar S. J., & Lemckert, F.L. 2012. Habitat Protection: Refuges and Reserves. Pp 3636-3675 In *Biology of the Amphibia Volume 10 - Conservation and Decline of Amphibians: Ecology, Effects of Humans, and Management*. H. Heatwole (Ed.). Surrey-Beatley and Sons, Sydney.

Lemckert, F.L., & Mahony, M.J. 2018. The status of Decline and Conservation of Frogs in Temperate Coastal South-eastern Australia. Pp 59-72 In *Amphibian Biology Volume 11 - Conservation and Decline of Amphibians: Eastern Hemisphere (Australia, New Zealand and Pacific Islands)*. H. Heatwole and J. Rowley (Eds.). CSIRO Publishing, Melbourne.

Lemckert, F.L., Hecnar S.J., & Pilliod, D.S. 2012. Habitat Destruction and Modification. Pp 3291-3342 In *Biology of the Amphibia Volume 10 - Conservation and Decline of Amphibians: Ecology, Effects of Humans, and Management*. H. Heatwole (Ed.). Surrey-Beatley and Sons, Sydney.

Lemckert, F.L. & Penman, T. 2012. Climate Change and Australia's frogs: how much do we need to worry? Pp 92-98 In: *Wildlife and Climate Change: towards robust conservation strategies for Australian fauna*. D. Lunney & P. Hutchings (Eds.). Royal Zoological Society of NSW, Mosman, NSW, Australia.

Hero, J-M, Richards, S, Alford, R., Allison, A., Bishop, P., Gunther, R., Iskandar, D., Kraus, F., Lemckert, F., Menzies, J., Roberts, D. & Tyler, M. 2008. Amphibians of the Australasian Realm. Pp 65-73 In: *Threatened Amphibians of the World*. S. N. Stuart, M. Hoffman, J. S., Chanson, N. A. Cox, R. J. Berridge, P. J. Ramani & B. E. Young (Eds.). Lynx Edicions, Barcelona.

Green, M., Thompson, M.B. & Lemckert, F.L. 2004. The effects of suspended sediments on the tadpoles of two stream-breeding and forest dwelling frogs, *Mixophyes balbus* and *Heleioporus australiacus*. Pp 713-720 In *Conservation of Australia's Forest Fauna, Second Edition*. D. Lunney (Ed.). Royal Zoological Society of NSW, Sydney.

Lemckert, F.L. & Slatyer, C. 2004. Herps in forests: schools to educate land managers in their conservation. Pp 1055-1058 In *Conservation of Australia's Forest Fauna, Second Edition*. D Lunney (Ed.). Royal Zoological Society of NSW, Sydney.

Lemckert, F. & Morse, R. 1999. Frogs in the timber production forests of the Dorrigo escarpment in northern NSW: an inventory of species present and the conservation of threatened species. Pp 72-80 In *Declines and Disappearances of Australian Frogs*. A. Campbell (Ed.). Environment Australia, Canberra.

