
Habitat
Innovation & Management

Habitat Innovation acknowledges the Traditional Custodians of country throughout Australia and their connections to land, sea and community. We pay our respects to the Kamilaroi people their Elders past, present and emerging.

We celebrate the stories, culture and traditions of Aboriginal and Torres Strait Islander Elders of all communities who also work and live on this land.

Much of our research was conducted on the Traditional Lands of the Wiradjuri people, on the slopes and adjacent plains of the sacred site Wahluu (Mount Panorama).

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Who are we and what do we do?

Habitat Innovation and Management is an ecological consultancy with a focus on positive conservation outcomes for the benefit of Australia’s flora and fauna

The work that we do includes:

- Artificial habitat installation
- Fauna surveys
- Flora Surveys
- Revegetation works
- Water quality sampling and monitoring
- Erosion control and monitoring
- Nest box monitoring

Mick and Mikayla

Mick is one of the Co-directors at Habitat Innovation and Management and is an experienced Ornithologist. Mick is one half of the Habitat Innovation artificial habitat design and development team and is recognised as an expert in hollow dependent fauna

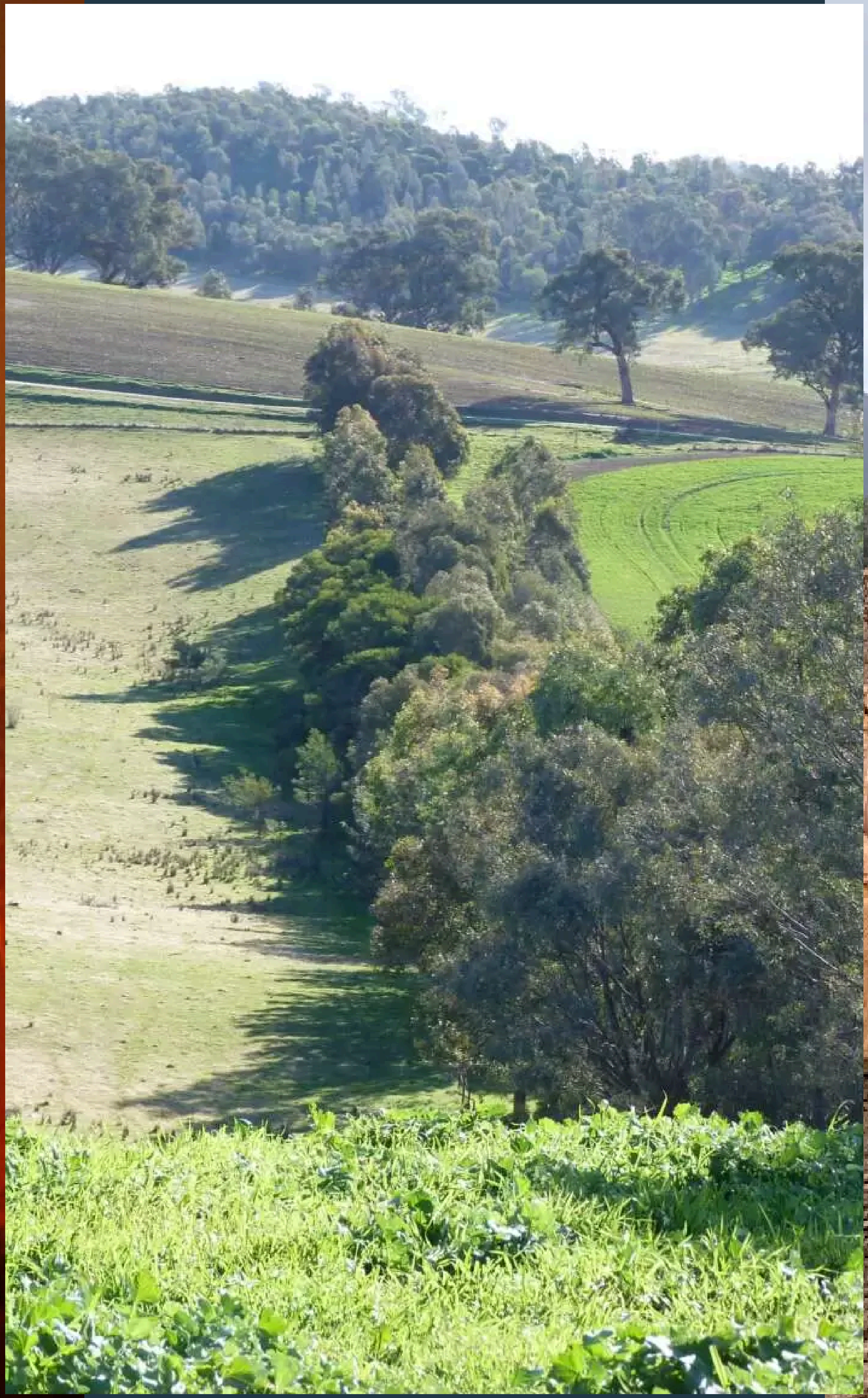
Mikayla is one of Habitat's tree climbing ecologists. She has a special interest in Australia's arboreal mammals (possums and gliders), having completed her Honours on Greater Gliders, and brings a broad range of skills including fauna survey and wildlife rescue

Schedule for today:

- Background information and presentation
- Install Habitat modular nest box
- Install Habitat marsupial den
- Construct a raptor platform

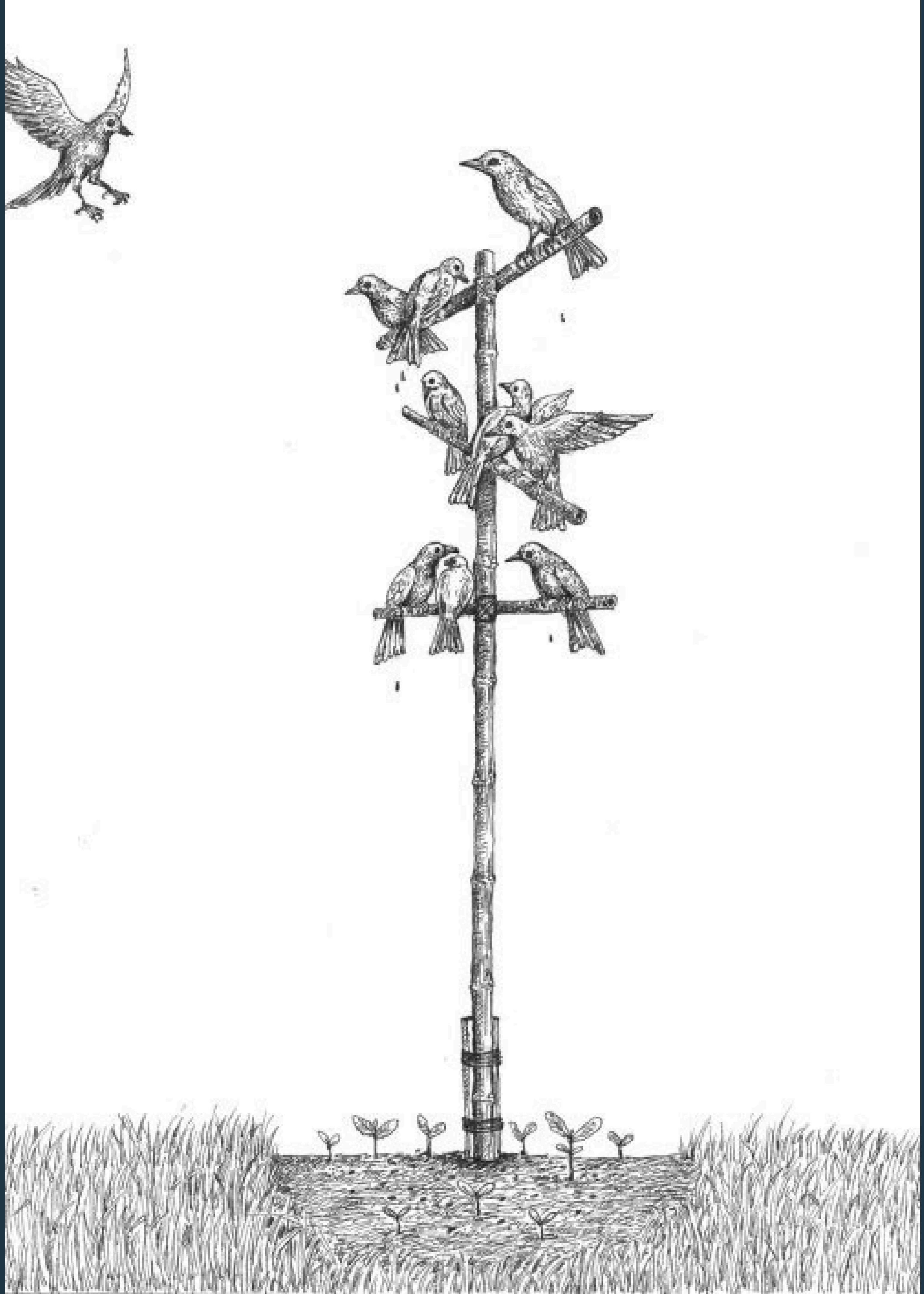
What are artificial habitat structures?

