Mt Webber Direct Shipping Ore: EPBC Compliance Report 2021-2022 - Stage 1 and 2

EPBC 2012/6611

13/07/2022

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Authorisation

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1	Annual Report	J. Mtezo	T. Sprenkels	S. Shute	25/07/2022

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1 Background

Atlas Iron Pty Ltd (Atlas Iron) operates the Mt Webber Direct Shipping Ore (DSO) Project (the Project) in the Pilbara region of Western Australia. The Project is located approximately 150 kilometres (km) southeast of Port Hedland.

Due to economic and opportunistic circumstances, the Project has been developed in stages with each assessed and approved individually. Stage 1 comprised the initial development of the mine (Ibanez and Fender pits), crushing infrastructure, contractor area, and permanent camp. Stage 2 comprised the development of the Dalton pit and associated mining infrastructure.

In accordance with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), Atlas submitted a referral to the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC), now the Department of Climate Change, Energy, the Environment and Water (DCCEEW, the Department) on 2 November 2012 to allow a determination of whether Stage 1 of the Project is a controlled action. On 3 December 2012, the DCCEEW advised the proposed action is 'controlled' and required to be assessed by preliminary documentation. Following the submission of additional documentation and public notification of the action, approval for Stage 1 was granted via EPBC 2012/6611 on 18 May 2013.

At the time of reporting, Stages 1 and 2 had progressed substantially with the completion of mining in the Ibanez and continuation of mining in the Dalton and Fender pits.

2 Objective

This report is intended to address Condition 9 of EPBC 2012/6611 whereby:

Within 3 months of every 12-month anniversary of the commencement of the action, the approval holder must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of the management plan as specified in the conditions. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the Department at the same time as the compliance report is published.

3 Scope

This report details the commitments outlined within the EPBC approval document and associated compliance with these commitments for the 1 July 2021 to 30 June 2022 period.

4 Compliance

EPBC 2012/6611		
Condition Number	**Description**	**Compliance Status**
1	Within 10 days after the commencement of the action, the approval holder must advise the Department in writing of the actual date of commencement.	Compliant: Atlas commenced the action on 11 July 2013. The Department were notified on 12 July 2013 (Appendix A).

EPBC 2012/6611		
2	For the purpose of the action, the approval holder must not clear outside of the approved application area as shown in Appendix 1 of this approval. Within the application area the approval holder must not clear more than 756 hectares of native vegetation.	Compliant: No clearing has occurred outside of the approved application area. To date, 315.22 hectares has been cleared.
3	The approval holder must not undertake drilling, blasting or excavation within 100 metres of the lateral extent of cave MW-AN-27.	Compliant: No drilling, blasting, or excavation has occurred within 100 metres of the lateral extent of cave MW-AN-27.
4	The approval holder must implement the Significant Species Management Plan.	Compliant: The Mt Webber Significant Species Management Plan (May 2013) is currently being implemented (Appendix B).

EPBC 2012/6611		
5	The approval holder must submit to the Minister for approval an Artificial Roost Research Plan for the Pilbara Leaf-nosed Bat. The plan must include: a) Provision for the construction of four artificial roosts; b) A summary of the research utilised to identify the required conditions and micro climate for suitable roosts for the species. This must include quantification of atmospheric conditions in cave MW-AN-27 and confirmation of its size and extent and whether it's a diurnal roost; c) The design details for the trial artificial roosts and how they will successfully recreate suitable micro climate for the Pilbara Leaf-nosed Bat; d) Discussion of alternative designs including a comparison of cost, longevity and justification for the preferred choice of design; e) A program to monitor the utilisation of the artificial roosts, including number of bats using the roost, timing of use (daily and seasonal), and how roost is used; and f) A requirement for an evaluation report to be prepared and made publically available on outcomes of the trial. The Artificial Roost Research Plan must be submitted to the Minister within 3 months of commencement of the action. The approved plan must be implemented.	Atlas submitted the Artificial Roost Research Plan (ARRP) for the Pilbara Leaf-nosed Bat to the Department on 11 October 2013. The Department provided comments on the plan to Atlas on 3 January 2014. Atlas submitted a response to the Department on 30 April 2014, with comments received from the Department to Atlas on 6 August 2014. After this time, the plan was in various stages of revision and review by MWH Pty Ltd (now Stantec Australia), with a final version provided to the Department on 3 August 2015. The final plan was approved on 3 February 2016 (Appendix C) and is being implemented accordingly. Atlas submitted quarterly ARRP progress report No. 1 to the Department on 19 March 2018 noting finalisation of artificial roost design, procurement of required materials to construct two roosts, and mobilisation of materials to site. Subsequent quarterly reports have been submitted to the Department, with the final ARRP progress report No. 6 being submitted on 28 June 2019 noting the completed construction of two additional artificial roosts within the Ibanez stage four backfill. The Draft Artificial Roost Monitoring Reports were submitted to the Department on 31 December 2019, 24 May 2020 and January 2022.

EPBC 2012/6611		
6	The approval holder must submit to the Minister a Regional Survey Plan for the Pilbara Leaf-nosed Bat to enable a better understanding of the habitat use and requirements for the species. The plan must include the aim, methodology and rationale for the survey, with a particular focus on: a) Location of roost sites and usage (transitory, day, colony and/or breeding roost) within 20km radius of the proposed action; b) The environmental attributes that influence roost selection and fidelity; c) The extent of movement between roosts; d) Foraging range for the species; e) Environmental attributes of foraging habitats; and f) Foraging energetics. The Regional Survey Plan must be submitted to the Minister within 3 months of the commencement of the action. The approved plan must be implemented.	Compliant: Atlas submitted the Regional Survey Plan for the Pilbara Leaf-nosed Bat to the Department on 11 October 2013. The Department provided comments on the plan to Atlas on 3 January 2014. Atlas submitted a response to the Department on 30 April 2014, with comments received from the Department to Atlas on 6 August 2014. After this time, the plan was in various stages of revision and review by MWH Pty Ltd (now Stantec Australia), with a final version provided to the Department on 3 August 2015. The final plan was approved on 3 February 2016 (Appendix C) and is being implemented accordingly. MWH Pty Ltd (now Stantec Australia) completed the regional Pilbara Leaf-nosed Bat survey in July 2016.
7	The approval holder must make a direct financial contribution of $70,000 (AUD) into an established fund administered by the WA DEC to implement actions for the management of those weeds identified as posing a risk to EPBC Act listed threatened species of the Chichester subregion of the Pilbara. Documentary evidence must be provided within 3 months of commencement showing that payment of $70,000 (AUD) to the established fund occurred.	Compliant: Atlas paid $70,000 (AUD) to the DEC (now Department of Biodiversity, Conservation and Attractions) on 20 September 2013 for the management of weeds. The Department was notified of the payment and provided with a receipt on 11 October 2013 (Appendix D).

EPBC 2012/6611		
8	The approval holder must maintain accurate records to substantiate all activities associated with or relevant to the conditions of approval, including measures taken to implement the plans, and make them available upon request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with Section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the Department's website. The results of audits may also be published through the general media.	Compliant: Records of activities associated with or relevant to the conditions of approval are currently being maintained.
9	Within three months of every 12 month anniversary of the commencement of the action, the approval holder must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of the plans specified in the conditions. Documentary evidence providing proof of the date of publication and non-compliance with any conditions of this approval must be provided to the Department at the same time as the compliance report is published.	Noted: This compliance report shall be published and made available on Atlas' website (Appendix E).
10	If the approval holder wishes to carry out any activity otherwise than in accordance with the plans specified then the person undertaking the action must submit to the Department for the Minister's written approval a revised version of that plan. The varied activity shall not commence until the Minister has approved the varied plan in writing. The Minister will not approve the varied plan unless the revised plan would result in an equivalent or improved environmental outcome over time. If the Minister approves the revised plan, that plan must be implemented in place of the plan originally approved.	Compliant: All activities being carried out are in accordance with the approved management plan.

EPBC 2012/6611		
11	If the Minister believes that it is necessary or convenient for the better protection of listed threatened species and ecological communities to do so, the Minister may request that the approval holder make specified revisions to the plans specified in the conditions and submit the revised plan within a specified timeframe for the Minister's written approval. The approval holder must comply with any such request. The revised approved plan must be implemented. Unless the Minister has approved the revised plan, then the approval holder must continue to implement the plan originally approved, as specified in the conditions.	Compliant: No specified revisions of the approved plans have been requested to date.
12	If at any time after five years from the date of this approval, the approval holder has not substantially commenced the action, then the approval holder must not substantially commence the action without written agreement.	Compliant: The action has been substantially commenced.
13	Unless otherwise agreed in writing by the Minister, the approval holder must publish the plans referred to in these conditions of approval on their website. Each plan must be published on the website within 1 month of being approved.	Compliant: The Mt Webber Significant Species Management Plan (May 2013), Artificial Roost Research Plan (July 2015), and Regional Survey Plan (July 2015) have been published on the Atlas Iron website (Appendix E).

Appendix A. Notification of commencement of action

12 July 2013

Pablo Shopen
Pilbara Taskforce
Department of Sustainability, Environment, Water, Population and Communities
GPO Box 787
CANBERRA 2601

Dear Mr Shopen,

RE: Atlas Iron Limited Mt Webber Direct Shipping Ore Project (2012/6611) commencement

As specified in condition 1 of the approval decision for the Mt Webber Direct Shipping Ore Project (2012/6611), I am writing to advise you that on Thursday 11 July 2013, ground disturbance for the Mt Webber project commenced.

Please do not hesitate to contact me on (08) 6228 8284 if you require additional information or have any questions.

Yours sincerely

Michael Rovira
Senior Environmental Advisor
Atlas Iron Limited

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Appendix B. Mt Webber DSO Significant Species Management Plan

SIGNIFICANT SPECIES MANAGEMENT PLAN

Mt Webber DSO Project

May 2013

3292AC_04_SSMP_v4

Appendix C. Approval of Artificial Roost Research Plan and Regional Survey Plan

Australian Government
Department of the Environment

Our reference: 2012/6611

Ms Esme Wink
Senior Environmental Advisor – Compliance
Atlas Iron Limiter
Level 18, 300 Murray Street
PERTH WA 6000

Dear Ms Wink

Mt Webber Direct Shipping Ore Project, 150 km south of Port Hedland, Pilbara WA (EPBC 2012/6611)

Thank you for your email dated 3 August 2015 to the Department, seeking approval of the Artificial Roost Research Plan for the Pilbara Leaf-nosed Bat (July 2015) and the Regional Survey Plan for the Pilbara Leaf-nosed Bat (June 2015), in accordance with conditions 5 and 6 of the approval decision dated 18 May 2013.

Officers of this Department have considered the Artificial Roost Research Plan for the Pilbara Leaf-nosed Bat (July 2015) and the Regional Survey Plan for the Pilbara Leaf-nosed Bat (June 2015) and are satisfied that they meet the requirements of conditions 5 and 6 of the approval for this project. On this basis, and as a delegate of the Minister for the Environment, I have decided to approve the Artificial Roost Research Plan for the Pilbara Leaf-nosed Bat (July 2015) and the Regional Survey Plan for the Pilbara Leaf-nosed Bat (June 2015). These plans must now be implemented.

In accordance with EPBC 2012/6611 condition 10, if the approval holder wants to act other than in accordance with this approved plan, the approval holder must submit a revised plan for approval. Until the Minister (or his delegate) has approved the revised plan, the approved version of the plan must continue to be implemented.

Should you require any further information please contact Matthew Plunkett, Project Officer, Post Approvals Section, on 02 6275 9453 or by email: post.approvals@environment.gov.au.