Scientific Papers

- Mahony, M.J., Penman, T., Bertozzi, T., Lemckert, F., Bilney, R. & Donnellan, S.C. In Review. Taxonomic revision of south-eastern Australian giant burrowing frogs (Anura: Limnodynastidae: Heleioporus Gray). *Zootaxa*.
- Gillespie, G.R., Roberts, J.D., Hunter, D., Hoskin, C.J., Alford, R.A., Heard, G.W., Hines, H. Lemckert, F., Newell, D. & Scheele, B.C. 2020. Status and Priority Conservation Actions for Australian Frog Species. *Biological Conservation* 247, 108543. <https://doi.org/10.1016/j.biocon.2020.108543>.
- Mahony, M., Moses, B., Mahony, S.V., Lemckert, F.L. & S Donnellan. 2020. A new species of frog in the *Litoria ewingii* species group (Anura: Pelodyadidae) from south-eastern Australia. *Zootaxa* 4858: 201-230.
- Henle, K., Osborne, W., & Lemckert, F. 2014. The herpetofauna of Kioloa, New South Wales: baseline observational data collected 30 years ago and inspired by R. E. Barwick. *Australian Journal of Zoology* 62:100–107.
- Mahony, M.J., Hamer, A.J., Pickett, E.J., McKenzie, D.J., Stockwell, M.P., Garnham, J.I., Keely, C.C., Deboo, M., O'Meara, J., Pollard, C.J., Clulow, S., Lemckert, F.L., Bower, D.S., & Clulow, J. 2013. Identifying conservation and research priorities in the face of uncertainty: a review of the threatened bell frog complex in eastern Australia. *Herpetological Conservation and Biology* 8:519-538.
- Waters, C.M., Penman, T.D., Hacker, R.B., Law, B., Kavanagh, R.P., Lemckert, F. & Alemseged Y. 2013. Balancing trade-offs between biodiversity and production in the re-design of rangeland landscapes. *The Rangeland Journal* 35:143-154.
- Daly, G. and Lemckert, F.L. 2011. Survey of the reptiles and amphibians of the montane forests near Tenterfield on the north coast of New South Wales. *Australian Zoologist* 35:957-972.
- Lemckert, F.L. 2011. Managing pond breeding anurans in the selectively harvested forests of coastal New South Wales, Australia. *Forest Ecology and Management* 262:1199–1204.
- Lemckert, F.L., Penman, T. & Haywood, A. 2011. Adaptive monitoring using the endangered northern corroboree frog (*Pseudophryne pengilleyi*) as a case study. *Proceedings of the International Academy of Ecology and Environmental Sciences* 1:87-96.
- Hamer, R., Lemckert, F.L. & Banks, P.B. 2011. Adult frogs are sensitive to the predation risks of olfactory communication. *Biology Letters* 7:361-363.
- Lemckert, F & Mahony, M.J. 2010. The relationship among multiple-scale habitat variables and pond use by anurans in northern New South Wales, Australia. *Herpetological Conservation and Biology* 5:537–547.
- Lemckert, F.L. 2010. The rich early history of frog research in Sydney. *Australian Zoologist* 36:102-106.
- Lemckert, F. 2010. Habitat relationships and presence of the threatened heath frog *Litoria littlejohni* (Anura: Hylidae) in central New South Wales, Australia. *Endangered Species Research* 11:271-278.
- Lemckert, F. & Grigg, G. 2010. Living in the 80s – seasonality and phenology of frog calling activity at Darkes Forest from 1987-1989. *Australian Zoologist* 35:245-250.
- Lemckert, F., Rosauer D. & Slatyer, C. 2009. A comparison of Australia's anuran records against the reserve system. *Biodiversity and Conservation* 18:1233-1246.
- Penman, T.D., Lemckert, F.L. & Mahony, M.J. 2008. Applied conservation management of a threatened forest dependent frog, *Heleioporus australiacus*. *Endangered Species Research* 5:45-53.
- Penman, T.D, Lemckert, F.L. & Mahony, M.J. 2008. Spatial ecology of the giant burrowing frog (*Heleioporus australiacus*): implications for conservation prescriptions. *Australian Journal of Zoology* 56:179–186.
- Lemckert, F.L. & Mahony, M.J. 2008. Core calling periods of the frogs of temperate New South Wales, Australia. *Herpetological Conservation and Biology* 3:71-76.
- Penman, T. D. & Lemckert F. L. 2008. Monitoring the green and golden bell frog: current problems and an alternative approach. *Australian Zoologist* 34:373-378.
- Penman, T., Mahony, M., Towerton, A. & Lemckert, F. 2007. Spatial models of giant burrowing frog distributions. *Endangered Species Research* 3:115-124.