Definition: Artificial habitat structures are purposefully designed habitats for wildlife meant as human-made substitutes for (or supplements to) natural habitat structures, and are usually deployed in degraded, disturbed, or modified environments


Why are artificial habitats important?

- Provide shelter
- A place to breed
- A place to raise young
- Protection from predators
- Protection from adverse weather
- Provide a place to hibernate



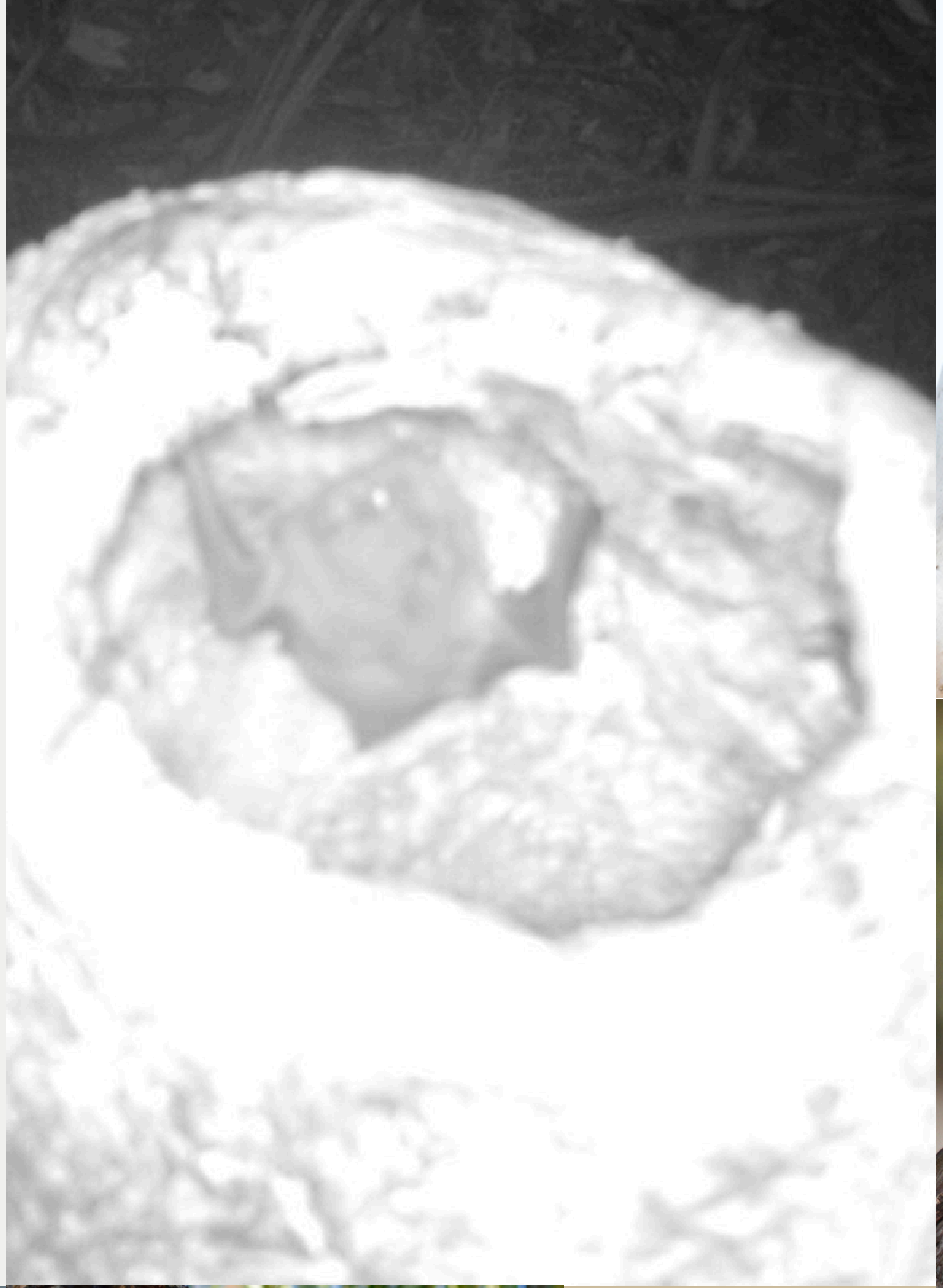
Types of artificial habitats

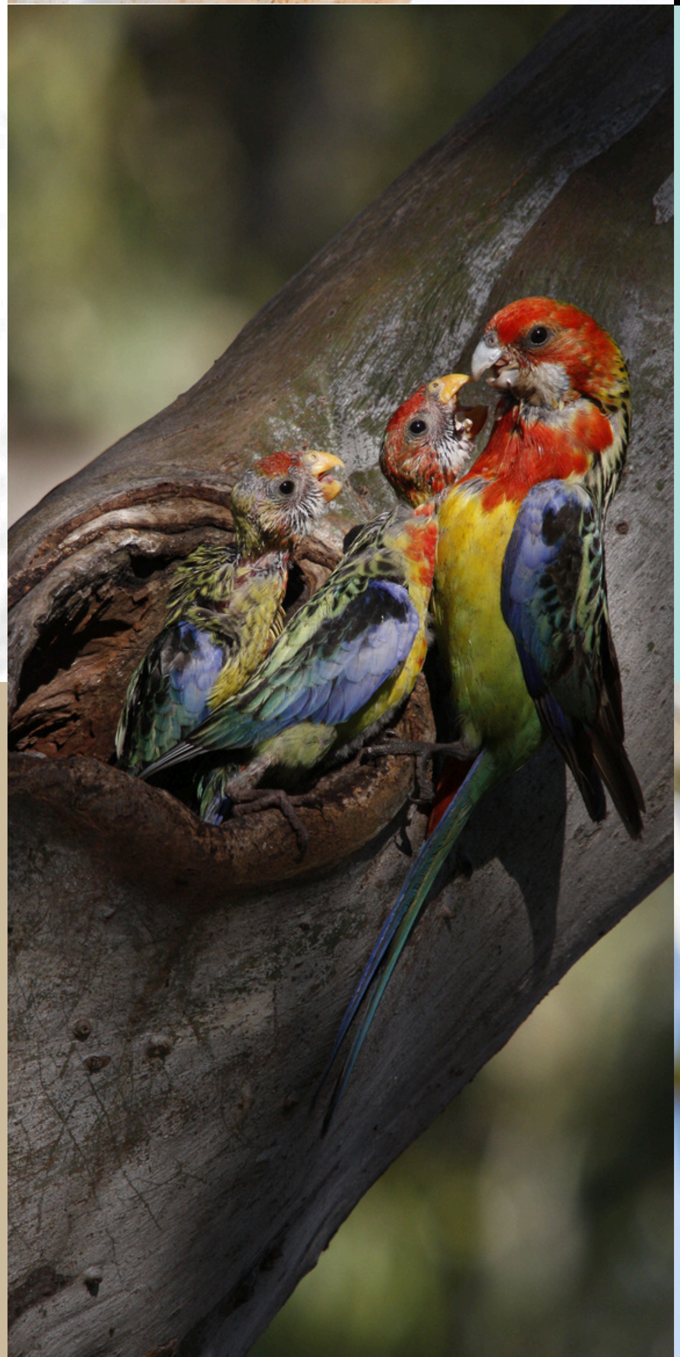
- Nest boxes
- Artificial nest
- Den
- Perches
- Refuges
- Roosts
- Gliding poles
- Road crossings

