

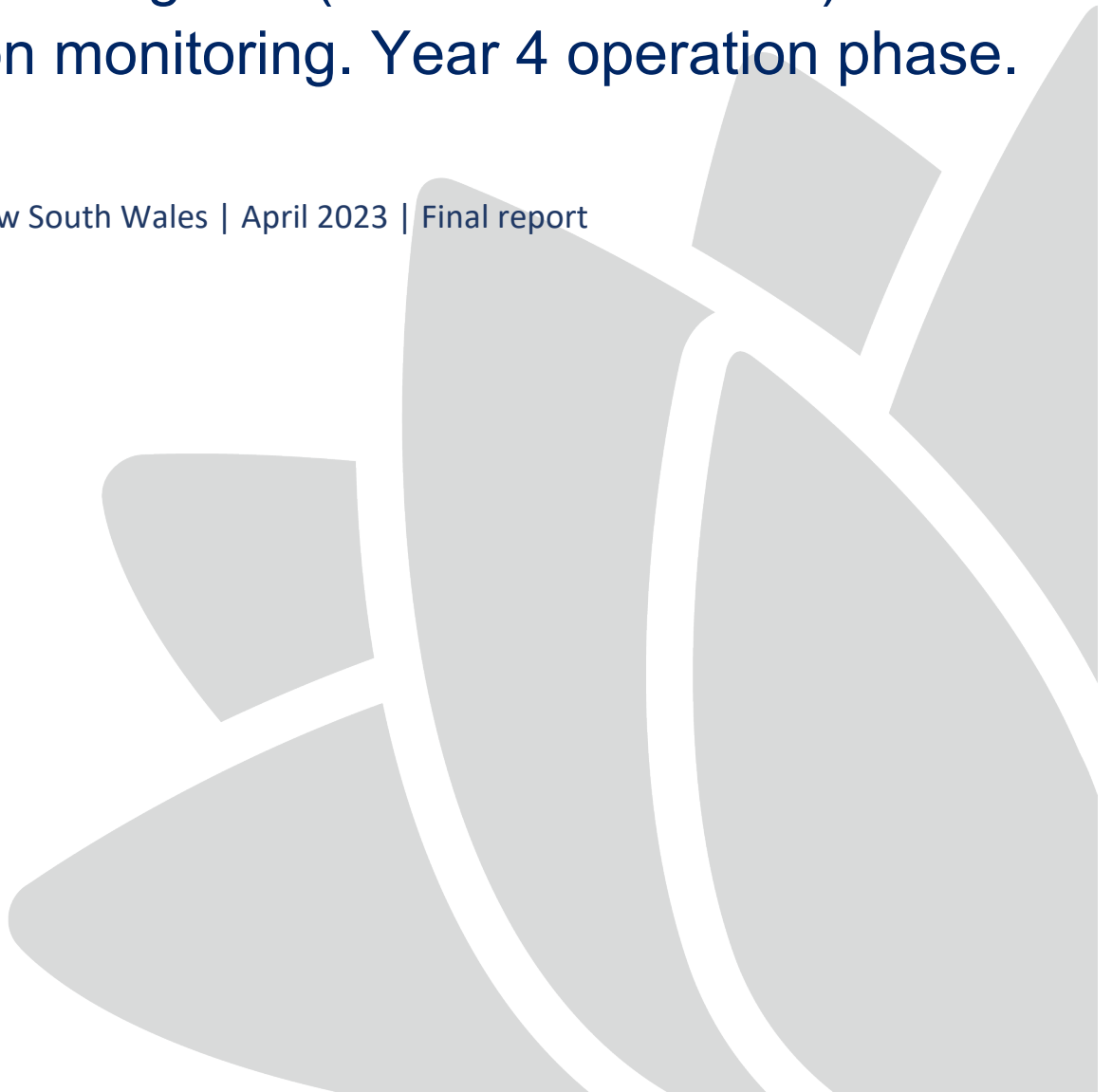


Transport  
for NSW

# Pacific Highway Upgrade Warrell Creek to Nambucca Heads

Yellow-bellied glider (*Petaurus australis*)  
population monitoring. Year 4 operation phase.

Transport for New South Wales | April 2023 | Final report





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australis*) population monitoring –  
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**Project team:**

Dr D. Rohweder (project management, reporting, field survey)  
Mr L. Andrews (field survey and reporting)  
Ms N. Makings (field survey)  
Ms. A. English (field survey)

**Report prepared for:**

Transport for NSW

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ABN: 82 084 096 828  
PO Box 401  
ALSTONVILLE NSW 2477  
P 0401 195 480 | E [david@sandpipereco.com.au](mailto:david@sandpipereco.com.au)

**Cover Photo:** Flooded gum at site 28 in Ngambaa Nature Reserve.

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# 1. Introduction

## 1.1 Background

Transport for NSW (TfNSW), in conjunction with Acciona Ferrovia Joint Venture (AFJV), commenced the upgrade of the Pacific Highway between Warrell Creek and Nambucca Heads (WC2NH) in 2015. The upgrade was subsequently completed and the final stage of the project open to traffic in June 2018.

Approvals for the WC2NH upgrade required monitoring of several species and mitigation measures during the operational phase. Species and mitigation measures targeted include koala *Phascolarctos cinereus*, yellow-bellied glider *Petaurus australis*, giant barred frog *Mixophyes iteratus*, constructed ponds for green-thighed frog *Litoria brevipalmata*, fauna underpasses, vegetated median, roadkill, exclusion fence, and threatened flora. Sandpiper Ecological Surveys (Sandpiper Ecological) was contracted by TfNSW to deliver the WC2NH operational ecological and water quality monitoring program in accordance with the WC2NH Operational Ecological and Water Quality Monitoring Brief (the Brief) as informed by the WC2NH Ecological Monitoring Program (EMP) (RMS 2018).

The EMP sets out a yellow-bellied glider monitoring program that extends to year 10 of the operational phase and refers to details provided in the WC2NH Ecological Monitoring Program for the Yellow-bellied Glider (YBGEMP) (Goldingay 2014). The program was largely based on pre-construction phase (baseline) surveys completed in 2014 (Goldingay 2015) and aims to assess both individual level and population level responses to the highway upgrade.

An individual level response will be measured by comparing forest use adjacent the highway upgrade before and after construction whereas a population level response will be measured by comparing the proportion of survey sites occupied by yellow-bellied gliders in Nambucca State Forest (SF) with that measured at reference locations before and after construction (RMS 2018). Assessment of the individual level response to the highway upgrade will be conducted using spotlighting and song meters to detect and record calls of the yellow-bellied glider near the highway upgrade (RMS 2018). Assessment of population response will be measured using spotlight transects located in Nambucca State Forest (SF) and at reference sites in Yarriabini National Park (NP) and Ngambaa Nature Reserve (NR).

In addition to baseline surveys the YBGEMP also required completion of construction phase population surveys, which were conducted in 2016/17 (Sandpiper Ecological 2018), and operation phase monitoring in years 1, 2, 4, 7 and 10 of the operational phase. Year one operation phase was completed in 2018/19 (Sandpiper Ecological 2019a), year two in 2019/20 (Sandpiper Ecological 2020) and an additional year three survey post fire and logging (Sandpiper Ecological 2021).

## 1.2 Species ecology

The yellow-bellied glider is Australia's largest Petaurid glider, weighing between 450 - 700 g (Russell 1995). It feeds on a range of food including plant and insect exudates (sap, manna gum, honeydew, nectar and pollen) as well as insects and spiders (Goldingay and Jackson 2004). Population abundance is strongly related to the degree of forest maturity and the diversity of floristic resources (Kavanagh 1987). Yellow-bellied gliders den within tree hollows in small family groups of 2 - 6 individuals, including an adult male and one to two females and their offspring (Goldingay and Kavanagh 1991). Breeding females give birth to one offspring in most years but may not breed when environmental conditions are poor (Craig 1985; Goldingay 1992).

Yellow-bellied gliders are highly mobile and family groups feature home ranges in the order of 25 - 84 ha (Goldingay and Jackson 2004). The species are also highly vocal and may be heard well over 200 m away. Individuals call up to 15 times/hour for several hours after dark (Goldingay 1994). Calls are given at frequencies of 700-6400 Hz (main energy band 1000 - 3000 Hz) and range in duration from less than one second for a gliding moan, and up to four seconds for a full call (Goldingay 1992). The loudness and frequency of yellow-bellied glider calling make them relatively detectable during population surveys. This is enhanced by use of call playback, which is known to elicit higher calling rates (Goldingay 1994).

### 1.3 Scope of works

The scope of works for the current reporting period included:

1. Spotlight surveys of all 92 transects across Nambucca State Forest (40 sites), Yarriabini National Park (20 sites) and Ngambaa Nature Reserve (32 sites) on three occasions during late winter/spring 2021 (year 4).
2. Installation of six song meters within each of the three Nambucca SF blocks (18 units in total), including six units near the alignment and six units away from the alignment in the north-west and south blocks, for a period of six months.
3. Analysis of song meter recordings for presence and frequency of yellow-bellied glider calls using Kaleidoscope Pro software.

The following report details and discusses year 4 operation phase yellow-bellied glider population monitoring activities. The report also considers the following performance indicators:

1. No reduction in proportion of sites occupied by yellow-bellied gliders in Nambucca SF post-construction.
2. No reduction in forest use adjacent to the highway in Nambucca SF post-construction.

## 2. Study Area

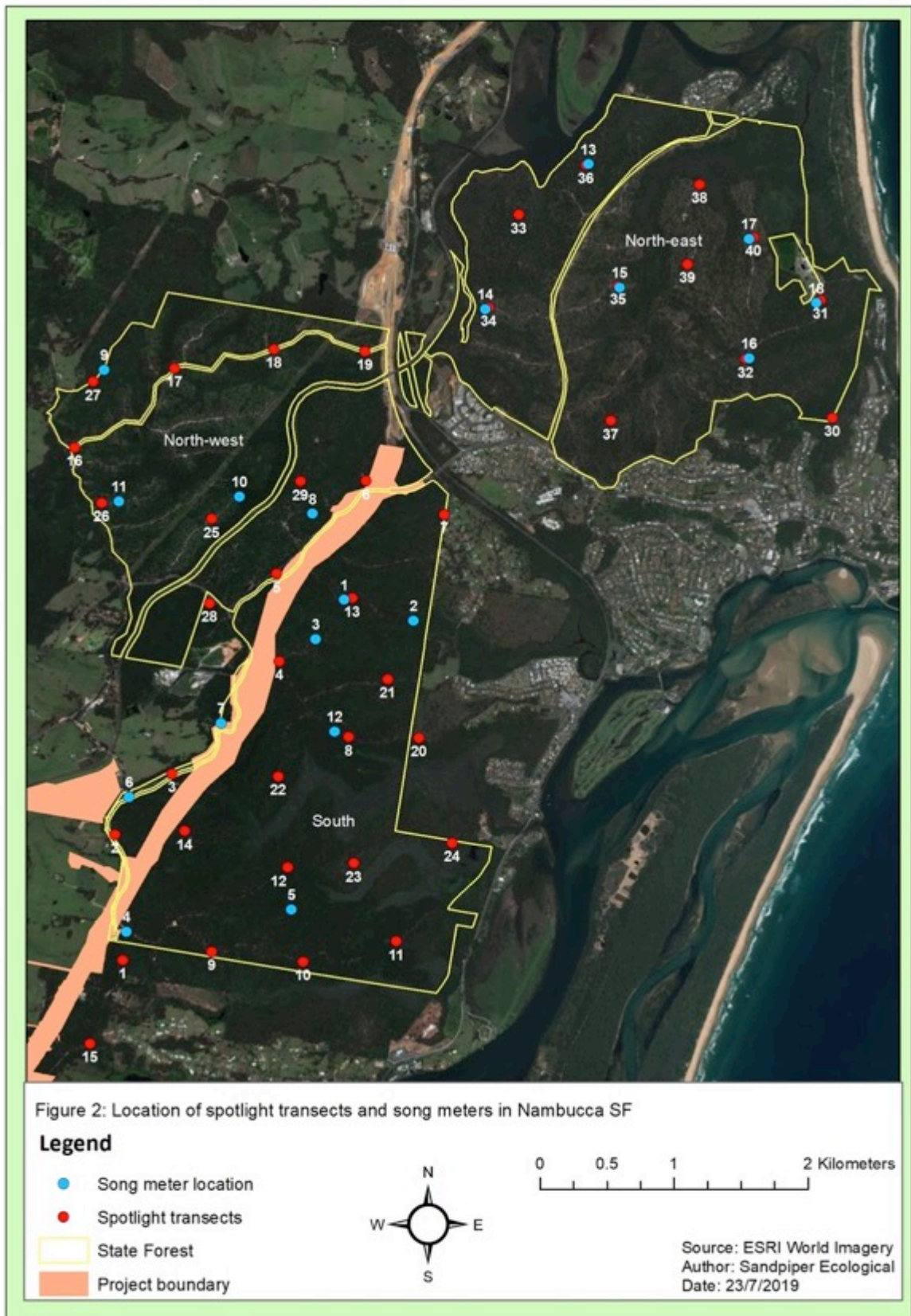
Surveys were conducted within Nambucca SF, which is located on the mid-north coast of NSW (Figure 1). Transects (200m long) were established during the pre-construction surveys in 2014 and were located on management tracks and spaced a minimum of 500m apart to increase the likelihood of independence. Forty transects were positioned in Nambucca SF (Figure 2), 20 in Yarriabini NP (Figure 3) and 32 in Ngambaa NR (Figure 4). The three study areas featured similar dry open forest habitat with moist gullies.

Nambucca SF featured three blocks: north-east, north-west, and south with the latter two blocks separated by the highway corridor (Figure 2). The north-east block has been heavily logged whereas the north-west and south blocks of Nambucca SF, Yarriabini NP, and Ngambaa NR have experienced less intensive, selective logging. Part of the south block in Nambucca SF was logged immediately prior to the 2020 survey.