Yours sincerely

S. Gaddes

Shane Gaddes
Assistant Secretary
Compliance & Enforcement Branch
Environment Standards Division

3/2/2016

Appendix D. Payment of AUD 70 000 to DBCA (Weed Management)

Department of
Parks and Wildlife

TAX INVOICE
ABN: 38 052 249 024

Date 11-SEP-13
Page 1 of 1

Number 1885

Customer 38475
Site 85429

Enquiries To : KATHY SALONGA
Phone Number (08) 9405 5198

Attn: Accounts Payable
ATLAS IRON LIMITED
PO BOX 7071
CLOISTERS SQUARE PO
PERTH WA 6850

Terms 30 NET
Salesrep
Due Date 11-OCT-13

Item	Description	Qty Ordered	Unit Price	Amount
1	Mt Webber Direct Shipping Ore Project (EPBC 2012/6611) Offset: Condition 7 - Contribution to Weed Management in Chichester Subregion	1	70,000.00	70,000.00

Special Instructions

Item Amount	GST	Freight	Total
70,000.00	7,000.00	0.00	77,000.00

Currency: AUD

Department of
Parks and Wildlife

ABN: 38 052 249 024

Remittance Advice

PLEASE DETACH AND RETURN WITH YOUR PAYMENT

Remittance Advice to be faxed to:
Senior Finance Officer
Fax (08) 9219 8896
Email: revenue@dpaw.wa.gov.au

Pay By Direct Deposit:
BSB 066-040
A/C No 11300006
Account Name: Department of Parks and Wildlife
Reference: 38475 / 1885

Pay By Cheque:
Make cheque payable to: Department of Parks and Wildlife
Mail to: Department of Parks and Wildlife
Locked Bag 104, Bentley Delivery Centre WA 6983

Customer Number	Invoice Number	Invoice Date	Invoice Total
38475	1885	11-SEP-13	77,000.00

DEC 738A

DEPT OF ENVIRONMENT AND CONSERVATION

ABN 38 052 249 024

POSTAL ADDRESS: LOCKED BAG 104, BENTLEY DELIVERY CENTRE
BENTLEY 6983
TELEPHONE: (08) 9334 0555

CUSTOMER No.

20 SEP 2013

38425 981

ATLAS IRON LIMITED

OFFICIAL RECEIPT

NOT VALID UNLESS PAYMENT IS RECEIPTED BY CASH REGISTER

DATE	REF.	DETAILS	BALANCE
		1885	77000.00

INPUT
at
HEAD OFFICE
Date :- 24 SEP 2013
Operator

GST

TICK BOX IF RECEIPT REQUIRED

TOTAL INCLUDES GST 77000.00

DEPT OF ENVIRONMENT AND CONSERVATION
17 DICK PERRY AVE, KENSINGTON WA 6151

Appendix E. Proof of publication of compliance report and management plans

Mt Webber Direct Shipping Ore Project

MT WEBBER ARTIFICIAL ROOST RESEARCH PLAN	DOWNLOAD
MT WEBBER REGIONAL SURVEY PLAN	DOWNLOAD
MT WEBBER SIGNIFICANT SPECIES MANAGEMENT PLAN	DOWNLOAD
MT WEBBER COMPLIANCE REPORT 2017 (EPBC2012/6611)	DOWNLOAD
MT WEBBER COMPLIANCE REPORT 2018 (EPBC2012/6611)	DOWNLOAD
MT WEBBER COMPLIANCE REPORT 2019 (EPBC2012/6611)	DOWNLOAD
MT WEBBER COMPLIANCE REPORT 2020 (EPBC 2012/6611)	DOWNLOAD
MT WEBBER COMPLIANCE REPORT 2021 (EPBC 2012/6611)	DOWNLOAD
MT WEBBER COMPLIANCE REPORT 2022 (EPBC 2012/6611)	DOWNLOAD

Appendix F. Mt Webber Artificial Bat Roost Monitoring Year 3: 2020-2021

Mt Webber Artificial Bat Roost Monitoring

Interim Year 3: October 2020 to March 2021

Biologic Environmental Survey

Report to Atlas Iron Pty Ltd

January 2022

Document Status				
Revision No.	Author	Review / Approved for Issue	Approved for Issue to	
			Name	Date
1	A. Jenkins	C. Knuckey	T. Sprenkels	30/06/2021
2	A. Jenkins	C. Knuckey	T. Sprenkels	12/01/2022

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In preparing this report we have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request or enquiry were complete, accurate and up-to-date. Where we have obtained information from a government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware of any reason why any of the assumptions are incorrect.

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EXECUTIVE SUMMARY

Atlas Iron Pty Ltd (Atlas Iron) constructed four artificial bat roosts within waste rock dumps at their Mt Webber Direct Shipping Ore Project (the Project), located approximately 170 kilometres (km) south of Port Hedland in the Pilbara region of Western Australia (WA). The four artificial roosts were constructed to meet Condition 5 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Approval Decision 2012/6611 for the Project. Specifications and key performance objectives for the roost were originally developed in the *Mt Webber Project: Artificial Roost Research Plan for the Pilbara leaf-nosed bat* (ARRP) and later revised by Bat Call (2018). The overall aim of the ARRP was to create four artificial roosts at Mt Webber to compensate for the removal of 17 nocturnal refuges utilised by the Pilbara leaf-nosed bat (*Rhinonicteris aurantia* Pilbara form). This experimental and adaptive management approach was developed to determine the feasibility of constructing artificial roost habitat as a viable management tool for the species, specifically within a post closure environment.

The first two roosts (MW-AR-01 and MW-AR-02) were installed in July 2018 within the Ibanez waste-rock landform. The second two roosts (MW-AR-03 and MW-AR-04) were installed within an area of backfill within the Ibanez pit in June 2019. All roosts are located approximately 3 km from the nearest permanent diurnal roost, MW-AN-27.

Biologic Environmental Survey (Biologic) was commissioned by Atlas Iron to undertake continuous monitoring of the four artificial roosts. The overarching objective of the monitoring was to identify and track the adoption of each artificial roost as a nocturnal refuge, particularly for the Pilbara leaf-nosed bat, in accordance with the ARRP and Bat Call (2018). Specifically, the report documents:

- when and by which bat species each roost was visited; and
- if the structures were being used by the Pilbara leaf-nosed bat and the extent to which the species were using the structures (night visitation, diurnal roosting etc.).

Microclimate data loggers were used to monitor temperature and relative humidity (RH) at all four artificial roosts as well as at two nocturnal refuges (MW-AN-17 and MW-AN-25) and one diurnal roost (MW-AN-27) known to occur in the area. The microclimate loggers were deployed from the 19th September 2020 to the 8th March 2021. Echolocation calls, recorded by SongMeter SM4BAT ultrasonic recorders (SongMeters), were used to record bat activity at the four artificial roosts as well as MW-AN-27 from 19th September 2019 to 8th March 2020. A SongMeter was placed internally throughout the monitoring period at MW-AR-01, MW-AR-02, MW-AR-03 and MW-AR-04. A total of 170 nights was recorded at MW-AR-01, MW-AR-02, MW-AR-03 and MW-AN-27. At MW-AR-04 142 nights were recorded. Due to technical difficulties with the recording devices, there was a gap in the data recorded at MW-AR-04

Microclimate

Temperatures inside MW-AR-01, MW-AR-02, MW-AR-03 and MW-AR-04 remained relatively stable and within the target range stipulated by the key performance indicator (i.e. 25–32°C) for most of the monitoring period (84.6%, 100%, 72.8% and 77.9%, respectively). The temperatures recorded inside the reference nocturnal refuges MW-AN-17 and MW-AN-25 were within the target range for 64% and

18.1%, respectively. MW-AN-27 was within the temperature range of a diurnal roost (28-32ºC) for 73.8% of the monitoring period.

Relative humidity within the roosts was highly variable and within the target range stipulated by the key performance indicator (i.e. 25–100%) for approximately 83.3% at MW-AR-01, 86.1% at MW-AR-02, 79.1% at MW-AR-03 and 85.0% at MW-AR-04 of the monitoring period. Relative humidity in the naturally occurring roosts also fluctuated, whereby MW-AN-17 and MW-AN-25 were within the target range of 60-100% for 75.3% and 94.9% of the monitoring period respectively. MW-AN-27 was within the target RH of a diurnal roost (85%-100%) for 6% of the monitoring period only, together with the temperature results, suggesting that the logger was not in the most representative location.

Roost Utilisation

No Pilbara leaf-nosed bats were detected on the internal recorders at the artificial roosts. Common bat species were recorded sporadically at MW-AR-03, however, they are likely to be foraging individuals outside the artificial roost. Pilbara leaf-nosed bat was detected in high numbers on all nights at MW-AN-27. Diurnal roosting was indicated for all nights during the monitoring period at MW-AN-27.

Conclusions

During the current monitoring period, Pilbara leaf-nosed bat was not recorded entering any of the four artificial roosts. The microclimate within the four artificial roosts was partially suitable for use as a nocturnal refuge, though temperature at MW-AR-02 was within the target range for 100% of the monitoring period. However, the artificial roosts are unable to maintain both the temperature and RH throughout the monitoring period under the current circumstances. Implementation of recommended roost alterations may increase the potential for a stable artificial roost microclimate and utilisation by Pilbara leaf-nosed bats. As such, none of the artificial roost, currently meet the criteria of a nocturnal refuge, as defined by Bat Call (2018). It is however important to recognise that it remains uncertain whether the criteria defined by Bat Call (2018) adequately represents conditions of a nocturnal refuge. Microclimate data obtained from other caves in the area (MW-AN-17 and MW-AN-25) would suggest that variation beyond the criteria occurs naturally.

Preliminary assessment of monitoring data against key performance indicators detailed in the ARRP, or subsequent revisions, indicated most key performance indicators are either being met or are on a positive trajectory towards being achieved.

1 INTRODUCTION

1.1 Project Background

Atlas Iron Pty Ltd (Atlas Iron) have developed the Mt Webber Direct Shipping Ore Project (the Project), located approximately 170 kilometres (km) south of Port Hedland, in the Pilbara region of Western Australia (WA) (Figure 1.1). In order to meet Condition 5 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Approval Decision 2012/6611 for the Project, Atlas Iron was required to develop and implement the *Mt Webber Project: Artificial Roost Research Plan for the Pilbara leaf-nosed bat (*ARRP*)* (MWH, 2015b). The overall aim of the ARRP was to create four artificial roosts at Mt Webber to compensate for the removal of 17 nocturnal refuges utilised by the Pilbara leaf-nosed bat (*Rhinonicteris aurantia* Pilbara form). The ARRP stipulates Atlas Iron must design and install four artificial roosts and, once the species' presence has been established within the roosts, bi-annual (six monthly) monitoring be undertaken over a period of five years.

This experimental and adaptive management approach was developed to determine the feasibility of constructing artificial roost habitat as a viable management tool for the species, specifically within a post closure landform. Exclusive to this project, the development of suitable artificial roosts has been highlighted as a research priority to assist in offsetting impacts to naturally occurring roosts of threatened bat species, including the Pilbara leaf-nosed bat (*Rhinonicteris aurantia* Pilbara form) and ghost bat (*Macroderma gigas*) (Cramer *et al.*, 2016) . It has been recommended that artificial roosts be constructed in areas of suitable substrate that permit regular monitoring of microclimates, bat utilisation and bat populations (Cramer *et al.*, 2016).

Accordingly, four artificial roosts have been installed at Mt Webber between 2018 and 2019 as detailed in Table 1.1 and illustrated in Figure 1.1.

