Volume 46 April 2021

CONSULTING ECOLOGY

www.ecansw.org.au ISSN 1836 – 6813

Journal of the Ecological Consultants Association of NSW

VOLUME 46 April 2021

INSIDE THIS ISSUE!

Front Cover Photo: Green and Golden Bell Frog *Litoria aurea.*

Courtesy of Nick Weigner

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ECA COUNCIL MEETINGS

The ECA Council meet every three months to discuss and deal with any current business of the association. Any member who wishes to view the minutes from any of the ECA council meetings may do so by contacting the Administration Assistant Amy Rowles admin@ecansw.org.au

Message from the President

Dear Members,

The role of the ECA is to represent the interests of our members, provide training opportunities, provide relevant information, keep up to date with changes that will impact our members and industry, encourage and promote membership and support areas of research that will benefit our industry. ECA meets its obligations via the ECA council and a number of sub committees which deal with:

- Annual conference organisation
- Training and information workshops
- NSW Government Liaison (DPIE)
- Commonwealth Government Liaison (DAWE)
- CPEC accreditation
- Annual student grant scheme
- Publication of the ECA journal.

While training and information workshops were not available in 2020 due to Covid, the ECA has been busy making sure that obligations to its members are being met.

This year we will once again be holding our Annual conference, Annual General Meeting and a workshop in Wollongong (Covid restrictions permitting). Details of the program will be provided soon, but we expect to provide an interesting conference concentrating on subjects that often get overlooked in addition to a topical workshop on the new East Coast PCT mapping and how to use the VIS to determine PCT's.

The ECA is planning a workshop regime to start up later this year or early 2022 with a back to basics approach dealing with topics such as flora and fauna survey methods to address changes to survey requirements. If you have any suggestions on workshops you would be interested in attending, please contact a councillor and let us know.

An ECA councillor has been attending stakeholder meetings with DAWE with regards to the EPBC Act review. The committee have taken on board the official review study and comments from public submissions. They have processed these and are working on changes to address shortfalls and issues. It appears there will not be so much an overhaul of the legislation itself, but more an overhaul of the procedures in places that are failing to achieve intended outcomes. If you would like to know more about what is going on, please see the short article in this copy of the Journal.

Liaison meetings with NSW DPIE, where we raise issues around the BAM and its execution are due to be held and the relevant subcommittee is hoping to hear more on this from DPIE soon. Last year a number of issues were raised by ECA representatives at these meetings including The Biodiversity Credit Market and the Role of the Biodiversity Conservation Trust, Koala Habitat SEPP and Linkages to the BOS, Offset and Survey Requirements for Microbats in Man-made Structures, Assessor Accreditation and Renewal and Membership of the BAM Accreditation Panel.

The CPEC program is still seeking experienced elders from the consulting industry to sign up and the relevant subcommittee is working on ways in which this can be encouraged.

Applications for the 2021 student grants have been received and are currently being reviewed by the student grant subcommittee.

The publication team have given their time to prepare this issue of our journal and I am sure you will find the articles within of interest.

Provision of information relevant to members as it comes to hand is also an important role of the ECA. Our administration officer regularly forwards information received to members and the ECA council has also established an ECA Facebook page. Information is regularly added to the Facebook page covering a range of topics such as disruption of shorebird behaviour due to vehicle access to beaches, recent results from research into the Regent Honeyeater, latest on the Koala SEPP, digital white cards, camera trap projects, etc.

Covid 19 has caused many people across the world and in Australia great difficulties, disruption and personal loss. We are extremely lucky that our industry appears to suffered little impact and that business has remained strong in our sector. This is supported by the steady stream of job advertisements appearing on our webpage.

So, if you are a member of the ECA please be assured that the ECA council is doing its best, at a very busy time for our industry, to meet its obligations to its members.

Best wishes

Belinda Pellow (*Acting President*)

PHOTO COMPETITION

Congratulations! to ***Nick Weigner*** for winning the last photo competition with his photograph featured on the front cover of *a* Green and Golden Bell Frog *Litoria aurea*.

Thank you to everyone who entered our photo competition. As we received so many entries, we have retained a random selection for the next competition. All entries for this competition have been included in the ECA Photo Gallery on the back cover and centre pages.

Email your favourite flora or fauna photo to admin@ecansw.org.au to enter a competition and have your photo on the cover of the next ECA newsletter. Win your choice of one year free membership or free entry into the next ECA annual conference. The winner will be selected by the ECA council. Runners up will be printed in the photo gallery. Please ensure that your photo is clear with a high resolution.

Photos entered in the competition may also be used on the ECA website

FOR SALE / WANTED

If you have 2nd hand ecological equipment that you would like to sell or would like to purchase you can place an ad in this newsletter. Free for members or $40 for non-members. Contact admin@ecansw.org.au.

INTERESTING OBSERVATIONS, TIPS AND FACTS

Scattered Trees and Widely Cultivated Native Species

Ian Colvin, GeoLink

Appendix B of BAM 2020 addresses the requirements for assessing 'scattered trees'. The module utilises three definitions for scattered trees, two of which reference *"ground cover species on the widely cultivated native species list"*. The BAM provides this definition:

"Widely cultivated native species: a variety of a native species developed in cultivation, usually for the purposes of agriculture, forestry or horticulture, and which, when reproduced retains its distinguishing features, and any native species listed on the high threat weeds list published in the BAM-C".

I made an enquiry to DPIE about this mysterious list in November 2020 and have followed up twice since then. The final response received (late April) is as follows:

Unfortunately progress on the widely cultivated native species list has been impacted by competing priorities and is now anticipated to be released in the third quarter of 2021. Our previous advice has not changed i.e. When the list is finalised and approved, it will be published on the BAM-C home page with the high threat weeds list.

In the interim, if you have a BAM assessment that the widely cultivated native species list is required for, please reply by outlining as many relevant details as possible for assistance. As you have referred to, relevant details will need to align with BAM 2020 Appendix B (for scattered trees) or D (for planted native vegetation) and the glossary definition of widely cultivated native species.

In the absence of this information, using the scattered tree module seems basically unworkable! Any feedback from others as to information and/or practice with this issue would be helpful.

Water Rat Tracks a Long Way from Water

Andrew Lothian, Biodiversity Monitoring Services

Interesting find from camera trap positioned over a sand pad on Newnes Plateau, a long way from any significant creek lines or body of water. Maps suggest the site is at least 400m from the nearest drainage lines (which are unlikely to contain any water flows). Likely sources of nearby water are the Wollongambe River 1.1km to the south west and south east of the site. The nearest water source to the north is 2km away (Dumbano Creek). A quick Bionet search reveals three close sightings; the Lithgow drinking water supply dam, the Wollongambe River near Mt Wilson, and the Wolgan River near the old Newnes township. Photos were confirmed by a colleague who has experience in tracking Water Rats around Sydney Harbour.

Eastern Pygmy-possums Survive the Fire

Andrew Lothian, Biodiversity Monitoring Services

After an absence of Eastern Pygmy-possums from post fire surveys on Newnes Plateau in Spring 2020, we have had our first record for 2021 in one of our nest boxes. These were made by the Lithgow Womens Shed after the Gospers Mountain fire destroyed extensive areas of habitat around Lithgow in December 2019.

When is a Gumnut Not a Gumnut

Rebecca Hayes, Hayes Environmental

I took these photos recently on a site in Belrose, northern Sydney – When is a gumnut not a gumnut? I've seen them around before so don't know if they're too common to be interesting. I don't actually know what little critter is responsible for it. There was a little spider in residence.

High Success Rate Detecting Eastern Pygmy-possums with a Thermal Camera

Amy Rowles, Corymbia Ecology

Eastern Pygmy Possums can be difficult to detect using traditional spotlighting techniques. A couple of years ago, I had the opportunity to use a thermal camera whilst spotlighting. The camera readily picked up the Pygmy Possums as well as sleeping birds. Once the small warm body was detected, we would then use a torch to verify the species. I would recommend including the use of a thermal camera for anyone targeting Eastern Pygmy Possum.

Interestingly, a moving Brushtail Possum glowed much brighter on the camera image than a still one, illustrating how insulative their fur is.

It is worth noting that thermal cameras work best when the contrast between the target and the background is greater, therefore this technique works best in cooler weather.

Cat’s Claw Creeper and Fire

Ian Colvin, GeoLink

A site near Casino in northern NSW (Myrtle Creek) was subject to high intensity wildfire in late 2019 and the riparian corridor was completely burnt out. Driving past in December 2020 (about one year on) I noticed Cats’ Claw Creeper (CCC) was recovering vigorously and creeping up the stems of fire killed eucalypts and rainforest trees, with few signs of native regeneration. In a drive by in March 2021, the CCC was more vigorous than before and was thriving and enveloping all the dead native stems and forming a carpet along the ground layer. Has anyone else observed CCC to be so aggressive and adaptive post-fire?

EVENTS

ECA ANNUAL GENERAL MEETING 2021

Date: 12.15-1.00pm, 19 July 2021

Location: Sage Hotel, Wollongong

ECA ANNUAL CONFERENCE and WORKSHOP

Date: 19-20 July 2021

Conference Theme: The Forgotten, Neglected or Ignored: Biodiversity Issues Requiring Attention.

Workshop Theme: The Bionet Vegetation Database: updates and application.

Location: Sage Hotel, Wollongong

See page 29 for details

Membership Report

Membership Category	***Total***
Full Member	
Practising Ecological Consultant	122
Early Career Ecological Consultant	7
Retired Ecological Consultant	2
Associate	
Government Ecological / Environment Officer (Associate)	27
Non-practising (Associate)	6
Student	2
Subscriber (Associate)	1
Grand Total	**167**

DAWE EPBC ACT REVIEW:
Stakeholder Meeting Summary, February 2021

Andrew Lothian
ECA Treasurer

Here is a quick summary of the February 2021 stakeholder meeting with DAWE, in regard to the EPBC Act review. DAWE provided updates on where each little cog in the system is at. The committee have taken on board the official review study and comments from public submissions. They have processed these and are working on changes to address shortfalls and issues. It appears that it is not so much an overhaul of the legislation itself, but more an overhaul of the procedures in place that are failing to achieve the intended outcomes.

Six sections that are dealing with the changes include:

- Online portal
- Policy development/advice
- Australian National Audit Office (ANAO) review
- Training/skills, development/sector engagement, local government engagement and website
- Gateway (referrals in) to help applicants with first stage of entry into the system
- Governance and correspondence

The current chair for the review committee is Mary Colreavy. Her role is also to see to implementation of eight key recommendations from the ANAO audit including: improve information collection and use; improve governance and oversight; improve measuring and reporting of admin; the need for a quality assurance framework; strengthen quality controls (consult with proponents before approval); and better compliance monitoring.

There are new internal training modules for DAWE staff, with a push to have this extended to consultants. This training has a potential to be adapted to a Cert IV qualification in the future.

The Reform Division are working on changes as a result of the Samuel Review Report. Recommendations have been grouped into 6 pillars of reform. Key priorities include national environmental standards, compliance and single touch approvals. I asked about approvals outside of the ratified state system (i.e. part 5 developments not opting into BAM). The state will need to put forward legislation to meet federal approval accreditation and meet standards. Some proposals may need to go to federal assessment separately.

Evaluation and assurance division are coordinating a response to the ANAO audit (this deals with systems and processes, holes in governance, shortfalls in IT systems, absence of monitoring and reporting). This really drives the changes we will notice with the portal and assessment system.

Gateway: A new gateway for lodging referrals will track everything and let every party see what the next step is, and what still needs to be done. Associated guidance documents will be available. Increased file size for attachment is a welcome addition. Christmas referrals will be deferred for two weeks in future to stop things sneaking through while people are on holidays. Recent workshops have been feeding into the development of this new gateway.

Portal and Assessment System: DAWE are piloting new digital program with the WA Environment online system, which will cover both state and federal assessment. This mainly consists of a mapped workflow for the approval with interaction points and expectations specified. Workshops have also been feeding into this. If you haven't had a chance to be part of one of these workshops it is a great way for you to raise issues with the programmers so it gets designed the way you want to use it. I highly recommend you take part in these workshops. I have done about 4 or so now and they rarely take more than an hour. The final release is planned for November 2021.

Biodiversity Data Repository: This appears to be like a national BioNet. Still looking for a partner to build the repository. National species list previously only included plants. They are currently funding integration of fauna. They are looking to include an app for data capture as well so a consistent national dataset is available. Will be tested later this year.

