

**Rio Tinto,
Ratty Spring and Paraburdoo Pools Pilbara leaf-
nosed Bat monitoring program,
2015 to January 2020**

Prepared for **Rio Tinto**

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Document Revision History

| Issue | Date | Revision History |
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Executive Summary

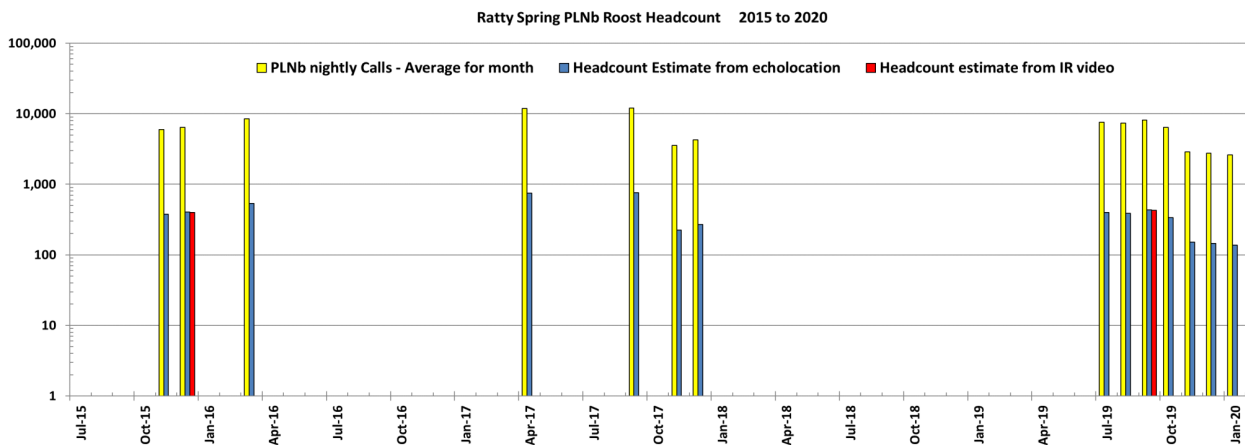
Pilbara leaf-nosed bats (*Rhinonictoris aurantia*) (PLNb) have been detected near Paraburdoo in the Pilbara, Western Australia. The species is listed as Vulnerable under federal and state legislation. A PLNb diurnal roost cave containing a large colony has been identified near Ratty Spring (Bat Call 2015) called the Ratty Spring Roost (RSR). A diurnal roost is one that is occupied during daylight hours for part or all of the year and is differentiated from a foraging location which is used only nocturnally. Permanent diurnal roosts are thought to be maternity sites. Monitoring of the activity of PLNb at RSR using an ultrasonic call detector is ongoing and two census' has been completed (December 2015 and September 2019). This monitoring has shown that PLNb are continuously resident throughout the year and numbered over 400 in September 2019.

Periodic monitoring of the roost began following its discovery in November 2015 and continuous monitoring has been undertaken since November 2017. The temporal patterns of calls detected confirm that PLNb were roosting diurnally throughout the monitoring period. At the diurnal roost cave there was PLNb activity on each night of the monitoring program with approximately 4,000 calls per night being recorded initially in 2015. This level of activity then increased until mid-2017 when approximately 15,000 calls were recorded per night. Following the very dry period from April to December 2017, this activity returned to the levels of 2015. With the installation of a radio frequency identification system (RFID) in the roost entrance in late 2017, the call counts during 2018 were lower, typically less than 250 per night. This reduction to 10% of the 2017 levels is shown to be due to the PLNb not using their echolocation when the RFID system is transmitting in the cave entrance. The echolocation microphone was moved further into the cave entrance in July 2019 to separate the two systems. The call count then returned to the levels of 2017.

Based on the long term trends in PLNb activity at RSR, estimates of colony size show that there has been a significant fluctuation in size since 2015 with the estimate rising from ~400 in late 2015 to ~900 by the beginning of the dry season of 2017. This then fell to ~250 by December 2017 prior to the RFID system installation. This variation is consistent with the variation in seasonal rainfall received in the district and also the reduction in calls detected following the installation of the directional microphone in the cave entrance. Notably, there was no other anthropogenic interference during this period.

During 2018 the nightly call count fluctuated between virtually no calling in March, April and October to December to highs of ~2,000 calls per night in June. This reduction in calls per night from 2017 levels is attributed to the presence of the RFID system. The data from that system shows that the bats have remained in the colony but do not call when in close proximity to the RFID system antenna. As a result, no estimate of headcount could be made during 2018.

From July to September 2019, the nightly call count averaged approximately 8000 with a stable headcount of approximately 450. However, the nightly call total dropped to approximately 3,000 from October to January 2020 corresponding to a headcount of approximately 200. This pattern is similar to that recorded in 2017.



PLNb activity was also recorded periodically during the second half of 2018 at five sites near semi-permanent pools in the district. These were east and west of the Ratty Spring pool, Seven Mile Crossing Pool, Kelly’s Pool and Western Range Pool 5. PLNb were detected on all recording nights at all pools with call counts varying from lows of ~10 at Kelly’s Pool to highs of over 1,000 at Ratty Spring Pool. The distant Western Range Pool 5 and at 7-mile Crossing Pool averaged approximately 20 and 50 calls per night respectively. These call levels confirm the persistence of the RSR colony throughout 2018. In the second half of 2019, calls were recorded again east and west of the Ratty Spring pool, at Kelly’s Pool, and at a site on Pirraburdu Creek 2.5 km north of the Ratty Spring roost. Call counts at the Ratty Spring pools, where water was present, were similar to the 2018 levels. Counts at Kelly’s Pool and Pirraburdoo Ck, where the sites were dry, were very low averaging under 5 calls per night.

Introduction

Project Background

Rio Tinto currently has mining operations at the Western Range Project, near Paraburdoo, as a part of its current Pilbara operations. Surveys at the project have detected the presence of Pilbara leaf-nosed bats, (*Rhinionictoris aurantia*) (PLNb).

A diurnal PLNb roost that has been shown to be permanent and therefore maternal was discovered in 2015. Periodic monitoring of the activity of PLNb has occurred since and a permanent continuous monitoring facility was installed in November 2017. This monitoring has shown that PLNb are resident at RSR throughout the year and has confirmed that this is a permanent diurnal roost. Currently, the nearest confirmed permanent roosts are at Paraburdoo East (approximately 2 km north of the Eastern Range mine), 15 km to the east, at Turee Syncline, 40 km to the north-east and at Hardey River, 45 km to the north-west.

The PLNb is listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. Within the state of Western Australia, it is listed as a Vulnerable species under the *Biodiversity Conservation Act 2016*.

Bat Call WA (Bat Call) was engaged by Rio Tinto to review ultrasonic call data collected at the roost and at a number of nearby permanent pools during the monitoring period and to characterise the variations in PLNb roosting activity.

This report provides the methods and call analysis results for the monitoring undertaken at RSR and the Paraburdoo pools from November 2015 to January 2020 and presents both the call count data and an ongoing estimate of headcount at the colony.



Figure 1: General Arrangement of the location of the PLNb diurnal roost at Ratty Spring. The locations of the closest confirmed diurnal/maternity roosts are at East Paraburadoo, 15 km to the east, Turee, 40 km to the north-east and at the Hardey River, 45 km to the north-west. Yellow pins denote the nearby permanent pools and creek monitoring sites.

Climate

Based on data from the nearest weather station at Paraburadoo the mean annual rainfall is 325 mm, with very high seasonal and annual variability (Bureau of Meteorology [BoM], 2020). The mean northern wet season (October to April) rainfall is 225 mm. The mean maximum temperatures at Paraburadoo are above 30°C for eight months of the year and exceed 35°C during the months of October to March. Mean maximum temperatures drop below 30°C during the months of May to August. Minimum overnight temperatures exceed 15°C for all but these cool months. Northern wet season rainfall from 2005/6 to 2019/20 is given in figure 2.