Table 1.1: Artificial roost locations

Artificial Roost	MW-AR-01	MW-AR-02	MW-AR-03	MW-AR-04
Installation Date	July 2018	July 2018	June 2019	June 2019
Location	Ibanez waste rock landform	Ibanez waste rock landform	Ibanez pit within area backfill	Ibanez pit within area backfill
Latitude and Longitude	-21.5377, 119.2849	-21.5386, 119.2846	-21.5354, 119.2936	-21.5379, 119.2919
Distance from MW-AN-27	~3.6 km	~3.6 km	~2.75km	~3.05km

*Note: MW-AN-27 is a natural Pilbara leaf-nosed roost.

Each roost comprises a large main chamber approximately 4.8 metres (m) in length by 2.4 m in height and width, with a single passage tunnel approximately 1.5 m in diameter and 8 m in length with a 90-degree elbow half-way along its length. The main chambers were constructed from solid concrete pillars originally designed and used as culverts for rail water crossings, and the entrance tunnel from cylindrical corrugated metal sheeting also used for culverts. Stainless steel chicken wire was applied to the internal upper surface of the main chamber at MW-AR-01, MW-AR-02 and MW-AR-03 to provide a surface to which bats can

attach. At MW-AR-04, purpose-built tiles designed from the roof of natural caves, were utilised to provide attachment points. A metal gate covering the roost's entrance tunnel was designed to prohibit entry by other animals, including the ghost bat which are known to prey on Pilbara leaf-nosed bats (Churchill, 1994). The entire roost structures were buried at a depth of approximately 3 m within a waste rock dump. Internal access to the main chambers is facilitated by a vertical monitoring conduit accessible from above the roost.

1.1 Survey Scope and Objectives

To evaluate the effectiveness of the artificial roosts and inform future management measures for the species, both at the Project and more broadly across the species' distribution, continuous monitoring with bi-annual reporting of the roosts is required in accordance with the ARRP. The ARRP prescribed five performance objectives which would need to be met for the artificial roosts to be deemed successful. To meet these performance objectives, key performance indicators (KPI) have been determined to assess success against each performance objective. The AARP performance objectives (MWH, 2015b) were based on documented performance indicators for a diurnal/maternal roost and included a range of features not applicable, or not applicable at the stated levels for a nocturnal refuge, which is the desired outcome of the artificial roosts. Bat Call (2018) provided an update to the artificial roost specifications and indicators applicable to a nocturnal refuge based on information acquired after development of the ARRP; such specifications are applied herein. The performance objectives, corresponding key performance indicators and their justification as detailed in the ARRP and revised by Bat Call (2018) are detailed in Table 1.2.

Biologic Environmental Survey (Biologic) was commissioned by Atlas Iron to undertake monitoring of the four artificial roosts to determine if the structures were being utilised by Pilbara leaf-nosed bats or any other bat species. This is the third interim monitoring report for the project from September 2020 to March 2021. For all information between the artificial roost installation date to October 2019 refer to Mt Webber artificial bat roost monitoring Year 1: October 2018 to October 2019 (Biologic, 2020b) and October 2019 to October 2021 refer to Mt Webber artificial bat roost monitoring Year 2: October 2019 to October 2020 (Biologic, 2021a). The overarching objective of the monitoring was to identify and track the adoption of each artificial roost as a nocturnal refuge, particularly for the Pilbara leaf-nosed bat in accordance with the ARRP and Bat Call (2018). Specifically, the report documents:

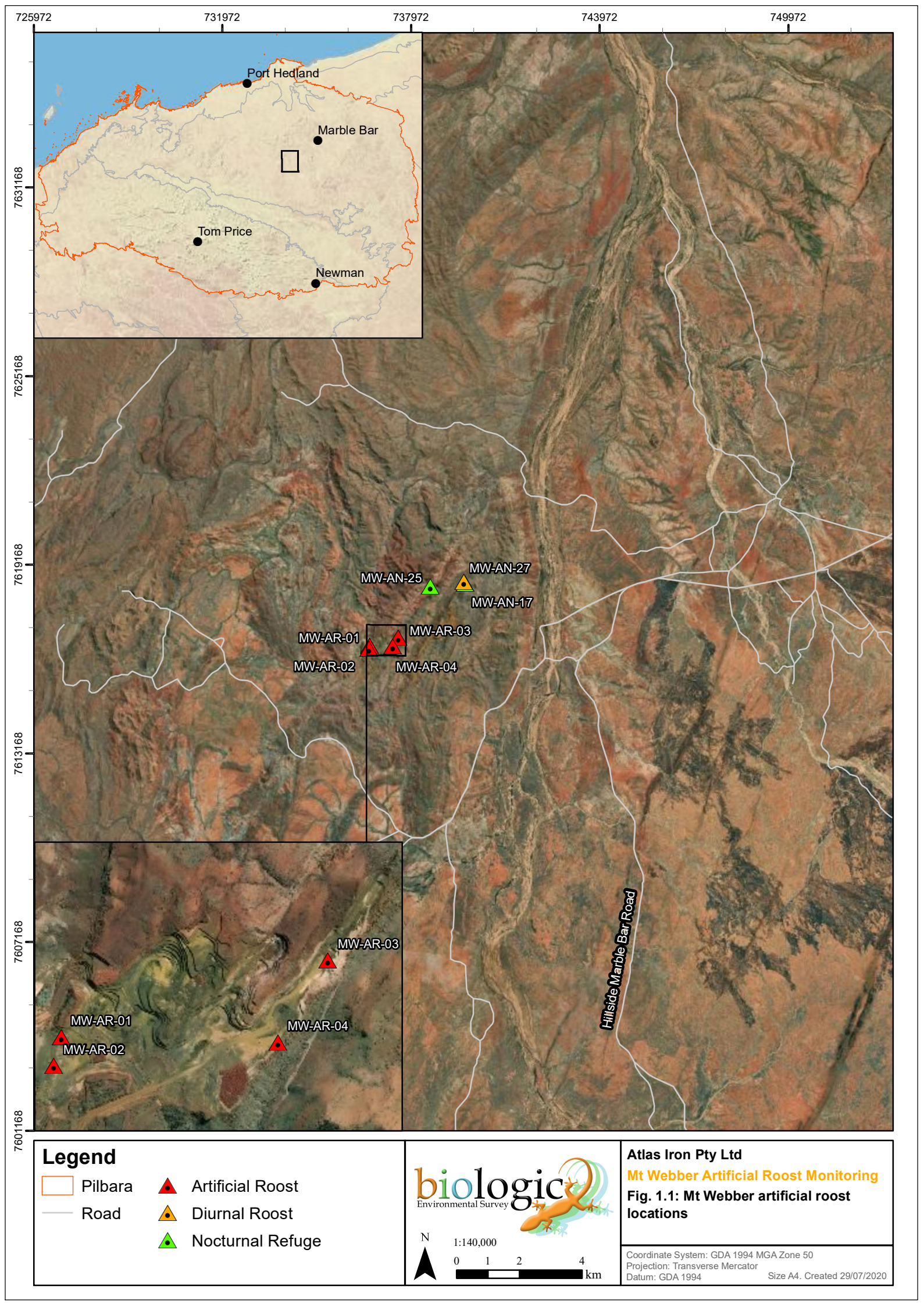
- when and by which bat species each roost was visited; and
- if the structures were being used by the Pilbara leaf-nosed bat, and the extent to which the species is using the structures (night visitation, diurnal roosting etc.).

Table 1.2: Key performance objectives for the evaluation of artificial roost success[1]

Performance objective	Key performance indicator (for diurnal/breeding roost)	Justification	Revised KPI for nocturnal refuge (following Bat Call (2018))
Design artificial roosts	Completed design for artificial roosts for Pilbara leaf-nosed bat complete with technical specifications (i.e. materials, dimensions, location, in cooperation with bat specialists and engineers)	The design component, which should be based on sound ecological and engineering knowledge, is critical to the success of the trial and ensuring the effectiveness of the artificial roosts.	No change
Construct four artificial roosts	Four roosts constructed according to design specifications	It is important to ensure that the roosts constructed are faithful to the original design specifications.	No change
Create and maintain a microclimate deemed suitable for supporting Pilbara leaf-nosed bat within the artificial roosts	Microclimate at different seasons characterised by: • temperature of 28–32°C • RH of 85–100%	These microclimatic attributes are deemed necessary in supporting populations of Pilbara leaf-nosed bat within roost caves.	Microclimate for nocturnal refuge characterised as: • temperature of 25–32°C • RH of 25–60%
Pilbara leaf-nosed bat utilising artificial roosts	Presence of Pilbara leaf-nosed bat detected at the entrance or within the chambers of the artificial roosts (i.e. pattern of activity indicating transitory visitation or greater)	Nocturnal refuges removed by the Project represented important habitat for the species and it is the intent of the trial to determine whether this habitat can be recreated and equivalent usage by the species restored.	No change
PLNB colonising artificial roost(s)	Status of roost(s) established as diurnal roost (i.e. bats residing within main chamber during daytime hours and exhibiting an activity profile of exiting at dusk and entering prior to dawn)	This objective represents an aspirational goal for the roosts; should this objective be satisfied, the trial would have resulted in a net positive gain for PLNB in the local area.	No change (Note this is an additional aspirational target and does not affect the success of the ARRP).

[1]Terminology describing the types of underground habitat used by Pilbara leaf-nosed bats has been aligned with (TSSC, 2016). Consequently, 'maternal roosts' are here referred to as 'breeding roosts', and 'nocturnal refuges/transitory roosts' are here referred to as 'nocturnal refuges'..

[2] Relative humidity has been interpreted as 25-100%, as a higher RH is likely to be preferred by the species (Baudinette *et al.*, 2000).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7619168
7613168
7607168
7601168
Port Hedland
Marble Bar
Tom Price
Newman
MW-AN-25
MW-AN-27
MW-AN-17
MW-AR-01
MW-AR-03
MW-AR-02
MW-AR-04
Hillside Marble Bar Road
Legend
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Diurnal Roost
Nocturnal Refuge
biologic
Environmental Survey
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1:140,000
0 1 2 4
km
Atlas Iron Pty Ltd
Mt Webber Artificial Roost Monitoring
Fig. 1.1: Mt Webber artificial roost locations
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994
Size A4. Created 29/07/2020

2 SPECIES OF INTEREST

Seventeen species of microbat occur within the Pilbara bioregion (McKenzie & Bullen, 2009; van Dyck & Strahan, 2008), of which five are obligate cave roosting bat species that are expected to make use of an artificial bat roost structure. These include two species listed as Vulnerable under the federal EPBC Act and WA *Biodiversity Conservation Act 2016* (BC Act); Pilbara leaf-nosed bat and ghost bat. Both species of conservation significance, the Pilbara leaf-nosed bat and ghost bat, are endemic to northern Australia and have historically been recorded roosting in the vicinity of the artificial roosts (MWH, 2015a, 2015b, 2016; Stantec, 2017). The three remaining species are the common sheath-tailed bat (*Taphozous georgianus*), Hill's sheath-tailed bat (*Taphozous hilli*) and Finlayson's cave bat (*Vespadelus finlaysoni*).

2.1 Pilbara leaf-nosed bat (*Rhinonicteris aurantia* Pilbara form)

The Pilbara leaf-nosed bat is listed as Vulnerable under the EPBC Act and the BC Act. The Pilbara leaf-nosed bat is recognised as a geographically isolated population of the orange leaf-nosed bat, distributed across northern Australia and separated from the Pilbara populations by approximately 400 km of the Great Sandy Desert (Armstrong, 2001). The Pilbara population is regarded as representing a single interbreeding population comprising multiple colonies (TSSC, 2016). The most updated conservation advice (TSSC, 2016) stated that there were at least 10 confirmed day roosts (including maternity roosts) and a further 23 unconfirmed roosts throughout the Pilbara region, although this is likely to be an underestimate based on unpublished data.