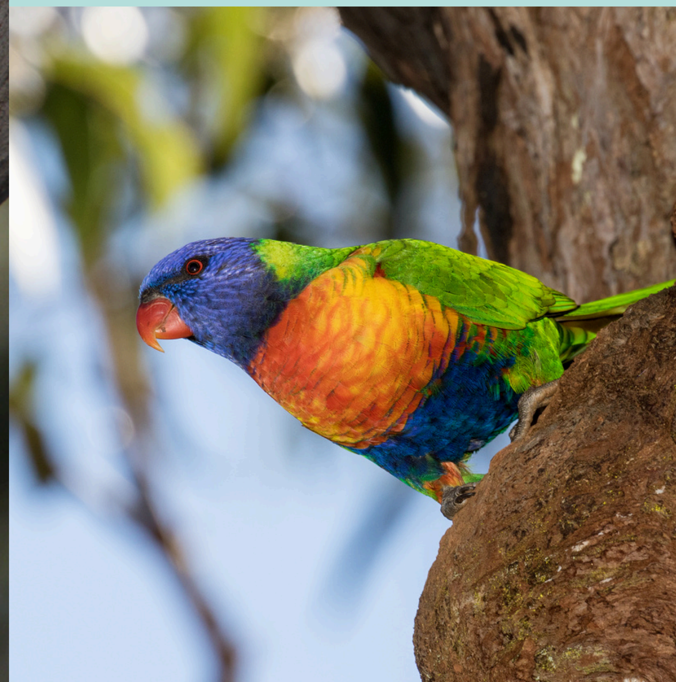
Nest boxes = mimic natural tree hollows

Tree hollows are a critical resource

Yet widespread land clearing is continuing globally





The Hollow Crisis

- Between 2000-2017 more than 7.7 million hectares of potential threatened species habitat was cleared across Australia
- 93% of this vegetation cleared was without federal approvals for threatened-species habitats
- Since 1990, more than 6.6 million hectares of mature forest have been cleared across Australia

We are now faced with a minimum of 100 years of declining hollow numbers before things may improve

HOW HOT IS THE COMPETION FOR HOLLOWS?


2019-02-20 12:56:14 PM M 3/3
34°C
HYPERFIRE 2 COVERT
RECONYX


2019-04-07 9:21:18 AM M 1/3
21°C
HYPERFIRE 2 COVERT
RECONYX


2019-04-26 8:44:09 PM M 1/3
12°C
HYPERFIRE 2 COVERT
RECONYX


2019-04-09 9:02:08 AM M 2/3
16°C
9
HYPERFIRE 2 COVERT
RECONYX


2019-02-20 11:18:18 PM M 1/3
18°C
HYPERFIRE 2 COVERT
RECONYX


2019-02-20 4:03:07 PM M 3/3
32°C
9
HYPERFIRE 2 COVERT
RECONYX


2019-02-20 6:15:56 PM M 1/3
28°C
9
HYPERFIRE 2 COVERT
RECONYX


2019-02-21 9:12:36 PM M 1/3
17°C
9
HYPERFIRE 2 COVERT
RECONYX

THE HOLLOW CRISIS

Under Australian conditions it takes a minimum of 80 to 120 years for a tree hollow to form naturally

AUSTRALIA HAS NO PRIMARY HOLLOW USERS

HOLLOW DEVELOPMENT IS INSTIGATED BY TREE DAMAGE

LARGE HOLLOWS TAKE HUNDREDS OF YEARS TO DEVELOP

THE PROCESS OF HOLLOW DEVELOPMENT CAN ALSO LEAD TO TREE FAILURE

THE HOLLOW CRISIS

Things will only get worse before they get better as tree clearing continues in Australia for a range of reasons

AUSTRALIA HAS NO PRIMARY HOLLOW USERSBETWEEN 2000-2017 MORE THAN 7.7 MILLION HECTARES OF POTENTIAL THREATENED SPECIES HABITAT WAS CLEARED ACROSS AUSTRALIA

WITHIN NSW ALONE, LLS HAS APPROVED 288,000 HECTARES OF NATIVE VEGETATION REMOVAL SINCE NEW LAND CLEARING CODES WERE INTRODUCED IN 2017 (AS OF AUGUST 2019!)

WE ARE FACED WITH A MINIMUM OF 100 YEARS OF DECLINING HOLLOW NUMBERS BEFORE THINGS MAY IMPROVE

WHY TIMBER NEST BOXES ARE NOT THE ANSWER

Nest boxes are on average 8 degrees hotter than tree hollows in Summer and can reach internal temperatures in excess of 50 degrees

Typically only last 8-10 years prior to failure

Used by many common and introduced species, but rarely by species of conservation concern

BUT THEY CAN BE PART OF THE ANSWER...

Well constructed, and routinely maintained nest boxes can offer greater longevity

Positioning of nest boxes can greatly reduce high temperature extremes

Providing habitat for even common species in urban and peri-urban environments can have multiple benefits

Thermal Profile

Recorded to be on average 8 degrees hotter in Summer than tree hollows

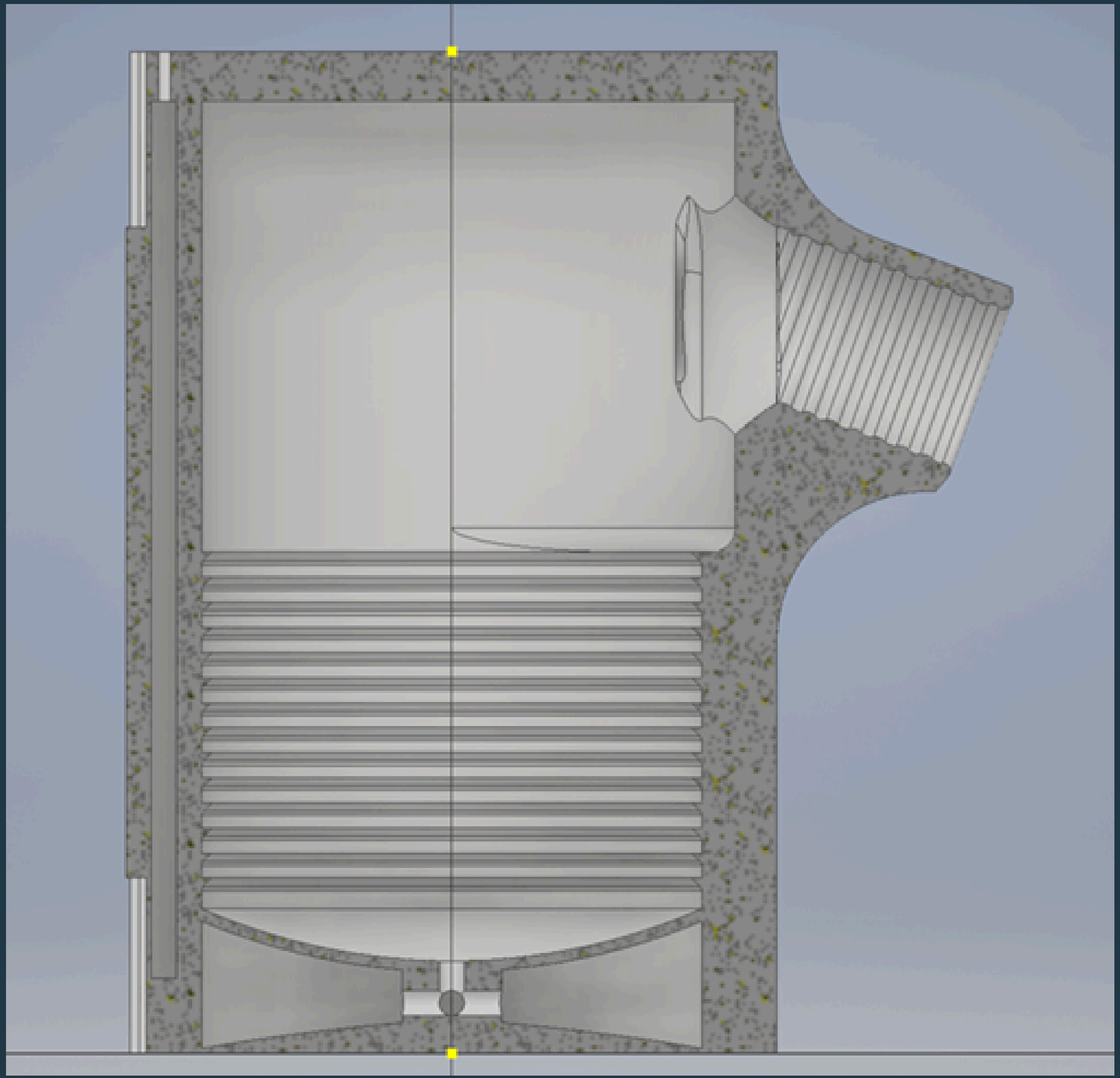
Longevity

High attrition rate with average nest box life of 8 to 10 years

Target Species

Known to support common species, but limited use by species of conservation concern

Issues with traditional timber nest boxes




5°C
#MOULTR

01

Feedback is priceless

Media for this project resulted in a signifcant amount of interest and feedback

02

Social media is ruthless

There is a very good reason that feedback through social media is for free!