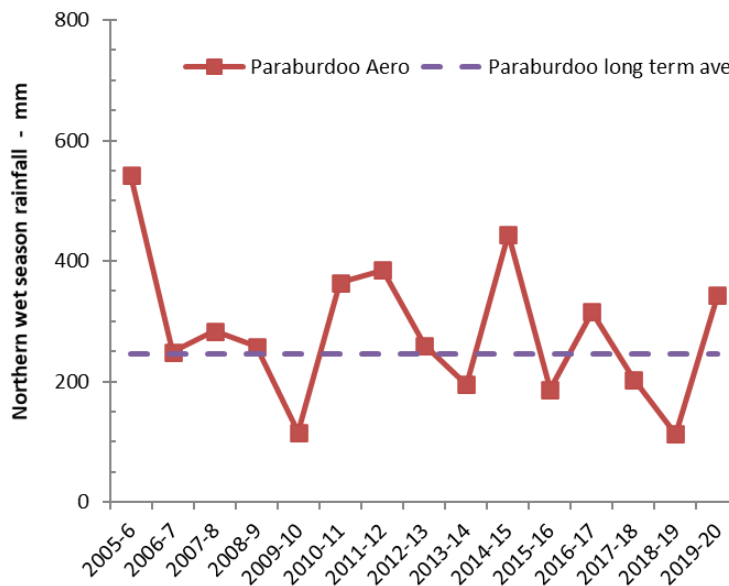


Figure 2. Long Term northern wet season (October to April) rainfall at BoM station at Paraburdoo Airport.

Surface Water

The ridge containing the RSR cave is drained by the ephemeral Pirraburdu Creek which includes Ratty Spring approximately 800 m north-west of the roost. The spring has a large permanent pool and there is another semi-permanent pool east of RSR. There are also permanent and semi-permanent pools at Seven-mile Crossing Pool (50K 566036 7432837), 10 km to the east, Kelly’s Pool (50K 563034 7432390) 7 km to the east, at Western Range Pool 5 (50K 545324 7435889), 11 km to the west and on Pirraburdu Creek to the north (50K 556175 7435230).

District Mining Operations

Open cut iron ore mining operations have been underway for six decades in the district. The Western Range mine pit is currently 1.3 km from RSR while the Paraburdoo and Eastern Range mines are further to the east.

Methodology

Survey Team

Mr Robert Bullen of Bat Call specified the equipment to be used for the survey. Mr Scott Reiffer of Rio Tinto completed the initial monitoring visits from 2015 to 2017 and from 2018 to 2020. Mr. Bullen and Ms. Tienielle Brown of Rio Tinto installed the permanent monitoring equipment at site in November 2017. Mr Bullen has visited the site each year and has reviewed all recordings made and has provided the analysis contained herein.

Survey Timing and Weather

The continuous monitoring program has run from 13th November 2017 to February 2020. The Pilbara’s 2015-16 wet season had poor rainfall and followed a series of years with above average rainfall. The 2016-17 wet season was above average, figure 2 however the 2017-18 and 2018-19 seasons were below average. Minimal rain fell between April 2018 and December 2019, figure 3. The analysis presented below includes meteorological data from the BOM weather station at Paraburdoo Airport (BOM 2018), approximately 21 km northeast of RSR.

Timing of sunset, sunrise, dusk and dawn civil twilight (CT) were calculated using the Geoscience Australia, Astronomical information website.

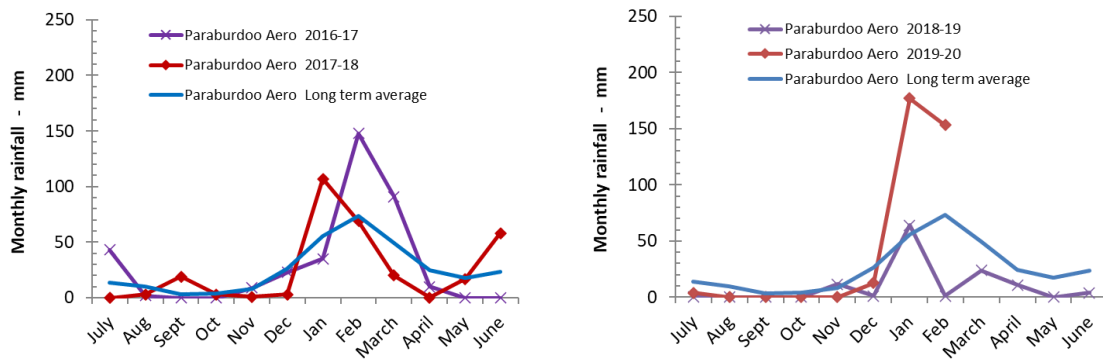


Figure 3. Monthly rainfall between July 2016 and February 2020 at Paraburdoo Airport.

Bat Observations

Early observations were made with a full spectrum ultrasonic bat detector (SM2BAT model Wildlife Acoustics, USA) fitted with an omnidirectional SMX-US microphone located at

the cave entrance. This recorded PLNb exiting, re-entering and passing outside the entrance. For the continuous monitoring program beginning in November 2017, a full-spectrum ultrasonic bat detector (SM4BAT FS model Wildlife Acoustics, USA) was selected for use as this system is proven to be superior in recording PLNb calls to other bat detector systems. The detector's microphone, a type SMM-U1 (fitted with a directional horn until mid-2019), was placed on a tripod in the entrance of the study cave, plate 1, to record numbers of PLNb present. The microphone is mounted on a tripod ~500 mm above the cave floor to reduce echoes and oriented horizontally and into the entrance to preferentially detect bats entering and exiting the cave. The settings used on the SM4 detector, in particular the Minimum Trigger Frequency setting of 65 kHz were targeting PLNb to maximise the recording time of the detector's internal memory. The PLNb presence was confirmed by recording distinctive diagnostic ultrasonic calls between 115 and 125 kHz (McKenzie and Bullen 2009). Using a high pass filter setting of over 70 kHz precludes the recording of other significant bat species that have ultrasonic calls below this frequency, e.g. Ghost bats (*Macroderma gigas*), *Taphozous* sp. and *Vespadelus finlaysoni* that may be present.



Plate 1: The entrance to RSR. The microphone is mounted on a tripod in the constriction.

The SM4 detector was powered by a 12-volt battery that was charged during the day using a 20 W solar panel. Each detector file contained one or more PLNb calls or passes (see also Survey limitations below). These were then reviewed using COOL EDIT 2000 (Now available as AUDITION from Adobe Systems Inc.) to ensure accuracy of file count number and timing of first and last calls. Bat activity levels were then assessed by counting the files identified and estimating call numbers using the call/file method (Bat Call 2015). The directional horn was removed when the microphone was moved approximately 15 m further inside the entrance in July 2019.

SM4 detectors with omnidirectional microphones were also placed at the nearby permanent pools between September and December 2018, and again between October and November 2019 to record PLNb activity. There are at Ratty Spring East (50K 555598 7432481), Ratty Spring West (50K 555016 7433392), Seven-mile Crossing Pool (50K 566036 7432837), Kelly's Pool (50K 563034 7432390), Western Range Pool 5 (50K 545324 7435889) and on Pirraburdu Creek (50K 556175 7435230). These have been placed with their SMM-U1 microphones aligned horizontally across the pool.

Survey Limitations

The primary objective of the scope of the survey was the continuous characterisation of the PLNb activity at RSR and the nearby pools over a long period. All aspects of the survey including site access, Rio Tinto and Bat Call team make-up and experience levels, equipment used, logistics and safety support provided by Rio Tinto were suitable for the task. SM4 detector fitted with a 'U1 microphone was specified for the continuous monitoring as it is proven to be superior to other detector systems in recording PLNb.