Pilbara leaf-nosed bats typically roost in undisturbed caves, deep fissures or abandoned mine shafts (Armstrong, 2000, 2001). The species' limited ability to conserve heat and water (Baudinette *et al.*, 2000) means they require warm (28-32ºC) and very humid (85-100%) roost sites to persist in arid and semi-arid climates (Armstrong, 2001; Churchill, 1991). Roost sites with such attributes are relatively uncommon in the Pilbara and the limiting factor of the species' distribution (Armstrong, 2001). During the dry season (June to November), individuals are believed to aggregate in roosts that provide a suitably warm, humid microclimate (Armstrong, 2000, 2001; Bullen & McKenzie, 2011). While in the wet season (December to May), when conditions are generally wetter and more humid, individuals typically disperse roosting in seasonally suitable features (Armstrong, 2000, 2001; Bullen & McKenzie, 2011). TSSC (2016) categorised underground refuges used by the species into four categories:

- **Permanent Diurnal Roosts** (Priority 1 – critical habitat for daily survival): are occupied year-round and are likely to be the focus for some part of the 9-month breeding cycle.
- **Non-Permanent Breeding Roosts** (Priority 2 - critical habitat for daily and long-term survival): are used during some part of the 9-month breeding cycle but not year-round.
- **Transitory Diurnal Roosts** (Priority 3 – critical habitat for daily and long-term survival): are occupied outside the breeding season and could facilitate long distance dispersal.
- **Nocturnal Refuge** (Priority 4 – not considered critical but important for persistence in a local area): are occupied or entered at night for resting, feeding or other purposes (excluding overhangs).

The species forages within and in the vicinity of roost caves and more broadly along waterbodies with suitable fringing vegetation supporting prey species (TSSC, 2016). Foraging sites surrounding known or

suspected roosts can be critical to the survival of the species. TSSC (2016) categorised foraging habitat into five categories: gorges with pools (Priority 1); gullies (Priority 2); rocky outcrops (Priority 3); major watercourses (Priority 4); and open grassland and woodland (Priority 5) (TSSC, 2016). The species is predicted to travel up to 20 km from roost caves during nightly foraging (Cramer *et al.*, 2016); however, seasonal variation is known to occur, with foraging occurring up to 20 km in the dry season and up to 50 km during the wet season (Bullen, 2013). Long-distance movements by the species have also been recorded, with a single monitored individual recorded from two roost caves located 170 km distant approximately 12 months apart (Bullen & Reiffer, 2019).

3 METHODS

3.1 Licensing and personnel

The survey was conducted under the Department of Biodiversity Conservation and Attraction's (DBCA) Section 40 license TFA 2020-0007 issued to C. Knuckey. Microclimate and SongMeter data was collected on approximately a 3-monthly basis by Atlas Iron or Biologic personnel. Biologic and Atlas Iron personnel conducted maintenance on monitoring equipment when required.

3.2 Timing

Monitoring of the artificial roosts, reference nocturnal refuges and reference diurnal roost occurred between the 19th September 2020 and 8th March 2021 (hereafter referred to as the monitoring period).

3.3 Monitoring Locations

Seven roosts (Table 3.1), including four artificial roosts (MW-AR-01, MW-AR-02, MW-AR-03 and MW-AR-04), two reference (naturally occurring) nocturnal refuges (MW-AN-17 and MW-AN-25) and one permanent diurnal roost (MW-AN-27), were monitored broadly following methods specified in the ARRP.

Table 3.1: Summary of monitoring caves

Artificial Roost	Installation Date	Pilbara leaf-nosed bat importance	Location	Latitude and longitude	Distance from MW-AN-27	Microclimate Type
MW-AR-01	July 2018	Artificial Roost	Ibanez waste rock landform	-21.5377, 119.2849	~3.6 km	iButton at all locations
MW-AR-02	July 2018	Artificial Roost	Ibanez waste rock landform	-21.5386, 119.2846	~3.6 km	1 HOBO, 2 iButtons
MW-AR-03	June 2019	Artificial Roost	Ibanez pit within area backfill	-21.5354, 119.2936	~2.75 km	1 HOBO, 2 iButtons
MW-AR-04	June 2019	Artificial Roost	Ibanez pit within area backfill	-21.5379, 119.2919	~3.05 km	1 HOBO, 2 iButtons
MW-AN-17	-	Nocturnal Refuge	-	-21.5196, 119.3140	~0.09 km	1 iButton
MW-AN-25	-	Nocturnal Refuge	-	-21.5205, 119.3032	~1.07 km	1 iButton
MW-AN-27	-	Permanent Diurnal Roost	-	-21.5190, 119.3134	-	2 iButtons

3.4 Microclimate Analysis

Microclimate loggers (Hydrochron iButton temperature and RH loggers (iButtons) or HOBO (MX2301A) temperature/RH Bluetooth data loggers) were deployed to assess the interior microclimate (temperate and RH) within the artificial roosts (MW-AR-01, MW-AR-02, MW-AR-03 and MW-AR-04), reference nocturnal refuges (MW-AN-17, MW-AN-25) and MW-AN-27. At all artificial roosts a total of three microclimate loggers were deployed, one outside the entrance tunnel (outside/external), one ~1 m inside the roost entrance (entrance), and one down the monitoring tube (5.3 – 8.9 meters) that leads into the main chamber (inside/internal). One microclimate logger was deployed inside MW-AN-17 and MW-AN-25, and two microclimate loggers was deployed inside MW-AN-27. The microclimate loggers were deployed from the 19th September 2020 to 8th March 2021 (Table 3.1).

All microclimate loggers recorded at 3-hour intervals. At each of the artificial roosts and nocturnal refuges, the range of temperature and RH recorded (daily minimum and maximum parameters records) was plotted against target ranges of a nocturnal refuge (as a minimum) and diurnal roost (as a maximum) as defined by Bat Call (2018), providing a range of 25–32°C for temperature and 25–100% for RH. The

higher maximum RH (of a diurnal roost - 100%) was used as it is likely to be preferred by the species (Baudinette *et al.*, 2000). The reference and diurnal roost was plotted against the target ranges of a diurnal roost (28–32°C for temperature and 85-100% for RH) (Armstrong, 2000).

Table 3.2: Location and deployment information of the microclimate loggers

Roost	Number of loggers	Microclimate logger location	Sep 20	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 2021
MW-AR-01	3	~1m inside roost entrance.							
		Outside entrance tunnel.							
		Monitoring tube.							
MW-AR-02	3	~1m inside roost entrance.							
		Outside entrance tunnel.							
		Monitoring tube.							
MW-AR-03	3	~1m inside roost entrance							
		Outside entrance tunnel							
		Monitoring tube							
MW-AR-04	3	~1m inside roost entrance							
		Outside entrance tunnel							
		Monitoring tube							
MW-AN-17	1	Inside roost							
MW-AN-25	1	Inside roost							
MW-AN-27	2	Inside roost							

Note: The grey box illustrates the period microclimate loggers were deployed.

3.5 Ultrasonic Analysis

To record bat echolocation calls, a single SongMeter SM4BAT-FS (SM4; Wildlife Acoustics, USA) powered by an external solar power supply was installed at each artificial roost (Appendix A). These more recently developed SM4 echolocation recording devices replaced the SM2BAT recorders (as specified in the ARRP), due to their greater accuracy and efficiency in relation to the monitoring requirements. Recorders were preconfigured to activate at astronomical sunset each day and deactivate at astronomical sunrise the following morning. Settings were adjusted to record calls for both the Pilbara leaf-nosed bat as well as any other cave dwelling bat species occurring in the region, with a frequency recording range of 12–160 kilohertz (kHz). Data was analysed on all recorded nights at the four artificial roosts and MW-AN-27 for all species of bats, including Pilbara leaf-nosed bats, ghost bats. All recordings were analysed by Robert Bullen of Bat Call WA using standardised bat call detection techniques. Raw files were first scanned for Pilbara leaf-nosed bat calls using Kaleidoscope software (Wildlife Acoustics, USA), then reviewed for significant times and call numbers using Cool Edit software (Adobe, USA). During analysis, a recording night was considered from sunset to sunrise the following day.

At the artificial roosts, microphones were deployed inside the monitoring tube that leads into the main roosting chamber of the artificial roost, to determine if Pilbara leaf-nosed bats were entering the roosts and if any diurnal roosting was occurring. A total of 170 nights was recorded at MW-AR-01, MW-AR-02, MW-AR-03 and MW-AN-27. At MW-AR-04 142 nights were recorded. Due to technical difficulties with the recording devices, there was a gap in the data recorded at MW-AR-04 (8th February to 8th March 2021; Table 3.3).

Table 3.3: Location and deployment dates of SongMeters at monitoring roosts

Roost	Sep 19	Oct 19	Nov 19	Dec20	Jan 20	Feb 20	Mar 20
MW-AR-01 Internal							
MW-AR-02 Internal							
MW-AR-03 Internal							
MW-AR-04 Internal						No data	
MW-AN-27							

Note: The grey box illustrate the period SongMeters were deployed, the white illustrates the period where SongMeters were decommissioned, the red box illustrates the period during which no data was recorded on account of technical issues.

4 RESULTS

4.1 Microclimate Analysis

4.1.1 Temperature

Similar mean temperatures were recorded inside the artificial roosts (MW-AR-01, MW-AR-02, MW-AR-03 and MW-AR-04), ranging from 29.3°C (at MW-AR-02) to 30.9°C (MW-AR-04) (Table 4.1). Lower variation was recorded inside the artificial roosts at MW-AR-01 and MW-AR-02 (6.0°C and 4.0°C difference between average minimum and maximum temperatures, respectively) compared to MW-AR-03 and MW-AR-04 (8.4°C and 7.4°C difference between average minimum and maximum temperatures, respectively). The percentage of recordings were consistently within the target range (25-32°C) at the artificial roosts. Though this was higher at MW-AR-01 and MW-AR-02 (84-100%) in comparison to MW-AR-03 and MW-AR-04 (72-78%). MW-AR-02 maintained within the temperature target range for the entire monitoring period. Although more stable, temperature at the artificial roosts followed the broad seasonal patterns experienced externally, recording increases in temperatures over the Pilbara summer season (November 2020 to February 2021).

The mean temperatures recorded inside the natural roosts (MW-AN-17, MW-AN-25 and MW-AN-27) were comparable to those recorded inside the artificial roosts (Table 4.1). Similar to the artificial roosts, minimal variation was recorded within the natural roosts, ranging from 3.0°C to 7.5°C. However, the natural roosts were typically within the temperature target for less periods of time than the artificial roosts, ranging from 18% - 73%. This was particularly evident at MW-AN-25, with temperatures within the target range for only 18.1%. Temperatures at the artificial roosts and natural roosts (excluding MW-AR-02) were sporadically above the temperature target range between November 2020 to March 2021 (Figure 4.1; Figure 4.2).

Table 4.1: Summary of temperature data recorded at artificial and natural roosts

Summary Statistics - Temperature	MW-AR-01	MW-AR-02	MW-AR-03	MW-AR-04	MW-AN-17	MW-AN-25	MW-AN-27
Mean (± standard error)	30.8 °C (± 0.03)	29.3°C (± 0.02)	30.8 °C (± 0.05)	30.9°C (± 0.04)	31.2°C (± 0.04)	32.6°C (± 0.02)	31.2°C (± 0.03)
Minimum	28.1°C	27.2°C	25.5°C	25.9°C	26.6°C	31.1°C	27.6°C
Maximum	34.1°C	31.3°C	33.9°C	33.2°C	34.1°C	34.1°C	33.0°C
Difference between Minimum and Maximum	6.0°C	4.0°C	8.4°C	7.4°C	7.5°C	3.0°C	5.4°C
Number of recordings within target range	1152	1364	994	1062	872	246	1003
Percentage of recordings within target range	84.6%	100%	72.8%	77.9%	64.0%	18.1%	73.8%

4.1.2 Relative Humidity

The artificial roosts recorded similar mean RH, ranging from 38.9% (at MW-AR-03) to 41.0% (at MW-AR-01) (Table 4.2). The artificial roosts recorded fluctuating RH, varying from 52.7% (at MW-AR-04) to 67.8% (at MW-AR-02). The artificial roosts were within the target RH range of 25-100% for the majority of the monitoring period (September 2020 – March 2021) ranging from 79.1% to 86.1%, with the highest RH being recorded at MW-AR-02.