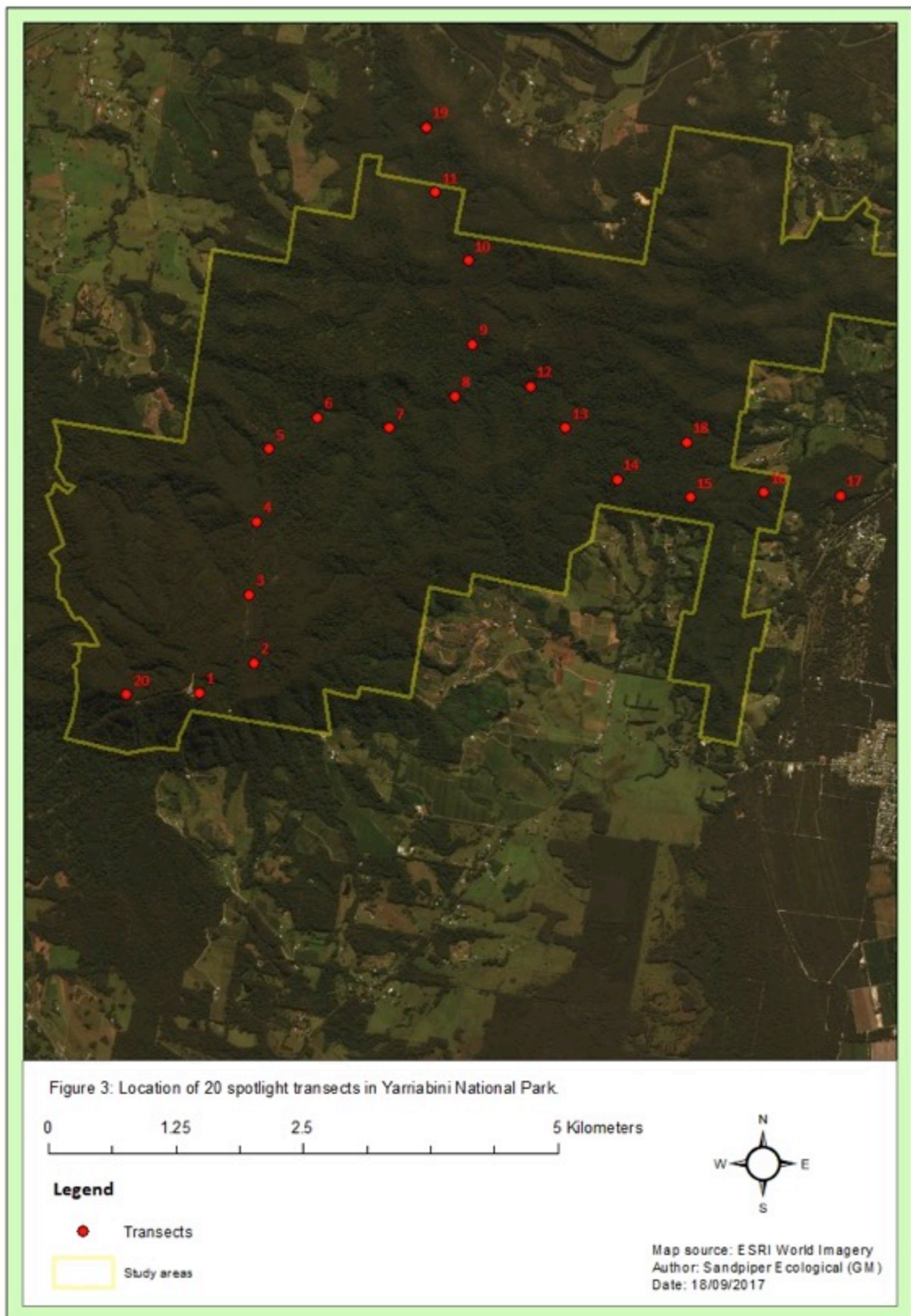




**Figure 1:** Location of Nambucca State Forest in relation to nearby conservation reserves.



**Figure 2:** Location of 40 spotlight transects and 18 song meters within Nambucca SF.



**Figure 3:** Location of 20 spotlight transects in Yarriabini NP.

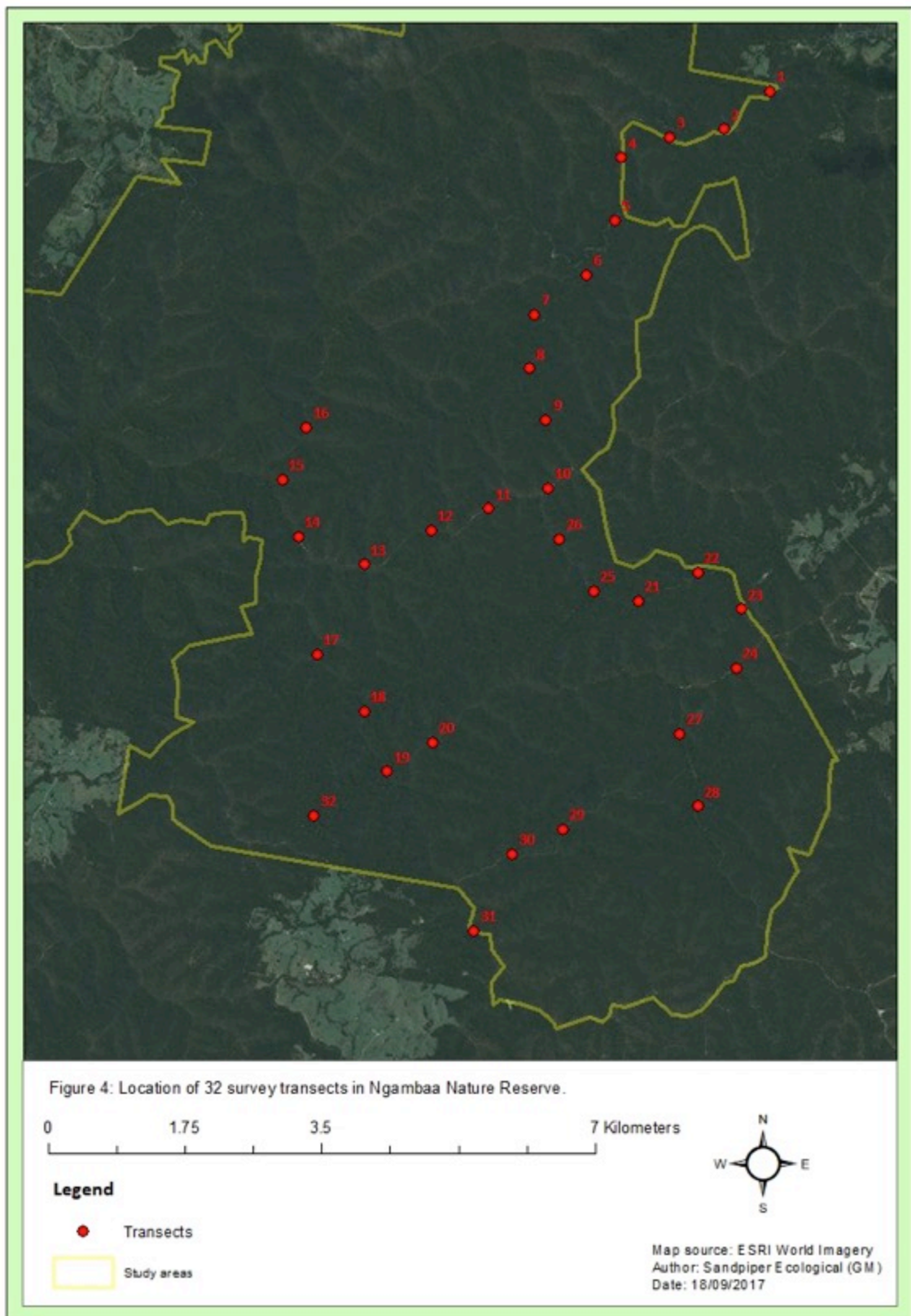


Figure 4: Location of 32 transects in Ngambaa NR.

## 3. Methods

### 3.1 Spotlight/Call Playback Surveys

Three spotlight/call playback survey sessions targeting yellow-bellied gliders were conducted during late winter/spring 2021. Surveys followed the method described by Goldingay (2015) and included the same sites in Nambucca SF as all previous surveys. At the beginning of the survey period, transects were located and their start and end points marked with a combination of flagging tape and reflective tape. Surveys occurred on 9-12 August (session 1), 13-16 September (session 2) and 25 October – 24 November (session 3). During session three all but four transects at Yarriabini were sampled between 25 and 27 October. Teams of three or four ecologists completed surveys operating concurrently on proximal transect. Surveys commenced when dark, approximately 40 minutes after sunset (i.e., after civil twilight), and most surveys were completed within four hours of sunset.

Transects were spotlighted on one occasion during each session. Each transect was spotlighted for a minimum of 20 person minutes by 1-2 personnel using a 250-lumen spotlight (Led Lenser P14 or equivalent) and binoculars, as required. At the 10-minute mark, four recorded calls of the yellow-bellied glider and four recorded calls of the powerful owl were broadcast from a 10watt megaphone. Call broadcast volume was calibrated to be audible to the human ear to approximately 200m and therefore easily audible to yellow-bellied glider within this range.

Information recorded for each yellow-bellied glider detection included: time, distance along transect, approximate distance and compass bearing from operator and mode of detection (i.e., heard call, saw individual, heard movement, saw eye-shine). The time and direction of yellow-bellied glider detections were compared at completion of surveys to ensure double counting did not occur for neighbouring transects.

Surveys were mostly conducted around the dark phase of the moon between last quarter and first quarter. Weather conditions were generally suitable for spotlight surveys (Tables A1-A3, Appendix A). Light rain occurred during sampling of five transects, two in August and three in October. Wind was variable between the sample sites and was typically stronger and more prevalent at Yarriabini and Ngambaa than Nambucca SF. Cloud was present during most surveys and was generally ranged from 3/8ths to 8/8ths. Air temperature was cool, ranging from 10 to 22°C over the three samples.

Full details of weather conditions and survey effort are provided in Appendix A.

### 3.2 Song Meter Surveys

#### 3.2.1 Song meter recording

Eighteen song meters (SM4 manufactured by Wildlife Acoustics, USA) were installed across Nambucca SF between 16-17 August 2021. The spatial configuration of the array was as per 2018/19 surveys (see Figure 2) and was as follows:

- North-east block: six units evenly spread across block.
- North-west block: 3 units <300m from highway (i.e. near), 3 units >700m from highway (i.e. away).
- South block: 3 units <300m from highway, 3 units >700m from highway.

Song meters were strapped to trees with a python lock at approximately 6m above ground level using a ladder. Each unit was powered by four 1.5v D-size batteries and received either two 32 gigabyte or one 64 gigabyte memory card. Units were programmed to record three hours of audio nightly beginning

approximately one hour after sunset. Song meters were inspected on 25 November 2021 to replace batteries and SD cards. All units were collected on the 21 March 2022.

### 3.2.2 Song meter analysis

Analysis of 2016/17 and 2018/19 audio recordings was performed using Song Scope (Version 4.0; Wildlife Acoustics) sound recognition software. This software has been largely superseded by Kaleidoscope Pro (version 5.1.9g, Wildlife Acoustics), a more advanced sound recognition software package. Kaleidoscope Pro enables users to undertake cluster analysis of sound recordings and to develop an advanced classifier to detect a vocalization of interest – in this case, the yellow-bellied glider.

An advanced classifier (i.e., YbG-AC) was built using annotated calls of the yellow-bellied glider derived from sound recordings from Nambucca SF in 2016/17 and 2018/19. The building process involves ‘training’ the advanced classifier to detect or match vocalisations of the yellow-bellied glider from sound recordings. Numerous sensitivity analysis tests are also performed to determine optimal signal parameters. In this way, the building process is highly iterative and proceeds through numerous ‘tuning’ phases whereby batches of sound files are progressively analysed and incorrectly labelled vocalisations (i.e. false positives) are removed and the classifier algorithm updated or refined. The outcome of this process was final candidate model YbG-AC (Settings: Range = 250-10000 Hz; Length = 1.0 – 7.5 sec; Max inter-syllable gap = 0.35 sec; FFT window = 5.33 ms; Max distance from cluster center = 1.4; Max states = 12; Max distance to cluster center for building clusters = 0.5; Max clusters = 500).

To determine the relative performance capabilities of the final candidate advanced classifier (YbG-AC), we analysed seven sound recording files previously analysed by the Song Scope Recogniser (i.e., YbG-Rec) and known to contain calls of yellow-bellied gliders. The YbG-AC detected equal or greater the number of calls than the YbG-Rec on four of the seven sound files (i.e., 57%). This suggested that the YbG-AC was moderately more effective than the YbG-Rec in detecting yellow-bellied glider vocalisations and thereby appropriate for analysing 2021/22 sound recordings.

The YbG-AC was then used to analyse recordings from each of the 18 song meters during year 4 monitoring using the Batch processing option. All audio recordings positively identified by the YbG-AC were subsequently checked and true-positive call detections logged. The number of true-positive call detections and number of nights when calls were detected were then tabulated for each song meter site.

## 4. Results

### 4.1 Spotlight surveys

Yellow-bellied gliders were detected once on transect N24 in Nambucca SF during the 2021 survey (Table 1). The individual was heard calling at dusk on 9 August 2021. At the Yarriabini NP reference site, yellow-bellied gliders were detected on two transects in surveys one and three, and one transect in survey two, including two individuals at site Y6 during each survey. Overall, yellow-bellied gliders were detected on three of 20 transects (i.e., 15% of transects sampled). Across the 32 transects in Ngambaa NR, yellow-bellied gliders were detected on seven occasions at five transects, or 16% of sample sites. There were two detections in survey one, one in survey two and four in survey three. Two individuals were recorded at site U27 in survey three.