Headcount of PLNb at the site is impossible to calculate precisely from ultrasonic recordings due to the possibility of multiple passes by individual bats. A count of calls is therefore used herein to establish an activity level of PLNb on any given night. Each recorded file is generated by the detector. Due to the large number of PLNb at RSR, each file often contains two or more calls. Note that during a census at RSR in December 2015 there was an average of 1.35 calls per file calculated (Bat Call 2015). This ratio will change over time as the call numbers per night vary. A comparison of files detected in this way with actual PLNb calls and movements recorded by video within the roost entrance is given in Bat Call (2015). Colony size estimates can then be made based on these data.

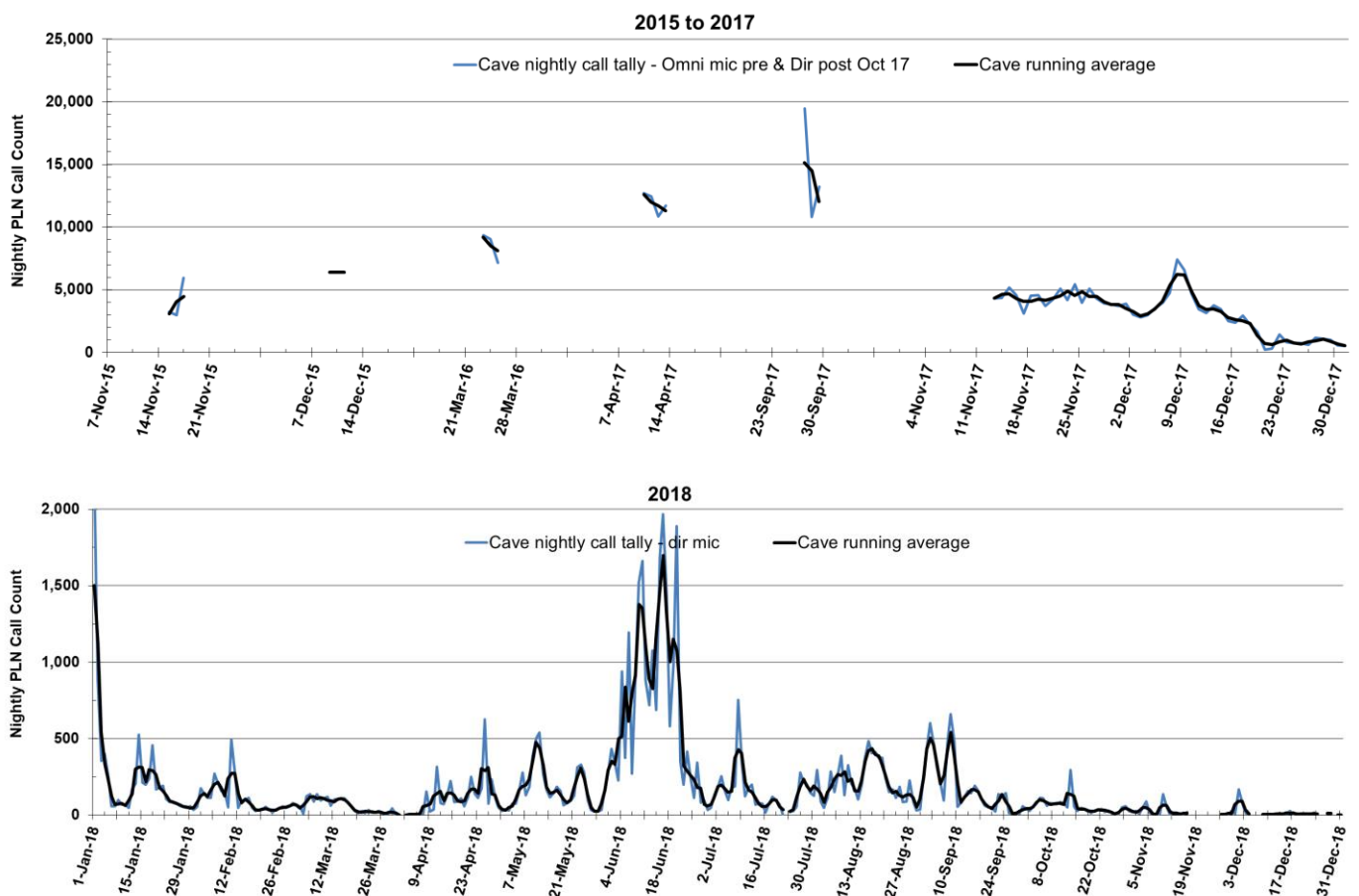
A radio frequency identification system (RFID) was placed in the entrance of the RSR cave in late 2017 and its operation began in January 2018. This analysis has shown that the PLNb call much less often when in the vicinity of this system, see Results section below. As a result, the PLNb call count data throughout 2018 is lower than would be expected by the size of the colony present and cannot be compared with the 2017 and 2019 data. However, it can still be used to confirm the presence of the colony.

Results and Discussion

Ratty Spring Roost

PLNb calls were detected at RSR continuously to December 2018 and from July 2019 to January 2020, figure 4. The minimum number of calls recorded on any night during 2015 was 3,100 on the 16th November 2015 with the omni directional microphone. The activity level then rose steadily until dry season 2017 when an average of 15,000 calls were recorded per night. The call count then declined to December 2017 when the nightly average was approximately 5,000 with the directional microphone during new moon periods. The nightly call count then fell in early January 2018 to less than 600 and with the exception of a three-week period in June, stayed at a very low level through to December, figure 4. This reduction in call count corresponds to the introduction of the RFID system in the cave entrance. A review of the recordings made shows that the RFID antenna transmits at a frequency of 135 kHz above, but close to, the frequency range used by the PLNb, figure 5.

Figure 4. Pattern of PLNb calls detected at RSR between November 2015 and January 2020. A three-night running average is also presented.