03

Timber is key

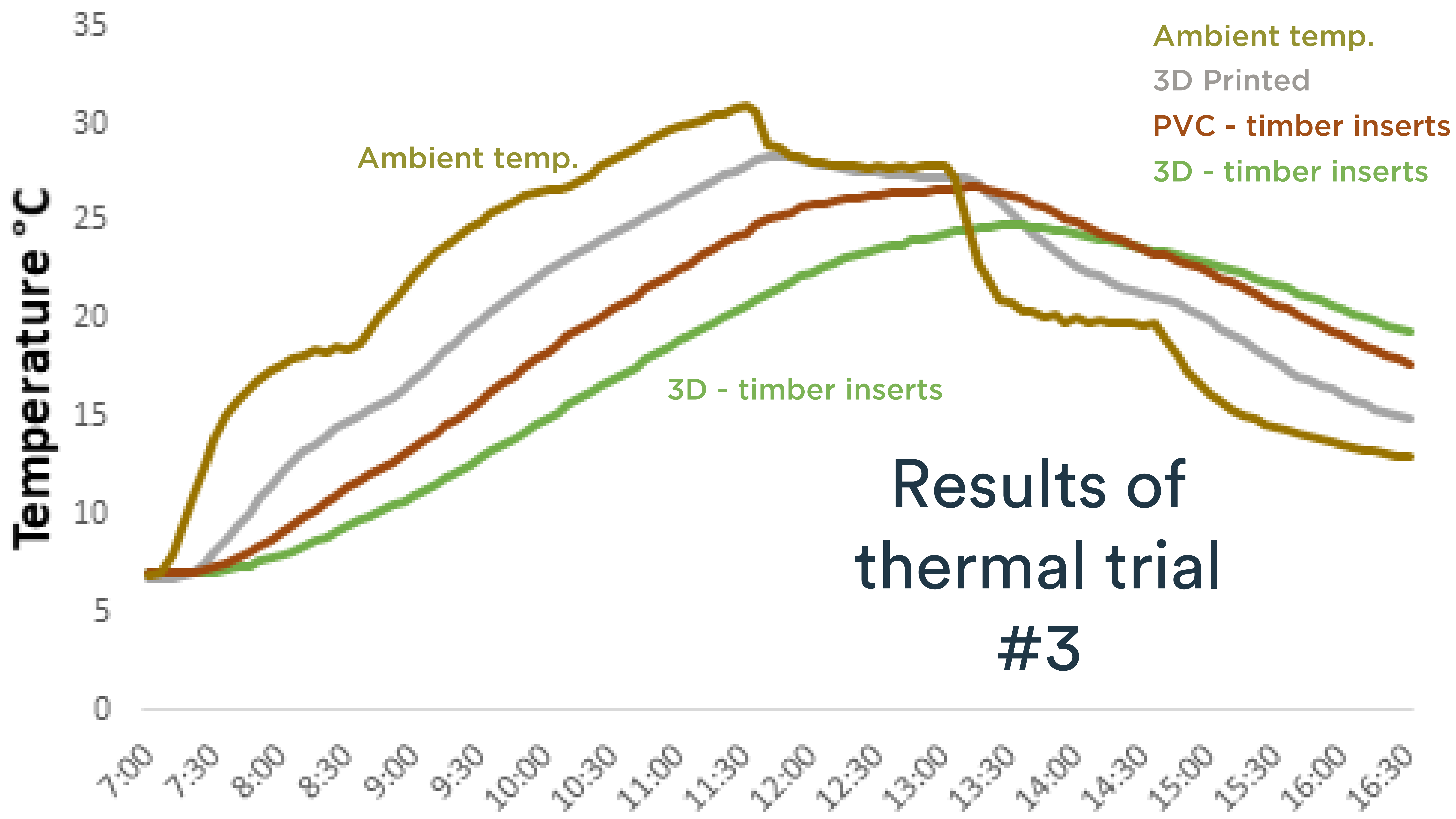
Despite our evidence, people could not believe that fauna will utilise a fully plastic nest box

04

The customer is always right

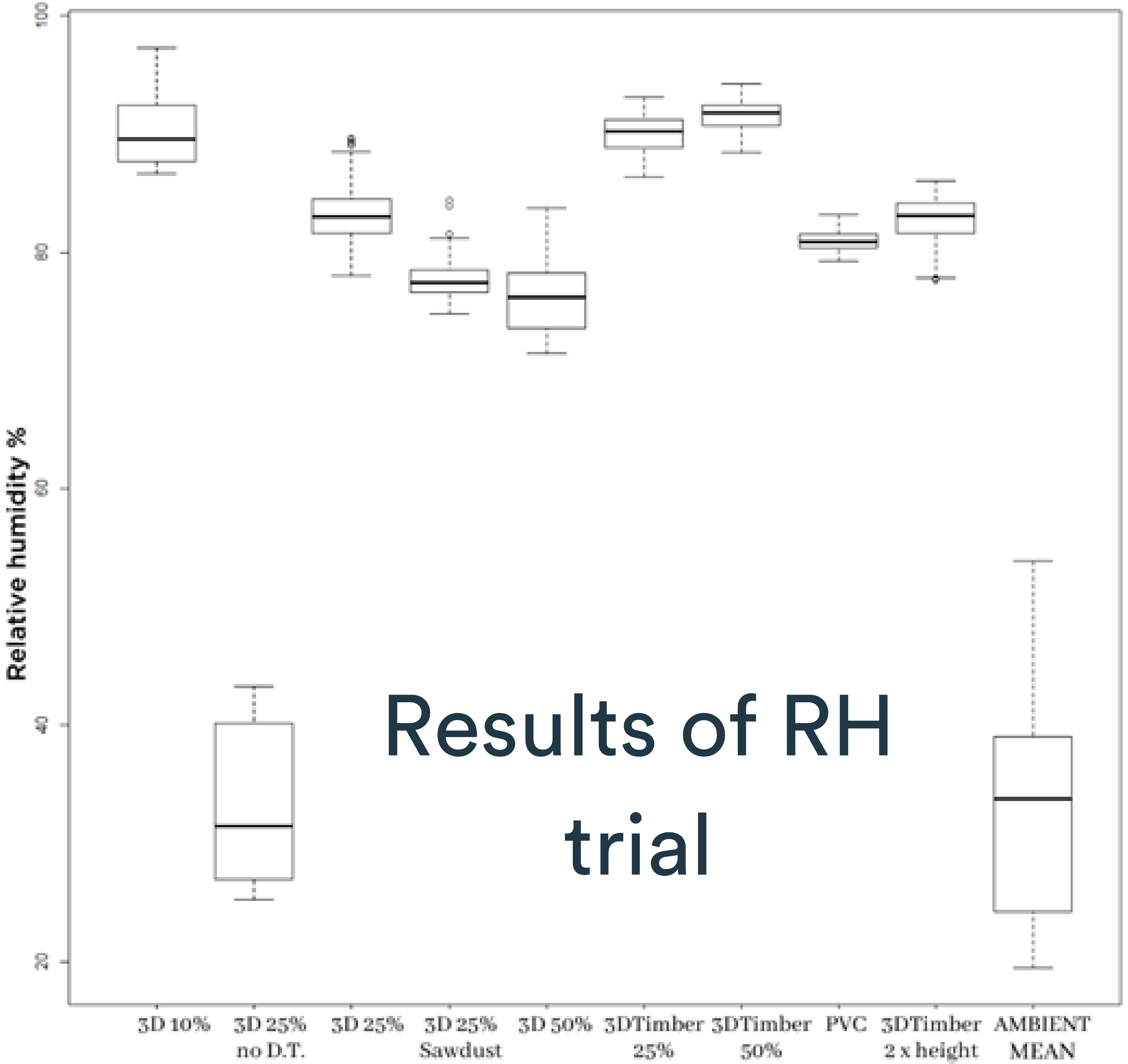
Even when the customer isn't the end product consumer. We needed timber.