Major Projects Division: Because timeframes are being met, not as many projects are being escalated to major projects to expedite via this pathway. More time is being spent at the pre-approvals stage in meetings about clear expectations. Consultation is dealing with project nuances better than prescribed conditions.

PMSTool: Beta release of the PMSTool - Go try it. Currently waiting for funding to finish it off and still taking feedback to improve functionality. At the moment, you can get different results depending on the version you use as the background calculations are different. You can export the data as an excel file and can get the report immediately.

Offset Guidelines and Register: This is in internal review at the moment. DAWE will take on feedback and test application, then it will go for external user testing. It will allow public view of offset metadata. Should help with the landscape level assessment which will be expected going forward. Not intended as a marketplace.

If there are any questions from the sector, please forward them to me and I will pass them along to Valerie Hush or Mary Colreavy who will facilitate response from the appropriate party. I strongly encourage anyone with EPBC referral experience to sign up for one of the workshops. Have a say in what is being produced for us so you don't sit and whinge about how useless it is later.

ECA RESEARCH GRANTS

2021 Grant Recipients

Grant	Recipient	Project Title	Affiliation
Ray Williams Mammal Research Grant 2021	Jana Stewart	Soil biota responses to reintroduced semi-fossorial mammals: a temporal comparison of soil biodiversity and ecosystem function	University of NSW
ECA Conservation Grant 2021	Thayanne Lima Barros	Microphytobenthos biomass as indicator of ecological impacts of the 2019/2020 bushfire season on estuaries in New South Wales, Australia	University of NSW

Ana Gracinin

Ray Williams Mammal Research Grant Recipient- 2016

Real Time Monitoring with Camera Trapping: An Emailing System Sending Images Direct from the Field

Ana Gracanin and Dr. Katarina Mikac, Centre for Sustainable Ecosystem Solutions, School of Earth, Atmospheric and Life Sciences, Faculty of Science, Medicine & Health, University of Wollongong NSW 2522 Australia

Abstract

Camera trapping is a highly useful and effective method for studying wildlife ecology. Used at both short- and long-term scales, camera trapping can be used to detect threatened species or threatening processes, such as invasive species or disease. Real time monitoring of wildlife is particularly promising as a management strategy for development projects, or conservation programs, as it allows data collection and analysis to occur immediately, with minimal delay between interpretation and management techniques to be implemented. Here we test the applicability of cameras with capabilities of emailing photos right as they are taken. We compare the time delay of emailed photos using extension antennas. We also test the use of a long-term bait station and observe behavioural responses over time to the bait. We found that the cameras could provide a long-term record (five months tested) of wildlife by a continuous baiting system drawing in a range of species, particularly possums, bandicoots, wombats, small mammal species (*Antechinus* and *Rattus sp.*) and foxes. Further testing however is required over greater temporal scales, and with more cameras. We believe these cameras can be used for invasive species management, threatened species monitoring, and as a monitoring requirement during development projects.

Introduction

Camera trapping is a versatile, cost effective and low invasive method for studying the ecology, behaviour, and health condition of a variety of wildlife (O'Connell et al. 2010). For highly sensitive and threatened species, camera trapping may provide much needed information on condition, reproductive status, and threatening processes (Michler et al. 2008, Towerton et al. 2011, Carricondo-Sanchez et al. 2017). However, there may be a significant delay between important data collection by the camera, data acquisition from the field, analysis and interpretation, and the management decisions made in response. One example of this includes the tracking of disease through camera trapping, such as the devil facial tumour disease in Tasmanian Devils (*Sarcophilus harrisii*). Monitoring the progression of this disease would be greatly benefited by real time data acquisition (Fleming et al. 2014).

As trail cameras become increasingly technologically advanced and relatively cheaper, one promising aspect is the use of a 'live feed' of camera trapping. Trail cameras that can email or MMS over a network, provide a possible method for real time monitoring of wildlife. These cameras can be implemented through a 'set-&-forget' method. Cameras are placed in distant and hard to reach terrain, are connected to solar power, and send images as they are taken (real-time) to a selected email account. The testing of 'set-&-forget' cameras has important implications in research and ecological consulting where budget and time constraints often impact upon the quality of data that can be obtained. The 'set-&-forget' system allows users to access a remote or difficult to reach sites only twice (at set-up and removal), reducing the need for site visits to change batteries, memory cards and bait (if bait is being used).

We aimed to test technical aspects of a 'set-&-forget' camera set-up for continuous monitoring including: the use of solar power, extra antenna, protective materials for against the elements, and a long-term baiting system. We also compared behavioural responses of wildlife to this long-term bait station over time.

Materials and methods

Eight Suntek HC-300M IR cameras were placed in remote and difficult to reach locations of Budderoo National Park. Four cameras had 3.5m wired antennas attached, and the other four used the included camera model's antenna (10cm long). Time delays were calculated by the difference between the time stamped on the photo taken, and the time of the email received of the photo sent. Time delays were compared for cameras using the extended antenna and the camera model antenna. Due to the initial zero success in photos being received via email for cameras without the extended antenna, an additional four extension antennas were attached on the remaining cameras.

Cameras were attached to trees, facing a long-term bait station. The bait consisted of a one litre bottle of tuna oil attached to a tree or rock 30cm above the ground. The bottle was inverted with multiple punctures made around the base of the bottle. This meant that over time as rain fell, water would enter, forcing the less dense oil to rise and drip out of the bottle.

Cameras were set to photograph once and video record for 30 seconds to detect behavioural responses to the long -term bait over time. A one minute delay was set between triggers. Four trail camera solar power batteries were randomly assigned to cameras. Cameras were set to email each photo to a specified email address over the Telstra 2G network (each email costing approximately 50kb of mobile data). Cameras were left in the field for eight months, between March 2016 and November 2016. Each camera had four to five months with bait, and the remaining months without bait.

Results and Discussion

Of the eight trail cameras, six were successful in maintaining a long-term record of wildlife, whilst the remaining two experienced technical issues and recorded intermittently. Cameras recorded consistent visitations over the baited four and five month periods, as the long-term bait source was successful in delivering an olfactory cue over a long timeframe. The use of extended antennas reduced the time delay significantly, with an average delay of 96sec from the time the photo was taken to the time the photo was received in email. Extension antennas were

Plate 1. From left to right: Trail camera solar panel, camera with sun and rain shield, long term bait station with inverted bottle of tuna oil and an additional ruler for measurements.

pivotal in accessing reception, and we experienced initial difficulty on many occasions in connecting to the network. We recommend placing antennas as high as possibly up trees, and that initial surveys are made into finding areas with network coverage. Unfortunately, in our study, the 2G network was discontinued halfway through our study.

Across all sites, 10 mammal species were identified (Table 1). Sites were highly variable, with habitats ranging from rainforest, open woodland, upland heath, and dense forests, indicating why sites varied greatly in species detection. Our relative low number of records is also due to a high rate of false triggers.

Table 1. Species recorded across all eight camera sites in Budderoo National Park.

Common Name (*Scientific Name*)	**Number of Camera Sites where Species was Recorded**
Swamp Wallaby (*Wallabia bicolor*)	5
Common Wombat (*Vombatus ursinus*)	3
Common Ringtail Possum (*Pseudocheirus peregrinus*)	1
Common Brushtail Possum (*Trichosurus vulpecula*)	2
Short-beaked Echidna (*Tachyglossus aculeatus*)	1
Long-nosed bandicoot (*Perameles nasuta*)	1
Long-nosed potoroo (*Potorous tridactylus*)	3
Small Mammals (e.g. *Antechinus stuartii*, *Rattus fuscipes*)	6
Red fox (*Vulpes vulpes*)	4
Domestic Cat (*Felis catus*)	1

Images emailed had a resolution of 640x480 pixels, compared to the original photo taken by the camera, which recorded at 3200x2400 pixels. Despite the low quality, species were easily identified, however timestamps were often difficult to read on emailed, coloured photos. One significant limitation of the study was the high rate of false triggers caused by wind moving vegetation: 40% of all triggers were false. Despite using plastic covers as a shield from sun, the sensitivity of the camera model to vegetation movement caused this high rate of false triggers (despite sensitivity set to low). Only one of the eight cameras experienced water damage with small amounts of rust inside. The use of a plastic shield, desiccant sachets, and waterproofing spray, aided greatly in reducing any water related damage for the remaining cameras.

The use of additional power through trail camera solar panels, were not a consistent reliable source of power. Depending on available current, the camera could switch between internal battery source and external solar. However, with the camera's preference to connect via external, the solar would connect whenever enough charge was present, but then disconnect repeatedly. This created a disrupted record as the camera would be turned off for certain amounts of time. It is recommended a high-quality solar panel connected to a large deep cycle battery, is to be used as a consistent long-term source of power.

To determine changes in behavioural responses to a long-term bait source, videos were analysed, and individual responses were identified as either interested (directly interacting with the bait bottle) or not interested (walking past in background or foreground but not stopping or pausing to investigate bait). Wombats, crows, brushtail possums and smaller mammals (*Antechinus* and *Rattus sp.*), showed a distinct interest over the four to five-month period (Table 2). We were unable to individually identify species and therefore if there were numerous repeated visits by select individuals. Fox interactions were nearly all described as fearful or cautious at our camera trap sites, possibly due to remains of human scent and/or sounds emitted from the camera (Meek et al. 2014). After nearly three months, foxes were first observed displaying direct interest in the bait without fear.

One record of our target species, the cryptic and threatened spotted-tailed quoll, occurred at a non-baited site. The quoll displayed interested in the ruler attached to the tree. The low resolution of the emailed photo meant individual identification via spot patterns, was unachievable.

In summary, this study has identified the possibility of using remote cameras with emailing capabilities to create a live monitoring program. The long-term bait stations can last up to five or more months at a time, before needing replenishment. These long-term placements reduce fort-nightly or monthly field effort and reduces the influence of human scent on visitation by certain wildlife. The camera is also able to notify researchers that battery levels are low, meaning visits are efficient as they occur only when needed.

Table 2. Number of visits to baited and non-baited sites, and behavioural responses to long term bait stations.

Species	Baited cameras		Non-baited cameras	Comments and Observations
	Interaction with bait	*No interaction with bait*		
Wombat	13	4	8	Interested
Fox	10	4	4	Interested/fear
Ringtail Possum	1	1	0	Interested
Brushtail possum	7	1	0	Interested
Wallaby	6	2	14	Interested
Bandicoot	1	3	1	Interested
Potoroo	0	7	19	Not interested
Crow	50	0	0	Interested/feeding
Quoll	0	0	1	Interested
Smaller mammals	203	49	21	Interested/feeding
Cat	1	0	0	Interested
Lyrebird	0	19	3	Not interested

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Chantelle Doyle

ECA Conservation Research Grant Recipient- 2019

Moving Threatened Plants: Story and Practice

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The question

What are the common surprises, successes and pitfalls of translocating threatened plant species?

To find out, researchers at The University of New South Wales (UNSW) are partnering with the Australian Network for Plant Conservation (ANPC) to ask these questions using mixed methods of research.

Translocation is defined as the movement or direct transport of plant material from one place to another, and encompasses salvage (or mitigation), introduction, reintroduction and augmentation (Commander, 2018). However, the term translocation refers only to the action of moving plants, underlying this action, practitioners have different motivations and perspectives, and are drawn from diverse and varied fields.

Undertaking a translocation relies on multiple factors, which may include location, time, cost, client expectation, species life history and ecology, type of translocation, population relatedness, propagule type and propagule quantity. Translocation is a simple word, which belies the potential complexity of numerous associated actions. Answering the question then, “What are the common surprises, successes and pitfalls of translocating threatened plant species?”, is also subjective and dependent on intentions and expectations. Our research needs to reflect individual experiences, that is why we are asking you to contribute your perspective.

Currently we are seeking consultants who have experience in moving threatened plants to contribute to our research through either:

- A confidential interview where participants can nominate to remain unidentified and/or
- A showcase story of your work communicated in a 30 min podcast and 5-minute mini documentary. An example of our first **three stories** can be found at www.plant-heroes.com

The documentary series will also be promoted by the ANPC through social media and in a series of three translocation workshops planned for 2022.