The artificial roosts recorded similar mean RH to those recorded in the natural roosts. Relative humidity varied 85.5% at MW-AN-17, and 80.5% at MW-AN-27, in comparison to MW-AN-25 with only 57.2% variation. MW-AN-17 and MW-AN-25 was within the target range (25-100%) for between 75.3% - 94.9%. MW-AN-27 was within the humidity range (85-100%) for only 6% of the monitoring period. The artificial roosts were typically within the target range for longer than the natural roosts. Similar mean RH was recorded between the artificial roosts and natural roosts, however, MW-AN-25 recorded slightly higher RH at 94.9%. Overall, RH was highest between December 2020 and March 2021, increasing from December 2020 until the end of the monitoring period at both the artificial roosts and natural roosts. Although more stable, RH cyclic pattern broadly mirrored cycles in ambient RH, corresponding to the Pilbara wet season (Figure 4.3; Figure 4.4).

Table 4.2: Summary of humidity data recorded at artificial and natural roosts

Summary Statistics – Relative Humidity	MW-AR-01	MW-AR-02	MW-AR-03	MW-AR-04	MW-AN-17	MW-AN-25	MW-AN-27
Mean (± standard deviation)	41.0% (± 0.38)	49.3% (± 0.52)	38.9% (± 0.38)	40.3% (± 0.36)	40.7% (± 0.53)	51.9% (± 0.41)	60.9% (± 0.58)
Minimum	12..6%	14.5%	9.6%	13.4%	11.3%	18.6%	19.5%
Maximum	70.6%	82.3%	67.8%	66.1%	96.8%	75.8%	100%
Difference between Minimum and Maximum	58.1%	67.8%	58.2%	52.7%	85.5%	57.2%	80.5%
Number of recordings within target range	1134	1175	1080	1160	1026	1292	81
Percentage of recordings within target range	83.3%	86.1%	79.1%	85.0%	75.3%	94.9%	6%

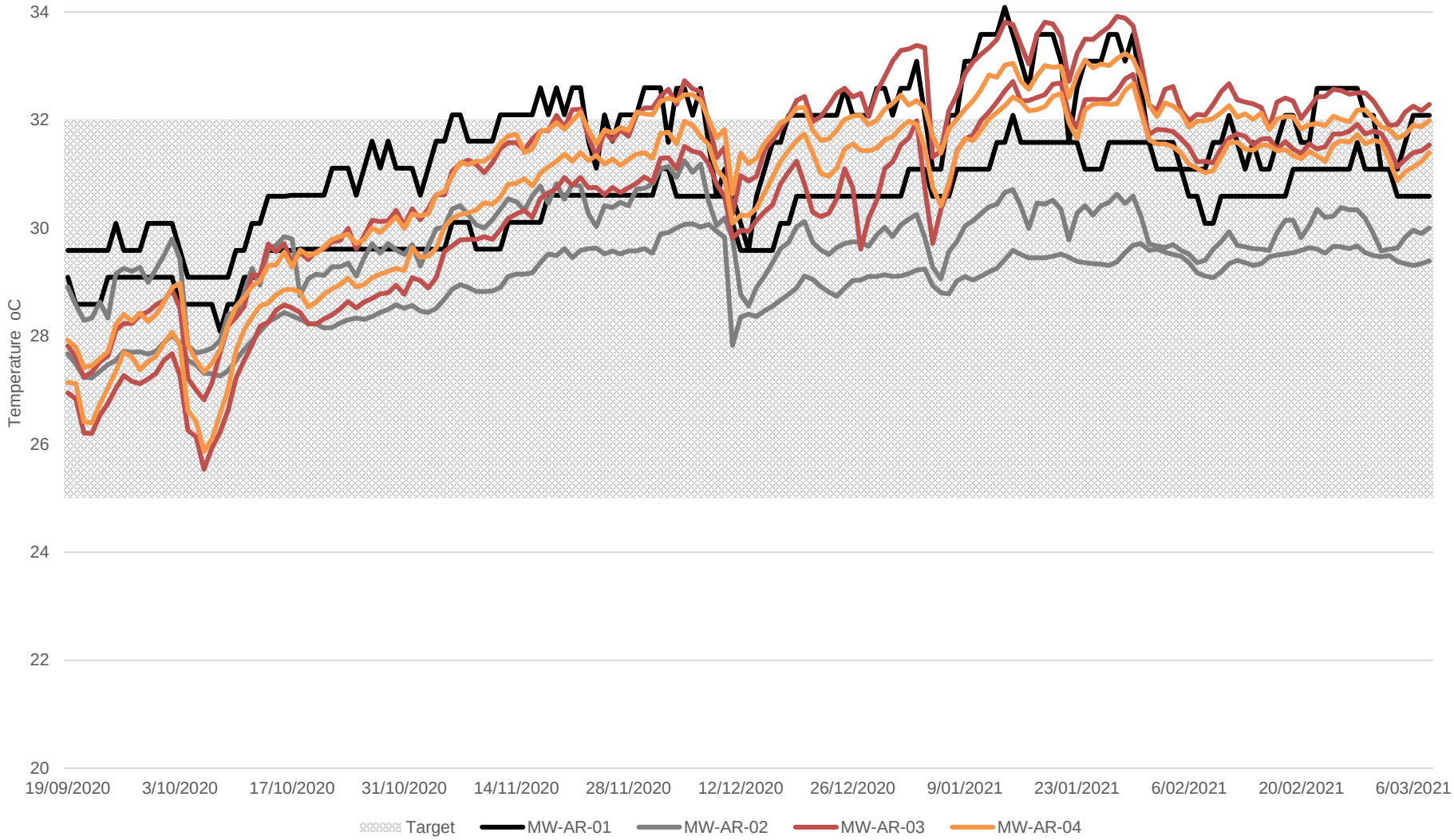

Figure 4.1: Daily relative temperature range recorded inside the artificial roosts during the monitoring period

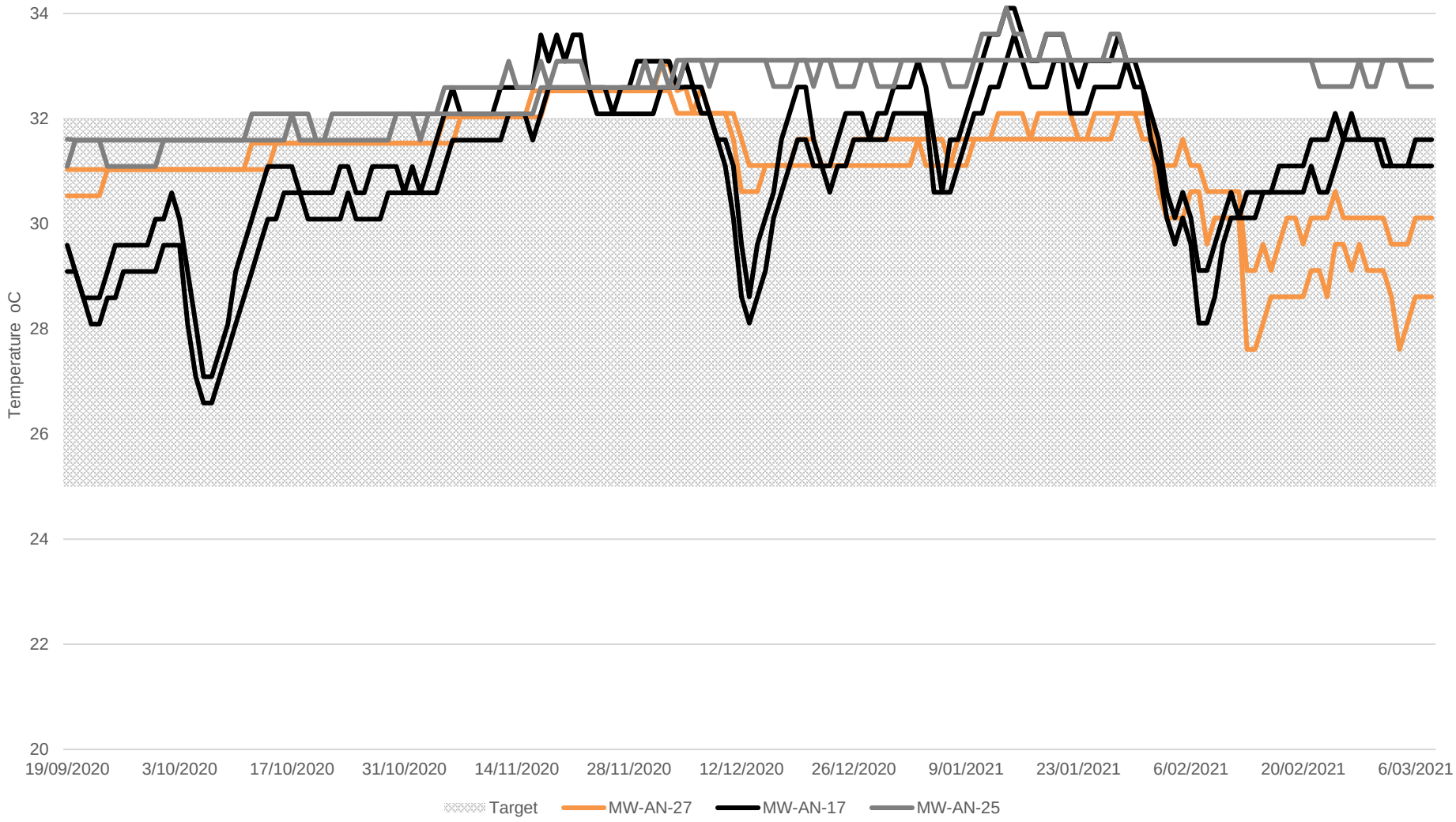

Figure 4.2: Daily relative temperature range recorded inside the natural roosts during the monitoring period