12



Results of thermal trial #3

Results of RH trial



3D 10% - 3D printed at 10% density

3D 25% no D.T. - 3D printed at 25% (no mudguts/decomposed heartwood)

3D 25% - 3D printed at 25% density

3D 25% Sawdust- 3D printed at 25% density with sawdust in wall cavity

3D 50% - 3D printed at 50% density

3D Timber 25% - 3D printed at 25% density with timber inserts

3D Timber 50% - 3D printed at 50% density with timber inserts

PVC - PVC pipe with timber inserts

3D Timber 2 x Height - 3D printed at 25% density with timber inserts x two body modules

AMBIENT MEAN - mean RH % of three ambient monitoring thermochrons

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RESEARCH ARTICLE

Influence of nest box design on internal microclimate: Comparisons of plastic prototypes

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Abstract

Hollow-dependent fauna are declining worldwide, due primarily to the widespread clearing of hollow-bearing trees. Artificial cavities such as timber and plywood boxes are commonly used to increase hollow availability, yet there is increasing evidence that they are poor facsimiles of natural cavities, characterized by lower insulative properties and a shorter field life. We evaluated whether plastic materials could create a nest box with a stable thermal profile that more closely resembles the complex shapes and textures of natural tree hollows while containing fewer mechanical joins that represent potential failure points when installed. We developed three sets of prototype nest boxes comprising various combinations of plastic density (10%, 25% and 50%), insulation (single vs. double wall with or without sawdust between them), nesting chamber (with or without timber inserts) and bedding (with or without decomposed heartwood) and compared their thermal performance in a temperature-controlled laboratory to compare internal temperature and relative humidity. We found double-walled plastic nest box with an internal timber-lined chamber was best able to buffer ambient temperature fluctuations, consistently recording internal temperatures of 6+°C below maximum ambient temperature, maintaining high levels of relative humidity (76%–92%) when furnished with decomposed timber heartwood. This design also performed better during a simulated hot day; internal temperatures exhibiting twice the lag time of single-walled designs, noting that plastic density had little influence on internal conditions. While the recruitment and protection of hollow-bearing trees must be a priority, this work shows significant potential in improving the design and functionality of artificial hollows that are critical to the conservation of hollow-dependent species.

KEYWORDS
3D-printing, cavity, climatic extremes, heat wave, thermal ecology

Data presented can be found in the above research article published in Austral Ecology doi: 10.1111/aec.13272

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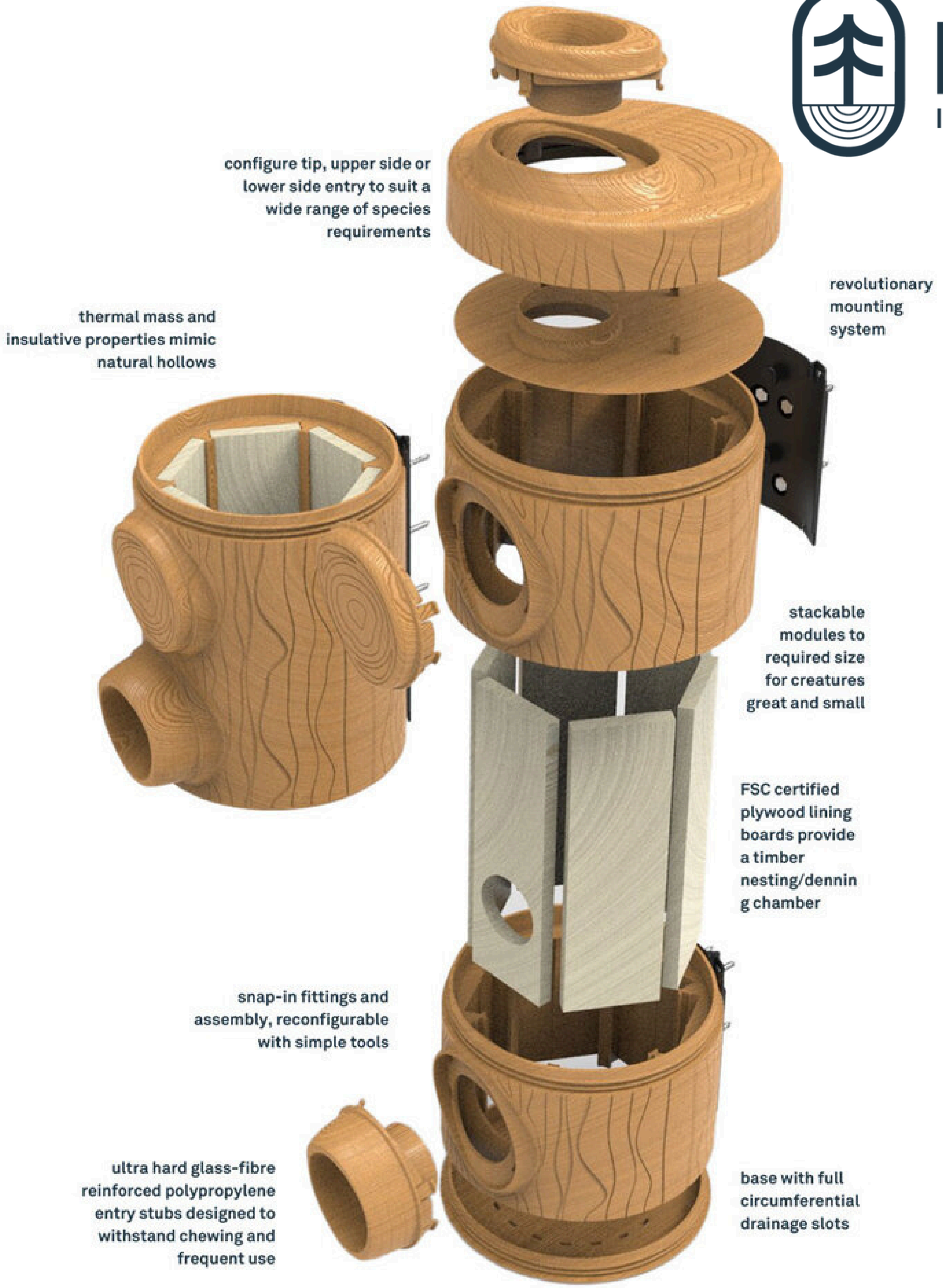

Thermal Profile

Comparable thermal profile to natural tree hollows, including high levels of humidity

Longevity

Constructed of glass reinforced, UV stabilised polymer for decades of life in the field

Target Species

Specifically configured to target species based on scientific literature by ecologists

Habitat modular nest boxes



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Small Gliders: Krefft's and Squirrel

Petaurus spp.

TREE HOLLOW REQUIREMENTS

Squirrel gliders (Petaurus norfolcensis) preferentially select hollow entrances in fissures in trunk and holes in branches over other hollow types. Entrance size of hollows appears to be the hollow attribute most important to squirrel gliders with Eucalypts exclusively used as refuge trees (Beyer et. al. 2008).

Dens with entrances of 3 to 5 cm are most frequently used by squirrel gliders with a den entrance height average of 6.8 +/- 1.2 m in QLD and 11.9 +/- 1.3 m in NSW, with tree height likely to influence this. Of 29 known den entrances, 18 faced north or east (Beyer et. al. 2008).

Other work more focused on nest box use by squirrel gliders suggests that a height of < 3.5 m is preferable for this species (Durant et. al. 2009).

Preference is for hollows in large trees, although this may be due to hollow availability (Durant et. al. 2009; Crane et. al. 2008). Will use live or dead eucalypts with a preference for hollows located on slopes rather than flat areas (Crane et. al. 2010).

There is extensive evidence of use of nest boxes by sugar gliders, krefft's gliders and savannah gliders with various nest box publications having boxes with recommended dimensions. Entrance size varies from 25 - 50 mm diameter; box width 200 - 220 mm; box length 200 - 250 mm and box height 300 - 500 mm (Shanahan et. al. 2008; Ridgeway 2019; Birdlife Australia 2021.

HABITAT AUGMENTATION

Providing suitable roosting habitat for small gliders is proposed to be done through the provision of double unit Habitech nest boxes. The internal chamber of these nest boxes measure 450 mm in depth/height with an internal diameter of approximately 225 mm. These boxes will be provided with a large 'branch stub' entrance, with an entrance hole diameter of 38 mm.

The nest boxes will be provisioned with a bedding material of eucalypt fines to small chips in order to provide a suitable

Habitech 2 unit nest box featuring a side entrance, into a 225 x 225 mm denning chamber

bedding substrate, as well as to regulate humidity within the nest/den box. Nest boxes would be installed at heights in the range of 4 to 15 metres.

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Gang-gang Cockatoo

Callocephalon fimbriatum

TREE HOLLOW REQUIREMENTS

Gang-gang Cockatoos select hollows in upright to steeply sloping hollows in the trunks of large trees, or sometimes in significant limbs where appropriate hollows are available. Hollows are often at considerable heights - 20 to 30 metres above ground - and often 1 to 2 metres in depth (1).