To date we have commenced three mini documentaries all of which were conducted for conservation purposes. These were *Allocasuarina portuensis* (Nielsen Park She-oak) (Plate 1), *Wollemia nobilis* (Wollemi Pine) (Plate 2) and *Grevillea wilkinsonii* (Tumut Grevillea) (Plate 3). However, we want to explore the other side of translocation; those projects conducted as part of mitigation or salvage.

Why is this relevant?

Although there have been reviews into translocation (Falk et al., 1996; Gallagher et al., 2015; Godefroid et al., 2016; Godefroid et al., 2011; Hancock et al., 2014) and guidelines are in place to inform planning and preparation (Commander, 2018; IUCN, 2013; Maschinski et al., 2017), these are not intended to represent the subjective experiences of practitioners, per se, despite the inclusion and even dedicated production of valuable case studies (e.g. IUCN Global Reintroduction Perspective series). These documents are not intended to directly portray the complexities (and realities) of stakeholder relationships, budgets, legislative requirements, funding cycles and timeline variations. Further, the communication medium for more detailed published results is often accessible only to those within the intended audience. Thanks to the work of Silcock et al., (2019) we know that of 1181 translocations documented in Australia, 787 have occurred for conservation purposes, of which only 109 have been published in peer reviewed literature. Of those, how many are behind pay walls inaccessible to non-academic audiences? A further 390 translocations were conducted as mitigation or salvage translocations, all with unknown publication status. These reports are commonly restricted to grey literature and difficult to access due to client confidentiality or a required knowledge of the project or may not be stored in a publicly accessible database.

Given that translocation practice has doubled in Australia since 2010 (Silcock et al., 2019) and will surely continue to rise under pressures of urbanisation and increasing population, conserving threatened flora will rely on iterative and shared learning. Certainly, it is important to understand what has worked, but of equal importance to learning is an understanding of the challenges, limitations, setbacks and outright failures, and how these were navigated. Planning for a best practice translocation also requires, where possible, a thorough estimate of necessary resources (labour and cost), time requirements, as well as an adequate understanding of the target species ecology and potential ecological limitations to establishment of a long-term self-sustaining population, assuming self-sustaining is the agreed measure of success (Menges, 2008; Monks et al., 2012).

What research is being conducted?

Using qualitative research, our project draws on practitioner experience to critique practical requirements of translocations and draw (some) conclusions about its application. Specifically, we aim to identify:

1. Timelines, resources and cost requirements (including in-kind/volunteer) of a translocation.
2. Practitioner experiences in and opinions of translocation practice, including successes and challenges.
3. If there is a difference between salvage/mitigation translocations (normally undertaken for developments or part of conditions of consent) and conservation translocations (i.e. those undertaken purely to reduce extinction risk, without a legislative compulsion).

We are using semi structured interviews with a range of practitioners (e.g. researchers, consultants, community groups) to combine the opinions into:

a) a review of trends between individual experiences and projects
b) an analysis of some of the most commonly shared perspectives and
c) a sharable and accessible mini documentary and podcast series which will complement existing guidelines (Commander, 2018; Maschinski et al., 2017). This information can be disseminated publicly to raise interest in plant conservation and link different stakeholders working in both conservation and mitigation translocation.

We hope that this research and mini documentary series will provide a novel communication tool to help inform effective decision making about the appropriateness of translocation as a conservation or mitigation action (Germano et al., 2015). Open accessibility will also mean that the series can be used as an introductory platform for non-academic audiences, including community groups, developers and legislators, without the time or need to access academic literature and a way to share the experience of consultants, who may not normally share results outside client reports. This series also aims to acknowledge the individuals and teams that donate, provide "in-kind" or un-costed overtime to and whose efforts are often critical to maintaining and monitoring translocated populations.

Get involved!

If you would like to know more, or think you have a story to tell, please get in touch via www.plant-heroes.com or email chantelle.doyle@student.unsw.edu.au. We would also appreciate any feedback to improve our series to be submitted via Plant Heroes Survey.

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Plate 1. Filming for case study of *Allocasuarina portuensis* translocation project. Pictured Mark Viler (Australian Botanic Garden Mt Annan and videographer Michael Lawrence-Taylor) *Photo: Chantelle Doyle*

Plate 2. Heidi Zimmer (NSW Department of Planning Industry and Environment) and Ian Allen inspecting translocated Wollemi Pine, burnt in 2019/2020 fires. *Photo: Michael Lawrence -Taylor*

Plate 3. Tumut Grevillea flower, a critically endangered species restricted to a 6km stretch of the Goobarragandra River near Tumut. *Photo: Chantelle Doyle*

Grant Webster

Terrestrial Ecology Research Grant Recipient- 2019

Ecology and Conservation of Mahony's Toadlet (*Uperoleia mahonyi*): Determining the Required Survey Effort for an Endangered Frog

Grant N. Webster
Supervisors: Dr Deborah Bower and Dr Simon Clulow

Abstract

Vegetation mapping frequently acts as a proxy for threatened species occurrence in environmental impact assessments. One threatened species listed as Endangered in New South Wales, and subject to ongoing development in its range, is the recently described and apparently range restricted myobatrachid frog *Uperoleia mahonyi* (Mahony's Toadlet). Despite this, its ecology and habitat preferences remain largely unknown preventing effective conservation action. Broadly, associations with eight particular plant community types (PCTs) have been observed for *U. mahonyi* including affinities for forest and sedgeland on coastal sands; swamp oak forest; swamp sclerophyll forests; and heath, wallum and forest on sandplains. We investigated the relationship between *U. mahonyi* occurrence and PCTs throughout its range. We determined detection probability by conducting repeated surveys at five sites where *U. mahonyi* presence is known, followed by conducting occupancy surveys throughout areas predicted to be "occupied" and "unoccupied" based on models created from vegetation mapping provided by the New South Wales Department of Planning, Infrastructure and the Environment. Two hundred surveys sites were identified and surveys were carried out at 56 of these sites to date (the remainder are ongoing). This tests the hypothesis that vegetation mapping can act as a suitable proxy for threatened amphibian occurrence, allowing us to examine the efficacy of "like-for-like" vegetation offsetting as a means of mitigating impacts to threatened species. We have also gathered data on calling phenology through establishing AudioMoth automated acoustic recorders at ten known breeding sites, and contributed to studies on the prevalence of chytrid fungus throughout its range. Additionally, we collected tissues to investigate where distinct populations occur and how much gene flow is occurring across the landscape.

Plate 1. Mahony's Toadlet (*Uperoleia mahonyi*) from Norah Head showing characteristic colour patches and markings. *Photo by Grant Webster.*

Results to Date

Determining detection probability and seasonality for U. mahonyi

We established detection probability under an occupancy modelling framework through repeated surveying of five sites that we knew were occupied by *U. mahonyi* (Table 1). Survey sites consisted of a 50 x 50 m quadrat and included both an area of land prone to inundation (“water area”) and an area which remained permanently dry (“land area”). Surveys lasted one hour and were conducted after sunset. Each survey consisted of, 5 minutes listening at the start of the hour for calling males, followed by 55 minutes of active searching. Habitat and climatic covariates recorded at the start of each survey included:

- Water availability i.e. the relative fullness of the pond (or “water area”) on a scale of 0-10;
- Relative humidity (%);
- Weekly rainfall (mm); and
- Air temperature (°C).

Water availability, relative humidity and weekly rainfall were all positively associated with detection, while air temperature was negatively associated. Detection time (i.e. duration of the survey in minutes before the species was detected) was recorded, with greater water availability, high humidity, more rainfall and cooler temperatures being associated with shorter detection time. A total of 142 detection surveys were carried out with surveys occurring in all months of the year to test for seasonality.

Table 1. Location of sites surveyed to calculate detection probability and the resulting naïve and modelled detection probabilities at each.

Site	No. Detections	No. Surveys	Naïve Probability	Modelled Probability
All	70	142	0.49	0.49
Norah Head	10	34	0.29	0.65
Masonite Road	2	12	0.17	0.30
Oyster Cove	16	28	0.57	0.43
Fingal Bay	40	46	0.87	0.54
Treachery Swamp	2	22	0.09	0.36

Uperoleia mahonyi was detected on 70 of the surveys resulting in an overall detection probability of 0.49. There was substantial variation in naïve detection probability between the five sites ranging from 0.09 to 0.87 (Table 1). For detection probability, models with the most support all included water availability (fullness) and humidity (Table 2) indicating that these were the most important covariates influencing detection. Perhaps surprisingly, season was not significantly correlated with detection and *U. mahonyi* was detectable in all months of the year, although active chorusing appeared to commence in mid-July and continued until mid-April. The average time to first detection was 13.8 minutes (although ranged between 0 and 60 minutes), with 95% of all detections occurring by 44 minutes. Modelled detection probability, which incorporated the influence of covariates also varied between sites ranging from 0.30 to 0.65 (Table 1), was then used to guide the appropriate number of surveys required to obtain 95% confidence of absences at sites.

Table 2. Occupancy models used to establish the influence of covariates on detection probability.

Rank	Model	DAIC	Weight
1	psi~1,p~fullness+humidity	0	0.45
2	psi~1,p~fullness+humidity+rainfall	0.39	0.37
3	psi~1,p~fullness+temperature+humidity	1.79	0.18

Occupancy surveys and model evaluation

We then conducted surveys to test the accuracy of the vegetation model using a similar methodology to the detection surveys; however survey time was reduced to 44 minutes. Sites were repeatedly surveyed to establish either (1) presence of *U. mahonyi* at the site; or (2) a 95% confidence of an absence based on the corresponding number of surveys required to achieve this level of confidence, by incorporating the modelled detection probability for specific survey conditions, using the following formulae:

1. $k = \log(1\text{-}p^*)/\log(1\text{-}p)$ and;
2. $p^* = 1–(1\text{-}p_{\text{-}1})(1\text{-}p_2)(1\text{-}p_3)\ldots(1\text{-}p_k)$

Where:

- k = number of surveys
- p = detection probability
- p* = overall detection probability (i.e. at least 0.95)

Formula 1 was used when p was constant for each survey, while formula 2 was used when p varied between surveys. Detection probability of each survey was established following the completion of the survey by incorporating the covariates of water availability, humidity, air temperature and weekly rainfall and is based on the detection probability modelling following the initial detection probability surveys.

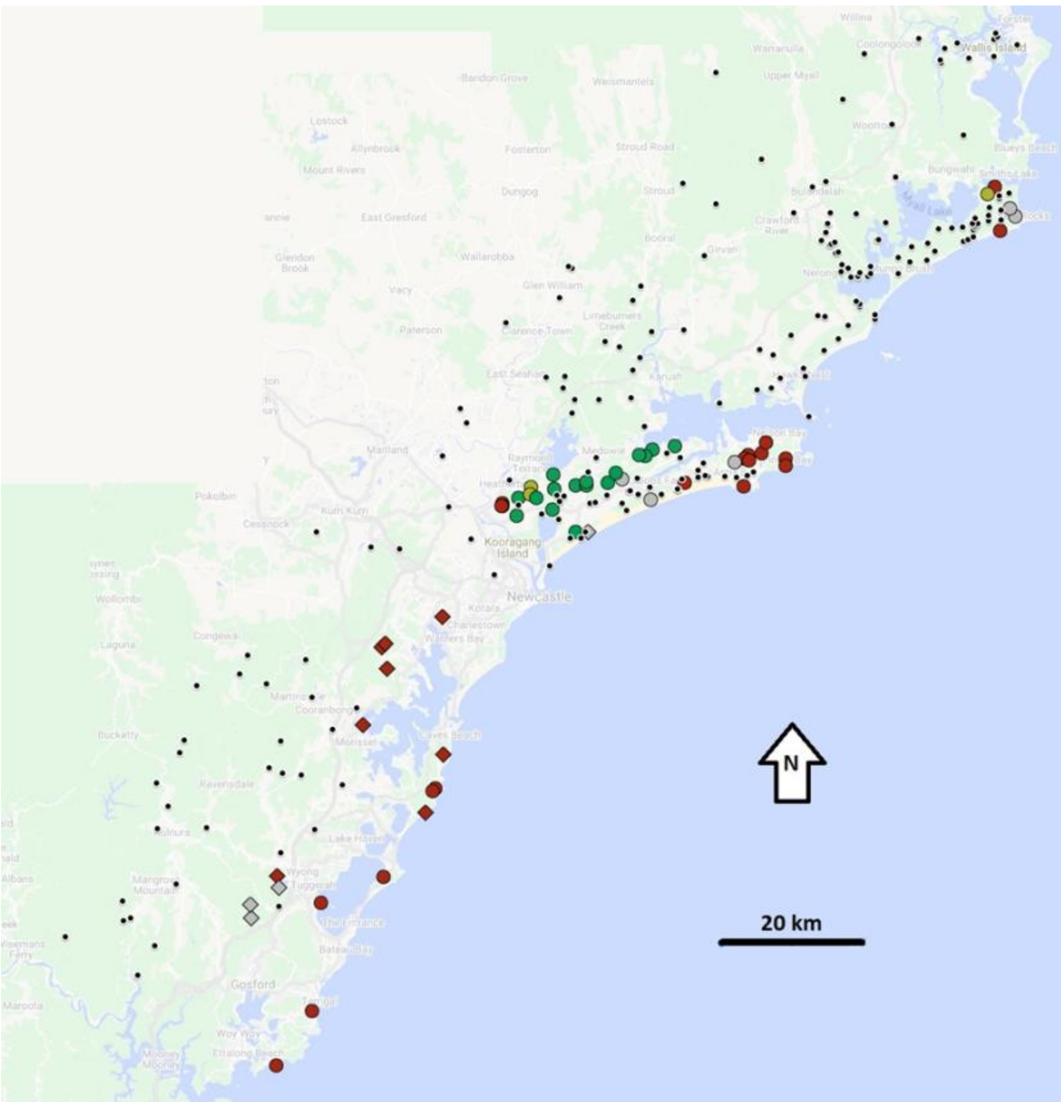
Based on the modelled detection probability, water availability and relative humidity had a large positive effect on detection and the required number of surveys varied widely depending on these covariates (Table 3). For example, to reach a 95% confidence of a true absence, 55 surveys would be required if water availability was 0 and humidity was 41.3%; however if humidity was 100% only four surveys are needed. Further, if water availability was 10, the number of required surveys ranges from eight to two, given humidity values of 41.3% and 100% respectively. However, this is true when air temperature and weekly rainfall are held at the observed median values and the number of required surveys changes slightly under different values for temperature and rainfall. Our analysis demonstrates how important it is to survey in favourable conditions in order to maximise detection probability. Consequently, surveys for this species should be conducted when breeding ponds contain water and humidity is high; and ideally from late winter to early autumn.