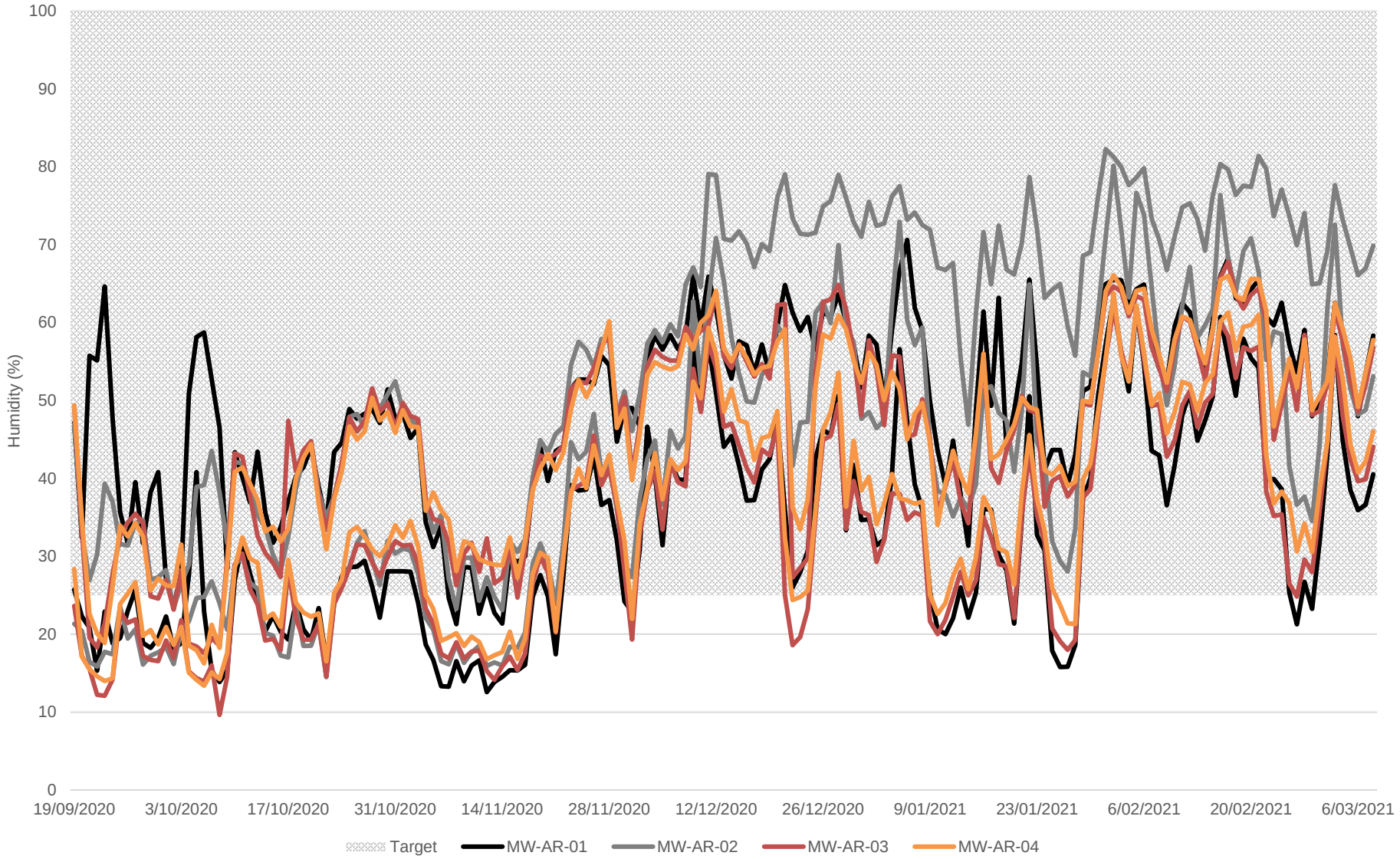

Figure 4.3: Daily relative RH range recorded inside the artificial roosts during the monitoring period

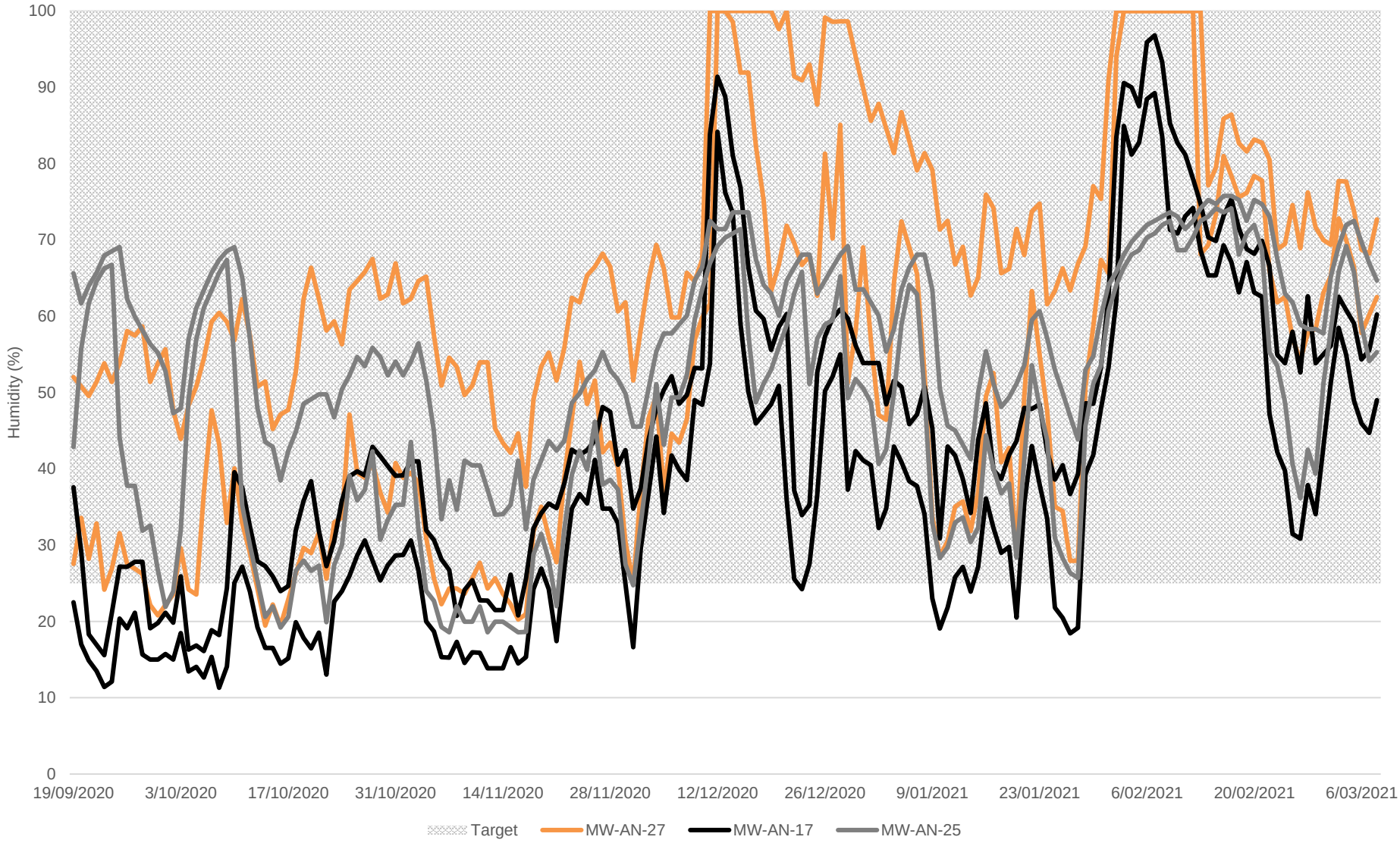

Figure 4.4: Daily relative RH range recorded inside the natural roosts during the monitoring period.

4.2 Ultrasonic Analysis

No Pilbara leaf-nosed bats were detected inside the main roosting chamber during the current monitoring period at the artificial roosts. No other bat species were recorded at MW-AR-01, MW-AR-02 and MW-AR-04. Other bat species have been recorded at MW-AR-03, in particular, *Vespadelus finlaysoni,* at times consistent with individuals foraging. However, it is possible that this is individuals flying outside the artificial roost as other species (*Chalinolobus gouldii*, *Taphozous* sp., *Chaerephon jobensis* and *Scotorepens greyii*) recorded are not typically recorded in cave environments and/or may be too large to enter through the holes in the entrance door (in the case of Taphozous spp.)

Pilbara leaf-nosed bats were recorded on all recording nights (100% of 170 nights) at MW-AN-27. The calls regularly occurred before civil dusk and after civil dawn, indicating diurnal roosting throughout the monitoring period at MW-AN-27. The number of calls recorded per night over the monitoring period ranged from 550 (on 14th November 2020) to 15,429 (on the 10th December 2020). The number of calls recorded was relatively low in November 2020, averaging 1,660 calls per night. In comparison, between December 2020 and February 2021 the number of calls recorded increased, averaging 4,443 calls per night (Figure 4.5).

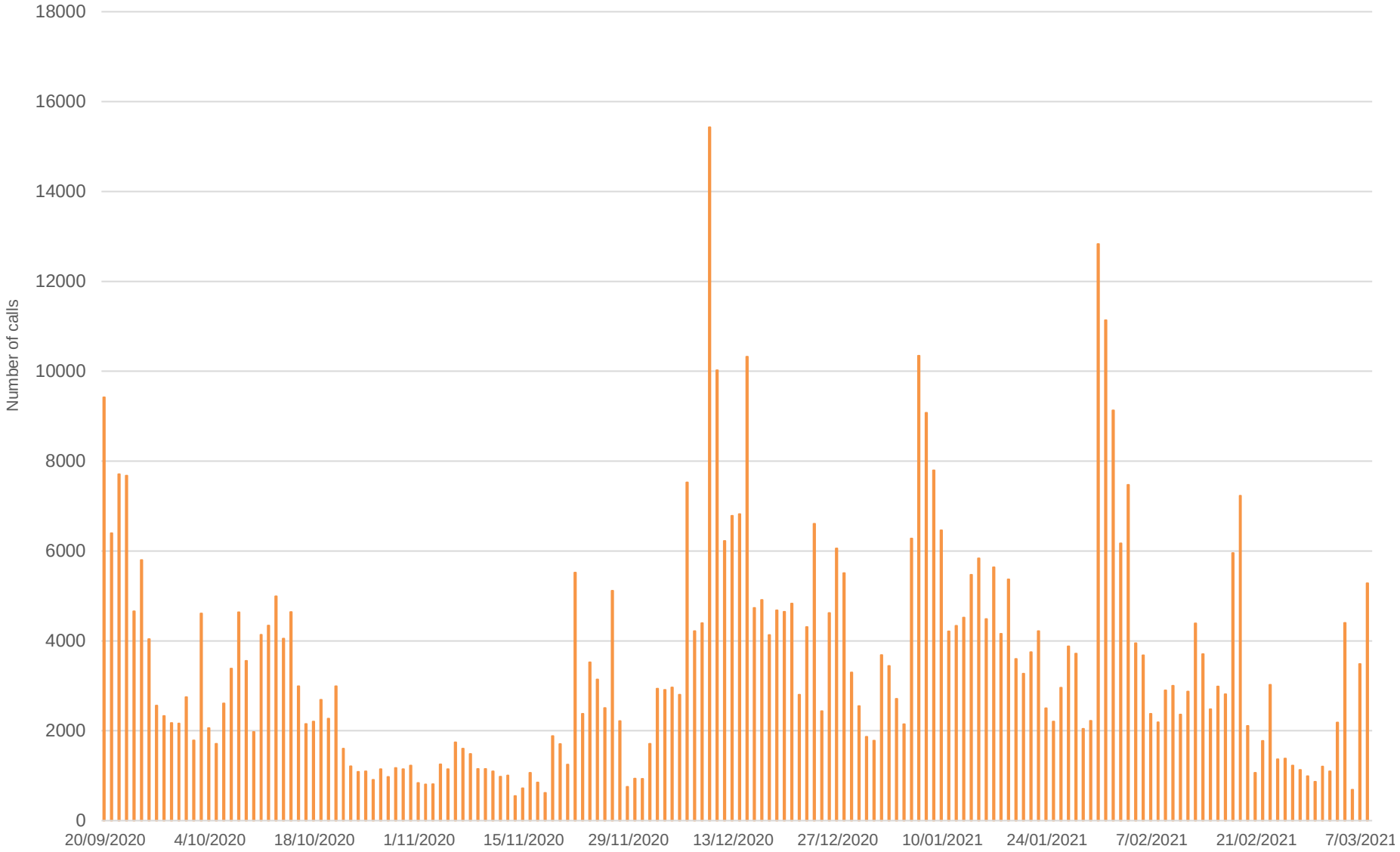

Figure 4.5: Number of Pilbara leaf-nosed bat calls per day at the entrance of MW-AN-27 during the monitoring period

5 DISCUSSION

5.1 Artificial Roost Microclimate

Pilbara leaf-nosed bats typically roost in undisturbed caves, deep fissures or abandoned mine shafts (Armstrong, 2000, 2001). The species' limited ability to conserve heat and water (Baudinette *et al.*, 2000) means they require warm (28-32 ºC) and very humid (85-100 %) roost sites to persist in arid and semi-arid climates (Armstrong, 2001; Churchill, 1991). Temperature and RH are recognised to be important factors influencing visitation and colonisation of roosts by Pilbara leaf-nosed bats. Temperature and RH are measured and managed within the artificial roosts in order to replicate and maintain the conditions inside a naturally occurring nocturnal refuge.