While there is limited knowledge of exact specifications for Gang-gang Cockatoo nest hollows in contemporary literature, some records are available. Hollow heights are variously recorded as being at least 9 metres above the ground (2), to 18 -21 metres above the ground in dead limbs of huge, living trees (3).

A detailed study of Gang-gang breeding hollow measurements from Canberra identifies hollows within a range of eucalypts with hollows located in the trunks or primary limbs of trees only. Hollows either had entrance holes in the trunks of trees, or were spout (open topped) hollows.

Hollow height entrances ranged from 4.5 to 8.5 metres above the ground with hollow entrance dimensions range being 100 - 250 mm high x 70 - 320 mm wide. Hollow depth ranged from 330 - 720 mm with internal floor diameters ranging from 200 - 260 mm (4).

HABITAT AUGMENTATION

Providing suitable nesting habitat for Gang-gang Cockatoos will be completed through the provision of a triple-unit Habitech nest boxes. These nest boxes have an internal chamber measuring 675 mm in depth/height with an internal diameter of approximately 225 mm. The boxes will be provided with a large entrance through the lid, measuring 135 mm x 185 mm. This design replicates a large spout hollow as used by this species in Box-gum woodland.

The nest box will be provisioned with a bedding material of eucalypt fines to small chips in order to provide a suitable bedding substrate as well as to regulate humidity within the nest/den box. It is recommended that the nest boxes be hung at minimum heights of 6 m in eucalypt trees when being installed in Box-gum woodland environments.

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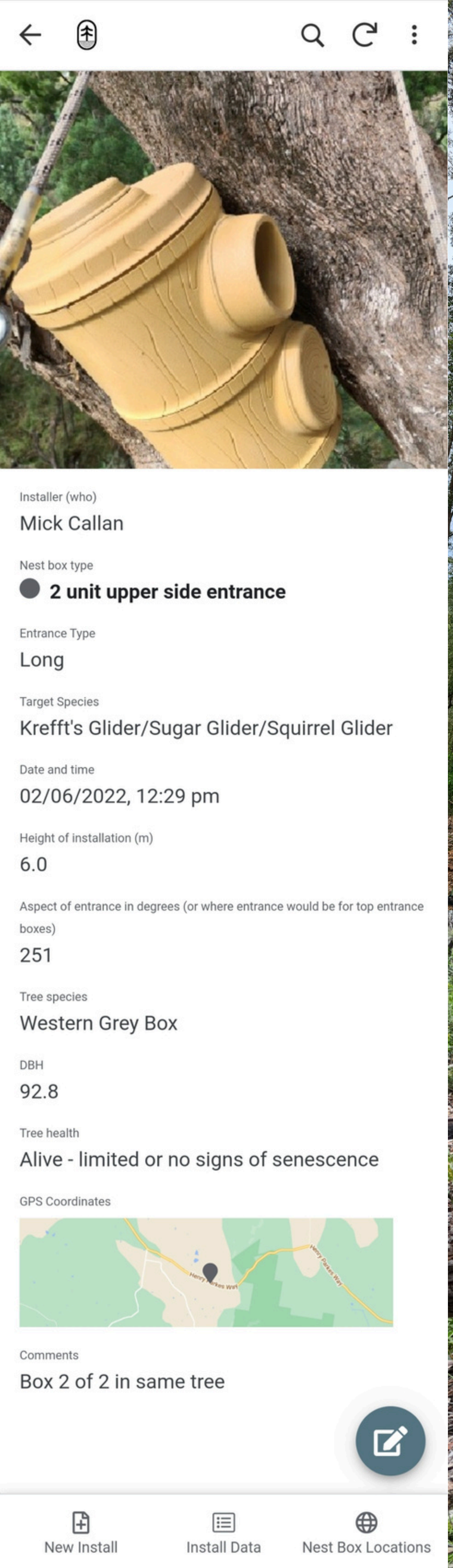
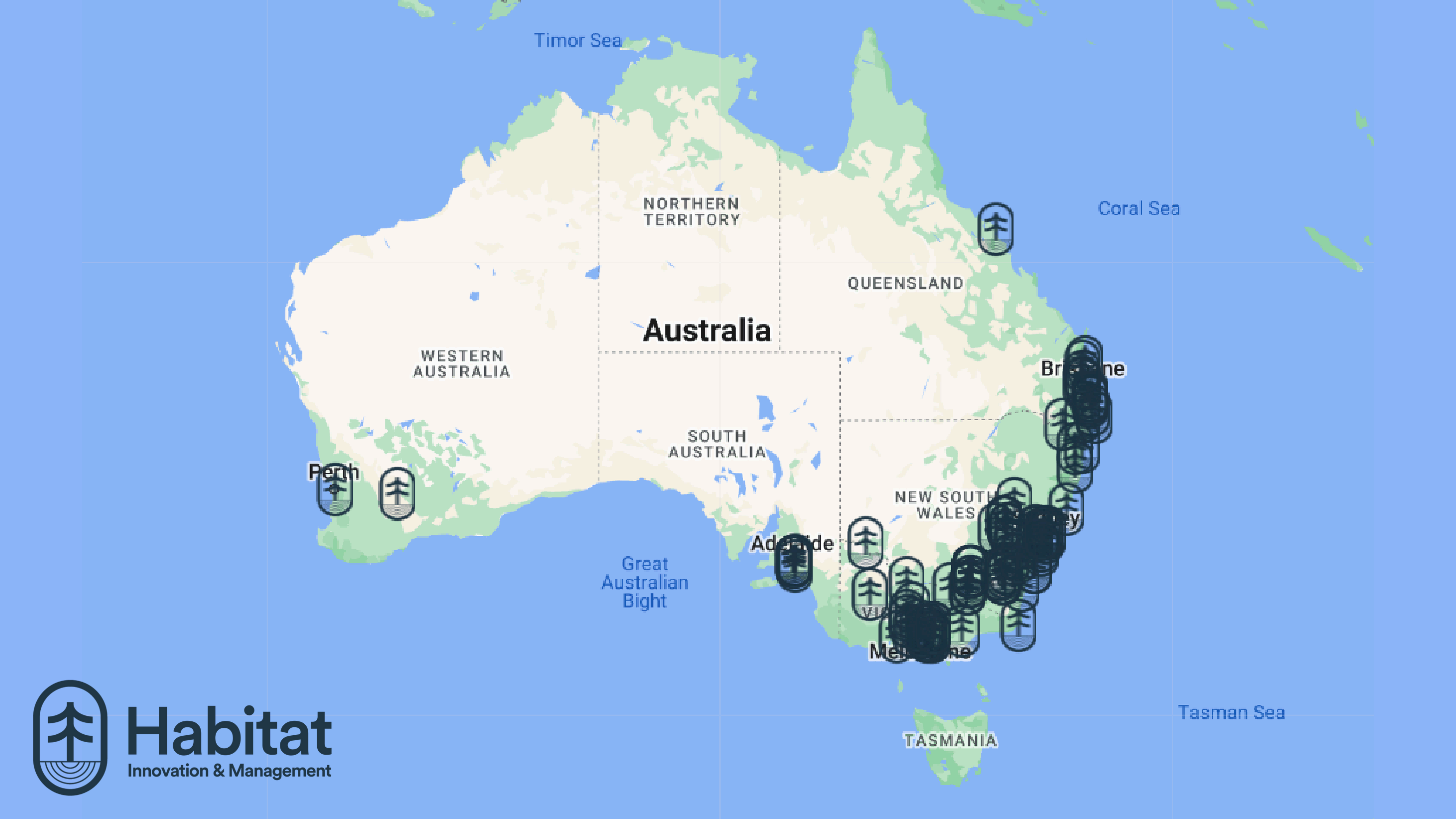

Installer (who)
Mick Callan
Nest box type
2 unit upper side entrance
Entrance Type
Long
Target Species
Krefft's Glider/Sugar Glider/Squirrel Glider
Date and time
02/06/2022, 12:29 pm
Height of installation (m)
6.0
Aspect of entrance in degrees (or where entrance would be for top entrance boxes)
251
Tree species
Western Grey Box
DBH
92.8
Tree health
Alive - limited or no signs of senescence
GPS Coordinates
Comments
Box 2 of 2 in same tree
New Install
Install Data
Nest Box Locations