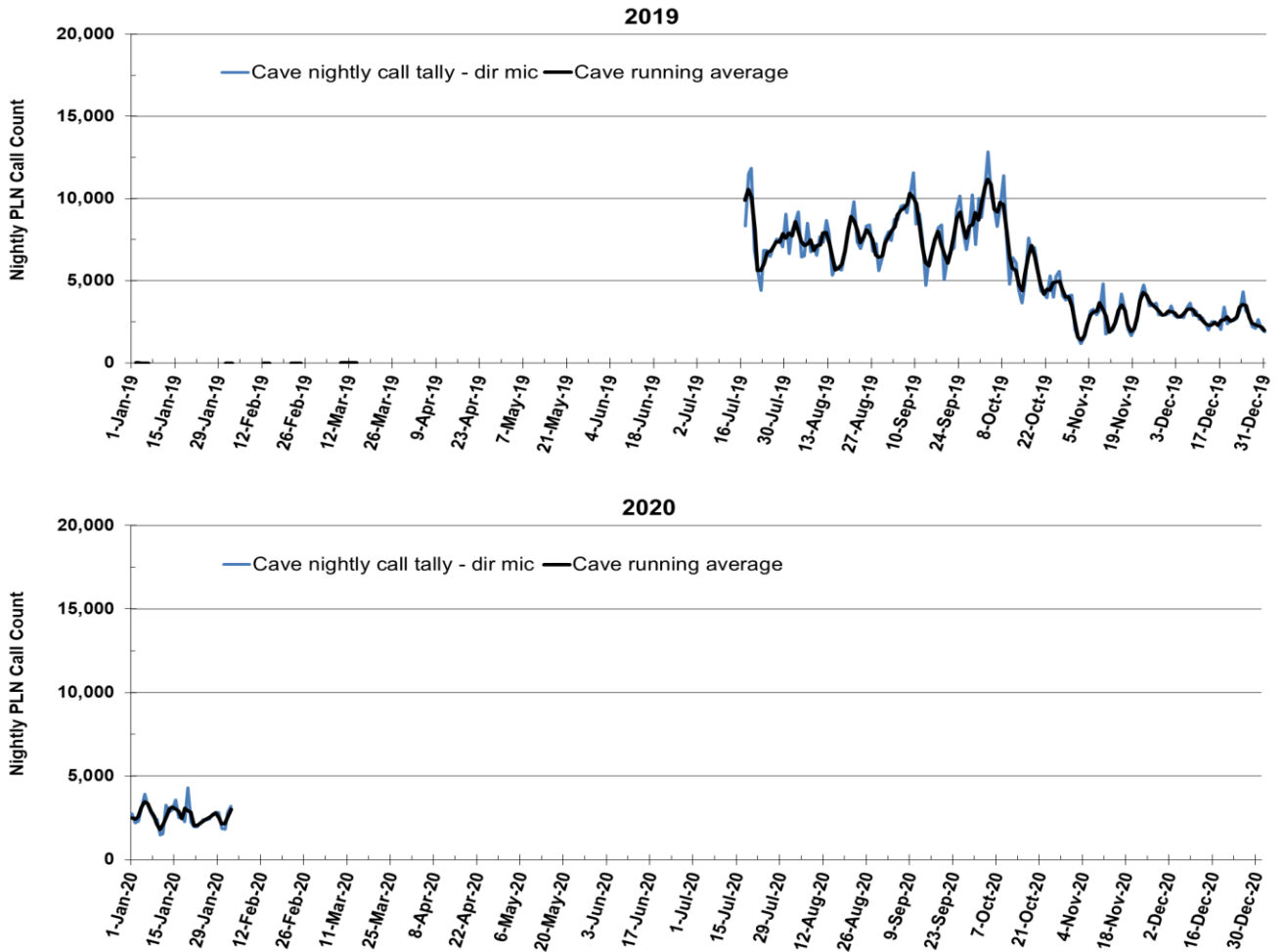
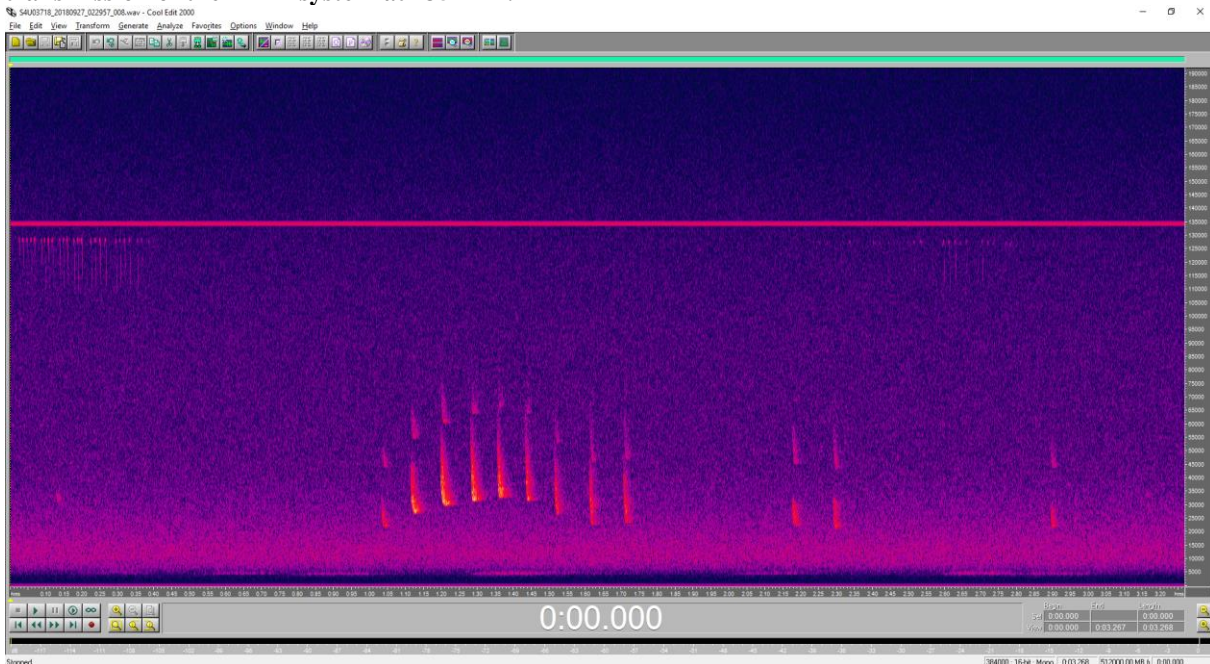


Figure 5. Example screen shot showing the proximity of two PLNb calls at ~120 kHz with the transmission of the RFID system at 135 kHz.



However, strong PLNb call recordings between September and December 2018 at the pools nearby the roost, combined with observations of multiple PLNb exiting the roost in September 2018, confirm that the colony remains in place at RSR, see further below. It is apparent that the sound emitted by the RFID system causes the PLNb to reduce the use of their ultrasonic calling when in close proximity to the RFID system.

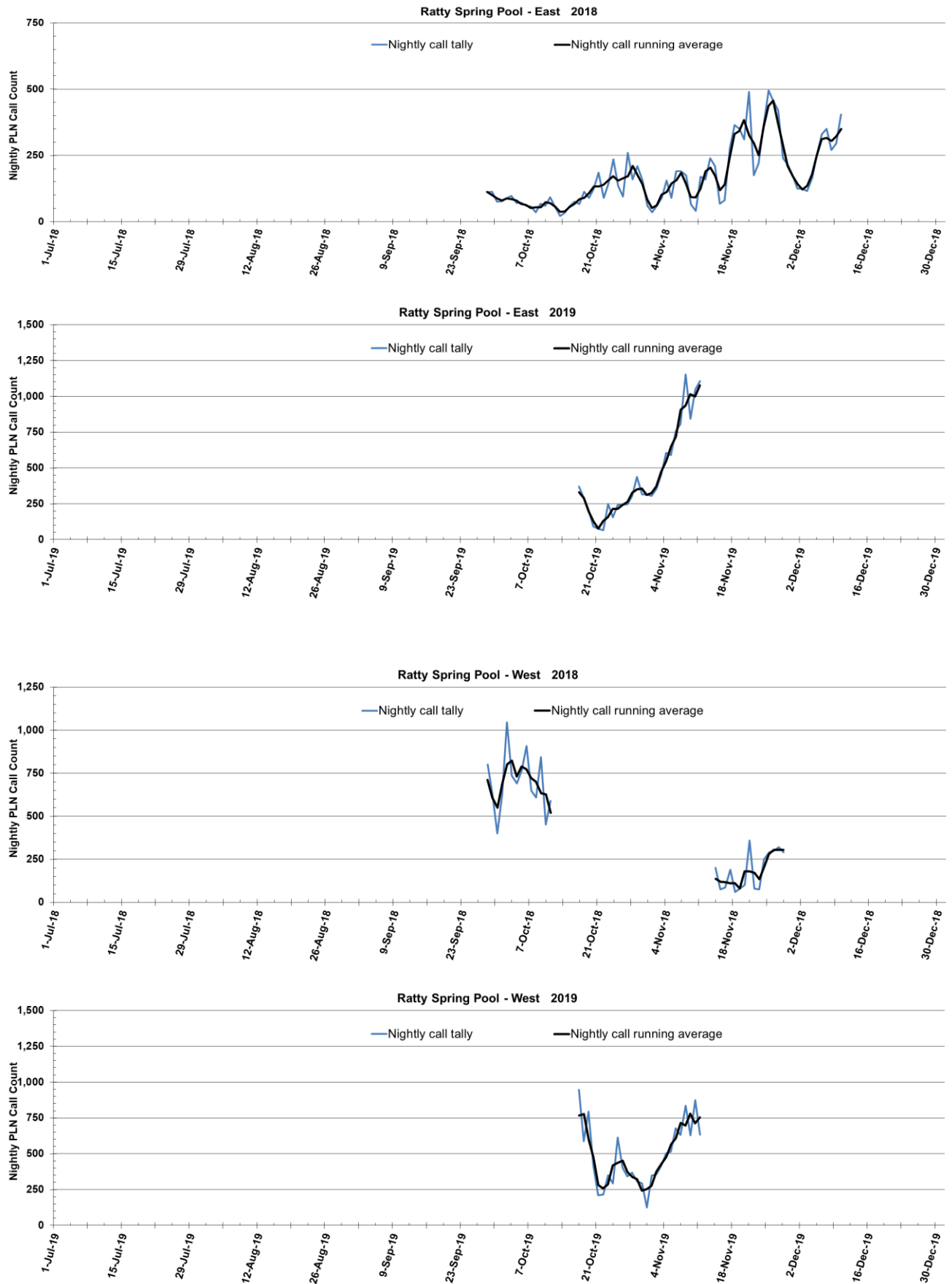
The echolocation microphone was moved further into the cave entrance in July 2019 to separate the two systems. The call count then returned to the levels of 2017, averaging approximately 8,000 between July and October. Following the pattern of 2017, this level dropped to approximately 3,000 nightly calls between November and January 2020.