At the time of writing, 170 surveys from 56 sites have been conducted, with surveys completed at 47 sites to the level of either confirmed presence, or 95% confidence of true absence. *Uperoleia mahonyi* was detected at 16 of these sites (Figure 1) and at other locations incidentally during fieldwork, bringing the total number of point localities for the species to 167. This is an increase of 76 localities since the start of this project, with almost all of these resulting from this study. As the fieldwork has not yet been completed, and thus the final accuracy of the vegetation model has not been determined, although *U. mahonyi* has so far only been detected at 36% of sites predicted to be "occupied" under the models and at no sites predicted to be "unoccupied".

Table 3. Number of surveys required to achieve a 95% confidence of an absence for different values of relative humidity (%) (x-axis) and water availability (pond fullness) (y-axis).

	41.3	52.5	61.5	66	69.7	75.1	80	82.6	85	90.1	94.8	100
0	54.6	31.0	19.8	16.0	13.4	10.4	8.4	7.2	6.7	5.4	4.5	3.7
1	44.2	25.2	16.2	13.1	11.0	8.6	7.0	6.0	5.7	4.6	3.9	3.2
2	35.9	20.6	13.4	10.8	9.2	7.2	5.9	5.1	4.8	4.0	3.3	2.8
3	29.2	16.8	11.0	9.0	7.6	6.1	5.0	4.3	4.1	3.4	2.9	2.5
4	23.8	13.8	9.1	7.5	6.4	5.1	4.2	3.7	3.5	3.0	2.6	2.2
5	19.4	11.4	7.6	6.3	5.4	4.4	3.6	3.2	3.1	2.6	2.3	2.0
6	15.9	9.4	6.4	5.3	4.6	3.7	3.2	2.8	2.7	2.3	2.0	1.8
7	13.1	7.9	5.4	4.5	3.9	3.2	2.8	2.5	2.4	2.0	1.8	1.6
8	10.8	6.6	4.6	3.9	3.4	2.8	2.4	2.2	2.1	1.8	1.6	1.4
9	9.0	5.6	3.9	3.3	2.9	2.5	2.1	2.0	1.9	1.6	1.5	1.3
10	7.5	4.7	3.4	2.9	2.6	2.2	1.9	1.8	1.7	1.5	1.4	1.2

Figure 1. Occupancy surveys conducted to date. Circles indicate sites predicted to be "occupied" by the models, while diamonds indicate sites predicted to be "unoccupied". Red indicates a site where surveys have been completed but the species was not found. Green indicates a site where surveys have been completed and the species was detected. Yellow indicates a site where surveys have been completed and the species was detected adjacent to the site, although not at the site itself. Grey indicates sites that have commenced but not yet been completed and black dots show sites that will be surveyed in coming months.



Assessing the Ecological Impacts of Edge Effects

James Gleeson
Resource Strategies

It is common for developments to be constructed adjoining the boundaries of natural habitats or for developments to create new habitat edges via clearance or disturbance of natural vegetation. Under the New South Wales (NSW) Biodiversity Assessment Method (Department of Planning Infrastructure and Environment [DPIE], 2020), it is a requirement to assess how 'edge effects' due to a development might reduce the viability of natural habitat. In order to do this, there needs to be an understanding of what edge effects are, how they influence ecological processes and what factors might need to be considered.

I have prepared this short article as it is apparent that there is room for improvement in the way edge effects are assessed and, although there is a wealth of scientific research on edge effects, there is a lack of literature on how edge effects might be assessed in the context of ecological impact assessment.

What are Edge Effects?

Edge effects describe changes in biological and physical conditions that occur both at an ecosystem boundary and within the adjoining habitat as a result of those changes at the boundary. In natural ecosystems, edge effects occur at ecotones between ecological communities, often adding to the complexity or variety of habitats in that location. For example, Berry (2001) found an increased diversity of birds at edges compared with a forest interior due to increased foraging opportunities. Interestingly, the creation of edges through forestry activities was once promoted as a means of enhancing habitat for wildlife prior to ecological research in the late 1970s which highlighted the negative impacts from modifying formerly intact habitat (Temple and Flaspohler, 1998). Creation of new habitat edges is often coupled with other impacts such as habitat fragmentation or patch shape changes (e.g. increased perimeter to area ratios).

Edge effects can be complex, so for the purpose of assessing the likelihood of potential impacts, the concept can be broken down into simple components as described below.

Clearance or Disturbance

Creation of a new edge in a development context generally begins with clearance or disturbance. The estimate of the clearance footprint should account for all physical damage to trees and other vegetation that occurs along boundaries, including any fallen timber or soil disturbance. In terms of a development, there may be other disturbances on the edge, e.g. pollution, fertiliser, dust (Farmer, 1993) or artificial lighting (Barber-Meyer, 2007).

Abiotic Changes

Abiotic environmental changes typically occur on the newly created edge; this could include more intense or longer duration of sunlight, change in temperature, altered evapotranspiration, increased wind or changes to surface water flow (Pohlman *et. al.*, 2009; Harper *et. al.*, 2005; Hobbs and Yates, 2003). Closed habitats (forests with microhabitats) may be more likely to be susceptible to abiotic environmental changes than open habitats due to what is known as patch (or edge) contrast - *the difference in composition, structure, function, or microclimate between adjoining ecosystems on both sides of the edge* (Harper *et. al.*, 2005; Ries *et. al.*, 2004; Hobbs and Yates, 2003).

Structural Changes

Environmental changes at a newly created edge can effect plant productivity, nutrient cycling, decomposition and dispersal (Harper *et. al.*, 2005). This can lead to structural responses such as changes to canopy cover, tree density, downed wood, leaf area and vegetative biomass. For example, for closed habitats (e.g. forests), there can be an increase in growth of light-demanding flora at the expense of light-sensitive species, as well as increases in sapling density, recruitment and understorey cover along an edge (Bach *et. al.,* 2005). The author has observed that the structure changes are likely to be less in open Eucalypt woodlands where the edge habitat is not as readily distinguished from the interior habitat of the patch. Lindenmayer and Fischer (2013) recognise that Eucalypt woodlands may have a lower edge contrast with surrounding cleared areas compared to tropical forests.

Species Response

The species response to edge effects varies depending on the ecological traits of the species and characteristics of the edge. Some species live solely within a patch and avoid habitat edges, other species use the edges as part of a larger home range, and some species prefer only the edges. For example, Bragg (2005) identified three reptile species with different responses to habitat edges delimiting open-forest and regenerating sand-mined areas at Tomago, NSW. Indirect biotic edge effects (e.g. predation, competition [e.g. aggressive behaviour of noisy miners (Piper and Catterall, 2003)], breeding and dispersal) have been shown to occur in some situations and not in others. For example, the results from nest predation studies are mixed (Ries, 2017; Boulton and Clarke, 2003; Lahti, 2001).

Assessing the Ecological Impacts of Edge Effects

From a review of literature on the topic, additional survey data may need to be gathered beyond that prescribed in the NSW Biodiversity Assessment Method (DPIE, 2020) to better describe the edge effects from a development. The information listed in Table 1 may be worth documenting in an ecological impact assessment to estimate possible or likely impacts from edge effects.

In the context of ecological impact assessment, edge effects are often assessed as a certain distance of possible adverse impacts into natural habitat. In the literature, the term 'Distance of Influence' is used to describe the distance from the edge into the community over which there is a significant influence – typically a gradient from the edge to the core habitat (Harper *et. al.,* 2005). The gradients are highly variable and can be sharp or gradual depending on the ecological attributes of the relevant habitat.

Edge effects are not always limited to a change in the habitat at the ecosystem boundary, but rather can influence the ecology of the patch as a whole or the ability of some species to use the patch. This is particularly true of small patches of habitat that may suffer reduced species diversity due to edge effects (Lindenmayer and Fischer, 2013; Bennett and Saunders, 2010; Ries *et. al.,* 2004).

Measures to Avoid or Mitigate Ecological Impacts from Edge Effects

Edge effects result from local impacts on extant vegetation next to a development. Therefore, local measures to avoid or minimise the adverse impacts of edge effects (where it is possible to do so) are likely to be more successful at addressing the issue rather than creating a biodiversity offset elsewhere. Measures that may be worth considering to avoid or minimise impacts from edge effects include (but are not limited to):

- re-positioning the development to avoid habitat that may have a higher sensitivity to edge effects (e.g. more elevated dryer woodland would likely be less susceptible than a closed riparian forest);
- re-positioning the development to result in edges that maintain viable patch sizes and reduce fragmentation;
- setting the development back from (buffering) existing habitat edges;
- careful clearing of vegetation to avoid excess damage;
- revegetation along habitat edges to maintain a greater area of core habitat;
- improving quality of the remaining habitat or core habitat through management measures (to compensate for edge impacts);

- minimising the duration of the disturbance, followed by revegetation (temporary developments may avoid longer-term adverse impacts);
- management of identified risks (e.g. management of weeds and animal pests along the edge);
- management of surface water runoff (e.g. use of drainage swales);
- strategic use of fencing to control access (livestock or people) that may exacerbate edge effects; and/or
- effective monitoring of changes in edges to inform the need for management measures.