- Phillot, A.D., Skerratt, L.F., McDonald, K.R., Lemckert, F.L., Hines, H.B., Clarke, J.M., Alford, R.A. & Speare, R. 2007. Toe-clipping as an acceptable method of identifying individual anurans in mark recapture studies. *Herpetological Review* 38:305-308.
- Semeniuk, M., Lemckert, F.L. & Shine, R. 2007. Breeding-site selection by cane toads (*Bufo marinus*) and native frogs in northern New South Wales, Australia. *Wildlife Research* 34:59-66.
- Slatyer, C., Rosauer, D. & Lemckert, F. 2007. An assessment of endemism and species richness patterns in the Australian Anura. *Journal of Biogeography* 34:583-596.
- Hero, J-M., Morrison, C., Gillespie, G., Roberts, J.D., Newell, D., Meyer, E., McDonald, K., Lemckert, F., Mahony, M., Osborne, W., Hines, H., Richards, S., Hoskin, C., Clarke, J., Doak, N. & Shoo, L. 2006. Overview of the conservation status of Australian Frogs. *Pacific Conservation Biology* 12:313-320.
- Lemckert, F., Haywood, A., Brassil, T. & Mahony, M. 2006. Correlations between frogs and pond attributes in central New South Wales, Australia: What makes a good pond? *Applied Herpetology* 3:67-82.
- Lemckert, F., Mahony, M., Brassil, T. & Slatyer, C. 2006. The biology of the threatened Green-thighed Frog *Litoria brevipalmata* (Anura: Hylidae) in the central and mid-north coastal areas of New South Wales. *Australian Zoologist* 33:337-344.
- Lemckert, F., Brassil, T., Kavanagh, R. & Law, B. 2006. Trapping small mammals for research and management: how many die and why? *Australian Mammalogy* 28:201-208.
- Penman, T.D., Lemckert, F.L. & Mahony, M.J. 2006. Meteorological effects on the activity of the giant burrowing frog, *Heleioporus australiacus*, in south-eastern Australia. *Wildlife Research* 33:35-40.
- Penman, T., Lemckert, F. & Mahony, M. 2006. A preliminary investigation into the potential impacts of fire on a forest dependent burrowing frog species. *Pacific Conservation Biology* 12:78-83.
- Penman, T., Lemckert, F., Slade, C. & Mahony, M. 2006. Non-breeding habitat requirements of the giant burrowing frog (*Heleioporus australiacus*) in south-eastern Australia. *Australian Zoologist* 33:251-257.
- Fitzgerald, F., Shine, R., Lemckert, F. & Towerton, A. 2005. Habitat requirements of the threatened snake species *Hoplocephalus stephensii* (Elapidae) in eastern Australia. *Austral Ecology* 30:465-474.
- Lemckert, F.L. 2005. Body size of male common eastern froglets *Crinia signifera* does not appear to influence mating success during explosive breeding events. *Acta Zoologica Sinica* 51:232-236.
- Lemckert, F.L. 2005. Population structure, individual growth and survival of an Australian frog *Crinia signifera* at a pond. *Acta Zoologica Sinica* 51:393-400.
- Penman, T., Mahony, M. & Lemckert, F. 2005. Soil disturbance in integrated logging operations. *Applied Herpetology* 2:415-424.
- Penman, T.D., Mahony, M.J., Towerton, A.L. & Lemckert, F.L. 2005. Bioclimatic analysis of disjunct populations of the giant burrowing Frog, *Heleioporus australiacus*. *Journal of Biogeography* 32:397-405.
- Fitzgerald, M., Shine, R. & Lemckert, F. 2004. Life history attributes of a threatened Australian snake *Hoplocephalus stephensii* (Elapidae). *Biological Conservation* 119:121-128.
- Lemckert, F.L. 2004. Variations in anuran movements and habitat use: implications for conservation. *Applied Herpetology* 1:165-181.
- Lemckert, F.L. & Brassil, T. 2004. Movements and habitat use by the giant burrowing frog, *Heleioporus australiacus*. *Amphibia-Reptilia* 24:207-211.
- Lemckert, F.L., Brassil, T. & Haywood, A. 2004. Effects of low intensity fire on pond-breeding anurans in mid-northern New South Wales, Australia. *Applied Herpetology* 1:183-195.
- Penman, T., Lemckert, F. & Mahony, M. 2004. Two hundred and ten years of looking for giant burrowing frog. *Australian Zoologist* 32:597-604.
- Fitzgerald, M., Shine, R. & Lemckert, F. 2003. A reluctant heliotherm: thermal ecology of the arboreal snake *Hoplocephalus stephensii* (Elapidae) in dense forest. *Journal of Thermal Biology* 28:515-524.
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