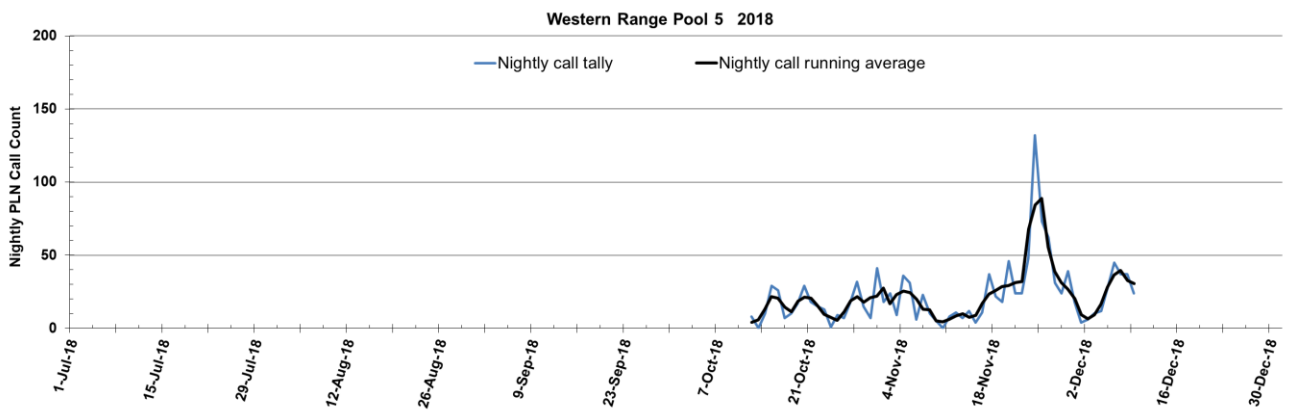
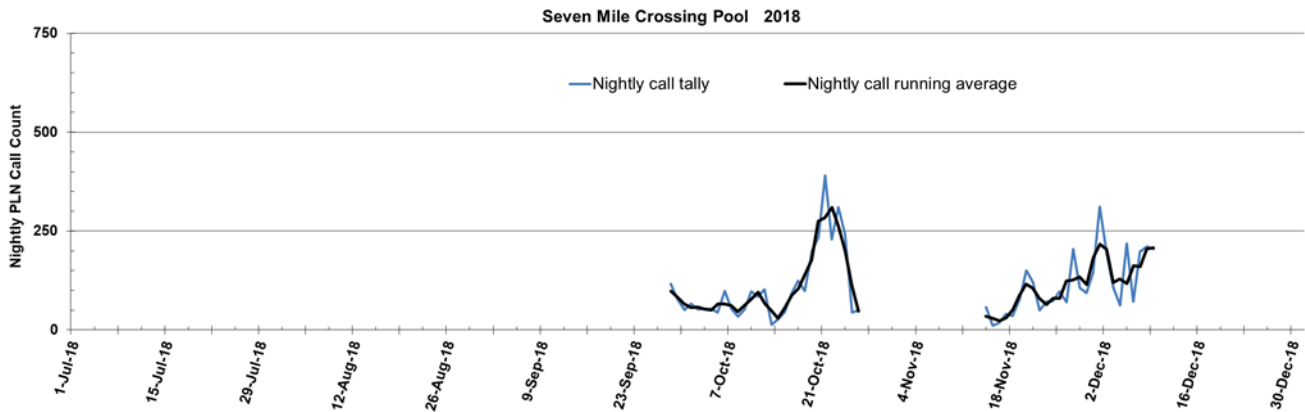
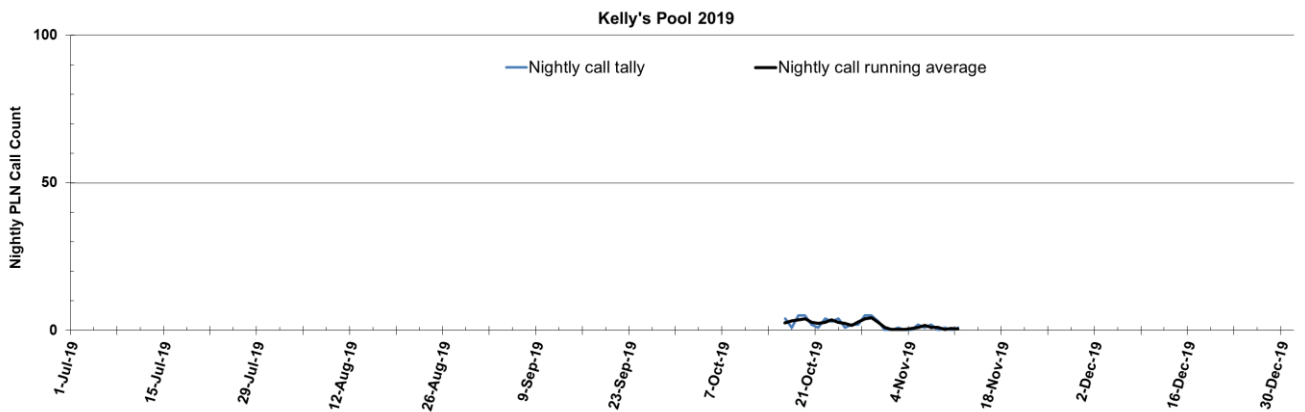
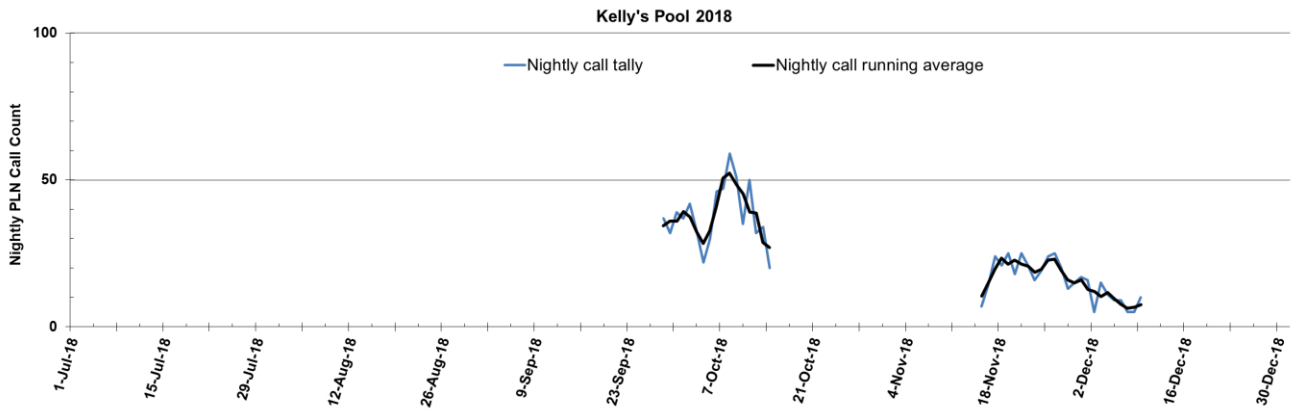
Paraburdoo pools.