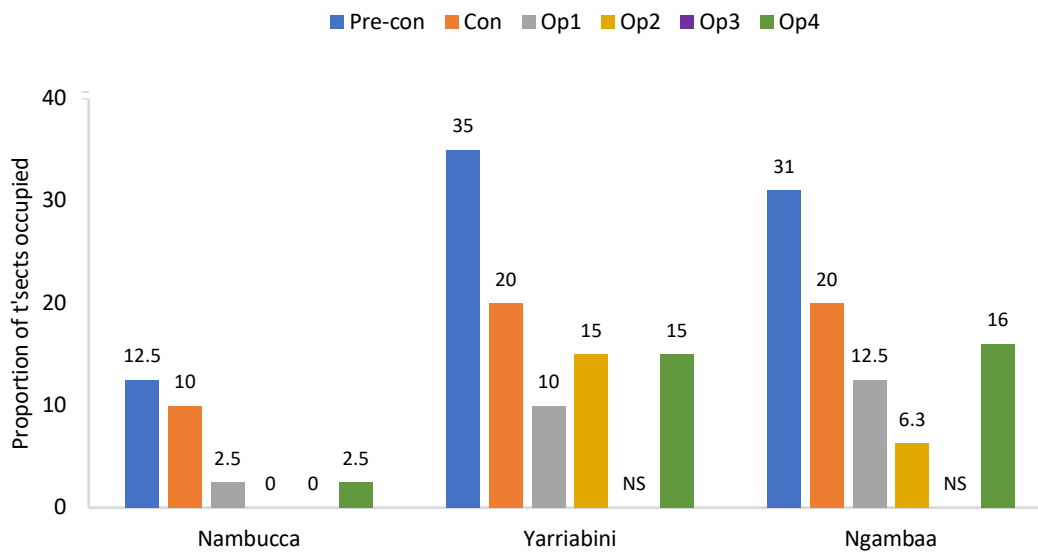
Across the three survey sites combined (i.e., 92 transects), yellow-bellied gliders were detected on 13 occasions on nine transects. Four detections at two sites were of two individuals. All detections were initially made by call. Gliders were detected by call before call broadcast on 43% of occasions and after call broadcast

on 57% of occasions, mostly within a few minutes. Full details of yellow-bellied glider spotlight surveys are provided in Appendix A.

**Table 1:** Yellow-bellied glider detections at Nambucca SF and two reference sites (Yarriabini and Ngambaa) in 2021. Data are pooled for the three surveys.

Site	Nambucca	Yarriabini	Ngambaa
Number of transects	40	20	32
Number of transects YbG detected on	1	3	5
% of transects YbG detected on	2.5%	15%	16%

A comparison across the survey periods shows a relatively consistent downward trend in occupation rate in Nambucca SF and Ngambaa NR from pre-construction to year 2 operation (Figure 5). A similar pattern was recorded at Yarriabini NP. There was a moderate increase in occupation rate at Yarriabini NP from year 1 to year 2 and that remained stable into year 4. Likewise, occupation rate at Ngambaa NR increased substantially from year 2 to year 4. Despite the upturn at Yarriabini NP and Ngambaa NR, the operation phase occupation rates at all three sites remain below that recorded during pre-construction. For example, occupation rate at Yarriabini and Ngambaa in year 4 were respectively only 43% and 52% of the pre-construction level, whilst Nambucca SF occupation rate in year 4 was 20% of the pre-construction level.



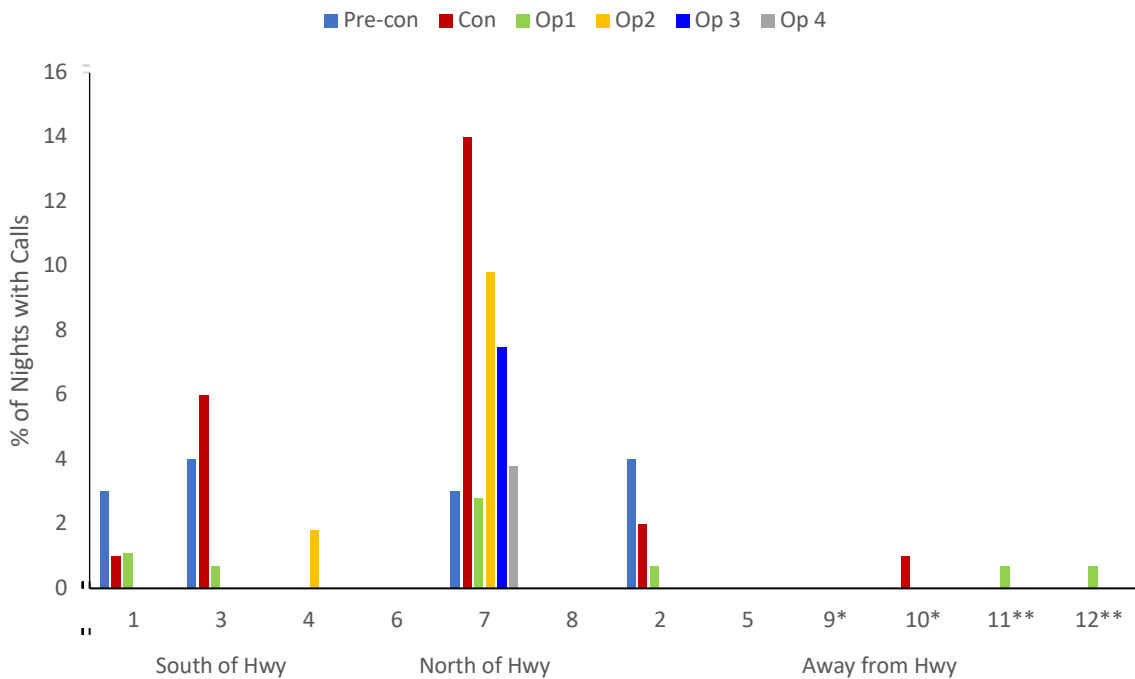
**Figure 5:** Proportion of survey site spotlight transects occupied by yellow-bellied gliders for each survey period. Pre-con = pre-construction (2014); Con = construction (2016); Op1 = operation phase year 1 (2018); Op2 = operation phase year 2 (2019); Op3 = operational phase year 3 (2020); Op4 = operational phase year 4 (2021); NS = not sampled.

## 4.2 Song Meter Surveys

The 18 song meters operated for a total of 3,192 nights and units were active for between 106 – 186 nights (mean  $177 \pm 24.02$  nights) during the 26-week deployment. Sixteen of the 18 units were active for the duration of the deployment period with two song meters (SM6 & SM10) becoming water damaged during rainfall in late December 2021 and early January 2022. Calls of the yellow-bellied glider were detected in the north-west forest block at SM7 only with overall calls detected on 0.22% of sampling nights (Figure 6 & 7). Calls were detected on 7 nights or 3.8% of sample nights at SM7 for an average of one call for every 26 nights sampled (Figure 6). No calls were detected in the north-east (i.e., SM13-18) or southern forest blocks (i.e., SM1-5 and SM 12).

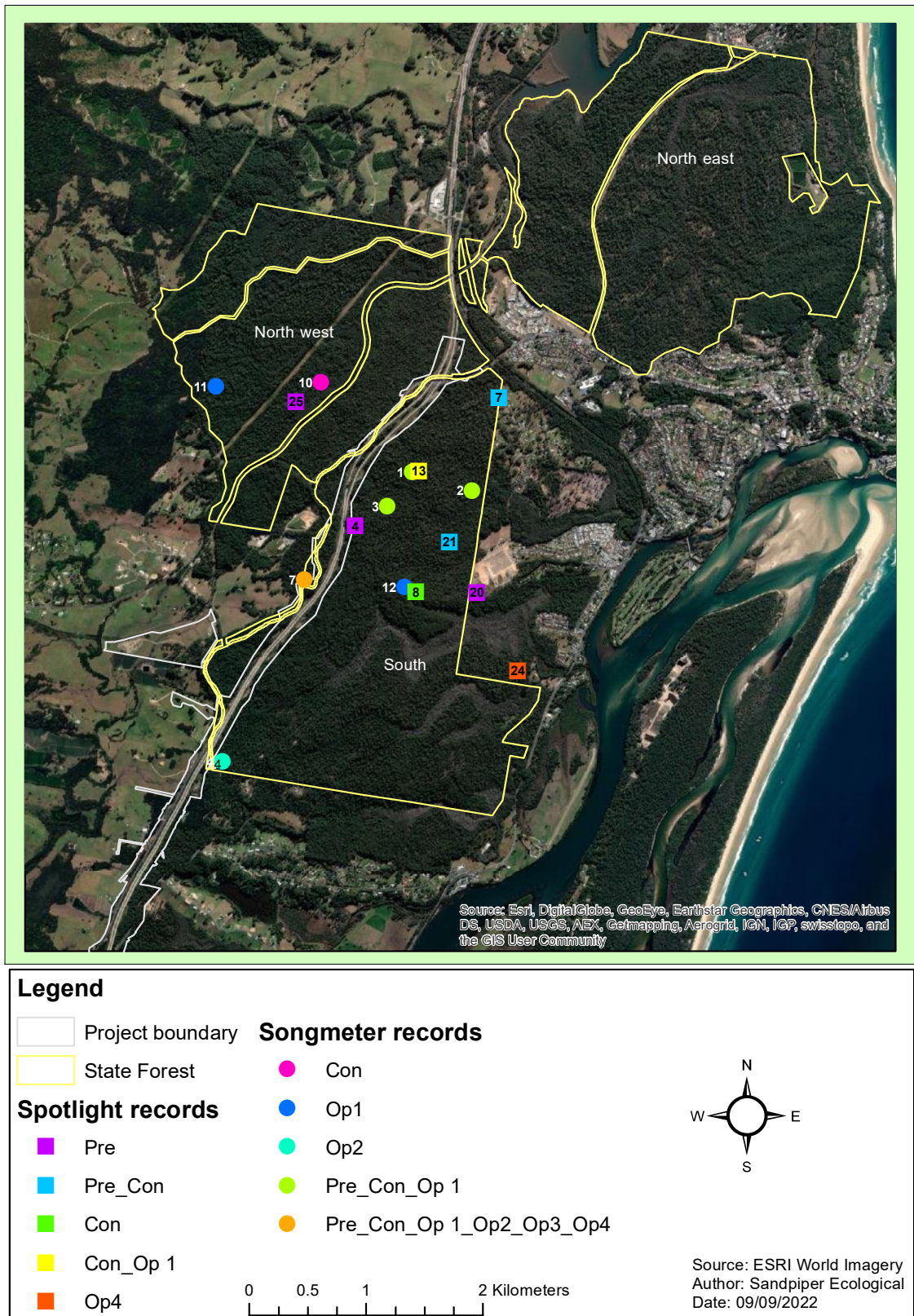
Calls of the yellow-bellied glider were detected at one of the three near-highway song meter sites where they were previously recorded (Figure 7). Yellow-bellied gliders have been detected at SM7 during all sample periods. At site SM7, the percentage of nights with calls (i.e., 3.8%) was like that recorded during pre-construction (i.e., 3%) but lower than that recorded during year 2 operation (9.8%) and year 3 operation (7.5%) (Figure 6). The mean proportion of nights with calls for the six near-highway song meters declined from 1.67% ( $\pm 1.86$  sd) to 0.77% ( $\pm 1.1$  sd) between pre-construction and operation year 1, increased during operation year 2 ( $1.93 \pm 3.92\%$  sd) and declined in operation year 3 ( $1.25 \pm 3.06\%$  sd) and year 4 ( $0.633 \pm 1.55\%$  sd). The mean values in operational years 2 and 3 was highly inflated by the high call rate at SM7. Yellow-bellied glider call detections away from the highway declined from three sites during operation year 1 to zero in year 4 (Figure 6). Yellow-bellied glider calls were detected at one of two away sites during pre-construction.

Full details of song meter deployment are provided in Appendix B.



**Figure 6:** Percentage of nights in which yellow-bellied gliders were detected by song meters in the north-west and southern blocks (numbered 1-12) near the highway alignment (i.e., <300m) and away from the alignment (i.e., >700m) during pre-construction (Pre-con), construction (Con) and operation year 1 (Op1), year 2 (Op2), year 3 (Op3) and year 4 (Op4). \* = song meters 9 & 10 deployed during construction and operation phases only; \*\* = song meters 11 & 12 deployed during operation phases only.





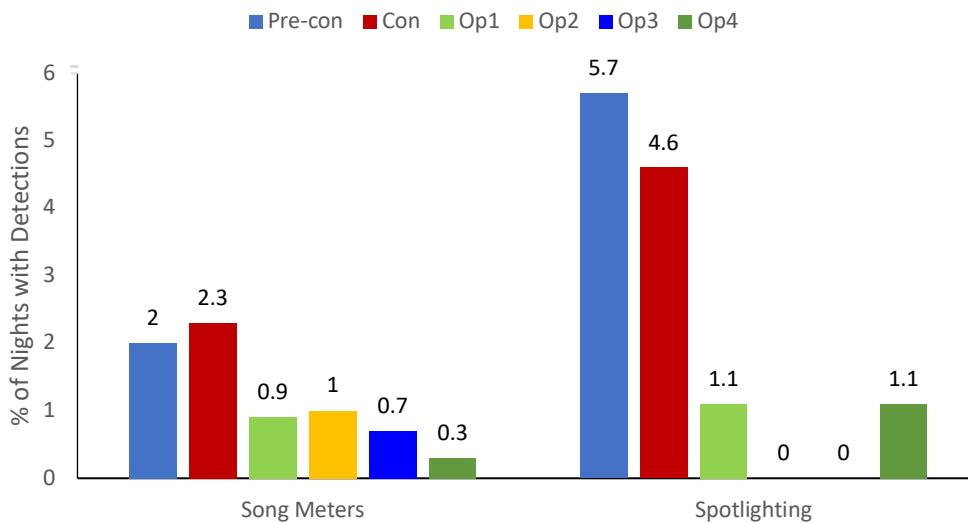
**Figure 7:** Song meter and spotlight transect locations where yellow-bellied glider calls were detected during the current and previous monitoring years. Pre=pre-construction; con = construction; Op1 = operational year 1; Op2 = operational year 2; Op 3 = operational year 3; Op 4 = operational year 4.