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Krefft's Glider


ID:0003
90%
2022/09/13
15:57:17


Australian Wood Duck
100%
2023/10/12 09:21:51 23℃ 73F TRAPS.COM.AU

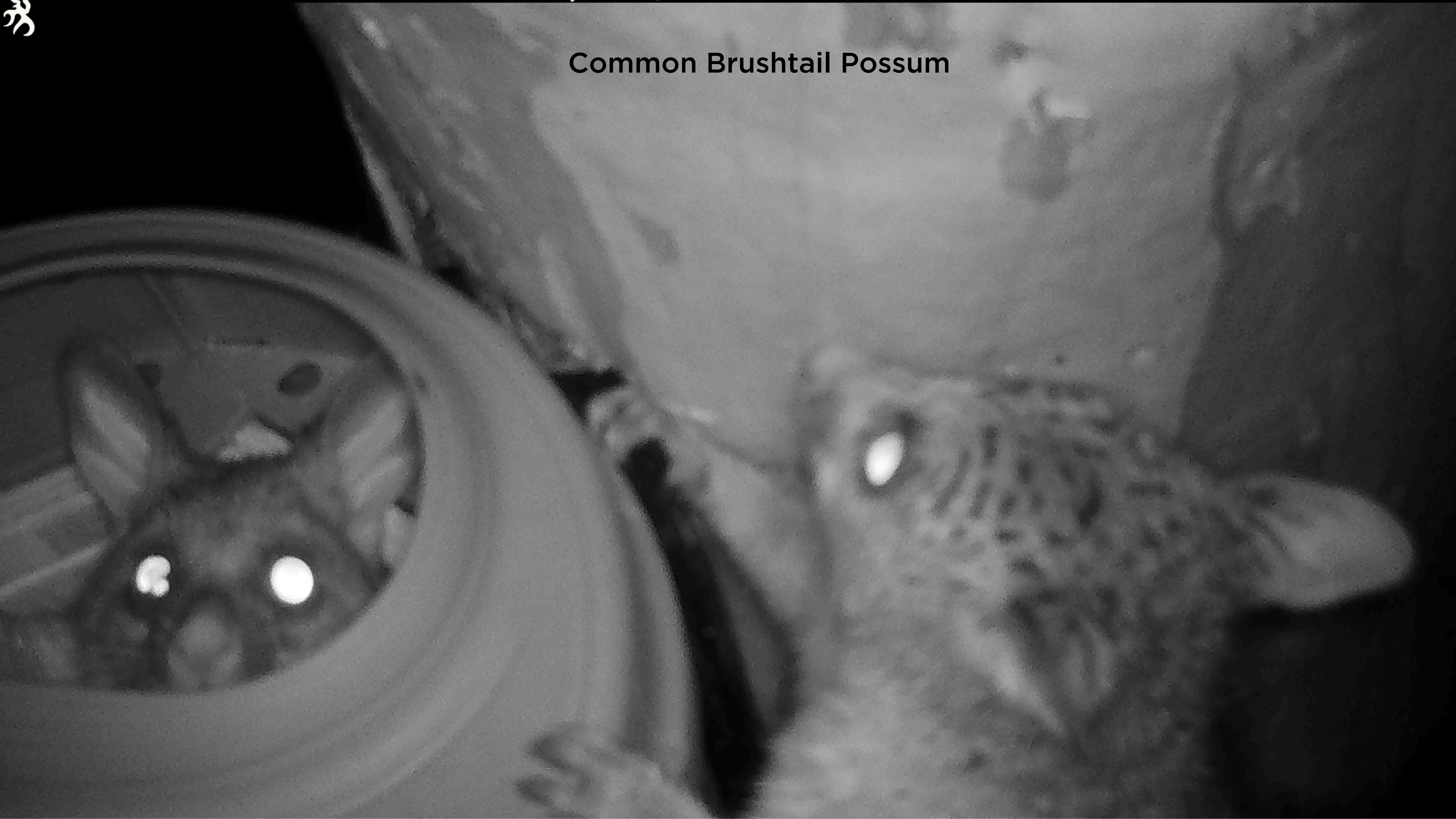

Common Brushtail Possum


Microbat sp.
0023 050F 10°C 04/22/2022 00:09:50

Crimson Rosella


2023-05-03 5:51:47 AM M 2/3
11°C
Sugar Glider
HC500 HYPERFIRE
RECONYX


White-throated Treecreeper
0002 055F 12C 04/08/2022 10:48:34


Common Brushtail Possum


Southern Greater Glider


Squirrel Glider


2022-08-02 19:54:33
M 1/3
4°C
Feathertail Glider
KQ03
RECONYX

Eastern Rosella

Owlet Nightjar


Krefft's Glider


Southern Greater Glider
TRAPS.COM.AU
80%
2024/06/04 17:25:27
3℃ 37℉ Camera1


2023-01-15 4:29:14 PM M 2/3 39°C
Lace monitor
HC500 HYPERFIRE
RECONYX


Rainbow Lorikeet

Custom roosts for Golden-tipped bats

- Golden-tipped bats roost in abandoned nests of Yellow-throated scrubwrens
- Habitat Innovation and Management have developed a custom 3D printed roost

CHAINSAW AND CARVED HOLLOWS

Mounting evidence that chainsaw carved hollows provide thermal properties equivalent to natural hollows

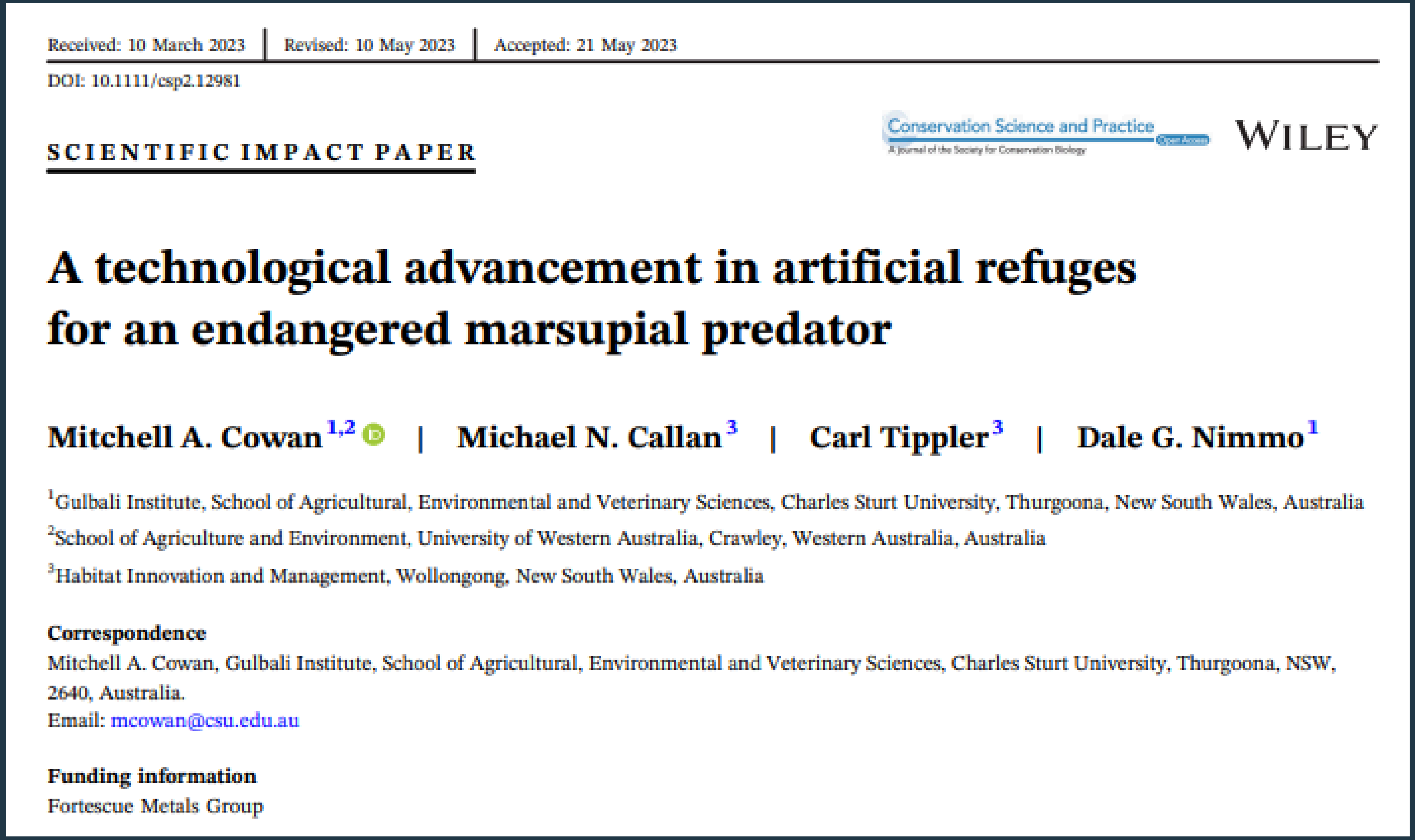
Are able to successfully provide habitat for a range of species