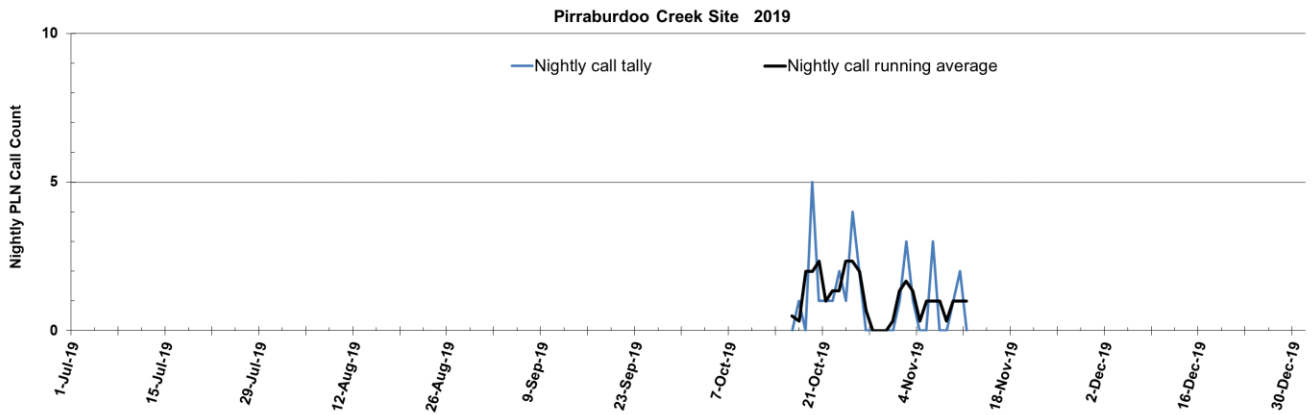
Monitoring of the PLNb calls at the pool sites in the Paraburdoo district has shown that the activity levels at all five remained strong during 2018 despite the apparent reduction of calls at the RSR entrance, figure 6. The Ratty Spring east and west detectors recorded strong but variable activity levels. The eastern site's calls varying from approximately 50 calls per night in September to approximately 350 in November. Conversely, the western detector recorded approximately 750 calls per night in October which then dropped to approximately 150 in late November. At Seven Mile Pool the call count varied between 50 and 250 per night. Lower call counts typically between 10 and 50 calls per night were recorded at the two most distant pools, Kelly's and Western Range Pool 5, figure 6. A single spike to 130 calls was recorded on the 24th November at the latter.

In 2019, the activity levels at the two pools at Ratty Spring were similar to the 2018 levels. However, call levels at both Kelly's Pool and Pirraburdu Creek were very low due to the sites being dry.

Figure 6. Pattern of PLNb calls detected at pool sites in the Paraburdoo district between September and December 2018 and October and November 2019. A three-night running average is also presented.