### 4.3 Aggregation of spotlighting and song meter data

Both the spotlighting and song meter data from the current and previous surveys demonstrate a marked decline in the number of yellow-bellied glider social groups residing in Nambucca SF (Figures 7 & 8). The six social groups identified during pre-construction and five identified during operation year one contracted to two social groups in the south block in year two and one social group in the south block in years three and four (Figure 8). Results indicate that the decline in glider occurrence occurred from construction (2016) to year one operation (2018/19) (Figure 8). This decline was prior to the severe drought of 2019 and logging and wildfire.

There is slight evidence of a second social group, or individual, in the south block where calls were detected by SM4 in operation year 2 and during spotlighting at N24 in year 4 (Figure 7). Neither song meters nor spotlighting in year 4 recorded evidence of the previously extant groups in the central regions of the south block and north-west block (see Figure 7). Both methods also confirmed the continued absence of yellow-bellied gliders in the north-east block.

If we disregard song meter and spotlighting effort in the north-east block, song meters have consistently detected yellow-bellied glider calls between 0.3% and 2.3% of sampling nights, including 0.3% of sampling nights during the current reporting period (Figure 8). Data collected from spotlighting is less consistent, however, it tends to compliment song meter data. Spotlighting recorded higher detection rates compared with song meters during the first two survey periods (Figure 8).



**Figure 8:** Percentage of survey nights in which yellow-bellied gliders were detected by song meters and spotlighting during pre-construction, construction, operation year 1, 2, 3 & 4 within Nambucca SF. Data from north-east block not included. Song meter data are for eight units during pre-construction (SM1-8), 10 units during construction (SM1-10) and 12 units during operation phases (SM1-12). Spotlighting detections are from three surveys of 29 sites across the north-west and south blocks in each monitoring period. Pre-con = pre-construction; Con = construction; Op1 = operation phase year 1; Op2 = operation phase year 2; Op3 = operation phase year 3; Op4 = operation phase year 4.

## 5. Discussion

### 5.1 Occupancy of yellow-bellied gliders in Nambucca SF

The proportion of spotlight survey sites occupied by yellow-bellied gliders in Nambucca SF has declined markedly from pre-construction levels. The scale of the decline during the operation phase has been in the order of 80% to 100%. Although not as pronounced, song meter data largely confirmed the scale of this decline and the likely loss of some social groups since 2014.

The frequency of call detections at SM7 (i.e., 3.8% of sampling nights) shows that a social group continues to persist in this section of Nambucca SF. The absence of call detections at SM4 supports the suggestion that the record in year two of the operational phase (2019/20) was a dispersal or range movement away from the central area of the south block where yellow-bellied gliders were recorded up to 2017/18. SM4 was also situated near the area logged in early 2020. The single call record at N24 in August 2021 shows that gliders continue to persist in the south block. Although the sparsity of records makes it impossible to determine the origins of that individual it could be the same glider recorded at SM4 in year 2 operation phase.

Year 4 results at Nambucca SF diverged from the population trend at Yarriabini NP and Ngambaa NR reference sites. Whilst occupation rates at these two sites declined from pre-construction levels by 71% and 57% (Yarriabini NP) and 59% and 80% (Ngambaa NR) in years 1 and year 2 operation phase, respectively, they remained steady at Yarriabini NP and increased at Ngambaa NR in year 4. Nonetheless, the modest increases in occupancy since year 1 operation phase at both sites belies the fact that year 4 rates are still well below pre-construction levels.

The increased occupation rate at Ngambaa NR from year 2 (2019) to year 4 (2021) may reflect a positive response to improved environmental conditions following the severe drought that occurred in 2019. The stable occupancy rate at Yarriabini NP over the same period suggests that the drought impact was less severe at that site, possibly due to its moister forest type and proximity to the coast. Monitoring elsewhere on the NSW north coast has recorded similar trends in occupancy of yellow-bellied gliders over the same period (Sandpiper Ecological 2021b), although trends are not consistent at all sites (Sandpiper Ecological 2022).

### 5.2 Individual and population level changes in occupancy

The WC2NH yellow-bellied glider monitoring program was designed to detect *individual* and *population* level responses to the upgrade (Goldingay 2014a). An individual response may occur if local habitat availability is reduced, and the highway poses a barrier to movement. Such a response may help to explain a subsequent population response, or it may be confined to a small number of animals living near the new highway (Goldingay 2014a). A population level response is indicated by changes in abundance of yellow-bellied gliders in Nambucca SF.

As is often the case with ecological monitoring, assigning cause and effect is difficult. This is exacerbated when the sample population is small and patchily distributed as is the present case and there are multiple threatening processes. Results of song meter and spotlight surveys show an obvious decline in occurrence of yellow-bellied glider in Nambucca SF from spring 2014 to spring 2021. The timing of this decline overlaps with highway construction, a major drought (2018/19), logging (2020), minor wildfire (2019) and clearing of land (i.e., at site 20).

Goldingay (2015) concluded that Nambucca SF was occupied by 5-6 social groups prior to construction (spring 2014). Whilst this conclusion is based on extensive experience with the species it may be an overestimate and

four social groups is plausible based on the distribution of records during the pre-construction phase. These social groups persisted into year one of the operational phase (i.e., 2018/19) where they were detected by song meters only. Operational phase surveys in years 3 and 4 confirmed the presence of one social group at SM7 and one individual. Results suggest an obvious population level response over the eight-year monitoring period.

Early evidence of a decline, albeit slight, was present during the construction phase, however, the decline was consistent at impact and reference sites and was attributed to broad-scale environmental conditions, specifically below average rainfall (Sandpiper Ecological 2020, 2021). The timing of this decline was consistent with monitoring of gliders for the Woolgoolga to Ballina Upgrade (Sandpiper Ecological 2023). Whilst the drought in 2018/19 is likely to have negatively impacted gliders recent data shows consistent or increasing occupancy at reference sites, contrasting with the trend at Nambucca SF. Glider occupancy in NSF declined by 75% between the construction phase survey in 2016 and the first operational phase survey between August 2018 and February 2019. During the same period occupancy declined by 50% at Yarriabini and 38% at Ngambaa.

Recent fire and logging in Nambucca SF may have contributed to a decline and/or hampered recovery. Likewise clearing of 10ha of vegetated near site 24, which was occupied by gliders during pre-construction, could have negatively impacted a social group. Whilst there is evidence to show that logging and fire negatively impact gliders inhabiting tall eucalypt forests in eastern Australia (Lunney 1987; McLean *et al.* 2018; Goldingay 2021; Lindenmayer *et al.* 2021; Bilney *et al.* 2022), some studies have identified positive or neutral impacts (Kambouris *et al.* 2013; Heise-Pavlov *et al.* 2017). Wildfire and logging in September 2019 and early 2020 impacted approximately 40 ha and 65 ha respectively of the south forest block. The cool burn that occurred in September 2019 impacted four transects and burnt to the mid-canopy level. Neither the scale of logging or the wildfire is regarded as sufficient to have a population level impact, although they likely added to the impact of highway construction and drought.

### 5.3 Assessment and management of potential impacts on yellow-bellied glider

Reasons for the apparent population level decline may include removal of important foraging or denning habitat, fragmentation of habitat, and isolation of family groups. Increased noise from vehicles could also disrupt communication within social groups. There are several features of yellow-bellied glider ecology that make them susceptible to impacts, including a specialised diet, low and variable breeding potential (i.e., maximum of one young/year), seasonal changes in habitat use associated with foraging, large and almost exclusive home ranges of up to 65ha, variable social system and short life-span (Goldingay & Kavanagh 1991, 1993; Goldingay *et al.* 2001). Their specialised diet means that gliders may move >2km in a night to forage on preferred plant and insect exudates, and variable breeding means that young are not produced each year.

Clearing for the highway and local development, logging, drought, and wildfire have all occurred in Nambucca SF in the last 7 years. Combined, these factors are likely to have impacted yellow-bellied gliders. Both logging and wildfire are suspected of being minor components of any impact. Logging was restricted to areas that did not contain social groups during pre-construction or construction and wildfire did not affect a large area of habitat or the forest canopy and is therefore likely to have had a minor impact only. The consistent decline in gliders between impact and reference sites in 2018 and 2019 was attributed to drought (Sandpiper Ecological 2021a). Whilst this seems likely the absence of a consistent trend between impact and reference sites in 2021 means other factors are influencing the Nambucca SF population.

At their lowest level the scale of decline in occupancy was fairly consistent across all sample sites with 80% at Nambucca SF, 72% at Yarriabini NP and 80% at Ngambaa NR when compared to baseline. In 2021, occupancy was 57% and 48% below baseline levels at Yarriabini and Ngaamba respectively yet remained 80% below

baseline at Nambucca SF. More data are required to confirm these trends and it is possible that the smaller population size at Nambucca and history of logging has hampered population recovery. This is particularly likely for species with low fecundity (Bennett & Owens 1997). Access across the highway by the one remaining social group at SM7 would improve recovery potential.

Goldingay (2014a) suggested that if the WC2NH project was adequately mitigated then the abundance of yellow-bellied gliders should not decline. This suggestion ignores the likely impact of habitat removal, which would have some negative effect. Contingency measures proposed in the Ecological Monitoring Program (RMS 2018) to address a reduction in occupancy within NSF include:

- review adequacy of crossing structures; and
- consult with Forests NSW about forest management practises.

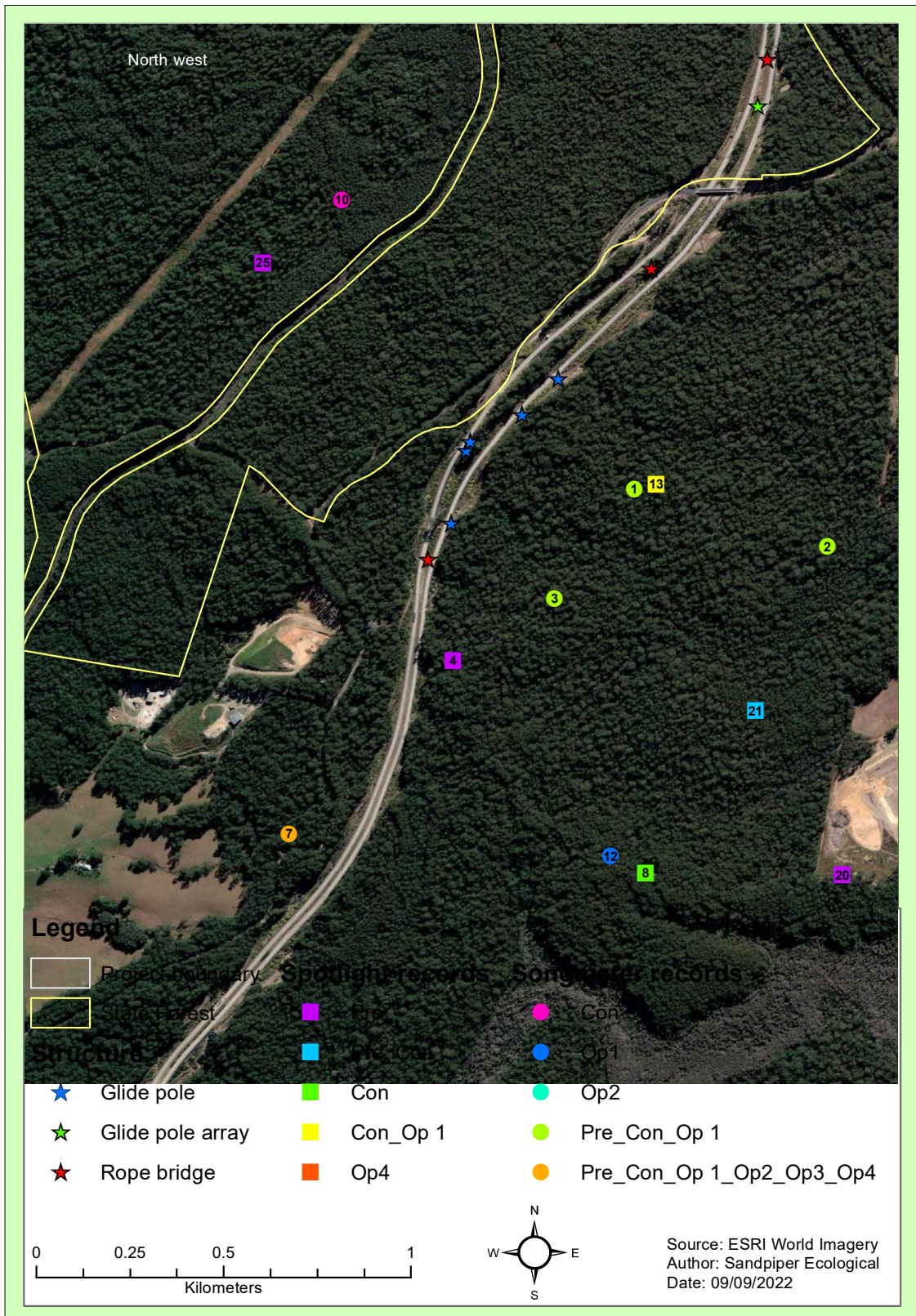
Consulting with Forests NSW about forest management in Nambucca SF is beyond the scope of this report, however, reviewing the adequacy of crossing structures is feasible. Aerial crossing structures within the WC2NH alignment include:

- A 1.5km vegetated median;
- Three rope bridges over a distance of 1.65km;
- Five, single glide poles (3 southbound & 2 northbound) that are situated to enhance functionality of the vegetated median; and
- One glide pole array consisting of three glide poles situated near the northern end of the vegetated median.

All crossing structures are situated within a 1.65km section of the alignment near the north extent of the project and provide linkage between the north-west and south-east forest blocks (Figure 9). Yellow-bellied gliders have not been detected during monitoring of the vegetated median (Sandpiper Ecological 2020b; 2021c), however, the median is used regularly by sugar glider (*Petaurus breviceps*) and feathertail glider (*Acrobates* spp). Based on published glide angles and tree heights yellow-bellied gliders should be able to cross the alignment via the vegetated median (Goldingay 2014b; Taylor & Rohweder 2013, 2020; Sandpiper Ecological 2021c).

