CSU Sustainability Grant Project Report

(Dot point answers are acceptable)

1. **Title of project: Artificial tree hollows – thinking outside the box**
2. **Project aims:**

1	Identify if 3D printing can create an artificial hollow with thermal properties that are equivalent to a natural hollow
2	Compare how 3D printed hollows compare to timber nest boxes in terms of installation and maintenance
3	Assess what are the benefits of 3D printed hollows for habitat improvement in terms of both initial design and ongoing occupancy

3. **Project team and other key stakeholders:**

Name	*Position*	*Department*
Prof. David M Watson	Professor of Ecology	School of Environmental Science
Michael N Callan	Graduate Bach. of Science (Honours)	School of Environmental Science
Shahid Ramazan	Laboratory Manager	School of Engineering

4. **In what year/timeframe did you receive funding for your project?**

From:	*10/2018*	*To:*	*10/2019*

5. **Inputs: budget versus actual expenditure**

Please complete the below table if you are unable to attach the grant acquittal statement.

Expenditure item	*Budgeted amount*	*Actual spent*
Design work – 3rd year Engineering Student	750	750
Production of 3D printed tree hollows	2,000	15,672
20 Hygrochron temperature and humidity data loggers and fobs	3,696	3,848.9
Reconyx HC 600 Hyperfire motion-triggered cameras	3,520	4,699
Sandisk 32GB SD Card	640	280
TOTALS:	**9,856**	**25,249**

6. Project timeline:

Step	*Brief description of activities implemented*	*Timing*
1	Literature review	12/2019
2	Hollow design and printing	04/2019
3	Hollow installation	05/2019
4	Hollow monitoring, data collection and assessment	10/2019
5	Dissemination of results, publishing	02/2020

7. Headline project achievements:

1	Design, manufacture and field testing of 20 small and 3 large 3D printed artificial hollows
2	Temperature controlled laboratory testing confirming that 3D printed artificial hollows closely resemble the thermal performance of natural tree hollows
3	Project has resulted in a patent for the design of artificial hollows with commercial production due to commence in late 2020

8. Photographs/images: *(Please attach before and after on ground activities, if relevant)*

9. Project outputs: *(As agreed to in the proposal Eg. courseware, tangible tools, maps, infrastructure, signs, catalogue etc.)*

1	23 x 3D printed artificial hollows produced – exceeding the agreed outputs by 3.
2	All artificial hollows were fitted with hygrochrons to measure the temperature and humidity within each artificial hollow, with additional hygrochrons used to record ambient temperature and humidity, as well as natural hollows – exceeding original agreement
3	All artificial hollows were monitored with remote-triggered cameras to record fauna visitation.

10. Project outcomes:

a. Participant/stakeholder **reactions** *(Include any quotes or feedback from stakeholders positive or negative.)*

This project received attention through print and social media with many comments on social media suggesting that people were dubious about the potential for plastic nest boxes to be utilised by fauna. Many other comments were more positive with people applauding the ingenuity of the project, as well as the objectives to find a suitable alternative to timber nest boxes.

b. To what extent has your project contributed towards any changes in **knowledge, attitudes, skills and aspirations** regarding sustainability? *(Please summarise your evidence.)*

One of the key issues with timber nest boxes is the short-term life in the field – typically only lasting in the range of 8-10 years. This project has demonstrated that plastic nest boxes can outperform timber nest boxes in terms of internal microclimate, but are also anticipated to have a service life in the order of 50 years. This means that a single plastic nest box would be significantly less resource intensive than the equivalent 5 timber nest boxes that would be required to provide habitat for an equivalent period. Additionally, as this design has led to a patent and proposed commercial manufacture of plastic nest boxes, that would be composed of 100% recycled plastic, it is considered that the re-use of waste material for wildlife habitat is major sustainability success.

c. To what extent has your project contributed towards **behaviour change** around sustainability? *(Please summarise your evidence.)*

This project has the potential to change the nest box industry in Australia and abroad. The use of a long-life, recycled and recyclable material to manufacture nest boxes could see a drastic reduction in the use of timber nest boxes in the long term. As it is anticipated that this form of artificial hollow would have a service life some five times that of timber nest boxes, this could result in a significant reduction in the use of timber for this purpose in the long-term.

d. **Impact – The most significant change** approach involves generating and analysing personal accounts of change and deciding which of these accounts is the most significant – and why.