5.1.1 Temperature

MW-AN-27 was within the temperature range (28-32°C) of a diurnal roost for only 73.5% of the monitoring period and uncharacteristic of permanent diurnal roosts previously studied (Armstrong, 2001). Anecdotal evidence suggests that an additional chamber exists (bats have been seen flying further into the roost, likely into an additional chamber where microclimate conditions are more optimal) that is yet to be monitored due to access difficulty. As the chamber has limited access and could cause significant disturbance to the Pilbara leaf-nosed bats when entering, long-term monitoring options are advisable (i.e. wired remote access microclimate loggers). Together this data, coupled with anecdotal evidence, demonstrates that the main roosting chamber used by the colony is not currently being accessed and sampled, and thus not reflective of the conditions sought by the species. For this reason, the temperature of MW-AN-27 is no longer discussed within this report.

Data loggers deployed at MW-AR-01, MW-AR-02, MW-AR-03 and MW-AR-04 indicate that temperatures inside the roosts were within the target range (25 to 32°C) for most of the monitoring period; 84.6%, 100%, 72.8% and 77.9%, respectively. Notably, the temperature fluctuations inside MW-AR-01 and MW-AR-02 were lower than MW-AR-03 and MW-AR-04, suggesting that temperature fluctuations may stabilise over time. Internally, the artificial roosts recorded a gradual increase in temperature over the summer months. The temperatures recorded inside the reference nocturnal refuges were within the target range (25 to 32°C) for 64.0% at MW-AN-17 and 73.8% at MW-AN-25 of the monitoring period. MW-AN-25 recorded stable temperatures throughout the monitoring period (September 2020 to March 2021) compared to MW-AN-17. However, both roosts increased above the typical limits of a nocturnal refuge during the summer months.

The temperatures exhibited inside the artificial roosts followed similar patterns to outside temperatures. Thus, it is important to restrict the effects of outside temperatures where possible. Recent maintenance at the artificial roosts (October 2020) (Biologic, 2021a) included improving the seal on the monitoring lids to maintain the internal microclimate. In comparison to the same time (October to March) in the previous monitoring period (Biologic, 2021a) temperatures were within the target range for a longer period of time at MW-AR-01 and MW-AR-02, though a slight decrease was recorded at MW-AR-03 and MW-AR-04.

5.1.2 Relative Humidity

Bats, and particularly bats of small body size, experience a disadvantage in temperature regulation and evaporative water loss on account of greater surface area and vascularisation of flight membranes (Baudinette *et al.*, 2000). The rate of evaporative water loss in the Pilbara leaf-nosed bat is double that of other bat species meaning that humid microclimates are preferred to help reduce the consequence of dehydration (Baudinette *et al.*, 2000). Furthermore, the species is dependent on warm and humid roosting sites, especially during the dry Pilbara winter months (Baudinette *et al.*, 2000). Typically the species' is confined to very humid caves which range annually between 85 and 100% RH (Armstrong, 2001; Churchill, 1991), which are usually host to large colonies of several hundred individuals year-round. MW-AN-27 is recognised as such a cave. Relative humidity within MW-AN-27 was within the target range of a diurnal roost for 6% of the monitoring period, again confirming that sampling to date has not been within the roosting chamber. For this reason, the RH of MW-AN-27 is no longer discussed within this report.

The RH levels recorded inside the artificial roosts were within the target range (25-100%) for most of the monitoring period (83.3% at MW-AR-01, 86.1% at MW-AR-02, 79.1% at MW-AR-03 and 85.0% at MW-AR-04). There was considerable variation in RH at the artificial roosts, with the highest recorded at MW-AR-02. During the monitoring period, MW-AN-17 and MW-AN-25 were within the RH target range (25-60%) of a nocturnal refuge for 75.3% and 94.9%, respectively. The artificial roosts were within the target range for longer periods of time than MW-AN-17 and MW-AN-25. Differences between minimum and maximum RH within the artificial roosts as well as the natural roosts were highly variable and fluctuated throughout the year. In a similar manner to temperature, the results of this year's monitoring demonstrate the 'target range' specified for the artificial roosts, is not something permanently experienced by naturally occurring nocturnal refuges.

As per the current monitoring period, the percentage of RH recordings within the target range has increased during the wet season. Similarly, natural caves have recorded variation in RH being negatively correlated with ambient temperature and mediated by two-week rainfall (Biologic, 2020a). Restricting the effects of outside temperature and RH is necessary to maintaining the microclimate within the artificial roosts. Since the maintenance conducted in October 2020, an increase in RH maintaining within the target range has been recorded at MW-AR-01, MW-AR-02 and MW-AR-03 (with a decrease at MW-AR-04) in comparison to the same time in the previous monitoring period (October to March).

5.2 Artificial Roost Utilisation

At MW-AN-27, the Pilbara Leaf-nosed bat was detected on all recording nights (100% of 170 nights). The calls regularly occurred before civil dusk and after civil dawn, indicating diurnal roosting throughout the monitoring period, confirming its status as a diurnal roost. Pilbara leaf-nosed bat calls remained relatively stable throughout the monitoring period, with calls increasing over the wet season.

No Pilbara leaf-nosed bat calls were recorded inside the main chamber at the four artificial roosts (MW-AR-01, MW-AR-02, MW-AR-03 and MW-AR-04) during the current monitoring period. However, common bat species were recorded sporadically during the monitoring period at MW-AR-03.

Due to the lack of recordings, interpretations of the data are limited. There is limited foraging habitat located around the artificial roosts and this is likely to limit the number of encounters of the artificial roosts

by the Pilbara leaf-nosed bat. Rehabilitation of the vegetation surrounding the artificial roosts may increase potential encounters. Confirmation of Pilbara leaf-nosed bats at the entrances of the artificial roosts demonstrates (Biologic, 2020b, 2021a) that waste-rock landforms will be visited by the species and gives confidence that artificial roosts in rehabilitated habitats may be successful.

5.3 Conclusions

Previous monitoring demonstrates that Pilbara leaf-nosed bats are sometimes present at the entrances to the artificial roosts, however, results from the current monitoring period indicates that they are yet to enter the artificial roosts. In addition, the microclimate within the roosts was suitable for use as nocturnal refuges for much of the monitoring period. Pilbara leaf-nosed bats are yet to be confirmed to enter the artificial roosts, with only limited visitations from common bat species at MW-AR-03. Further monitoring of the artificial roosts and bat utilisation will provide more clarification on this.

Key performance indicators (see Table 5.1) in the ARRP stipulated that Pilbara leaf-nosed bats be detected at the entrance or within the chambers of the artificial roosts to determine if transitory roosts can be recreated. Pilbara leaf-nosed bats have been recorded at the entrance of all roosts, inclusive of the Year 1 monitoring period, satisfying the objective for the species to utilise the artificial roosts. However, no Pilbara leaf-nosed bats were recorded entering or roosting within the artificial roosts. As such, the artificial roosts are yet to achieve the aspiration goal of roost colonization. Temperature and RH was within the target range for most of the monitoring period at the artificial roosts. The microclimate within the artificial roosts is currently suitable for use as nocturnal refuges for temporary periods of time, however, the artificial roosts are yet to meet the key objective to maintain temperature and humidity consistently within the target range. Initial results suggest it may require time for the artificial roosts to achieve maximum thermal and water retention, however, the current results are promising. As the reference nocturnal refuges also show seasonal variation and do not always exhibit a microclimate within the target range, it is unlikely that the condition stipulated by Bat Call (2018) are required for the artificial roosts to be used by the species.

The recommendations from the 2019-2020 artificial roost monitoring report (Biologic, 2021b) aimed to improve the artificial roosts and the quality of data collected during subsequent monitoring events. In addition to the recommendations suggested since the previous monitoring period (Biologic, 2021b), rehabilitation of the vegetation surrounding the artificial roosts may increase encounters by Pilbara leaf-nosed bats. Furthermore, due to the activity outside MW-AR-03 it is strongly suggested that alterations are made to the gates on the artificial roosts (i.e. bigger holes in the gate or removal of gate completely).

Overall, assessment of monitoring data against key performance objectives detailed in the ARRP, or subsequent revisions, indicated most key performance objectives are either being met or are on a positive trajectory towards being achieved. Implementation of recommended roost alterations may increase the potential for a stable artificial roost microclimate and utilisation by Pilbara leaf-nosed bats. Future monitoring will play an important role in revealing more about the suitability of the artificial roosts as nocturnal refuges and the extent to which the performance objectives are to be achieved.

Table 5.1: Preliminary evaluation of artificial roosts against key performance objectives prescribed in the ARRP

Performance objective	Key performance indicator (following ARRP and Bat Call (2018) where applicable)	Objective met	Justification
Design artificial roosts	Completed design for artificial roosts for Pilbara leaf-nosed bat with technical specifications (i.e. materials, dimensions, location, in cooperation with bat specialists and engineers)	Yes	Artificial roosts (nocturnal refuges) have been designed with all consideration for optimal conditions for Pilbara leaf-nosed bat where possible, including structure and appropriate microclimatic conditions to support the species.
Construct four artificial roosts	Four roosts constructed according to design specifications	Yes	Four artificial roosts have been constructed (MW-AR-01, MW-AR-02, MW-AR-03 and MW-AR-04) to design specifications.
Create and maintain a microclimate deemed suitable for supporting Pilbara leaf-nosed bat within the artificial roosts	Microclimate at different seasons characterised by: • temperature of 25–32°C • RH of 25–100%	No – Temperature and RH were not maintained within the target range.	Temperature was within the target range for most of the monitoring period at the four artificial roosts (84.6% at MW-AR-01, 100% at MW-AR-02, 72.8% at MW-AR-03 and 77.9% at MW-AR-04). RH was within the target range for most of the monitoring period (83.3% at MW-AR-01, 86.1% at MW-AR-02, 79.1% at MW-AR-03 and 85.0% at MW-AR-04). It is anticipated that the microclimate within the four artificial roost will stabilise within the target range with time/age.
Pilbara leaf-nosed bat utilising artificial roosts	Presence of Pilbara leaf-nosed bat detected at the entrance or within the chambers of the artificial roosts (i.e. pattern of activity indicating transitory visitation or greater)	Yes – Species detected at the entrance of all four roosts at some point since their installation.	The Pilbara leaf-nosed bat was detected at the entrance of all four artificial roosts on multiple occasions at some point since their installation. As of yet, no Pilbara leaf-nosed bats have been recorded on the internal recorders at any of the artificial roosts. Continued monitoring via the use of recorders is necessary to determine if the species is entering the artificial roosts in the future.
PLNB colonising artificial roost(s)	Status of roost(s) established as daytime roost (i.e. bats residing within main chamber during daytime hours and exhibiting an activity profile of exiting at dusk and entering prior to dawn)	Uncertain	This objective is an aspirational goal and not a measure of the success of these roosts providing a nocturnal refuge. Data from MW-AR-01 and MW-AR-04 suggested possible roosting events during Year 1 of monitoring, however, this was not verified by an internal ultrasonic recorder. No calls have been detected inside the roost during the current monitoring period, suggesting that establishment of the artificial roosts as a diurnal roost is yet to occur. Future monitoring will help to verify the occurrence of diurnal roosting and confirm whether this performance objective has been met.