Major limitations relate to the size of hollows that can be safely installed

Artificial dens = mimic excavated and natural burrows or dens

Habitat Marsupial den design and development

- Approached by Fortescue metals
- Collaboration between Habitat Innovation and Charles Sturt University
- Designed specifically to suit the dimensions and specifications of Northern Quoll (Endangered species) dens
- Suitable for other ground dwelling species such as echidnas, antechinus, bandicoots, native rodents etc.
- Currently are deployed in fire affected areas, predator free release zones, and as supplementary habitat to disturbed areas
- Designed to preferentially exclude pest predators such as feral cats and foxes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DOI: 10.1111/csp2.12981

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WILEY

SCIENTIFIC IMPACT PAPER

A technological advancement in artificial refuges for an endangered marsupial predator

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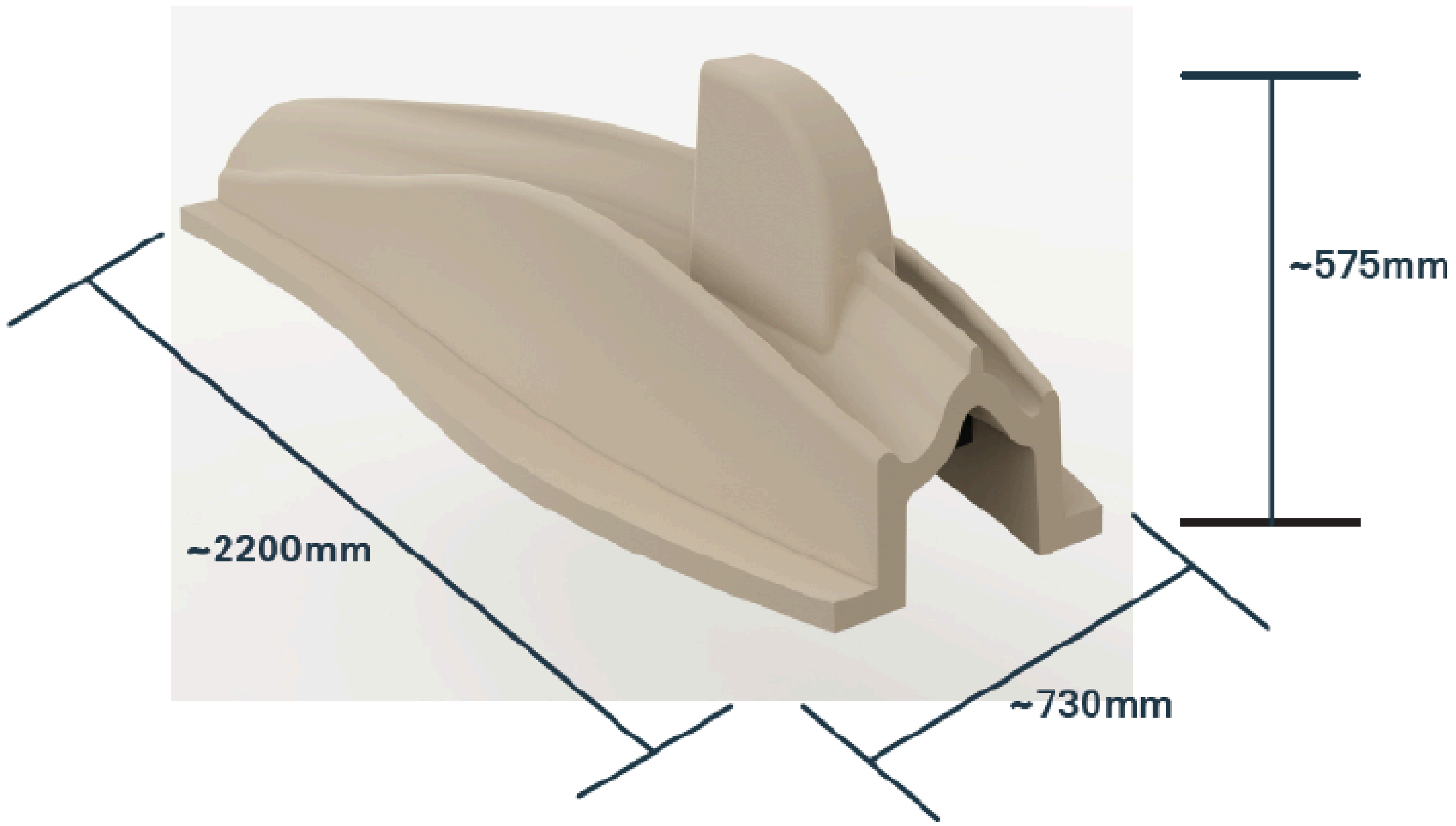
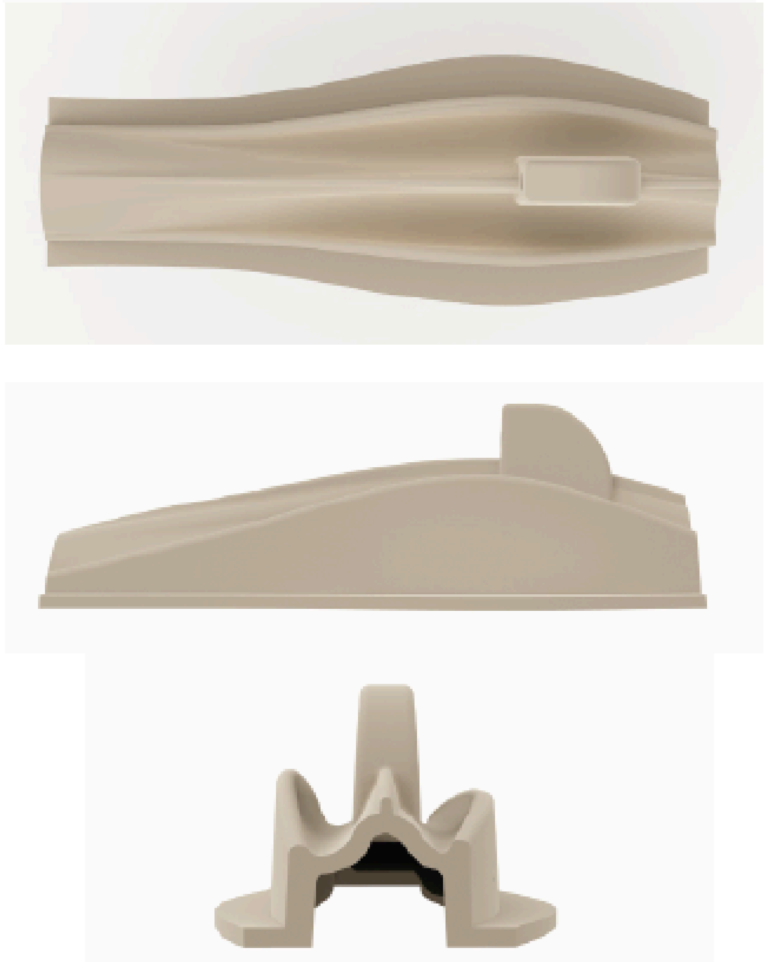
Funding information
Fortescue Metals Group

Marsupial Den Size Scale

Two colour options - made to blend into different landscapes
Woodland Grey
Pilbara Red





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Installed marsupial den built to blend in with the natural environment and being monitored by a motion sensored trail camera

Marsupial Den installed in the Pilbara, Western Australia

Raptor platforms = mimic platforms/ideal locations for raptors to construct nests

Artificial nests = mimic abandoned or inactive nests of other species that the raptor uses for breeding

Raptor platform vs artificial nest

Some raptors (birds of prey) build their own nests, and others use inactive/abandoned nests of other species

Wedge-tailed Eagles construct their own nests

Black Falcons use inactive nests of corvids

Therefore to provide nesting habitat for raptors, some need us to build the who nest for them (artificial nest) while others just need a solid platform to build their own (raptor platform)

Raptor platform construction process

Constructed raptor platform

Relevant Publications

- Cowan, M., Callan, M.N., Watson, M. J., Watson, D., Doherty, T. S., Michael, D., Dunlop, J., Turner, J., Moore, H., Watchorn, D., & Nimmo, D. (2021). Artificial refuges for wildlife conservation: what is the state of the science? Biological Reviews.
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