There has been an almost universal desire from people within the environmental field, who have been exposed to this project, to want to get behind this project, trial the use of plastic artificial hollows, and even invest in the commercial manufacturing of these as a marketable product. This is an extraordinary change from the initial feedback online, prior to field trials, where the majority of comments were negative due to putting plastic into the environment, the fear that plastic hollows would be thermally inappropriate, that target species would reject plastic, among other concerns. Once people understand that the product is actually less resource intensive in the medium to long term than the equivalent wooden nest boxes, and that they have improved thermal properties, there is a significant change in attitudes.

Briefly **list the changes** that occurred as a result of this project. *(Positive and/or negative)*

1	Unique collaboration between School of Environment & School of Engineering
2	Introduction of a new way of thinking about artificial hollows – potentially the first real revolution in nest box design in 3,000 years
3	Confirmation that well designed and engineered nest boxes can provide a thermal microclimate similar to that of natural tree hollows

e. Select one change that you feel is **the most significant change** and **explain why** you selected this change? *(Justify)*

Many common and introduced species in Australia, as well as most hollow-dependent mammals, will readily accept nest boxes. For many threatened species though, there is little to no evidence of use of nest boxes. One common theory for this is that the thermal properties of timber nest boxes experience large fluctuations in temperature being colder than ambient temperatures in cool weather, and significantly hotter than ambient in warm weather. Natural hollows are much better insulated and are able to buffer temperature changes to provide a stable temperature profile.

Mammals and many of the introduced bird species will typically construct some type of nest or den that is likely to assist in insulating the nest/den and buffering temperatures, but for most native birds species there is no nest construction at all, leaving them more vulnerable to temperature fluctuations. Creating an artificial hollow that successfully buffers temperature peaks could be a game-changer in being able to attract previously unrecorded species to utilise artificial structures.

f. Briefly describe what was the situation like **before** your project?
As outlined above, many threatened species and species of conservation concern are not known to utilise artificial hollows/nest boxes which may be due to the thermal profile within these structures. Additionally, timber nest boxes have a typical lifespan of 5-10 years prior to needing significant repairs or replacement.

g. Briefly describe what is the situation like **now** at the conclusion of your project?
(Additional supporting materials may be supplied to demonstrate before and after scenarios if desired.)

This new type of artificial hollow is anticipated to have a field life in the range of 50 years while maintaining a stable thermal profile. It has the potential to revolutionise the artificial hollows/nest boxes market in Australia and beyond, potentially aiding the recovery of a range of threatened species that are declining in numbers due to a lack of natural hollows and the unsuitability of current nest box designs.

11. Amendments to the project - What did not go so well?

1	This project suffered significant delays as the 3D printers at the School of Engineering were unable to produce the required designs. This resulted in the private purchase of several 3D printers that added significant time and expense to the project.
2	Due to the manufacturing delays, many of the field trials were monitored outside of the core breeding season for the target species.
3	One artificial hollow was vandalised and destroyed. Fortunately, this occurred after the completion of the monitoring period and did not impact on our results.

12. What were the key lessons learnt?

1	Well designed 3D printed artificial hollows with an incorporated timber nesting chamber can provide a much more stable thermal profile than timber nest boxes, more approximating those of natural hollows.
2	With current 3D printers available to the home hobbyist, it is not practical to 3D print suitable nest boxes due the materials being unsuited to long-life in field conditions.
3	In field trials there are many species that investigated the artificial hollows showing that the use of plastic is not a deterrent to native fauna.

13. Recommendations for the future:

1	This collaboration between the School of Environmental Science and School of Engineering has shown that cross-school collaboration on research projects can provide innovative and exciting research outcomes and should be encouraged in the future.
2	Further trials should be conducted in the future to determine the most appropriate bedding material to be installed in artificial hollows, as our preliminary findings suggested that this can play a significant role in both temperature and humidity stabilisation.
3	Further field trials should be conducted during peak breeding seasons to determine if native fauna will successfully reproduce in plastic artificial hollows.

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