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7 APPENDIX

Appendix A – Location of monitoring equipment at artificial roost

Setup of monitoring equipment at MW-AR-04 showing recording equipment (in grey box) and solar power supply.

Purpose-built tiles installed at MW-AR-04, designed to mimic the roof of natural caves.

Appendix B – Pilbara leaf-nosed bat visitation details

Date	Civil Dusk	Civil Dawn	MW-AN-27		
			First Call	Last Call	Total Calls
19/09/2020	18:20	05:32	18:25	05:57	12117
20/09/2020	18:21	05:31	18:04	05:15	9418
21/09/2020	18:21	05:30	18:28	04:47	6399
22/09/2020	18:21	05:29	18:27	05:23	7709
23/09/2020	18:21	05:28	18:24	05:05	7680
24/09/2020	18:22	05:27	18:24	05:23	4661
25/09/2020	18:22	05:26	18:33	05:25	5802
26/09/2020	18:22	05:25	18:27	05:25	4040
27/09/2020	18:23	05:24	18:28	05:21	2562
28/09/2020	18:23	05:23	18:22	05:11	2330
29/09/2020	18:23	05:22	18:29	05:23	2171
30/09/2020	18:23	05:21	18:26	05:24	2165
1/10/2020	18:24	05:20	18:25	05:13	2750
2/10/2020	18:24	05:19	18:30	05:05	1788
3/10/2020	18:24	05:19	18:27	05:09	4611
4/10/2020	18:25	05:18	18:17	05:10	2059
5/10/2020	18:25	05:17	18:09	04:59	1714
6/10/2020	18:25	05:16	18:12	05:06	2610
7/10/2020	18:26	05:15	18:15	04:53	3385
8/10/2020	18:26	05:14	18:09	05:09	4638
9/10/2020	18:26	05:13	18:20	05:01	3556
10/10/2020	18:27	05:12	18:32	05:00	1974
11/10/2020	18:27	05:11	18:37	05:01	4137
12/10/2020	18:28	05:10	18:38	05:00	4340
13/10/2020	18:28	05:09	18:41	05:05	4996
14/10/2020	18:28	05:09	18:34	05:15	4054
15/10/2020	18:29	05:08	18:30	04:58	4644
16/10/2020	18:29	05:07	18:34	04:51	2993
17/10/2020	18:30	05:06	18:36	05:00	2150
18/10/2020	18:30	05:05	18:27	04:48	2208
19/10/2020	18:30	05:05	18:34	04:52	2689
20/10/2020	18:31	05:04	18:34	04:52	2271
21/10/2020	18:31	05:03	18:35	04:51	2991
22/10/2020	18:32	05:02	18:41	05:16	1604
23/10/2020	18:32	05:01	18:40	05:04	1213
24/10/2020	18:33	05:01	18:42	04:56	1086
25/10/2020	18:33	05:00	18:35	04:51	1096
26/10/2020	18:34	04:59	18:30	04:54	907
27/10/2020	18:34	04:59	18:38	04:50	1148
28/10/2020	18:35	04:58	18:32	04:48	976
29/10/2020	18:35	04:57	18:21	04:47	1172
30/10/2020	18:36	04:57	18:30	04:52	1148
31/10/2020	18:36	04:56	18:29	04:43	1227

1/11/2020	18:37	04:55	18:32	04:48	837
2/11/2020	18:38	04:55	18:38	04:49	808
3/11/2020	18:38	04:54	18:33	04:42	813
4/11/2020	18:39	04:54	18:35	04:45	1251
5/11/2020	18:39	04:53	18:42	04:50	1145
6/11/2020	18:40	04:53	18:47	04:45	1741
7/11/2020	18:41	04:52	18:32	04:41	1606
8/11/2020	18:41	04:52	18:48	04:41	1485
9/11/2020	18:42	04:51	18:51	04:40	1150
10/11/2020	18:42	04:51	18:45	04:47	1153
11/11/2020	18:43	04:50	18:48	04:47	1099
12/11/2020	18:44	04:50	18:50	05:00	981
13/11/2020	18:44	04:50	18:42	04:54	1008
14/11/2020	18:45	04:49	18:57	04:49	550
15/11/2020	18:46	04:49	18:53	04:37	724
16/11/2020	18:46	04:49	18:53	04:38	1064
17/11/2020	18:47	04:48	18:48	04:42	849
18/11/2020	18:48	04:48	18:52	04:45	621
19/11/2020	18:48	04:48	18:44	04:52	1883
20/11/2020	18:49	04:48	18:46	04:42	1708
21/11/2020	18:50	04:48	18:59	04:50	1246
22/11/2020	18:51	04:47	19:04	04:47	5523
23/11/2020	18:51	04:47	18:40	04:40	2376
24/11/2020	18:52	04:47	18:55	04:41	3522
25/11/2020	18:53	04:47	18:47	04:42	3143
26/11/2020	18:53	04:47	18:36	04:46	2510
27/11/2020	18:54	04:47	18:39	04:39	5118
28/11/2020	18:55	04:47	18:48	04:39	2219
29/11/2020	18:55	04:47	18:46	04:41	754
30/11/2020	18:56	04:47	18:40	04:27	934
1/12/2020	18:57	04:47	18:58	04:39	929
2/12/2020	18:58	04:47	18:56	04:37	1712
3/12/2020	18:58	04:47	18:48	05:04	2935
4/12/2020	18:59	04:47	18:39	04:46	2911
5/12/2020	19:00	04:48	18:49	04:51	2967
6/12/2020	19:00	04:48	18:47	04:38	2804
7/12/2020	19:01	04:48	19:05	04:50	7526
8/12/2020	19:02	04:48	18:58	04:49	4218
9/12/2020	19:02	04:49	19:03	04:58	4394
10/12/2020	19:03	04:49	19:02	05:00	15429
11/12/2020	19:04	04:49	18:45	05:09	10023
12/12/2020	19:04	04:49	18:51	04:36	6224
13/12/2020	19:05	04:50	19:02	04:44	6787
14/12/2020	19:05	04:50	19:14	04:36	6822
15/12/2020	19:06	04:51	19:09	05:01	10326
16/12/2020	19:07	04:51	19:10	04:43	4735

17/12/2020	19:07	04:51	19:02	05:06	4914
18/12/2020	19:08	04:52	19:19	04:55	4131
19/12/2020	19:08	04:52	19:05	04:45	4679
20/12/2020	19:09	04:53	19:15	04:53	4649
21/12/2020	19:09	04:53	19:03	04:38	4830
22/12/2020	19:10	04:54	19:28	04:31	2804
23/12/2020	19:10	04:54	19:24	04:37	4311
24/12/2020	19:11	04:55	19:26	04:48	6607
25/12/2020	19:11	04:55	19:16	05:00	2438
26/12/2020	19:12	04:56	19:09	04:45	4623
27/12/2020	19:12	04:57	19:14	04:59	6061
28/12/2020	19:12	04:57	19:15	04:40	5507
29/12/2020	19:13	04:58	19:11	04:45	3299
30/12/2020	19:13	04:58	19:08	04:49	2551
31/12/2020	19:13	04:59	19:24	04:57	1868
1/01/2021	19:14	05:00	19:15	04:47	1782
2/01/2021	19:14	05:00	19:20	05:01	3685
3/01/2021	19:14	05:01	19:23	04:48	3442
4/01/2021	19:14	05:02	19:24	04:54	2712
5/01/2021	19:15	05:02	19:05	04:47	2146
6/01/2021	19:15	05:03	19:09	05:03	6281
7/01/2021	19:15	05:04	19:02	04:57	10347
8/01/2021	19:15	05:05	19:14	04:57	9076
9/01/2021	19:15	05:05	19:24	04:52	7798
10/01/2021	19:15	05:06	19:23	04:57	6460
11/01/2021	19:15	05:07	19:26	05:16	4215
12/01/2021	19:16	05:07	19:35	05:28	4334
13/01/2021	19:16	05:08	19:33	05:02	4518
14/01/2021	19:16	05:09	19:34	05:23	5472
15/01/2021	19:16	05:10	19:12	05:34	5838
16/01/2021	19:15	05:10	19:08	05:35	4489
17/01/2021	19:15	05:11	19:24	05:21	5638
18/01/2021	19:15	05:12	19:15	05:32	4159
19/01/2021	19:15	05:13	19:17	05:31	5372
20/01/2021	19:15	05:13	19:00	05:18	3598
21/01/2021	19:15	05:14	19:18	05:33	3273
22/01/2021	19:15	05:15	19:24	05:31	3752
23/01/2021	19:14	05:16	19:16	05:37	4218
24/01/2021	19:14	05:16	19:13	05:22	2501
25/01/2021	19:14	05:17	19:24	05:39	2208
26/01/2021	19:14	05:18	19:12	05:28	2960
27/01/2021	19:13	05:18	19:15	05:42	3881
28/01/2021	19:13	05:19	19:15	05:37	3717
29/01/2021	19:13	05:20	19:01	05:35	2047
30/01/2021	19:12	05:21	19:04	05:28	2223

31/01/2021	19:12	05:21	19:03	05:45	12831
1/02/2021	19:12	05:22	18:55	05:27	11136
2/02/2021	19:11	05:23	18:57	05:47	9128
3/02/2021	19:11	05:23	19:15	05:34	6170
4/02/2021	19:10	05:24	18:52	05:42	7475
5/02/2021	19:10	05:25	19:01	05:07	3952
6/02/2021	19:09	05:25	19:09	05:06	3682
7/02/2021	19:09	05:26	19:25	05:14	2380
8/02/2021	19:08	05:26	19:21	05:25	2191
9/02/2021	19:08	05:27	19:16	05:18	2902
10/02/2021	19:07	05:28	19:21	05:20	3001
11/02/2021	19:06	05:28	19:13	05:26	2365
12/02/2021	19:06	05:29	19:30	05:47	2873
13/02/2021	19:05	05:29	19:22	05:33	4388
14/02/2021	19:05	05:30	19:12	05:23	3709
15/02/2021	19:04	05:31	19:22	05:22	2481
16/02/2021	19:03	05:31	19:21	05:22	2989
17/02/2021	19:03	05:32	19:00	05:21	2816
18/02/2021	19:02	05:32	19:04	05:31	5955
19/02/2021	19:01	05:33	19:08	05:27	7229
20/02/2021	19:00	05:33	19:04	05:18	2110
21/02/2021	19:00	05:34	18:59	05:24	1067
22/02/2021	18:59	05:34	19:01	05:20	1777
23/02/2021	18:58	05:35	19:09	05:19	3023
24/02/2021	18:57	05:35	19:03	05:40	1365
25/02/2021	18:57	05:36	19:04	05:20	1381
26/02/2021	18:56	05:36	19:01	05:22	1229
27/02/2021	18:55	05:37	19:04	05:24	1129
28/02/2021	18:54	05:37	19:01	05:26	992
1/03/2021	18:53	05:38	19:06	05:39	866
2/03/2021	18:52	05:38	19:02	05:22	1204
3/03/2021	18:52	05:38	18:53	05:16	1097
4/03/2021	18:51	05:39	18:53	05:20	2184
5/03/2021	18:50	05:39	19:00	05:27	4403
6/03/2021	18:49	05:40	19:07	22:17	691
7/03/2021	18:48	05:40	19:07	05:38	3486
8/03/2021	18:47	05:40	18:57	05:39	5284