There is no information on how gliders moved across the alignment footprint prior to construction, and it is impossible to determine glider movement from point locality records (from song meters and spotlighting). Even though the median occurs adjacent to several YBG records it seems likely that the array of crossing structures has not provided sufficient connectivity to mitigate the population decline, or population decline occurred prior to the connectivity structures becoming functional. Their large home range and low density means it is likely to take considerable time for gliders to discover and use crossing structures. And population decline may have occurred before social groups whose home ranges overlapped the highway discovered the structures.

The next population survey is scheduled for year 7 (spring 2024). Given the present situation, a three-year gap between surveys is too large and raises the prospect that gliders could disappear from Nambucca SF between surveys and before any additional mitigation could be considered. Better tracking of glider population trends would be achieved by moving the year 7 survey to year 6 and, depending on results, having the option to undertake a targeted song-meter survey of Nambucca SF only in year 8. Undertaking additional mitigation immediately seems premature, however, a preliminary assessment of installing an additional glide pole/s near SM7 would be worthwhile to avoid delays should the year six survey confirm the need for additional mitigation.



**Figure 9:** Location of yellow-bellied glider records in relation to crossing structures installed on the WC2NH alignment.

## 5.4 Program review

Goldingay (2014a) recommended that the effectiveness of spotlighting versus song meter surveys for detecting yellow-bellied gliders in Nambucca SF and overall effectiveness of the monitoring strategy should be reviewed at completion of year four. Song-meter and spotlight surveys in Nambucca SF tend to complement each other and have provided similar results over the monitoring period. Differences in glider detection between the two methods are largely due to sample site distribution. Despite their comparability, changing methods part way through a long-term monitoring program is not recommended (see Ellingsen *et al.* 2017) as it would create uncertainty when comparing data between years within a site (i.e., Nambucca SF) and between sites (i.e., impact & reference sites).

Song-meters have proven to be an effective means of detecting yellow-bellied gliders and should be considered as a component of any future studies. They would be an effective means of determining the status of gliders within Nambucca SF, as proposed for year 8, if additional units could be deployed. In addition to providing comparable occupancy data song-meters are more cost effective than spotlighting and reduce the need to have staff working at night.

One methodological change that could be considered is limiting night surveys to playback only as most glider detections are individuals responding to playback. Playback followed by 10-15 minutes of listening time at each site may be an efficient method of detecting yellow-bellied glider. This would reduce survey time at each site and enable more sites to be sampled. Once again changing methods part-way through a monitoring program is not recommended.

## 6. Recommendations

Recommendations stemming from the year 4 operational phase survey are presented in Table 2.

**Table 2:** Recommendations based on findings of the year 4 operational phase (2021/22) yellow-bellied glider monitoring program.

Number	Recommendation	Transport for NSW Response
1	Move the programmed year 7 yellow-bellied glider population survey to year six (i.e., spring 2023) to reduce the time between samples and better track population change.	Agreed
2.	Should recommendation 1 be adopted consider undertaking a song-meter survey of NSF in year 8 (2024) of the monitoring program.	Agreed
3.	Ensure that Forests NSW are aware of the survey results and particularly the persistence of one social group in the vicinity of the Nambucca Waste Management facility. Avoiding logging in that area would assist in protecting that social group.	Agreed

## 7. References

- Bennett, P. M. & Owens, I. P. F. (1997). Variation in extinction risk among birds: chance or evolutionary disposition. *The Royal Society*: **264**, <https://doi.org/10.1098/rspb.1997.0057>
- Bilney, R. J., Kambouris, P. J., Peterie, J., Dunne, C., Makeham, K., Kavanagh, R. P., Gonsalves, L. & Law, B. (2022). Long-term monitoring of an endangered population of yellow-bellied gliders *Petaurus australis* on the Bago Plateau, New South Wales, and its response to wildfires and timber harvesting in a changing climate. *Australian Zoologist*: **42**, 592-607.
- Craig, S. (1985). Social organisation, reproduction and feeding behaviour of a population of yellow-bellied gliders, *Petaurus australis* (Marsupalia: Petauridae). *Australian Wildlife Research* **12**, 1-18.
- Ellingsen, K. E., Yoccoz, N. G., Tveraa, T., Hewitt, J. E. & Thrush, S. F. (2017). Long-term environmental monitoring for assessment of change: measurement inconsistencies over time and potential solutions. *Environmental Monitoring and Assessment*: **189**, article 595.
- Goldingay, R. (1992). Sociology of the yellow-bellied glider in a coastal forest. *Australian Journal of Zoology* **40**, 267-278.
- Goldingay, R. L & Kavanagh, R. P. (1991). The yellow-bellied glider: a review of its ecology, and management considerations. Pages 365-375 in Conservation of Australia's Forest Fauna, ed D. Lunney, Royal Zoological Society of New South Wales, Mosman.
- Goldingay, R. L & Kavanagh, R. P. (1993). Home-range estimates and habitat of the yellow-bellied glider (*Petaurus australis*) at Waratah Creek, New South Wales. *Wildlife Research*: **20**, 387-403.
- Goldingay, R. (1994). Loud calls of the yellow-bellied glider *Petaurus australis*: territorial behavior by an arboreal marsupial? *Australian Journal of Zoology* **42**, 279-93.
- Goldingay, R. L., Quin, D. G., & Churchill, S. (2001). Spatial variability in the social organisation of the yellow-bellied glider (*Petaurus australis*) near Ravenshoe, north Queensland. *Australian Journal of Zoology*: **49**, 397-409.
- Goldingay, R. (2014a). WC2NH Pacific Highway Upgrade: A 10-year Ecological Monitoring Program for the Yellow-bellied Glider. Prepared for NSW Roads and Maritime Services.
- Goldingay, R. L. (2014b). Gliding performance in the yellow-bellied glider in low-canopy forest. *Australian Mammalogy*: **36**, 254-258
- Goldingay, R. (2015). *WC2NH Pacific Highway Upgrade: Baseline Monitoring of the Yellow-bellied Glider Population in Nambucca State Forest*. Report prepared for NSW Roads and Maritime Services.
- Goldingay, R. L. (2021). General or local habitat preferences? Unravelling geographically consistent patterns of habitat preference in gliding mammals. *Forest Ecology and Management*: **491**, 119204.
- Goldingay, R. and Jackson, S. (2004). A review of the ecology of the Australian Petauridae. In 'The biology of Australian possums and gliders'. (Eds RL Goldingay and SM Jackson) pp. 376-400. (Surrey Beatty & Sons: Chipping Norton)



Goldingay, R., and Kavanagh, R. (1991). The yellow-bellied glider: a review of its ecology, and management considerations. In *'Conservation of Australia's forest fauna'*. (Ed D Lunney) pp. 365-375. (Royal Zoological Society of NSW: Mosman).

Heise-Pavlov, S. R., Chizinski, T. & Walker, N. E. (2017). Selection of sap feed trees by yellow-bellied gliders (*Petaurus australis*) in north-eastern Queensland, Australia – implications for site specific habitat management. *Australian Mammalogy*: **40**, 10-15.

Kambouris, P. J., Kavanagh, R. P. & Rowley, K. A. (2013). Distribution, habitat preferences and management of yellow-bellied glider, *Petaurus australis*, on the Bago Plateau, New South Wales: a reassessment of the population and its status. *Wildlife Research*: **40**, 599-614.

Kavanagh, R. (1987). Forest phenology and its effect on foraging behaviour and selection of habitat by the yellow-bellied glider, *Petaurus australis* Shaw. *Australian Wildlife Research* **14**, 371-384.

Lunney, D. (1987). Effects of logging, fire and drought on possums and gliders in the coastal forests near Bega, NSW. *Australian Wildlife Research*: **14**, 263-274.

Lindenmayer, D. B., Blanchard, W., Blair, D., McBurney, L., Taylor, C., Scheele, B. C., Westgate, M. J., Robinson, N., Forster, C. (2021). The response of arboreal marsupials to long-term changes in forest disturbance. *Animal Conservation*: **24**, 246-258.

Mclean, C. M., Kavanagh, R. P., Penman, T. D. & Bradstock, R. A. (2018). The threatened status of the hollow dependent arboreal marsupial, the greater glider (*Petauroideus volans*) can be explained by impacts from wildfire and selective logging. *Forest Ecology and Management*: **415-416**, 19-25.

Roads and Maritime Services NSW (2018a). *Warrell Creek to Nambucca Heads Ecological Monitoring Program (June 2018)*. Roads and Maritime Services, Sydney.

Russell, R. (1995). Yellow-bellied Glider. In *'The Mammals of Australia'*. (Ed. R Strahan) pp. 226-228. (Reed Books: Chatsworth, Sydney).

Sandpiper Ecological (2018). *Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway Upgrade - Yellow-bellied glider Population Monitoring – Construction Phase Surveys*. Report prepared for NSW Roads and Maritime Services.

Sandpiper Ecological (2019). *Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway Upgrade - Yellow-bellied glider Population Monitoring – Year 1 Operation Phase Surveys*. Report prepared for NSW Roads and Maritime Services.

Sandpiper Ecological (2020a). *Pacific Highway Upgrade – Warrell Creek to Nambucca Heads: yellow-bellied glider (Petaurus australis) population monitoring: year 2 operational phase*. Report prepared for Transport for New South Wales.

Sandpiper Ecological (2020b). *Warrell Creek to Nambucca Heads: vegetated median monitoring report – year two operational phase (2019-20)*. Report prepared for Transport for New South Wales.

Sandpiper Ecological (2021a). *Pacific Highway Upgrade – Warrell Creek to Nambucca Heads: yellow-bellied glider (Petaurus australis) population monitoring: year 3 operational phase post fire and logging*. Report prepared for Transport for New South Wales.

Sandpiper Ecological (2021b). *Woolgoolga to Ballina Pacific Highway Upgrade: threatened gliders monitoring program annual report 2020 (year 4)*. Report prepared for Pacific Complete.

Sandpiper Ecological (2021c). *Warrell Creek to Nambucca Heads: vegetated median monitoring report – year three operational phase (2020-21)*. Report prepared for Transport for New South Wales.

Sandpiper Ecological (2022). *Pacific Highway Upgrade Woolgoolga to Ballina: threatened gliders monitoring program, year 5 (2021)*. Report prepared for Transport for New South Wales.

Sandpiper Ecological (2023). *Pacific Highway Upgrade Woolgoolga to Ballina sections 3-11: threatened gliders monitoring program, year six (2022)*. Report prepared for Transport for New South Wales.

Taylor, B. D. & Rohweder, D. A. (2013). Radio-tracking three sugar gliders using forested highway median strips at Bongil Bongil National Park, north-east New South Wales. *Ecological Management & Restoration*: **14**, 228-230.

Taylor, B. D. & Rohweder, D. A. (2020). Yellow-bellied gliders use glide poles to cross the Pacific Highway at Halfway Creek, north-east New South Wales. *Australian Mammalogy* **42**(3), 385-387.

Wildlife Acoustics (2011). *Song Scope Software Version 4.0 User Guide*. Maynard, USA.

Wildlife Acoustics (2021). *Kaleidoscope Pro 5 User Guide*. Maynard, USA

## Appendix A – Yellow-bellied glider spotlight surveys field data

**Table A1:** Yellow-bellied glider detections and weather conditions during three spotlight/call playback surveys conducted in late winter/spring 2021 in Nambucca State Forest. se = saw eyeshine; hc = heard call; hm = heard movement; sm = saw movement; PB = playback; GHFF – grey-headed flying-fox; CRP – common ringtail possum; ONJ – owl nightjar; WtNJ = white-throated nightjar; SuG – sugar glider; TF – tawny frogmouth; CBTP – common brushtail possum; SeBtP = short-eared brushtail possum; BbO – southern boobook; PO = powerful owl; FtG – feathertail glider; Nmn – new moon; FQ – first quarter; LQ – last quarter

Transect	Date	Obs	Start	Finish	YbG (no. ind s)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
N1	9/08/21	DR	1022	1035	0	NA	ONJ		Nil	Nmn			Nil		Nil
	13/09/21	DR&NM	2115	2125	Nil	NA	SuG (se)			FQ	17.8	72	Nil	8/8	MLB
	25/10/21	DR	2112	2133	0	NA	Nil		Nil	LQ	18	90	Nil	Nil	Nil
N2	9/08/21	DR&NM	1107	1109	0	NA	Nil		Nil	Nmn			Nil		Nil
	13/09/21	DR&NM	2152	2202	Nil	NA	TF		Nil	FQ	16.7	71	Nil	5/8	MSB
	25/10/21	DR	2215	2224	0	NA	ONJ		Nil	LQ	17	90	Nil	Nil	Nil
N3	9/08/21	DR&NM	1125	1138	0	NA	Nil		Nil	Nmn			Nil		Nil
	13/09/21	DR&NM	2210	2220	Nil	NA	Nil		Nil	FQ	16.1	74	Nil	5/8	Nil
	28/10/21	DR	2155	2215	0	NA	SuG x 2 (1x HC; 1x O); ONj		Nil	LQ	21	99	Nil	Nil	Nil
N4	9/08/21	LA/AE	1855	1905	Nil	NA	Nil		Acacia	Nmn	11.5	84	Nil	8/8	Nil
	13/09/21	LA/AE	1800	1820	Nil	NA	Nil		Nil	FQ	18.5	72	Nil	8/8	Nil
	28/10/21	NM/AE	2004	2014	Nil	NA	Nil		Nil	LQ	23.8	82	Nil	3/8	Nil
N5	9/08/21	LA/AE	2200	2210	Nil	NA	Tawny frogmouth		Nil	Nmn	12.1	87	Nil	8/8	Nil
	13/09/21	LA/AE	2044	2054	Nil	NA	Nil		Iron bark	FQ	18.5	72	Nil	8/8	MSB
	25/10/21	NM/AE	1240	1250	Nil	NA	Nil			LQ	14.7	100	Nil	2/8	RL
N6	9/08/21	LA/AE	2135	2145	Nil	NA	Nil		Acacia	Nmn	12.1	87	Nil	8/8	Nil
	13/09/21	LA/AE	2000	2010	Nil	NA	Nil		Nil	FQ	18.5	72	Nil	8/8	MSB