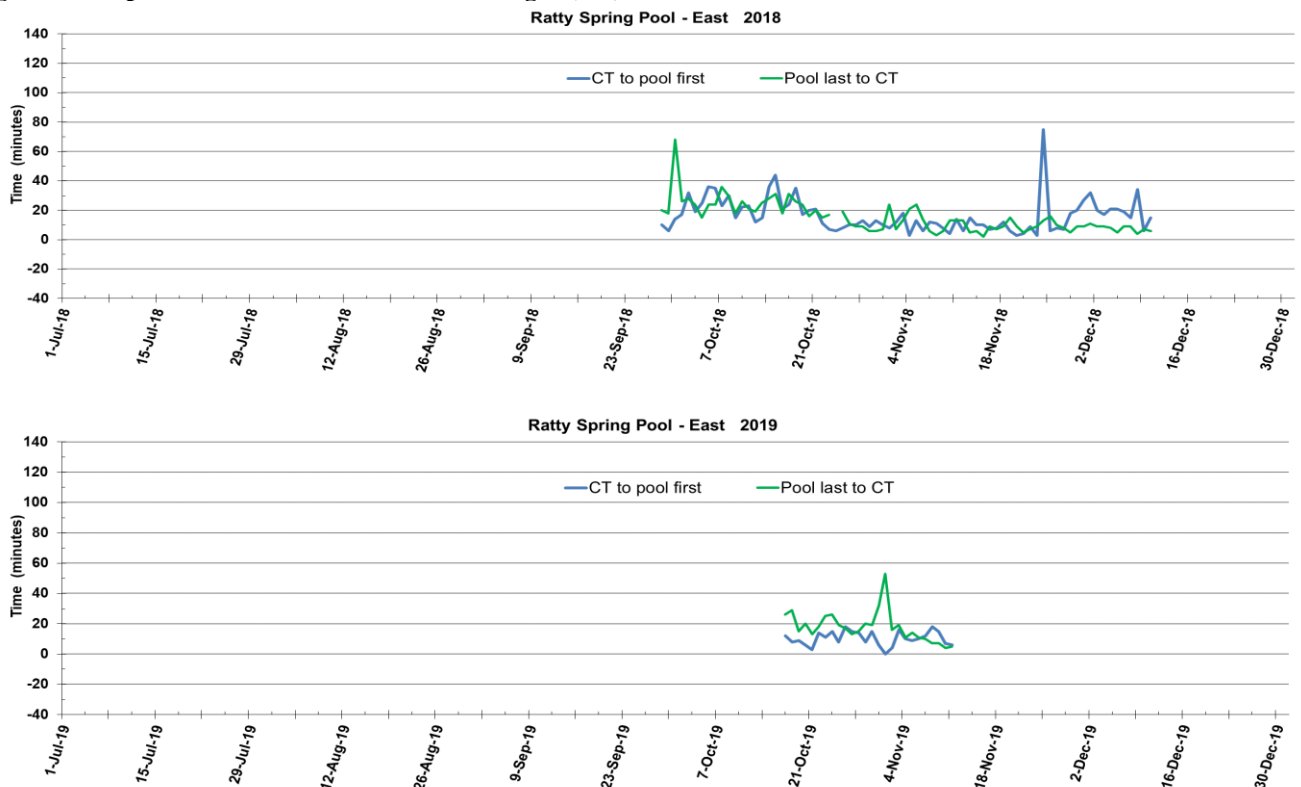


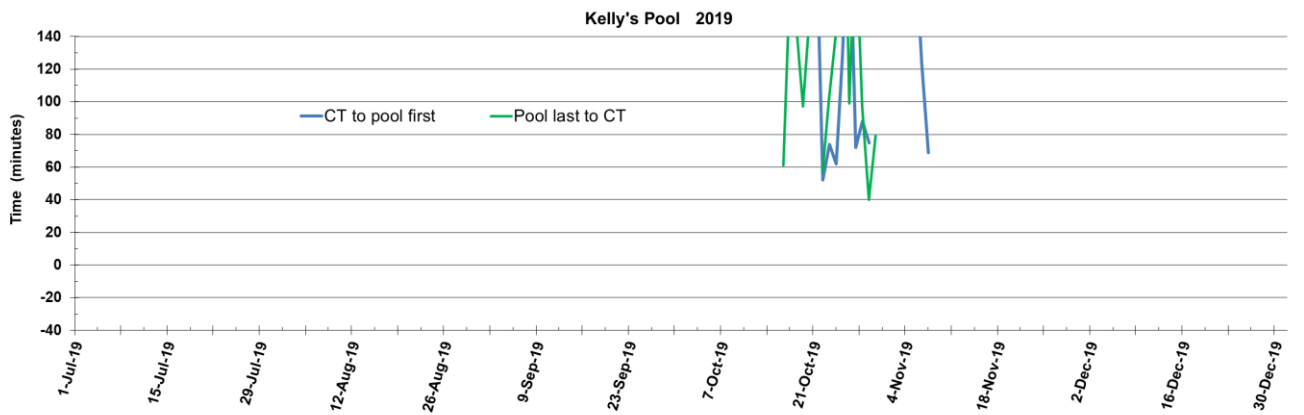
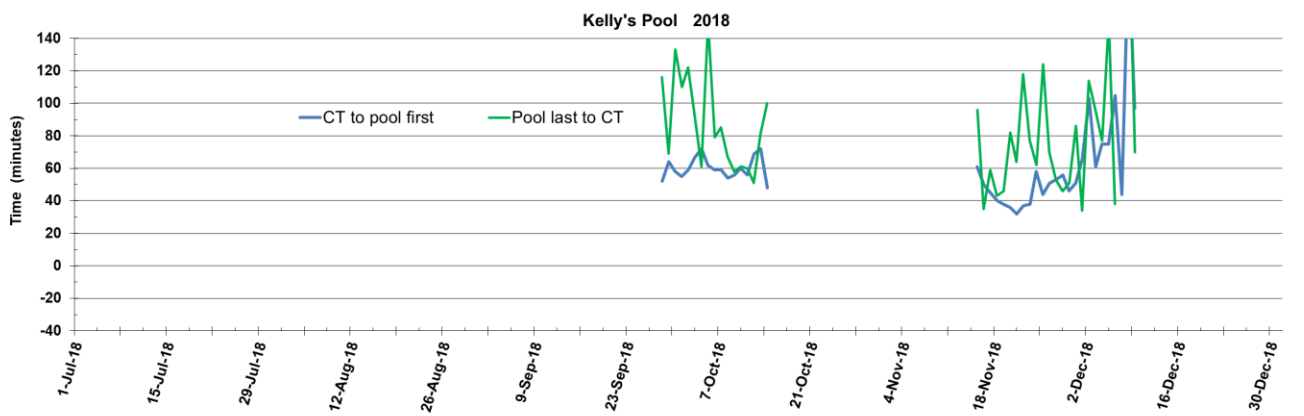
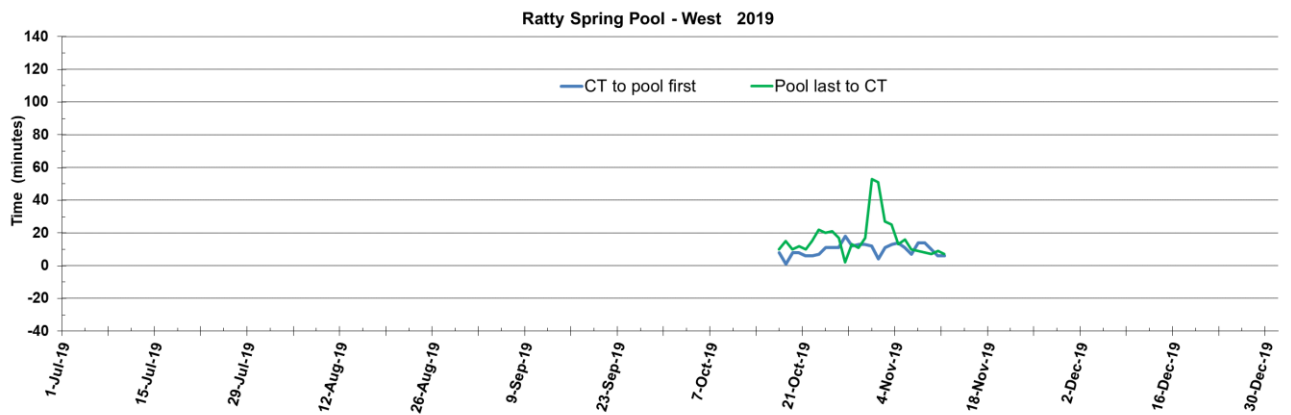
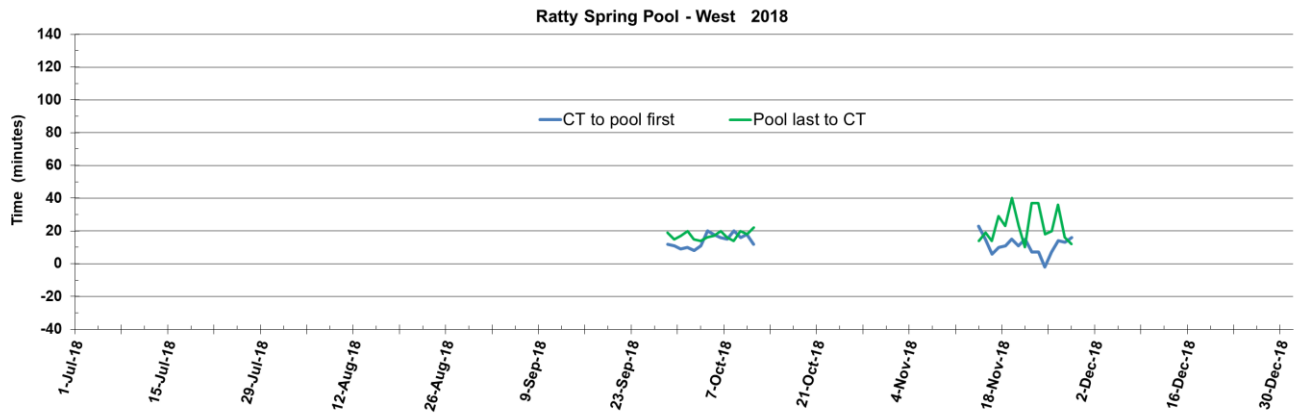