Table 1. Example of Information to Consider in Assessing Ecological Impacts of Edge Effects

Aspect	Information to Consider
Clearance or Disturbance	• Landscape attributes (existing patch size, connectivity) and how these might change with the created edges (e.g. are the patches becoming habitat sinks (rather than sources) due to reduced patch size and increased edge influence). • Whether clearance along the edge would be absolute (clean cut) or if cleared material is to be left along the edge. • Whether the edge is proposed to be routinely cleared (e.g. fire break, powerline maintenance). • The time over which edge effects might occur and whether the created edge will be temporary or permanent. • Length of the created edge.
Environmental Changes	• The degree of exposure the development will cause on the created edge (e.g. narrow track verse wide road or sealed road verse an unsealed road). • Activities proposed adjacent to the edge that may facilitate favourable conditions for weeds or pathogens (e.g. landscaping or unsealed tracks). • Activities proposed adjacent to the edge that may alter surface water flow (e.g. runoff from hard surfaces or compacted soil). • Whether the proposed development is likely to create any artificial lighting influence or shading along the edge.
Structural Changes	• Characteristics of the retained vegetation community (structure, canopy height, canopy cover, tree species composition, and understorey density). • Condition of the retained vegetation (e.g. reduced species diversity due to historic land management). • Current and ongoing management of the retained vegetation (e.g. thinning or grazing livestock). • Site-specific observations of existing edges (e.g. notes on the time since disturbance, external influences on the edge, species composition, any notable differences to the interior of the vegetation [core area], or plant health/dieback). • Occurrence of plant species that may be sensitive to sunlight/moisture changes (e.g. shade tolerant species).
Species Response	• Activities proposed adjacent to the edge that may pose a risk to animal movement (e.g. new growth along a road edge may be a food source for fauna which may make them susceptible to vehicle strike). • Site-specific observations of species avoidance of existing edges of the vegetation. • Impediments to movement or dispersal of species. • Existing presence of species known to be susceptible to edge effects, particularly if those species are known to occur in the areas of the created edges. • Loss of foraging or breeding habitat resources along the edge. • Importance of the habitat within the edge zone to the inhabitants of the patch. • The likelihood of the habitat transitioning from a source habitat (whereby organisms reproduce and spread) to a sink habitat (where organisms enter and perish) due to edge effects.

Documenting observations about existing habitat edges and improving the way in which edge effects are assessed during ecological impact assessment would lead to a greater understanding about the nature and magnitude of these impacts. Monitoring and documenting the effectiveness of targeted management measures would lead to a greater understanding about how edge effects can be managed.

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Hairy Jointgrass - When Paddocks Become Threatened Species Habitat

Ian Colvin
GeoLink

Hairy Jointgrass (*Arthraxon hispidus*) is a conservation conundrum for multiple reasons. Listed as a vulnerable species under both the BC Act and EPBC Act the species flew relatively low under the conservation radar in the early days since it was listed in 1995 (after having been originally listed under the RoTAP system). But in northern NSW it was 'discovered' on several development sites in 2007/2008 and since then knowledge about this species has grown slowly over time through the development assessment process. 'HJG' (as it's known) has become a developer's nightmare to some extent - it appears to happily thrive in agricultural land when conditions are suitable (such as edge of spring/ seepages on lower hillslopes), and tolerates grazing and disturbance. As an annual which dies back in winter, its management is also problematic.

HJG is a good example of a 'sleeper' species that has been long overlooked; for years it has probably been quietly hiding away in grazed paddocks and on wetland margins but until it came onto the radar it was rarely detected because no-one ever surveyed paddocks with any serious intent - why scrutinise a mess of Kikuyu, Setaria, Buffalo, Carpet Grass and common agricultural weeds? Since then, when ecologists have started looking closely, HJG has cropped up all over the place; where ever development pressure occurs including coastal regions around Byron Bay, Lennox Head, Ballina, Lismore, and along the new Pacific Highway alignments between Ballina to Woolgoolga. An example of the 'sleeper' status of HJG is relevant to strategic residential rezonings completed prior to 2007/2008 (ie. before awareness of HJG). Such rezonings may not be developed for years later, with a general acceptance that biodiversity constraints have been identified and addressed. This is not the case for HJG, where large areas of 'cleared' land earmarked for subdivision via rezoning are subsequently identified as threatened species habitat.

It's likely that HJG was also never taken seriously as a threatened species because of substantial knowledge gaps and as an obscure annual grass it probably ranked lowly in terms of conservation effort and further study. It was only when HJG became a problem for developers that interest was sparked and the species was taken seriously as a 'real' threatened species which required targeted survey and assessment like any other listed flora. Targeted surveys for HJG can be a hard slog - traversing damp paddocks of tall grass on foot in 5 m parallel transects for days on end between February and April (when flowering/ seeding occurs and the species is most easily detected) - a time consuming (and costly) exercise. On the other hand, you do get a chance to really hone in on your grass and wetland plant ID, not to mention getting well acquainted with an extensive range of environmental and agricultural weeds.

Plate 1. This distinctive purple seedhead of HJG amongst *Hypolepsis muelleri* and *Commelina benghalensis*.

As for managing the species in-situ, that brings another suite of issues. HJG occupies a narrow environmental niche - wetland edges or soaks, seepage areas and creekbanks, often within agricultural environments where land has been cleared and highly modified. A high proportion of development sites comprise old farmland which has been subject to grazing for many years. The fact that HJG has persisted on these sites indicates the species is resilient and disturbance adapted to some degree. This may represent a habitat shift where HJG migrates into pasture adjacent to former wetland habitats which have been historically cleared providing that competition is sufficiently reduced. This 'blurred line' between habitats can make habitat identification tricky, particularly within native wetlands where some assemblages are not well described.

The problem with retaining HJG populations within degraded/modified development sites is that development brings change in many guises. Removing cattle means changing a grazing regime which may have been in place for decades - the grassland dynamic changes, weeds may proliferate and the absence of cattle may remove an agent of seed dispersal. Development may also change hydrology of the site which is a critical requirement for the species. A conserved population of HJG that I monitor has been quietly declining over several years for these reasons, with translocated/ seeded plants all succumbing to pasture grass invasion. A further factor over which we have no control is climate - two very dry springs (the time of HJG germination and growth) saw plant density drop substantially. HJG is very vulnerable in this way; as an annual, the next generation generally occupies a similar spatial area to parent plants from fallen seed. In a dry year, plant survival and seeding success is much lower and so there is a reduction in seed and fewer individuals germinate in the next generation. In several successive years of drought, this cascade effect can reduce HJG populations by a significant degree.

Research on the species in Australia has been scant, but several recent studies have added to the picture, with HJG most commonly associated with Swamp Foxtail (*Cenchrus purpureum*), along with various pasture grasses in areas of high topographic wetness and persistent moisture, particularly in and around drainage lines or on south-facing slopes (White *et al*. 2019a).

BioNet records indicate HJG has been recorded generally along coastal regions between Port Macquarie and Tweed Heads, while extensive field research by White *et al.* (2019a) identified the extent of occurrence of HJG over approximately 30,000 km² in northern NSW. However, the extent of HJG within conservation reserves is poorly known. A population of HJG is known from a montane bog/fen in Washpool National Park, while outside of NSW a population is known from within a unique mound spring wetland in Carnarvon Gorge National Park (Qld). The lack of HJG records from native vegetation types (as opposed to disturbed or degraded land) may be more reflective of the fact that high quality habitats (such as montane peat swamps, carex fens and some types of coastal freshwater wetlands) are typically poorly reserved. HJG populations in these native communities are often on private or crown land.

Plate 2. HJG hiding amongst wetland plants.

Research by White *et al.* (2019a) concluded that HJG is much more widespread in NSW than previously thought and hence is at a lower extinction risk. When assessed against four of the five IUCN species assessment criteria, the results indicated little evidence to support the listing of HJG in any threatened category based on the species' population size and/or geographic distribution within NSW, leading to the conclusion that *"…a judicious review is needed of the ongoing investment of resources in the conservation of this species when many endemic species in Australia are at risk of extinction"* (White *et al.* 2019).

So, after a good 15 years or so of HJG survey and management, are the conservation outcomes from development 'offsets' successful? Based on my experiences, most probably not. Conserving and managing HJG on private land is a difficult business - weed control, selective slashing and biomass removal on a regular, nuanced basis in perpetuity. That adds up to a lot of time and money to manage a species which requires a very 'hands on' management approach in modified landscapes where multiple variables may need to be addressed. Findings by White *et al.* (2020) that HJG has a high tolerance for waterlogging and achieves its best cover when growing with other moisture-associated plants, suggests that establishing long term offset populations is best focussed on sites with appropriate hydrology where conservation outcomes are more achievable. Unfortunately, in 'paddock' situations where HJG persists in an 'unnatural' environment, the enhancement, and maintenance of wetland areas has its own challenges. This may be further complicated in 'residue' areas on development sites where habitat conservation often has to compete with other factors such as stormwater management, bushfire hazard reduction and even recreation.

While we now have good knowledge of HJG habitat requirements, it is the management of these habitats that remains a future challenge and whether HJG can be conserved in-situ in persistent populations with minimal intervention.

Thanks to Dr. Laura White for some comments and suggestions.

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Plate 3. HJG transect surveys through field of swamp foxtail.

A Record of the Sand Goanna *Varanus gouldii* (Varanidae) from the Footslopes of the Snowy Mountains

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The Sand Goanna *Varanus gouldii* is the most widespread of all monitors in Australia (Wilson & Swan, 2010). This short note provides the detail of the first record of this species from the foot hills of the NSW Snowy Mountains and documents the use of rock outcrops by this species.

One juvenile *V. gouldii* was observed on 19 December 2019 near Adelong at the foot hills of the NSW Snowy Mountains (**Plate 1**). The general landscape around Adelong is characterised by extensive clearing for agricultural activities with isolated patches of box-gum woodland on the fertile lower slopes and dry foothill forest on the less fertile soils. Exposed rock outcrops are common in this landscape and are dominated by granite boulders many exceeding two metres in diameter. The site of this observation was characteristic of the wider landscape, with large granite boulders present in a previously cleared area with scattered Long-leafed Box (*Eucalyptus goniocalyx*) and Red Stringybark (*Eucalyptus macrorhyncha*). The presence of both tree species suggests the former presence of dry foothill forest.

Plate 1. Sand Goanna basking near Adelong at the foot hills of the NSW Snowy Mountains.

A review of existing records for *V. gouldii* from the NSW BioNET Atlas of Wildlife and Australian Museum suggest that a population of this species from this region was previously unknown (**Figure 1**). Records for this species in the far-south east of NSW from the NSW Atlas of Wildlife database are likely to be incorrect as the species does not occur there.

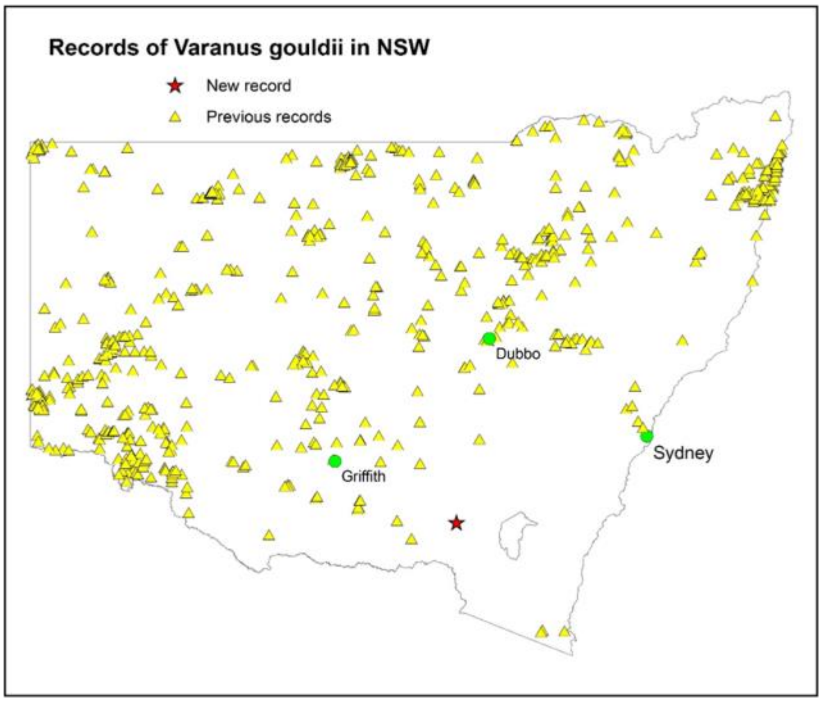

Figure 1. Existing records from the NSW BioNET Atlas of Wildlife and this new record.

Rock outcrops, and particularly those in agricultural landscapes, are known to support high levels of reptile diversity (Michael *et al.*, 2008; Sass, 2003). Relevant to this observation, the rock outcrops scattered along the foothills of the Snowy Mountains are likely to provide a thermally stable environment in a landscape characterised by mild temperatures. The closest town, Adelong, has a mean minimum temperature of 6.7 °C and a mean maximum of 21.8 °C (BOM, 2011).

This record of *V. gouldii* at the foot hills of the NSW Snowy Mountains suggests that their natural distribution in NSW is greater than previously thought and may overlap with the threatened species, Rosenbergs Goanna (*Varanus rosenbergii*). In addition, this observation also confirms that the species can use rocky outcrops which are of particular relevance in cooler climates that may not be conducive to thermoregulatory requirements.