Transect	Date	Obs	Start	Finish	YbG (no. ind s)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
	25/10/21	NM/AE	2342	2352	Nil	NA	Nil		Nil	LQ	16.9	93	Nil	3/8	Nil
N7	9/08/21	LA/AE	2025	2035	Nil	NA			Nil	Nmn	12.1	87	Nil	8/8	Nil
	13/09/21	LA/AE	1935	1945	Nil	NA			Nil	FQ	18.5	72	Nil	8/8	MLB
	28/10/21	NM/AE	2144	2154	Nil	NA			Nil	LQ	19.6	94	Nil	8/8	Nil
	9/08/21	LA/AE	1810	1820	Nil	NA			Nil	Nmn	11.5	84	Nil	8/8	Nil
N8	13/09/21	LA/AE	1910	1920	Nil	NA			Acacia	FQ	18.5	72	Nil	8/8	Nil
	28/10/21	NM/AE	2107	2117	Nil	NA			Nil	LQ	21.4	90	Nil	8/8	Nil
	9/08/21	DR&NM	1853	1907	Nil	NA	Sugar glider; ONJ		Nil	Nmn			Nil		Nil
N9	13/09/21	DR&NM	2054	2104	Nil	NA	OnJ		Acacia	FQ	17.8	72	Nil	8/8	MLB
	25/10/21	DR	1945	2005	Nil	NA	Sugar glider (hc)		Nil	LQ	19	84	Nil	5	Nil
	9/08/21	DR&NM	1939	1953	Nil	NA	GHFF		Nil	Nmn			Nil		Nil
N10	13/09/21	DR&NM	2015	2025	Nil	NA			Nil	FQ	17.8	72	Nil	8/8	MLB
	25/10/21	DR	2010	2030	Nil	NA				LQ					
	9/08/21	DR&NM	2000	2014	Nil	NA	Powerful owl; ONJ		Nil	Nmn			Nil		Nil
N11	13/09/21	DR&NM	1955	2005	Nil	NA			Acacia	FQ	18.4	61	Nil	8/8	MLB
	25/10/21	DR	2037	2100	Nil	NA	Sugar glider x 3 (1x HC; 2x se); Masked owl (hc)		Nil	LQ	19	84	Nil	Nil	Nil
	9/08/21	DR&NM	1918	1930	Nil	NA			Nil	Nmn			Nil		Nil
N12	13/09/21	DR&NM	2034	2044	Nil	NA			Acacia	FQ	17.8	72	Nil	8/8	MLB
	28/10/21	DR	2119	2140	Nil	NA	Masked owl		Nil	LQ	21	96	Nil	Nil	Nil
	9/08/21	LA/AE	1940	1950	Nil	NA		Koala scat	Nil	Nmn	11.5	84	Nil	8/8	Nil
N13	13/09/21	LA/AE	1830	1840	Nil	NA			Tallowwood	FQ	18.5	72	Nil	8/8	Nil
	28/10/21	NM/AE	1945	1955	Nil	NA			Nil	LQ	23.8	82	Nil	3/8	Nil

Transect	Date	Obs	Start	Finish	YbG (no. ind s)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
N14	9/08/21	DR&NM	2154	1007	Nil	NA	Tawny frogmouth		Nil	Nmn			Nil		Nil
	13/09/21	DR&NM	1800	1810	Nil	NA	Koala,se@495964.6607713		Acacia	FQ	18.3	71	Nil	8/8	Msb
	Thursday, 28 October 21	DR	2047	2107	0	NA	Nil		Nil	LQ	22	90	Nil	Nil	Nil
N15	9/08/21	DR&NM	1040	1055	0	NA	SEBTP; ONJ		Nil	Nmn			Nil		Nil
	13/09/21	DR&NM	2127	2137	Nil	NA	SEBTP, hm		Nil	FQ	16.7	71	Nil	4/8	Msb
	25/10/21	DR	2145	2205	0	NA	ONJ		Nil	LQ	18	90	Nil	Nil	Nil
N16	9/08/21	LA/AE	0015	0025	Nil	NA	Night jar		Nil	Nmn	11.5	84	Nil	8/8	Nil
	13/09/21	LA/AE	22:35	2245	Nil	NA	Koala x2 mother and Joey and SUG	healthy, 495177 6610623	Ironback	FQ	18.5	72	Nil	8/8	Nil
	28/10/21	NM/AE	2312	2322	Nil	NA	OnJ, GHFF		Tallowwood	LQ	19.6	94	Nil	2/8	Nil
N17	9/08/21	LA/AE	0035	0045	Nil	NA	Night jar, sugar glider		Nil	Nmn	11.5	84	Nil	8/8	Nil
	13/09/21	LA/AE	2155	22:05	Nil	NA	Nil		Nil	FQ	18.5	72	Nil	8/8	Nil
	28/10/21	NM/AE	2230	2240	Nil	NA	OnJ, GHFF		Nil	LQ	18.9	100	Nil	1/8	Nil
N18	9/08/21	DR&NM	1225	1240	0	NA	ONJ		Nil	Nmn	10.9	86	Nil	Nil	Nil
	13/09/21	DR&NM	2300	2310	Nil	NA	ONJ		Nil	FQ	15.9	72	Nil	5/8	RI
	28/10/21	DR	2300	2321	0	NA	ONj		Tallowwood	LQ	21	99	Nil	Nil	Nil
N19	9/08/21	DR&NM	1205	1219	0	NA	Nil		Nil	Nmn			Nil		Nil
	13/09/21	DR&NM	2244	2254	Nil	NA	Nil		Acacia	FQ	16.1	74	Nil	5/8	RI
	28/10/21	DR	2234	2255	0	NA			Nil	LQ	21	99	Nil	Nil	Nil

Transect	Date	Obs	Start	Finish	YbG (no. ind s)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
N20	9/08/21	LA/AE	1750	1800	Nil	NA	Nil		Nil	Nmn	11.5	84	Nil	8/8	Nil
	16/09/21	NM/LA	2210	2220	Nil	NA	Nil		Nil	FQ	14.2	76	Nil	5/8	RL
	28/10/21	NM/AE	2123	2133	Nil	NA	Nil		Nil	LQ	21.4	90	Nil	8/8	Nil
N21	9/08/21	LA/AE	1915	1925	Nil	NA	Nil		Nil	Nmn	11.5	84	Nil	8/8	Nil
	13/08/21	LA/AE	1850	1900	Nil	NA	Nil		Tallowwood	FQ	18.5	72	Nil	8/8	Nil
	28/10/21	NM/AE	2021	2031	Nil	NA	Nil		Nil	LQ	21.4	86	Nil	3/8	Nil
N22	9/08/21	LA/AE	1835	1845	Nil	NA	Nil		Acacia	Nmn	11.5	84	Nil	8/8	Nil
	13/09/21	LA/AE	1925	1935	Nil	NA	Nil		Nil	FQ	18.5	72	Nil	8/8	Nil
	28/10/21	NM/AE	2046	2056	Nil	NA	Nil		Nil	LQ	21.4	86	Nil	8/8	Nil
N23	9/08/21	DR& NM	1830	1843	0	NA	Nil		Nil	Nmn			Nil		Nil
	13/09/21	DR& NM	1854	1904	Nil	NA	PO,hc	After PB	Acacia	FQ	18.3	71	Nil	8/8	MLB
	28/10/21	DR	2014	2034	0	NA			Nil	LQ	22	90	Nil	90	Nil
N24	9/08/21	DR&NM	1805	1817	1	Call; 0600, 100m at 120 deg from centre of transect	Sugar glider	YbG called at dusk	Nil	Nmn	14	70	Nil	75	Nil
	13/09/21	DR&NM	1915	1925	Nil	NA	Nil	PO on walk there	Nil	FQ	18.4	61	Nil	8/8	MLB
	Thursday, 28 October 21		1945	2005	0	NA	Nil		Nil	LQ	22	90	Nil	15	Nil
N25	9/08/21	LA/AE	2300	2310	Nil	NA	Nil		Nil	Nmn	12.1	87	Nil	8/8	Nil
	13/09/21	LA/AE	1922	1932	Nil	NA	Nil		Acacia	FQ	18.5	72	Nil	8/8	Nil
	25/10/21	NM/AE	0003	0013	Nil	NA	GHFF		Tallowwood	LQ	16.9	93	Nil	3/8	Nil
N26	9/08/21	LA/AE	2325	2335	Nil	NA	Nil		Nil	Nmn	12.1	87	Nil	8/8	Nil
	13/09/21	LA/AE	2220	2230	Nil	NA	Nil		Nil	FQ	18.5	72	Nil	8/8	Nil
	28/10/21	NM/AE	2232	2242	Nil	NA	GHFF		Nil	LQ	19.6	94	Nil	8/8	Nil
N27	9/08/21	LA/AE	23:40	2350	Nil	NA	Nil		Nil	Nmn	12.1	87	Nil	8/8	Nil

Transect	Date	Obs	Start	Finish	YbG (no. ind s)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
	13/09/21	LA/AE	2155	2110	Nil	NA	Nil		Ironbark	FQ	18.5	72	Nil	8/8	Nil
	28/10/21	NM/AE	2251	2301	Nil	NA	OnJ,GHFF		Nil	LQ	19.6	94	Nil	8/8	Nil
N28	9/08/21	LA/AE	2242	2252	Nil	NA	Nil		Nil	Nmn	12.1	87	Nil	8/8	Nil
	13/09/21	LA/AE	2110	2120	Nil	NA	Nil		Nil	FQ	18.5	72	Nil	8/8	Nil
	25/10/21	NM/AE	0003	0013	Nil	NA	Nil		Nil	LQ	16.9	93	Nil	3/8	Nil
N29	9/08/21	LA/AE	2222	2232	Nil	NA	Nil		Nil	Nmn	12.1	87	Nil	8/8	Nil
	13/09/21	LA/AE	20:20	2030	Nil	NA	Nil		Nil	FQ	18.5	72	Nil	8/8	MSB
	28/10/21	NM/AE	2202	2212	Nil	NA	OnJ		Nil	LQ	19.6	94	Nil	8/8	Nil
N30	12/08/21	LA/AE	2030	2040	Nil	NA	Nil		Nil	Nmn	18	83	Light rain	8/8	Nil
	16/09/21	NM/LA	2015	2025	Nil	NA	Nil		Nil	FQ	15.3	69	Nil	3/8	RL
	25/10/21	NM/AE	2143	2153	Nil	NA	Nil		Nil	LQ	17.8	94	Nil	3/8	RL
N31	12/08/21	LA/AE	2010	2020	Nil	NA	Nil		Nil	Nmn	18	78	Nil	6/8	Nil
	16/09/21	NM/LA	1815	1825	Nil	NA	PO,hc		Nil	FQ	16.5	66	Nil	2/8	MSB
	25/10/21	NM/AE	1945	1955	Nil	NA	Nil		Nil	LQ	19.8	87	Nil	Nil	RL
N32	12/08/21	LA/AE	1955	2005	Nil	NA	Nil		Nil	Nmn	18	78	Nil	6/8	Nil
	16/09/21	NM/LA	1858	1908	Nil	NA	Nil		Nil	FQ	16.5	67	Nil	2/8	MSB
	25/10/21	NM/AE	2005	2015	Nil	NA	SuG,se		Nil	LQ	19.5	88	Nil	Nil	RL
N33	12/08/21	LA/AE	1940	1950	Nil	NA	Nil		Nil	Nmn	18	78	Nil	6/8	Nil
	25/10/21	NM/AE	2226	2236	Nil	NA	Nil		Nil	FQ	17.8	94	Nil	3/8	RL
	25/10/21	NM/AE	2225	2235	Nil	NA	Nil		Nil	LQ	17.8	94	Nil	3/8	RL
N34	12/08/21	LA/AE	1810	1820	Nil	NA	Nil		Nil	Nmn	18	78	Nil	6/8	Nil
	16/09/21	NM/LA	2036	2046	Nil	NA	Nil		Nil	FQ	14.5	73	Nil	3/8	RL
	25/10/21	NM/AE	2205	2215	Nil	NA	OnJ		Nil	LQ	17.8	94	Nil	3/8	RL
N35	12/08/21	LA/AE	1850	1900	Nil	NA	Nil		Nil	Nmn	18	78	Nil	8/8	Nil
	16/09/21	NM/LA	2126	2136	Nil	NA	SuG, hc		Nil	FQ	14.2	76	Nil	5/8	RL
	25/10/21	NM/AE	2305	2315	Nil	NA	Nil		Nil	LQ	17	92	Nil	2/8	RL
N36	12/08/21	LA/AE	1835	1845	Nil	NA	Frog mouth sm		Nil	Nmn	18	78	Nil	8/8	Nil

Transect	Date	Obs	Start	Finish	YbG (no. ind s)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
	16/09/21	NM/LA	2102	2112	Nil	NA	Nil		Nil	FQ	14.5	73	Nil	3/8	RL
	25/10/21	NM/AE	2242	2252	Nil	NA	OnJ		Nil	LQ	17.8	94	Nil	3/8	RL
N37	12/08/21	LA/AE	1925	1935	Nil	NA	Nil		Nil	Nmn	18	78	Nil	8/8	Nil
	16/09/21	NM/LA	2146	2156	Nil	NA	Nil		Nil	FQ	14.2	76	Nil	5/8	RL
	25/10/21	NM/AE	2326	2336	Nil	NA	Nil		Nil	LQ	17.2	93	Nil	2/8	RL
N38	12/08/21	LA/AE	2120	2130	Nil	NA	Nil		Nil	Nmn	18	83	Light rain	8/8	Nil
	16/09/21	NM/LA	1924	1934	Nil	NA	Nil		Nil	FQ	16.5	66	Nil	2/8	MSB
	25/10/21	NM/AE	2035	2045	Nil	NA	OnJ		Nil	LQ	18.8	89	Nil	2/8	RL
N39	12/08/21	LA/AE	2258	2208	Nil	NA	Nil		Nil	Nmn	18	83	Light rain	8/8	Nil
	16/09/21	NM/LA	1946	1956	Nil	NA	2 x PO, hc		Nil	FQ	16.3	70	Nil	2/8	MSB
	25/10/21	NM/AE	2100	2110	Nil	NA	OnJ		Nil	LQ	18.3	92	Nil	1/4	RL
N40	12/08/21	LA/AE	2030	2040	Nil	NA	Nil		Nil	Nmn	18	83	Showers	8/8	Nil
	16/09/21	NM/LA	1835	1845	Nil	NA	Nil		Nil	FQ	16.5	66	Nil	2/8	MSB
	25/10/21	NM/AE	2120	2130	Nil	NA	Nil		Nil	LQ	18.3	92	Nil	1/4	RL



**Table A2:** Yellow-bellied glider detections and weather conditions during three spotlight/call playback surveys conducted in late winter/spring 2021 in Ngambaa Nature Reserve. se = saw eyeshine; hc = heard call; hm = heard movement; sm = saw movement; PB = playback; GHFF – grey-headed flying-fox; CRP – common ringtail possum; OnJ – owlet nightjar; WtNJ = white-throated nightjar; SuG – sugar glider; TF – tawny frogmouth; CBTP – common brushtail possum; SeBtP = short-eared brushtail possum; BbO – southern boobook; PO = powerful owl; FtG – feathertail glider.