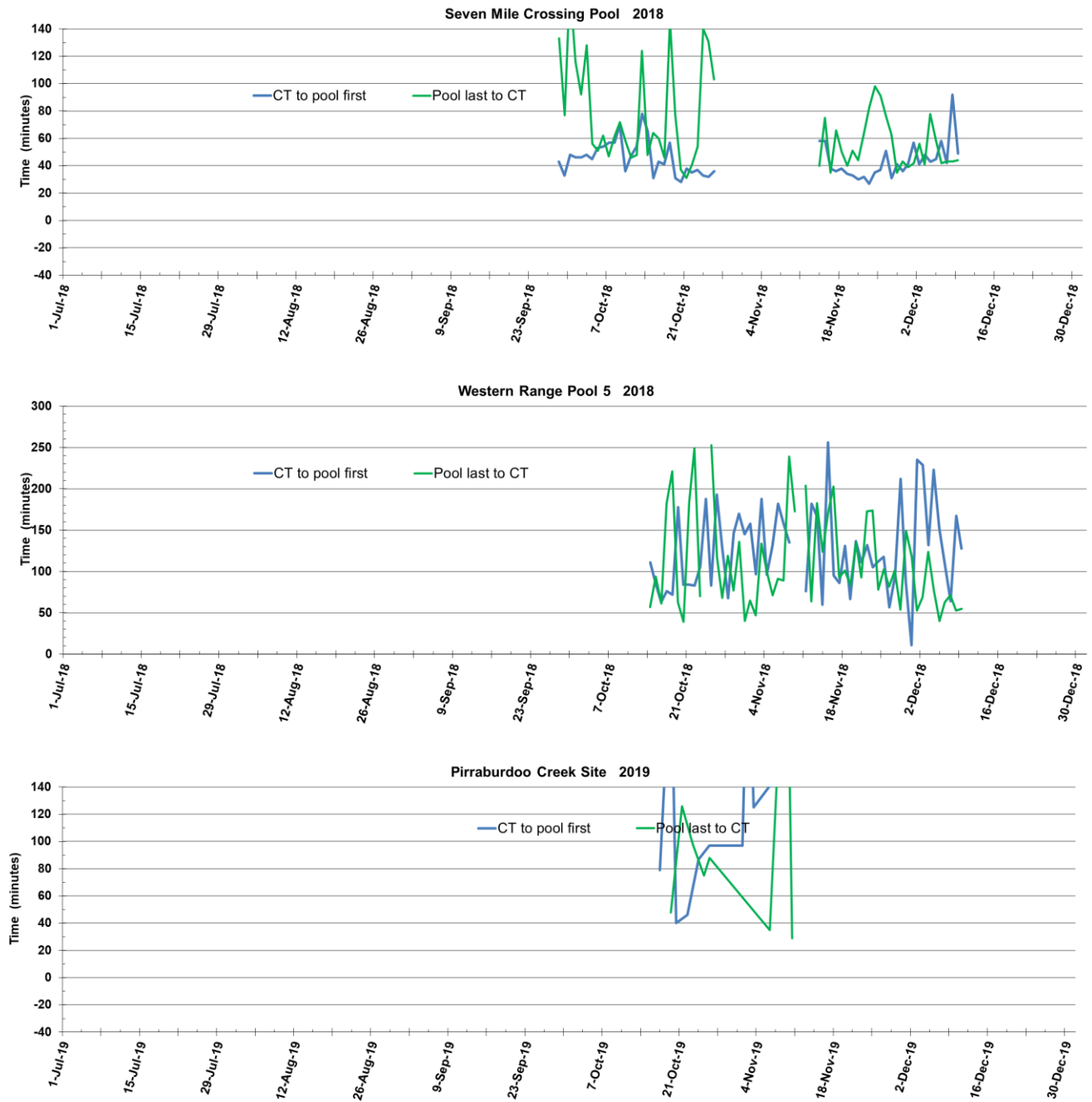


Further evidence of the ongoing health of the colony at RSR is given by the timing of the first and last calls each night at each of the pools. At the two pool sites closest to RSR, approximately 800 m distant, the times showed little variation with the first call typically being detected between 5 and 20 minutes after CT throughout the period, figure 7. The timing differential from CT then increased as the distance from RSR increased with 40 minutes being typical at Seven Mile Creek Pool, 5.5 km distant, and 50 minutes and over being typical at Kelly’s and at Western Range Pool 5, both over 10 km distant.

Figure 7. Trend curves showing the time differential between the first and last PLNb call detected each night at each pool and dusk and dawn civil Twilight (CT)





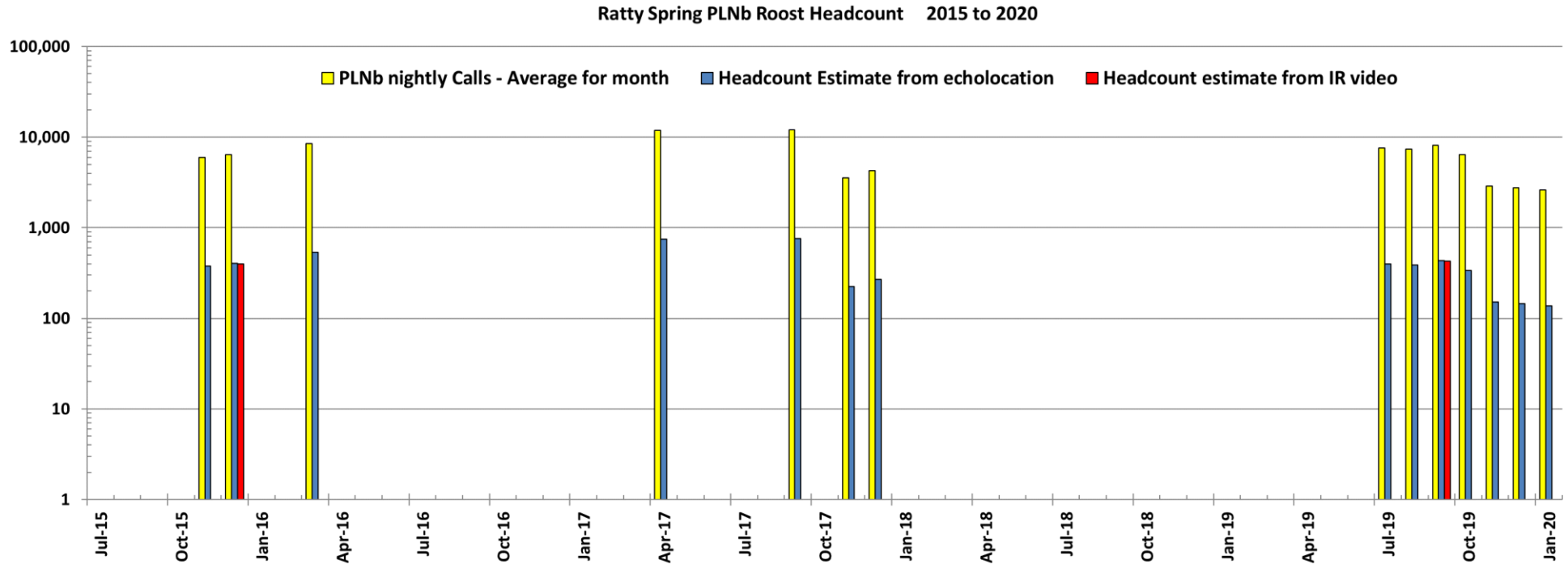


RSR Headcount Estimate.

Monthly estimates of the headcount of PLNb present at RSR have been made from the available echolocation data using the video census' of December 2015 and September 2019 as baselines. These two methods are the direct counting of PLNb leaving the roost using IR lit video, and the calls per file method where the number of call sequences is estimated from the number of files. The call count is then ratioed to give a headcount estimate.

The series of headcount estimates from available data between November 2015 and January 2020 is presented in figure 5. The headcount of ~400 from late 2015 increases progressively to over 900 in the dry season of 2017. The estimate then drops to ~250 by December 2017. The increase in colony size between 2015 and 2017 in two reproductive cycles is above that expected from normal levels of recruitment where increases of under 50% per year would be expected making allowance for wet season reproduction followed by dry season attrition in numbers. This suggests that there was significant immigration into the colony, or more probably, an increase in PLNb circling activity outside the roost entrance during periods of congestion. This increased activity would be detected by the omni microphone but not the directional mic within the entrance. The reduction during the late dry season of 2017 corresponds to the very dry period from March to December 2017 when virtually no rain fell in the district and the withdrawal of the omni microphone. A similar pattern was repeated in 2019. From July to October the headcount was over 400. It then dropped to approximately 200 between November and January 2020.

Figure 8: Estimated PLNb headcount at RSR between November 2015 and January 2020. Results are presented using video census of December 2015 and September 2019 as baselines. Note that the apparent increase in activity from November 2015 to dry season 2017 cannot be explained by recruitment alone and may include a component of immigration from another roost.



RSR Roost Significance.

PLNb have been detected continuously on the nights that recordings are available during the long-term monitoring project that began in November 2015 with the discovery of the roost cave and with increased detail since November 2017 with the establishment of the permanent monitoring station. The number of detections and the temporal pattern of the calls each night at RSR and at the nearby pools are consistent with the cave continuing to be a large permanent diurnal roost for the species throughout this period.

The estimated colony size has fluctuated since 2015 from approximately 400 to a high of over 900 in mid-2017 before dropping to ~200 in early 2020. All fluctuations correspond to natural cycles based on rainfall patterns although the magnitude of the increase between 2015 and 2017 cannot be explained by recruitment alone. This colony size is typical of others discovered in the Pilbara so far.

No impact from Rio Tinto's operations at Paraburdoo is evident in the data during the period.

References

- Bat Call (2015). Rio Tinto, Ratty Spring Pilbara leaf-nosed bat roost census, December 2015. Unpublished report for Rio Tinto, Issue 1.
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