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ECA ECOLOGICAL CONSULTANTS ASSOCIATION of NSW Inc

ECA of NSW Annual Conference and Workshop

Monday 19th and Tuesday 20th July 2021

Sage Hotel, Wollongong

The Forgotten, Neglected or Ignored: Biodiversity Issues Deserving Attention

Monday 19th

The 2021 ECA conference includes a wide range of topics with something to interest everyone. We will hear presentations on: the Commonwealth EPBC act; lessons from the oldest offset sites; success with fauna recovery programs; cryptic species such as Hairy Joint Grass and Mahony's Froglet; new technology such as the use of drones in ecology and environmental DNA; and less well known aspects of biodiversity including fungi, lichens and algae, invertebrates and stygofauna.

The BioNet Vegetation database: updates and application

Tuesday 20th

The workshop will be presented by DPIE staff who will cover a range of topics related to Plant Community Type (PCT) classification and mapping. This will include: what the new PCTs look like, their associated botanical and environmental parameters; how to identify PCTs using BAM plots and the latest online tools; other interactions with Bionet including uploading and downloading data; and elucidation of the soon-to be released east coast vegetation mapping.

Program and Registration available online

http://www.ecansw.org.au

	2 day	1 day
Members	$225	$125
Non-members	$350	$200
Student	$125	$75
Conference Dinner		$55

ECA PHOTO COMPETITION ENTRIES

TOP LEFT: Hoary Sunrays near Marulan. *Addy Watson.*

ABOVE: Sulphur-crested Cockatoo. *Geraldene Dalby-Ball.*

TOP RIGHT: Water Dragon after the fires. *Andrew Lothian.*

LEFT: Postmans Tree - Nightcap National Park. *Ian Colvin.*

RIGHT: Young Blue-tongued Lizard and BOTTOM RIGHT: *Geraldene Dalby-Ball.*

BOTTOM LEFT: *Philotheca buxifolia*. *Isaac Mamott.*

ECA PHOTO COMPETITION ENTRIES

LEFT: Xanthorrhoea. *Tim Johnson*

RIGHT: *Geraldene Dalby-Ball*

CENTRE LEFT AND CENTRE: *Ryan Herbert*

RIGHT CENTRE: *Patersonia glabrata* from Mount Hayes Jan 2019; and BOTTOM CENTRE: *Cyrioides imperialis* sitting on a Banksia near Cordeaux Dam, Feb 2019. *Stephanie Clark*

BOTTOM LEFT: Parsley Fern fertile frond. *Brian Wilson*

BOTTOM RIGHT: 2020 new growth. *Tim Johnson*

ECA PHOTO COMPETITION ENTRIES

TOP LEFT: Scarlet-Chested Parrot. *Steve Sass.*

RIGHT and CENTRE RIGHT: Pink Flannel Flowers. *Tim Johnson*

BELOW: ***Phebalium squamulosum ssp. squamulosum.*** *Frances O'Brien.*

ABOVE: ***Pterostylis nana*** **Dwarf Greenhood in** ***Acacia curranii*** **Curlybark Watlle (Vulnerable-BC Act, EPBC Act).** *Phil Cameron.*

RIGHT: ***Grammitis stenophylla.*** *Ian Colvin.*

FAR RIGHT: *Ryan Herbert*

An Isolated Population of the Spinifex Delma (*Delma butleri*) (PYGOPODIDAE): Records from the Barrier Ranges near Broken Hill, Western NSW and Implications for their Future Survival

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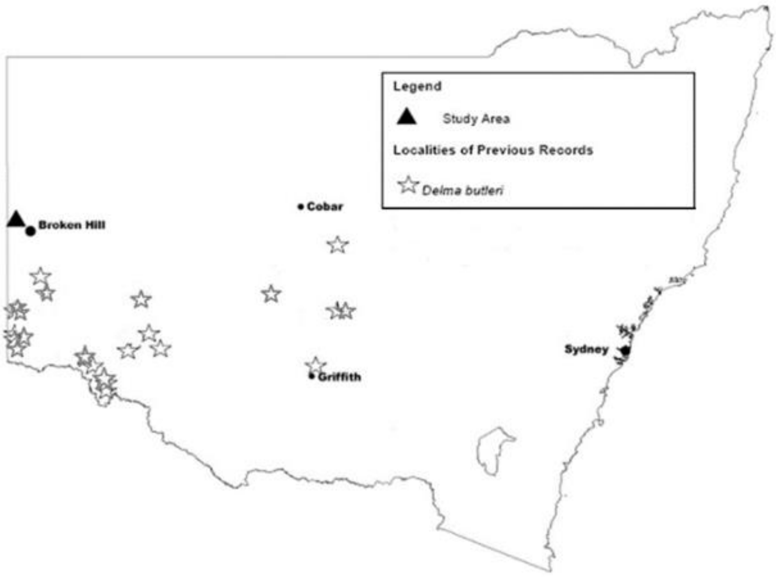
The Spinifex Delma (*Delma butleri*) was first described in 1987 (Storr, 1987) and is generally considered to be restricted to spinifex habitats (Swan et al., 2017, Wilson and Swan, 2017, Val et al., 2001, Val et al., 2012, Driscoll, 2004) (Plate 1). The species has been recorded throughout Western Australia, South Australia and Victoria, with scattered records in New South Wales (OEH, 2021) (Figure 1). This short note documents the presence of an isolated population of *Delma butleri* within the Barrier Range Bioregion in western NSW and implications for their future survival.

Plate 1: One of the *Delma butleri* recorded in the Barrier Ranges. *Photo by Gerry Swan.*

Figure 1: General location of the population of Spinifex Delma north of Silverton and localities of previous records from NSW Atlas of Wildlife Database, BioNET, Swan *et al.* (2017) and Sass *et al*. (2005).



While conducting biodiversity surveys for the then proposed Silverton Wind Farm, between September, 2007 and November, 2008 13 individuals of *Delma butleri* (Figure 1 & 2) were found in isolated spinifex patches amongst rock outcrops. Due to the rocky nature of the study area and the inability to install pitfall buckets, only hand searches of live and dead spinifex clumps could be done. However, not all clumps were searched in an effect to conserve habitat for these and other spinifex-obligate reptile species. Presence was confirmed in four of the seven known patches of spinifex (Figure 2), but it is likely that the species is also within the remaining three spinifex patches. As the surveys were designed to reveal presence only, it is assumed that these 13 individuals comprise part of a larger population. This new location is separated from the nearest known suitable habitat by extensive expanses of unsuitable Mulga and Chenopod Shrublands. The closest areas of spinifex habitat to this location are within Mutawintji National Park (approximately 120 km north-east) and despite extensive surveys, the Spinifex Delma has not been recorded there (Swan and Foster, 2005). The closest known NSW records are around 140 kms to the south near Coombah Roadhouse (Sass et al., 2011) (Figure 1).

Previous to the discovery of this isolated population, *Delma butleri* was only known to occur in NSW on the sand dunes and sand plains where spinifex occurs. This population occurs where spinifex is growing amongst pre-Cambrian metamorphic rock outcrops on crests and slopes of extensive rocky ridges where no sand dunes or sand plains occur (Plate 2 & 3). This ecological trait suggests that this isolated population is ecologically distinct from other populations in NSW. Given the disjunct nature of this population from the known populations (Figure 1), the disjunct nature of habitats within the isolated population (Figure 2), the absence of sand dunes and sand plains in the rocky hills of the Barrier Ranges, and that the population is confined to seven disjunct habitat patches comprising of ~300 hectares in total, the population is considered to be of significant conservation value.

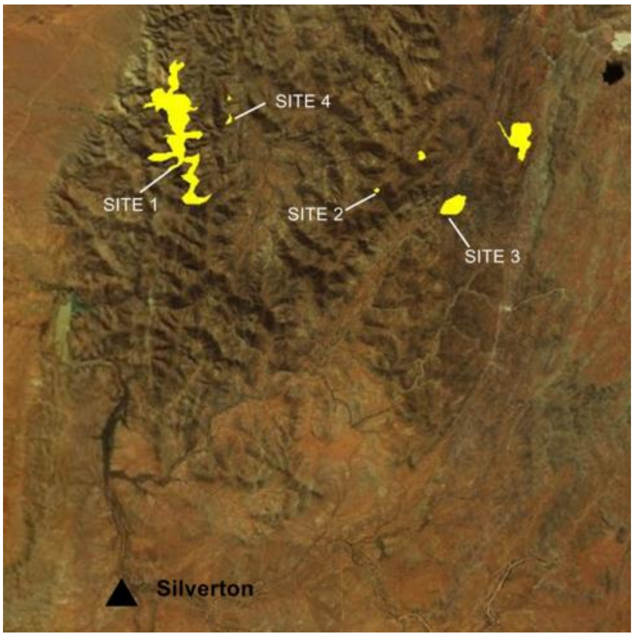


Figure 2: Habitat for the isolated population of Spinifex Delma occurs in seven isolated spinifex patches.

There are a number of likely threats to this isolated population. The severely fragmented nature of the seven remaining patches threatens the genetic exchange and subsequent long-term viability of the population, especially considering the low-dispersal capability and low fecundity of *Delma butleri*. Reduced rainfall during drought periods combined with grazing by introduced and native herbivores is known to directly modify spinifex communities (Cohn and Bradstock, 2000). This threat is likely to result in a continuing decline in the quality and extent of available habitat and therefore a decline in the population of *Delma butleri*. Continued pressure within the spinifex habitats could result in disease and abnormal dieback (Benson and Sass, 2008), which would result in degradation of the habitat. Since the field surveys were completed, the Silverton Wind Farm has been constructed and is now operational and impacts have largely avoided spinifex habitats. However, the Barrier Ranges are particularly susceptible to sheet erosion which could be exacerbated by the construction of roads and other infrastructure for the wind farm.

Plate 2: *Delma butleri* habitat on the western side of Barrier Ranges. *Photo by Steve Sass.*

The population size of *Delma butleri* in NSW is unknown. However, surveys in suitable mallee/spinifex habitats across NSW frequently detect this species (Sass et al., 2005, Wassens et al., 2005, Val et al., 2001, Driscoll, 2004, Driscoll and Henderson, 2008, Olsson et al., 2005) suggesting that extreme fluctuations are not evident in the NSW population. However, given the isolated nature and limited extent of the spinifex habitat in the Barrier Ranges, this population is likely to have already experienced population decline due to an inability to maintain genetic viability as has been experienced elsewhere with habitat fragmentation and reptiles (Driscoll, 2004). Further, long-term threats to this habitat have the potential to significantly affect the quality and diversity of their habitat within the Barrier Ranges potentially resulting in extreme negative fluctuations in this isolated population.

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Plate 3: *Delma butleri* habitat on the eastern side of Barrier Ranges.
Photo by Steve Sass.

Koala Survey and the SEPP (Koala Habitat Protection) 2019 and 2021

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Abel Ecology

The *State Environmental Planning Policy (Koala Habitat Protection) 2019* comes with the *Koala Habitat Protection Guideline Implementing State Environmental Planning Policy (Koala Habitat Protection) 2019*. We now have the Koala SEPP 2021 which will be supported by a guideline which is likely to borrow heavily on the 2019 guideline. The Guideline (2019) requires the use of the Spot Assessment Technique (SAT) (Phillips and Callaghan 2011) to survey for koalas by presence of scat pellets. In this note I raise an inadequacy in the specification in the Guideline for use of the SAT and some other considerations.

Koalas produce a distinctive faecal pellet (scat) that can be used to detect the past presence of a koala in the landscape (Sluiter *et al.* 2001; Dique *et al.,* 2003, 2004; Phillips and Callaghan 2011; Woosnam-Merchez *et al.,* 2012; Cristescu 2011; Cristescu *et al.* 2012).

However scats are unable to provide a basis for assessing koala activity or population data (Dique *et al.* 2003, 2004; Woosnam-Merchez *et al.,* 2012). Pellet distribution under trees is also not an indicator of diet or tree preference (Ellis *et al.* 1999; Sluiter *et al.* 2001; Woosnam-Merchez *et al.,* 2012).