Transect	Date	Obs	Start	Finish	YbG (no. ind s)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
U1	11/08/2021	LA/AE	1845	1855	Nil	Nil	Sugar glider, hc	Nil	Nil	Nmn	14	67	Nil	8/8	MSB
	14/09/21	DR/NM	2356	2406	Nil	Nil	Nil	Nil	Nil	FQ	12.5	72	Nil	3/8	MSB
	26/10/21	DR	2455	0108	0	Nil	ONJ	Nil	Mahogany	LQ	17	85	Nil	Nil	Nil
U2	11/8/21	DR	1828	1851	0	Nil	ONJ	Nil	Nil	Nmn	16	70	Nil	Nil	RL
	14/9/21	LA/AE	2335	2345	Nil	Nil	Nil	Nil	Nil	FQ	14	67	Nil	8/8	MSB
	26/10/21	NM/AE	0048	0058	Nil	Nil	OnJ	Nil	Nil	LQ	17.6	91	Nil	5/8	Nil
U3	11/08/2021	LA/AE	1820	1830	Nil	Nil	Nil	Nil	Nil	Nmn	17	72	Nil	8/8	Nil
	14/9/21	DR/NM	2337	2347	Nil	Nil	ONJ x 2	Nil	Nil	FQ	12.5	72	Nil	3/8	MSB
	26/10/21	NM/AE	0032	0042	Nil	Nil	Nil	Nil	Nil	LQ	17.6	91	Nil	5/8	Nil
U4	11/08/2021	LA/AE	1805	1815	Nil	Nil	Nil	Nil	Nil	Nmn	17	72	Nil	8/8	Nil
	14/9/21	LA/AE	2320	2330	Nil	Nil	Nil	Nil	Nil	FQ	12	72	-	4/8	MSB
	26/10/21	DR	2425	2445	0	Nil	SuG (hc); ONJ	Nil	Nil	Nil	18	80	Nil	Nil	Nil
U5	11/8/21	DR	1800	1820	0	Nil	Tawny frogmouth	Nil	Nil	Nmn	18	73	Nil	Nil	RL
	14/9/21	DR/NM	2315	2325	Nil	Nil	ONJ	Nil	Nil	FQ	12	72	Nil	3/8	RL
	26/10/21	NM/AE	0014	0024	1	>PB 70n,50e 0015	SuG,hc	Nil	Nil	LQ	17.6	91	Nil	5/8	Nil
U6	10/08/2021	LA/AE	0020	0030	Nil	Nil	Possible sugar glider sighting	Nil	Nil	Nmn	14	67	Nil	8/8	MSB
	14/9/21	LA/AE	2255	2205	Nil	Nil	SuG	Nil	Nil	FQ	12	72	-	4/8	MSB
	26/10/21	NM/AE	0000	0010	Nil	Nil	Nil	Nil	Nil	LQ	17.6	91	Nil	5/8	RL
U7	10/8/21	DR	1150	1215	Nil	Nil	SEBTP		Nil	Nmn	13	67	Nil	Nil	Nil
	14/9/21	DR/NM	2253	2303	Nil	Nil	ONJ x 2	GBF calling	Nil	FQ	12.4	70	Nil	5/8	RL

Transect	Date	Obs	Start	Finish	YbG (no. ind s)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
	26/10/21	DR	2355	2415	0	Nil	CBP x 2 (se); ONj		Nil	LQ	18	80	Nil	20	Nil
U8	10/08/2021	LA/AE	2350	2400	Nil	Nil	Nil	Nil	Nil	Nmn	14	67	Nil	8/8	MSB
	14/9/21	LA/AE	2235	2245	Nil	Nil	Nightjar, barn owl and CBTP	Nil	Nil	FQ	12	72	Nil	4/8	MI
	26/10/21	NM/AE	2340	2350	Nil	Nil	Barn owl, OnJ	Nil	Nil	LQ	17.6	91	Nil	5/8	RL
U9	10/08/2021	LA/AE	2330	2340	Nil	Nil	Nil	Nil	Nil	Nmn	14	67	Nil	8/8	MSB
	14/9/21	DR/NM	2231	2241	Nil	Nil	Nil	Nil	Nil	FQ	12.4	70	Nil	5/8	MSB
	26/10/21	DR	2333	2300	0	Nil	ONj			LQ	18	80	Nil	25	Nil
U10	10/8/21	DR	2034	2056	0	Nil	ONJ		Nil	Nmn	13	67	Nil	Nil	MSB
	14/9/21	LA/AE	2002	2012	Nil	Nil	-	-	-	FQ	12	-	-	4/8	MSB
	26/10/21	NM/AE	2322	2332	Nil	Nil	BtPoss,OnJ	Nil	Nil	LQ	18.1	82	Nil	5/8	Nil
U11	10/08/2021	LA/AE	2025	2035	Nil	Nil	Nil	Nil	Nil	Nmn	14	67	Nil	8/8	MSB
	14/09/21	DR/NM	2013	2023	Nil	Nil	Nil	Nil	Nil	FQ	12.8	65	Nil	5/8	MSB
	26/10/21	DR	2306	2325	0	Nil			Mahogany	LQ	18	81	Nil	75	Nil
U12	10/08/2021	LA/AE	2005	2015	Nil	Nil	Powerful owl hc	Nil	Nil	Nmn	14	67	Nil	8/8	MSB
	14/9/21	LA/AE	2020	2031	Nil	Nil	Nightjar	-	-	FQ	12	-	-	4/8	MSB
	26/10/21	NM/AE	2052	2102	Nil	Nil	3 x OnJ	Nil	Nil	LQ	18.1	82	Nil	5/8	Nil
U13	10/8/21	DR	2000	2023	0	Nil			Nil	Nmn	14	70	Nil	Nil	MSB
	14/9/21	DR/NM	2036	2046	Nil	Nil	Nil	Nil	Nil	FQ	12.4	65	Nil	3/8	MSB
	26/10/21	DR	2233	2253	0	Nil	SEBP (se)			LQ	18	81	Nil	20	RL
U14	10/8/21	DR	1925	1946	0	Nil	ONJ		Nil	Nmn	14	70	Nil	Nil	MSB
	14/9/21	DR/NM	2202	2212	Nil	Nil	Nil	Nil	Nil	FQ	12.4	70	Nil	5/8	MSB
	26/10/21	NM/AE	2227	2237	Nil	Nil	Nil	Nil	Nil	LQ	18.6	80	Nil	3/8	RL
U15	10/08/2021	LA/AE	1940	1950	Nil	Nil	Nil	Nil	Nil	Nmn	14	67	Nil	8/8	MSB
	14/09/21	DR/NM	2143	2153	Nil	Nil	Nil	Nil	Nil	FQ	11.9	72	Nil	3/8	MLB

Transect	Date	Obs	Start	Finish	YbG (no. ind s)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
	26/10/21	DR	2203	2225	0	Nil	SuG x 2 (se); ONJ; SEBP (se)			LQ	17	78	Nil	25	Nil
U16	10/08/2021	LA/AE	1920	1930	Nil	Nil	Sugar glider, night jar hc	Nil	Nil	Nmn	14	67	Nil	8/8	MSB
	14/09/21	DR/NM	2125	2135	Nil	Nil	Nil	Nil	Nil	FQ	11.9	72	Nil	3/8	MLB
	26/10/21	NM/AE	2005	2015	Nil	Nil	Nil	Nil	Nil	LQ	18.6	80	Nil	3/8	RL
U17	10/08/21	LA/AE	1855	1902	Nil	Nil	Nil	Nil	Nil	Nmn	14	67	Nil	8/8	MSB
	14/09/21	DR/NM	2058	2108	Nil	Nil	Nil	Nil	Nil	FQ	11.9	72	Nil	4/8	MSB
	26/10/21	NM/AE	2135	2145	Nil	Nil	Nil	Nil	Nil	LQ	19.2	75	Nil	4/8	RL
U18	10/8/21	DR	1847	1907	0	Nil	FtG; ONJ		Nil	Nmn	15	73	Nil	Nil	MSB
	14/9/21	LA/AE	2201	2211	Nil	Nil	PO HC	Nil	Nil	FQ	12	72	-	4/8	RL
	26/10/21	NM/AE	2105	2115	1	150N,70e after pb 2112	OnJ	Nil	Nil	LQ	19.2	75	Nil	4/8	RL
U19	10/08/21	LA/AE	1800	1810	Nil	Nil	Powerful owl hc	Nil	Nil	Nmn		67	Nil	8/8	MSB
	14/9/21	LA/AE	2115	2125	Nil	Nil	CBTP, ONJ	Nil	Nil	FQ	12	72	-	4/8	RL
	26/10/21	NM/AE	2040	2050	Nil	Nil	OnJ	Nil	Nil	LQ	19.2	75	Nil	6/8	RL
U20	10/08/21	LA/AE	1820	1830	Nil	Nil	Powerful owl, hc	Nil	Nil	Nmn	17	67	Nil	8/8	RL
	14/9/21	LA/AE	2053	2003	Nil	Nil	Boobook	Nil	Nil	FQ	12	72	-	4/8	RL
	26/10/21	NM/AE	2020	2030	Nil	Nil	OnJ	Nil	Nil	LQ	19.2	74	Nil	6/8	RL
U21	10/8/21	DR	2108	2131	0	Nil	Greater glider; ONJ x 3		Nil	Nmn	13	67	Nil	Nil	RL
	14/9/21	DR/NM	1934	1944	Nil	Nil	ONJ x 2		Nil	FQ	12.8	65	Nil	5/8	MSB
	27/10/21	NM/AE	2100	2110	Nil	Nil	OnJ x 2	Nil	Nil	LQ	21.7	83	Nil	1/8	RL
U22	10/8/21	LA/AE	2120	2130	Nil	Nil	Nil	Nil	Nil	Nmn	14	67	Nil	8/8	MSB
	14/9/21	LA/AE	1925	1935	-	Nil	-	-	-	FQ	12	-	-	4/8	MSB
	27/10/21	DR	2054	2113	1	HC-p, 50m along T & 50m sth	ONj		Nil	LQ			Nil	Nil	Nil
U23	10/08/21	LA/AE	2140	2150	Nil	Nil	Night jar, hc	Nil	Nil	Nmn	14	67	Nil	8/8	MSB

Transect	Date	Obs	Start	Finish	YbG (no. ind s)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
	14/9/21	LA/AE	1908	1918	Nil	Nil	Nil	Nil	Nil	FQ	12	-	-	4/8	MSB
	27/10/21	NM/AE	2041	2051	Nil	Nil	OnJ	Nil	Nil	LQ	21.7	83	Nil	1/8	RL
U24	10/8/21	DR	2144	1006	0		ONJ		Nil	Nmn	13	67	Nil	Nil	RL
	14/9/21	LA/AE	1850	1900	-	Nil	Nil	Nil	-	FQ	12	-	-	4/8	MSB
	27/10/21	SR	2027	2946	0		ONJ		Nil	LQ			Nil	Nil	Nil
U25	10/8/21	LA/AE	2100	2110	Nil	Nil	Night jar, hc	Nil	Nil	Nmn	14	67	Nil	8/8	MSB
	14/9/21	LA/AE	1940	1950	Nil	Nil	OnJ, SuG, hc	-	-	FQ	12	-	-	4/8	MSB
	27/10/21	NM/AE	2115	2125	Nil	Nil	Nil	Nil	Nil	LQ	21.7	83	Nil	1/8	RL
U26	10/8/21	LA/AE	2040	2050	Nil	Nil	Nil	Nil	Nil	Nmn	14	67	Nil	8/8	MSB
	14/09/21	DR/NM	1954	2004	Nil	Nil	Nil	Nil	Nil	FQ	12.8	65	Nil	5/8	MLB
	27/10/21	DR, NM, AE	2122	2138	0		ONj		Nil	LQ			Nil	Nil	Nil
U27	10/8/21	LA/AE	2200	2210	1 YBG	HC 150s100me, time 2212	Nil	Nil	Nil	Nmn	14	67	Nil	8/8	MSB
	14/9/21	LA/AE	1835	1845	Nil	Nil	-	-	-	FQ	12	-	-	4/8	MSB
	27/10/21	DR	2011	2020	2	HC-ob, 50m along & 50m east			Nil	LQ			Nil	Nil	Nil
U28	10/8/21	DR	1018	1041	0		Nil		Nil	Nmn	13	67	Nil	Nil	RL
	14/9/21	LA/AE	1815	1825	Nil	Nil	-	-	-	FQ	12	-	-	4/8	MSB
	27/10/21	DR	1947	2006	0		WTNj x 2; ONj		Nil	LQ			Nil	Nil	MSB
U29	10/8/21	LA/AE	2225	2235	Nil	Nil	Night jar hc	Nil	Nil	Nmn	14	67	Nil	8/8	MSB
	14/9/21	DR/NM	1904	1914	Nil	Nil	PO hc	Nil	Nil	FQ	12.7	66	Nil	1/8	MLB
	27/10/21	NM/AE	2020	2030	Nil	Nil	OnJ	Nil	Nil	LQ	21.7	83	Nil	1/8	RL
U30	10/8/21	DR	1057	1118	0		SEBTP; sugar glider		Nil	Nmn	13	67	Nil	Nil	Nil
	14/9/21	DR/NM	1847	1857	Nil	Nil	Nil	Nil	Nil	FQ	12.7	66	Nil	1/8	Nil
	27/10/21	NM/AE	2005	2015	Nil	Nil	White-throated nightjar	Nil	Nil	LQ	21.7	83	Nil	1/8	MSB
U31	10/8/21	LA/AE	2245	2255	Nil	Nil	Owl sp.	Nil	Acacia	Nmn	14	67	Nil	8/8	MSB
	14/9/21	DR/NM	1820	1830	Nil	Nil	Nil	Nil	Nil	FQ	12.7	66	Nil	1/8	MLB