Decay rate of scats varies with vegetation community, substrate type, sunlight, moisture in the litter layer, fungal decay, invertebrate activity and climatic factors such as rainfall (Cristescu 2011, 2012; Woosnam-Merchez *et al.,* 2012) but the mechanisms and influences are unpredictable. For example in Blackbutt (*Eucalyptus pilularis*) forest scats persisted at greater than 50% and at 80% in woodland after 40 weeks on North Stradbroke Island in Queensland (Cristescu 2011; Cristescu *et al.* 2012).

Detectability of scats in highly complex litter such as occurs in Eucalypt forests is lower than in simple litter such as under she-oaks (Allocasuarina and Casuarina species). The range is from 87% detectability within two minutes on simple litter, 30% in complex litter to 11% in highly complex litter (Cristescu 2011; Cristescu *et al.* 2012). That variability in detection imposes a very large bias in detection rate where vegetation across a study area is heterogeneous. Decay or disturbance is higher after a rain event so survey in the wet season or after a rain event is likely to result in under-detection of scats (Cristescu 2011; Cristescu *et al.* 2012).

Decay time affects detection of pellets as both false-negative error and the potential for false-positive errors. In one case study (Rhodes *et al.* 2011), false-negative errors were low on average and the expected time interval prior to surveys that detected pellets indicate the species was present within less than 2–3 years, with potential for false -positives.

In an area with a low population density and possible infrequent use of individual trees by koalas the distribution of scats is inherently sparse. Where a family group occurs with a number of individuals with discrete home ranges the scat distribution would be expected to be locally relatively dense. However that is not necessarily the case (Cristescu 2011; Cristescu *et al.* 2012).

Pellet production rates can also be expected to affect detectability of scats. Daily pellet production averages 175 for a koala and may range from 140-205 per animal (Ellis *et al.* 1999) but habitat quality may affect food intake (Moore *et al.* 2004). The great majority of pellets are produced about 34 to 154 hours after feeding and are voided mostly at night at a rate of up to 15 pellets per hour (Ellis *et al.* 1999).

The spot assessment technique or SAT (Phillips and Callaghan 2011) suffers various flaws including the fundamental flaw of bias. The flaws also include the methodological impossibility of reproducing the process, the requirement to search within 100cm of the base of a tree and the two minute search time, regardless of litter complexity (Woosnam-Merchez *et al.* 2012). As a further limitation on the probability of detection as little as 20%

and up to 47% of scats may be deposited within one metre of a trunk (Phillips and Callaghan 2011), thus considerably reducing the potential effectiveness and reliability of the SAT.

Consequently any attempt to estimate population distribution or abundance based on that approach is fundamentally flawed and inappropriate to use for the purpose of the koala SEPP and (draft) Guideline (2019). That the literature on this issue is up to a decade old is a sad indictment on the inadequacy of the new koala SEPP and Guideline.

The inherent bias in the SAT must be addressed in policy documents and environmental planning instruments. The Koala Rapid Assessment Method (KRAM) (Woosnam-Merchez *et al.*, 2012) is a far more reliable means to survey koala populations. There is an even better refinement on that method that I have been using for more than five years, based on fresh scats, with great success. However, that is another paper, beyond the scope of this note. I hope to provide more information on this method in a future issue of Consulting Ecology.

It is in my view unfortunate that so many councils and KPoMs also use the SAT as well. The SAT has become the default method since it is neat and tidy and its shortfalls are not recognised. The time elapsed since the SAT has been critiqued is enough for recognition and acceptance of alternative assessment techniques that need to be considered as new methods and technologies (eg. drones, dogs) become available.

A different consideration is the definition of “suitably qualified and experienced person” as having “experience in conducting koala surveys”. It is my experience that a consultancy company may have one person as an employee who has some experience but will send an inexperienced person to conduct field work. The botanical skill required to accurately identify tree species is another potential shortfall in an inexperienced surveyor sent to a site. For example I have experience of one KPoM for a local government area in which a feed tree species is mapped, but that that species does not occur in that area.

The guideline to accompany the SEPP 2021 will be revised and presumably go on exhibition for comment, so there is opportunity for comment regarding adoption or refinement of methods.

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Studies of the Barking Owl in the NSW Northern Rivers District

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The NSW population of the Barking Owl has collapsed over the past few decades and only two sub-populations appear likely to have the capacity to remain viable in the longer term. One of these occurs in the Pilliga forests and woodlands in the north west of the State and the other is found in the mid and lower catchments of the Richmond and Clarence Rivers in the far north east.

The Pilliga population has been relatively closely investigated in recent years but the lower Richmond-Clarence population has remained comparatively poorly known. To remedy the latter situation, particularly with regard to providing information for conservation management, the NSW DPIE initiated a systematic survey across the district in 2018.

This survey resulted in records of Barking Owls at 34 sites from a total of 90 sites surveyed. An estimated 21 territories were derived from an analysis of the survey results and these territories are being further investigated by the NSW Nature Conservation Council's Large Forest Owl Project, funded by the DPIE's SoS program with back-up funding from the DPIE's Biodiversity and Conservation Division.

Plate 1. The male Barking Owl from the Bungawalbin Creek territory at its roost site pre-fire. Plate 2. The same male showing why this species is also called the Winking Owl

SM4 Song Meters are being employed throughout the majority of the estimated territories to obtain an indication of Barking Owl activity, which provides a focus for detailed territory core and nest site searches.

By late 2019, several territory cores had been located and two active nests were under investigation. One of these was on Bungawalbin Creek, a tributary of the Richmond River and the other at the toe of the Richmond Range on the boundary between the Minyumai Indigenous Protected Area and Bundjalung National Park.

Then the October-November wildfires raged through the area, terminating the breeding of the Bungawalbin and Minyumai-Bundjalung pairs. The Bungawalbin nest tree, a 152 cm dbh Forest Red Gum containing a well-developed owlet was incinerated, ignited from an old basal fire scar that turned the hollow trunk into a chimney. However, the Bundjalung-Minyumai nest tree, a 142 cm dbh Small-fruited Grey Gum without basal fire scarring survived, although the nest hollow in a dead spout was cracked by intense heat. It is not known whether the owlet in the latter nest survived.

Plate 3. The Forest Red Gum nest tree of the Bungawalbin Barking Owl pair incinerated in the November 2019 wildfires.

Plate 4. The Small-fruited Grey Gum nest tree of the Bundjalung-Minyumai Barking Owl pair (centre of photo) that survived the 2019 wildfires .

Studies post fire, together with data from the Song Meters indicate that the Barking Owl pairs occupying territory cores pre-fire are still present in these areas, although currently there is no indication of breeding. Small arboreal marsupial populations throughout the owl territories appear to be substantially reduced and continuing monitoring of owl pairs should provide evidence on whether the fires have had a detrimental effect on breeding in this and subsequent years.

Buildings and Birds: The Good, Bad and the Ugly

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Introduction

A growing number of ornithologists worldwide are spending a significant part of their professional time observing and thinking about birds, buildings and urban infrastructure. When I first explained this to my peers in the consulting industry, most automatically thought that this involved assessments of potential impacts of proposed developments on bird species (threatened species, in particular) and their habitats. Well, yes, but there is more …

Most bird species can be categorised as urban dwellers, urban utilisers or urban avoiders (Johnston 2001; McKinney 2002; Fischer *et al*. 2015). *Urban dwellers* (also known as *urban exploiters*) are species that thrive in urban landscapes away from natural habitats and typically have flexible diets and behaviours, or who have co-evolved with humans (Kark *et al*. 2007; Fischer *et al*. 2015). They are generally aggressive to other species, or comprise individuals that are more aggressive than their rural conspecifics (Foltz *et al*. 2015; Davies & Sewall 2016; Martin & Bonier 2018). *Urban utilisers* (also known as *urban adapters*) are species that use urban landscapes, but generally do not benefit from them, and are typically native species that rely primarily on natural habitats for survival. *Urban avoiders* are species that are significantly impacted by urbanisation, are typically native specialist species that only use non-urban habitat, or occur in cities and towns as accidental vagrants, or in remnant habitat or other natural areas that are within urban boundaries (Sandstroem *et al*. 2006: Kang *et al*. 2015; Rega *et al*. 2015). Urban dwellers and urban utilisers are usually granivores (e.g. feral pigeons, cockatoos, corellas, some parrot species, and sparrows) or omnivores (e.g. Common Myna *Sturnus tristis*, Common Starling *Sturnis vulgaris* and Noisy Miner *Manorina melanocephala*), some are carnivores (e.g. falcons and kestrels), while urban avoiders tend to be insectivores. There are exceptions, of course, the Welcome Swallow (*Hirundo neoxena*) is one insectivore that is a common inhabitant of Australian cities and towns, and often roosts and nests in buildings.

Most avian urban dwellers (e.g. Feral Pigeon *Columba livia* and European Sparrow *Passer domesticus*) and some urban utilisers (e.g. Little Corella *Cacatua sanguinea* and Peregrine Falcon *Falco peregrinus*) are often found on or around city or town buildings. The buildings can be used by these species for roosting, nesting, shelter, resting, foraging, and/or as vantage points from where they can view the surrounding landscape. But urban utilisers and avoiders sometimes use buildings as resting points while on migration, dispersing or when displaced from natural areas as a result of habitat clearance or extreme natural events (e.g. cyclones, prolonged drought, bushfires, floods). There is also some evidence that buildings can be refuelling (foraging) points for some migrating birds (Partridge & Clark 2018). But for many birds, buildings and associated structures (e.g. phone towers, cables) can be physical obstacles that lead to bird strikes and consequent bird mortality (Loss *et al*. 2014) or can be ecological traps for birds (e.g. Sumasgutner *et al*. 2018). Conversely, if buildings become too attractive to avian urban dwellers, a few of these species can reach pest levels and become an environmental health hazard for humans and other species, as well as competitively excluding more timid bird species that could otherwise colonise or move through cities and towns.

Ornithological consultants play a critical role in studying and managing the relationships between bird populations and the built environment. The present essay identifies the good, bad and the ugly relationships between buildings and birds, and how these impact on urban biodiversity and the health of human communities in cities and towns. Finally, specific management issues for achieving a desirable ecological balance between birds and humans in the built environment are discussed.

The Good: Green Roofs and Ledges (well, sort of …)

Green Roofs

A green roof is a vegetated green space on top of a building, and created by adding layers of growing medium (root protection, drainage, and substrate or soil layers) and plants on a waterproof membrane (SCC 2014). Green roofs are usually grouped into two categories: extensive and intensive green roofs (Fernandez-Canero & Gonzalez-Redondo 2010). *Extensive green roofs* have a thin growing medium, are vegetated with slow-growing succulent shrubs (e.g. Crassulaceae species) and grasses, require little maintenance, and rely on rainfall and dew as their only sources of moisture. *Intensive green roofs* have much thicker layers of growing medium, usually contain more complex vegetation associations and layering, including small trees, require a lot of maintenance, and usually have an established irrigation system.

Extensive and semi-intensive green roofs (Plates 1 and 2) are generally simple habitats in a harsh environment, similar to the hard ground surfaces, thin substrates and low-moisture conditions found in brownfields and grasslands (Lundholm *et al. 2010*). Therefore, fauna that use these areas are usually tolerant of moderate to high ambient temperatures, bright sunlight, dry conditions, acidic and low-nutrient soils, and originate from grasslands and pioneer habitats (Madre *et al*. 2013; Rumble & Gange 2013; Pétremand *et al*. 2018).

Plate 1. Green roof with a variety of grasses, flowering shrubs and bare ground.
Source: **Reynolds, A. (2017). Urban stability is growing** **https://mirimichigreen.com/articles/urban-sustainability-growing/**

Plate 2. Green roof at St Bernard's College, Essendon, Victoria
Source**: Architecture & Design Pty Ltd** **https://www.architectureanddesign.com.au/suppliers/fytogreen/roof-gardens**

Intensively-managed green roofs (Plate 3) often have a more limited value as fauna habitat because they often contain areas of mowed lawn and pesticide and fertiliser application. They are also likely to be subject to more disturbances due to human and pet activity, which can also result in trampling of vegetation and compaction of the growing medium (Lundholm 2011; Sarah *et al.* 2015).