Transect	Date	Obs	Start	Finish	YbG (no. ind s)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
	27/10/21	NM/AE	1945	1955	Nil	Nil	Boobook	Nil	Nil	LQ	21.7	83	Nil	1/8	MSB
U32	10/8/21	DR	1810	1830	0			No PB	Nil	Nmn	17	52	Nil	10	MSB
	14/9/21	LA/AE	2135	2145	1	hc 180s 10m w	Powerful owl	Nil	Nil	FQ	12	72	-	4/8	MLB
	26/10/21	NM/AE	1945	1955	1	HCOm50mW, time 1945 onwards before and after pb	Nil	Nil	Nil	LQ	19.2	74	Nil	6/8	RL

**Table A3:** Yellow-bellied glider detections and weather conditions during three spotlight/call playback surveys conducted in late winter/spring 2021 in Yarriabini National Park. se = saw eyeshine; hc = heard call; hm = heard movement; sm = saw movement; PB = playback; GHFF – grey-headed flying-fox; CRP – common ringtail possum; OnJ – owl nightjar; WtNJ = white-throated nightjar; SuG – sugar glider; TF – tawny frogmouth; CBTP – common brushtail possum; SeBtP = short-eared brushtail possum; BbO – southern boobook; PO = powerful owl; FtG – feathertail glider.

Transect	Date	Observer	Start	Finish	YbG (no. ind's)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
Y1	11/08/2021	LA/AE	23:00	23:10	Nil	Nil	Nil	Nil	Nil	Nmn	17	67	Nil	8/8	RL
	15/09/21	NM/AE	1823	1833	Nil	Nil	Nil	Nil	Nil	FQ	12.6	74	Nil	1/8	MSB
	27/10/21	DR	2437	2457	0				Nil	LQ	21	93	Nil	Nil	Nil
Y2	11/08/2021	LA/AE	2300	23:10	Nil	Nil	Nil	Nil	Nil	Nmn	17	67	Nil	8/8	RL
	15/09/21	NM/AE	1841	1851	Nil	Nil	Nil	Nil	Nil	FQ	12.6	74	Nil	1/8	MSB
	27/10/21	DR	2414	2433	0		Boobook (hc)		Nil	LQ	21	89	Nil	Nil	Nil
Y3	11/8/21	DR	1053	1113	0		Sugar glider; FtG		Nil	Nmn	14	67	Nil	Nil	RL
	15/09/2021	LA	1843	1903	Nil	Nil	Nil	Nil	Nil	FQ	12.8	73	Nil	1/8	RL
	27/10/21	NM/AE	0000	0010	Nil	Nil	Nil	Nil	Nil	LQ	20.9	95	Nil	1/8	Nil
Y4	11/08/2021	LA/AE	2245	22:55	Nil	Nil	Nil	Nil	Nil	Nmn	17	67	Nil	8/8	RL

Transect	Date	Observer	Start	Finish	YbG (no. ind's)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
	15/9/21	NM/AE	1900	1910	Nil	Nil	Nil	Nil	Nil	FQ	12.3	77	Nil	2/8	RL
	27/10/21	DR	2353	2409	1	HC - p, 100m along & 50m east				LQ	21	89	Nil	Nil	Nil
Y5	11/8/21	DR	1023	1045		0	Boobook		Nil	Nmn	16	76	Nil	Nil	RL
	15/09/2021	LA	1907	1927	Nil	Nil	Nil	Nil	Nil	FQ	12.8	73	Nil	1/8	RL
	27/10/21	NM/AE	2340	2350	1	Hc after pb, 50e60s	Nil	Nil	Nil	LQ	20.9	95	Nil	1/8	Nil
Y6	11/08/2021	LA/AE	2200	22:10	2	Sm, 150 w, 30 e and hc at 170w 100m e	Nil	Nil	Flooded gum	Nmn	17	67	Nil	8/8	RL
	15/9/21	NM/AE	1933	1943	2	HC after pb, 1933,0m,30mw. 0m, 50ms	Nil	Nil	Nil	FQ	12.3	77	Nil	2/8	RL
	27/10/21	DR	2325	2343	2	HC-pb, immed call from 0m	SuG (hc)			LQ	21	89	Nil	Nil	Nil
Y7	11/08/2021	LA/AE	2211	2221	Nil	Nil	Nil	Nil	Flooded gum	Nmn	17	67	Nil	8/8	RL
	15/09/2021	LA	1941	2001	Nil	Nil	BOO	Nil	Nil	FQ	12.8	73	Nil	1/8	MSB
	27/10/21	NM/AE	2322	2332	Nil	Nil	Nil	Nil	Nil	LQ	20.7	96	Nil	1/8	Nil
Y8	11/8/21	DR	1002	1024	0		Boobook		Nil	Nmn	16	76	Nil	Nil	Nil
	15/9/21	NM/AE	1957	2007	0	Nil	Nil	Nil	Nil	FQ	11.7	76	Nil	2/8	RL
	27/10/21	NM/AE	2306	2316	Nil	Nil	GG.se, Boobook, hc, OnJ	Nil	Nil	LQ	20.7	96	Nil	1/8	Nil
Y9	11/8/21	DR	1958	820	0		Boobook; ONJ		Nil	Nmn	16	76	Nil	Nil	Nil
	15/09/2021	LA	2143	2203	Nil	Nil	Nil	Nil	Nil	FQ	10.2	86	Nil	2/8	MSB
	27/10/21	DR	2256	2315	0		Boobook; ONJ			LQ			Nil	Nil	Nil

Transect	Date	Observer	Start	Finish	YbG (no. ind's)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
Y10	11/08/2021	LA/AE	1947	1957	Nil	Nil	Nil	Nil	Nil	Nmn	17	67	Nil	8/8	RL
	15/09/21	NM/AE	2155	2205	Nil	Nil	Nil	Nil	Nil	FQ	10.1	88	Nil	2/8	MSB
	27/10/21	NM/AE	2242	2252	Nil	Nil	Nil	Nil	Nil	LQ	20.7	96	Nil	1/8	Nil
Y11	11/08/2021	LA/AE	1930	19:40	Nil	Nil	Nightjar, hc	Nil	Nil	Nmn	17	67	Nil	8/8	RL
	15/09/21	NM/AE	2217	2227	Nil	Nil	Nil	Nil	Nil	FQ	10.1	88	Nil	2/8	RL
	27/10/21	NM/AE	2228	2238	Nil	Nil	Nil	Nil	Nil	LQ	20.7	96	Nil	1/8	Nil
Y12	11/08/2021	LA/AE	2010	20:20	Nil	Nil	Nightjar, hc, Boobook, hc	Nil	Nil	Nmn	17	67	Nil	8/8	RL
	15/09/2021	LA	2009	2029	Nil	Nil	Nil	Nil	Nil	FQ	12.8	73	Nil	1/8	RL
	27/10/21	DR	0110	0130	0		Boobook		Nil	LQ	18	90	Nil	Nil	Nil
Y13	11/08/2021	LA/AE	20:25	20:35	Nil	Nil	Nil	Nil	Nil	Nmn	17	67	Nil	8/8	RL
	15/09/21	NM/AE	2021	2031	Nil	Nil	Nil	Nil	Nil	FQ	11.7	76	Nil	2/8	MSB
	28/10/21	NM/AE	1327	1337	0	Nil	OnJ	Nil	Nil	LQ	20.4	95	Nil	1/8	Nil
Y14	11/8/21	DR	832	854	0		Powerful owl; ONJ		Nil	Nmn	16	81	Nil	Nil	MSB
	15/09/2021	LA	2035	2055	Nil	Nil	Nil	Nil	Nil	FQ	10.2	86	Nil	2/8	MSB
	28/10/21	NM/AE	1312	1322	0	Nil	Boobook	Nil	Nil	LQ	20.4	95	Nil	1/8	Nil
Y15	11/8/21	DR	902	924	0		Boobook		Nil	Nmn	16	80	Nil	Nil	MSB
	15/09/2021	LA	2109	2129	Nil	Nil	Nil	Nil	Nil	FQ	10.2	86	Nil	2/8	MSB
	24/11/21	LA AE	22:16	22:26	Nil	Nil	Nil	Nil	Nil	LQ	21.2	100	Light rain	8/9	MSB
Y16	11/08/2021	LA/AE	21:08	21:18	Nil	Nil	Sug se; FtG se	Nil	Nil	Nmn	17	67	Nil	8/8	MSB

Transect	Date	Observer	Start	Finish	YbG (no. ind's)	OBS type (< or > PB), Time; Loc	Other species	Comments	Flowering	Moon	Temp	Humidity	Rain	Cloud	Wind
	15/09/21	NM/AE	2126	2136	Nil	Nil	Nil	Nil	Nil	FQ	10.2	86	Nil	2/8	MSB
	24/11/21	LA/Ae	2140	2155	Nil	Nil	Nil	Nil	Nil	LQ	21.2	100	Light rain	8/9	MSB
Y17	11/08/2021	LA/AE	21:35	21:45	Nil	Nil	Nil	Nil	Nil	Nmn	17	67	Nil	8/8	MSB
	15/09/21	NM/AE	2108	2118	Nil	Nil	Nil	Nil	Nil	FQ	10.2	86	Nil	2/8	MSB
	24/11/21	LA/AE	22:00	22:10	Nil	Nil	Nil	Nil	Nil	LQ	21.2	100	Light rain	8/9	MSB
Y18	11/08/2021	LA/AE	20:50	21:00	Nil	Nil	Nil	Nil	Nil	Nmn	17	67	Nil	8/8	MSB
	15/09/21	NM/AE	2044	2054	Nil	Nil	Nil	Nil	Nil	FQ	10.4	84	Nil	2/8	MSB
	24/11/21	LA/AE	22:40	22:50	Nil	Nil	Nil	Nil	Nil	LQ	21.2	100	Light rain	8/9	MSB
Y19	11/8/21	DR	724	746	0		ONJ		Nil	Nmn	17	76	Nil	Nil	Nil
	15/09/2021	LA	2215	2230	Nil	Nil	Nil	Nil	Nil	FQ	10.2	86	Nil	2/8	MSB
	27/10/21	DR	2226	2246	0		ONj		Tallowwood mahogany	LQ			Nil	Nil	Nil
Y20	11/08/2021	LA/AE	23:50	00:00	Nil	Nil	Nil	Nil	Nil	Nmn	14	67	Nil	8/8	MLB
	15/09/2021	LA	1819	1839	Nil	Nil	Nil	Nil	Nil	FQ	12.8	73	Nil	1/8	MLB
	27/10/21	NM/AE	0024	0034	Nil	Nil	Boobook, hc	Nil	Nil	LQ	20.9	95	Nil	1/8	Nil



## Appendix B – Song meter deployment data

**Table B1:** Song meter deployment data for 2021/22 year 4 monitoring period.

Site No.	Forest Block	Easting	Northing	SM number	Start Date	Check Date	Status	Collect Date	Status	Last date	Days Active	Notes
SM1	S	497127	6609463	7	17/09/2021	25/11/21	active	21/3/22	Active		185	
SM2	S	497643	6609308	17	17/09/2021	25/11/21	active	21/3/22	Active		185	
SM3	S	496914	6609169	10	17/09/2021	25/11/21	active	21/3/22	Active		185	
SM4	S	495500	6606980	5	16/09/2021	25/11	active	21/3/22	Active		186	
SM5	S	496730	6607147	6	16/09/2021	25/11	active	21/3/22	Active		186	
SM6	NW	495517	6607987	8	16/09/2021	24/11	active	21/3/22	Flooded	11/1/22	117	Flooded on collection (21/3)
SM7	NW	496204	6608540	1	16/09/2021	24/11	active	21/3/22	Active		186	
SM8	NW	496890	6610107	11	16/09/2021	26/11	active	21/3/22	Active		186	
SM9	NW	495333	6611184	9	16/09/2021	26/11	active	21/3/22	Active		186	
SM10	NW	496345	6610236	15	16/09/2021	26/11	active	21/3/22	Flooded	31/12/21	106	Flooded on collection (21/3)
SM11	NW	495445	6610199	18	16/09/2021	26/11	active	21/3/22	Active		186	
SM12	S	497064	6608479	14	17/09/2021	25/11	active	21/3/22	Active		185	
SM13	NE	498950	6612723	12	16/09/2021	25/11	active	21/3/22	Active		186	
SM14	NE	498181	6611637	**	16/09/2021	25/11	active	21/3/22	Active		186	
SM15	NE	499184	6611800	2	16/09/2021	25/11	active	21/3/22	Active		186	
SM16	NE	500154	6611271	19	17/09/2021	25/11	active	21/3/22	Active		185	
SM17	NE	500154	6612164	13	17/09/2021	25/11	active	21/3/22	Active		185	
SM18	NE	500653	6611684	16	17/09/2021	25/11	active	21/3/22	Active		185	