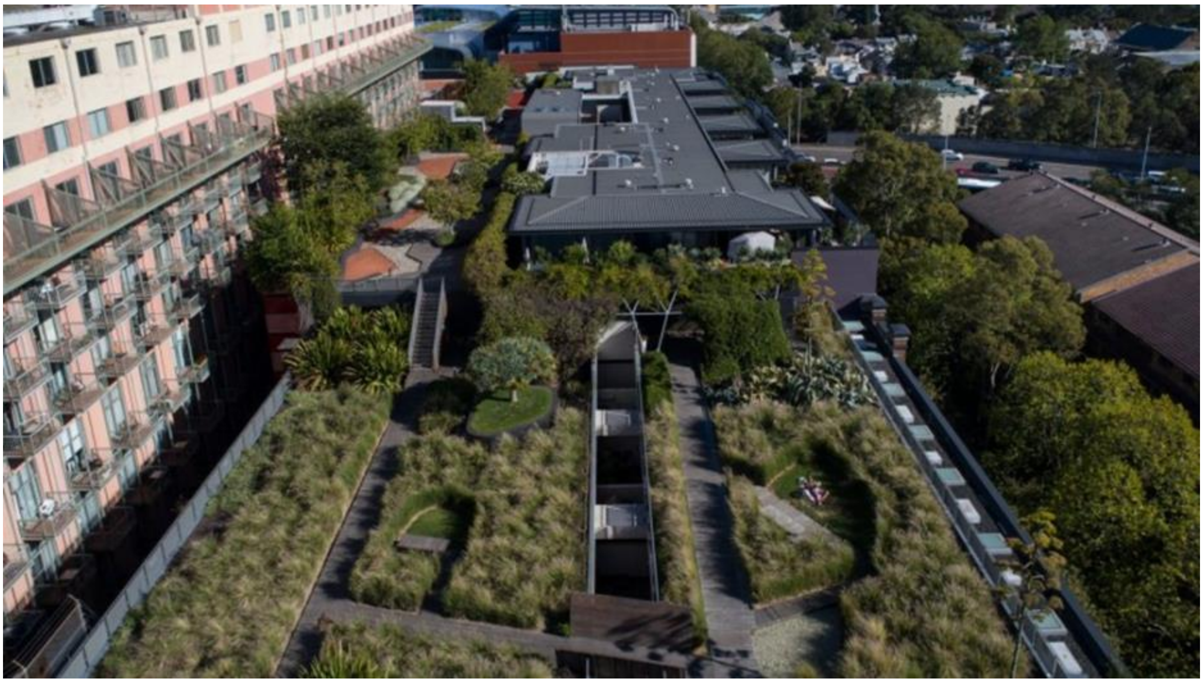

Plate 3. An intensively-managed green roof on top of an apartment building in Pyrmont, City of Sydney
Source: Visentin, L. (2018). "Missed Opportunity" for green roofs as Sydney's apartment boom continues (Sydney Morning Herald, 19 January 2018) https://www.smh.com.au/national/nsw/missed-opportunity-for-green-roofs-as-sydneys-apartment-boom-continues-20180118-h0k8pu.html

Globally, at least 50 bird species have been recorded using green roofs, 29 of these have nested on them (Dover 2015). Bird taxa recorded using green roofs include gulls and terns; oystercatchers, plovers and lapwings; ducks and geese; pigeons and doves; larks and skylarks; falcons; and grassland, scrubland and woodland passerines (Fernandez-Canero & Gonzalez-Redondo 2010). While the number of bird species recorded using green roofs is not very high, some are species of conservation significance (Grant *et al*. 2003; SLBAP 2010). The main values of green roof habitats for birds are provision of food (Diekelman 2009); shelter from extreme weather and predators (Brenneisen 2006; Cantor 2008; Grant 2006); breeding habitat (Baumann 2006; Dover 2015), refuge habitat (Hung *et al*. 2006); drinking water (dew), or drinking and bathing water (if the green roof is irrigated or has a pond) (Baumann 2006; Brenneisen 2006); resting and refuelling spots for migratory and dispersing birds (Partridge & Clark 2018); and additional habitat for individuals of resident bird populations to colonise or occupy (Taylor 2008). They may also act as "stepping stones" between larger green spaces in the urban environment in the absence of continuous corridor links.

Food may be in short supply for birds that live in city environments, and Dunnett & Kingsbury (2004) suggest that this is one of the main reasons that birds visit green roofs. Arthropods that are potential food for birds readily colonise green roofs. These include spiders, beetles, bugs, springtails, flies, butterflies, bees, wasps and ants (e.g. Kadas 2006; Blank *et al*. 2017; Dromgold *et al.* 2020). Seeds, fruit (Fernandez-Canero & Gonzalez-Redondo 2010) and nectar are also important food sources for some bird species that use green roofs. Seewagen *et al.* (2011) observed migratory land-birds add body mass during feeding stopovers in a heavily urbanised landscape. Some birds forage on green roofs while on migration and these sites are likely to be important refuelling spots on short stop-overs (Partridge & Clarke 2018).

Birds nest on green roofs because there are suitable nest sites (Brenneisen 2006). The vegetative cover provides protection against extreme weather, including shade from the heat, relief from the wind and rain and radiant heat loss at night (Fernandez-Canero & Gonzalez-Redondo 2010). However, there is little evidence of birds breeding successfully on green roofs (Baumann 2006).

Are green roof patch sizes and abundances adequate for contributing significantly to bird species richness and diversity in cities and towns? This is a complex question to address because of the different spatial and ecological requirements and mobility of each bird species, the structure of green roof habitats and their ability to provide areas where birds can retreat from anthropogenic disturbances, the structures of city flora and fauna communities, and the need to consider the distances of green roofs from other green spaces in the broader landscape.

Green roofs are still really not that common in world cities. For instance, Paris (France) had only 44 ha of green roofs (1.4% of the city's green space) in 2013, and Zurich (Switzerland) had 87 ha of vegetated roofs in 2007 (Mayrand & Clergeau 2018). Abundances and designs of green roofs are restrained by building architecture, the practical difficulties of establishing them (especially on the roofs of tall buildings), exposure to extreme ambient conditions (e.g. climate, weather and sunlight), fire risk, the costs and time involved in maintaining them, and the inadequacy of many city councils in encouraging and regulating the establishment of green roof spaces.

At least 10-35 ha of continuous green space are required to support most urbanised bird populations (Fernandez-Juricic & Jokimaki 2001; Chamberlain *et al*. 2007). Green spaces greater than 50 ha in size are necessary for the conservation of most threatened and urban avoider species (Beninde e*t al.* 2015). However, most city parks fall below this size range (Jokimaki 1999), and even small urban green spaces can support considerable biodiversity provided that there is sufficient habitat quality (Matthies *et al.* 2017). The minimum theoretical patch size threshold for sustaining populations of urban-adapted species is 4.4 ha (Berninde *et al*. 2015). Existing extensive and semi-intensive green roofs range from less than 0.01 ha to over 1.3 ha in area, whereas intensively-managed green roofs are known to range from 0.1 to 10 ha. Therefore, on size alone, while green roofs may be important stopping-over points for migrating birds, important stepping-stones between larger green spaces, or refuge habitat for displaced birds or individuals seeking shelter from the weather and predators, they are most likely only of value in helping to sustain city populations of urban-adapted grassland, shrubland and open woodland species. This may change in the future if more green roofs with suitable habitat, and shorter distances between them, are established in cities, adding significantly to a city's total green space area.

A summary of recommended design strategies for maximising biodiversity on green roofs is shown in Table 1. Important components of the green roof design are the choice of target species or populations that one wishes to attract to the roof and the identification of their habitat requirements (food, cover, water and space). Substate and vegetation layers can then be selected and designed to create rooftop habitats that mimic natural habitats of those organisms. Variation in substrate topography and vegetation composition, as well as the addition of logs, log piles, rocks or stones, native bee houses and nest boxes, provide microhabitats for the target organisms and their invertebrate prey.

Green Walls and Facades

Green walls and facades are vegetated areas growing on vertical surfaces of buildings (Plate 4) or vertical external or internal walls (Plate 5). Like most green roofs, growing medium, irrigation and drainage into a single system, and plant species are incorporated in to the design. *Green facades* (Plate 6) usually consist of only a few plants that climb and spread to cover the vertical surface, whereas *green walls* rely on multiple containerised plantings to create the vegetation cover. Green facades are planted typically with hardy climbers and vines that have the ability to grow quickly over a large vertical surface area and are hardy enough to withstand extreme conditions such as very hot and cold temperatures, low moisture, bright sunlight and shade. Green walls are planted typically with epiphytes, including vines, creepers, ferns, herbs, orchids, cactuses and often edible plants such as Chinese Cabbage (*Brassica rapa*), Spinach (*Spinacea oleracea*), Lettuce (*Lettuce sativa*) and chili (*Apsicum* species).

At a local scale, green walls have proven benefits for biodiversity, with even simplistic flora assemblages providing a habitat for invertebrates (Francis & Lorimer 2011). In the United Kingdom, they provide nest sites, food and shelter for urban birds, including at least two species of conservation significance. Birds generally use the upper half of green walls, and species are more likely to use green roofs if the buildings also have green walls (Chiquet *et al*. 2013).

Current green wall and façade research is focused on creating designs that replicate more closely the natural habitats of biodiversity that benefit from them. Green walls can support biodiversity in cities at a landscape scale by acting as a "corridor" or "stepping stone" to facilitate movement and dispersal (Angold *et al*. 2006). Therefore, some overseas city councils are beginning to invest in studies that examine the economic costs and the biodiversity benefits of incorporating green walls and facades into this urban landscape approach. One difficulty with this approach is that many green walls are analogous to natural vertical habitats for wildlife, such as vegetated cliffs, rockfaces and waterfalls that normally attract species that are adapted specifically to living in those areas. Therefore, there is a real question mark over the potential roles of green walls in connecting other green spaces.

Green walls and facades may possibly act as sources for arthropods that subsequently disperse to other urban areas, thus seeding food supplies for birds in other green spaces. But this is likely to be very limited in large cities, even for insects that can fly or spiders that sail on the wind by silk thread. This is because of the extensive distances that arthropods need to travel, the alien environment of the city landscape, and buildings (especially tall ones) are physical obstacles that also modify the local wind systems used in arthropod dispersal. Creating more green walls to form landscape corridors or stepping stones may aid the dispersal of arthropods by reducing their flying or soaring distances.

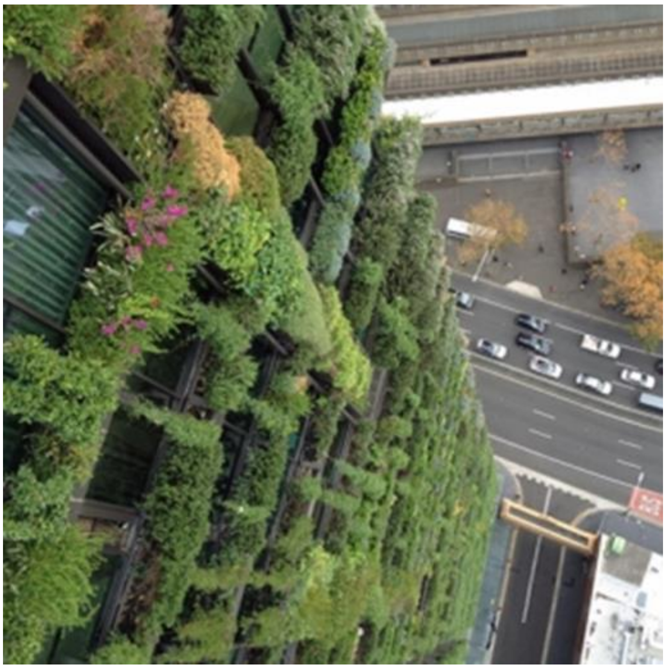

Plate 4. Example of a green wall growing on the sides of a tall multi-storey building,
Source: Wilkinson, S. (2018). Turf wars: 13 reasons why you would install a green wall and three reasons why you might not (Junglefy.com).
https://junglefy.com.au/media/turf-wars-13-reasons-install-green-wall-3-reasons-might-not/

Plate 5. Example of a green wall at ground level in a city centre.
***Source:* Wilkinson, S. (2018). Turf wars: 13 reasons why you would install a green wall and three reasons why you might not (The Fifth Estate).**
https://www.thefifthestate.com.au/columns/spinifex/turf-wars-13-reasons-why-you-would-install-a-green-wall-and-3-reasons-why-you-might-not/97550/

Table 1 **Recommended design strategies for maximising biodiversity on green roofs.**

Outcome	Recommended Actions: Currie & Bass (2010)	Recommended Actions: SLBAP (2010)
Identification of biodiversity target.		• Identify what species and populations you want living, growing and thriving on the green roof. • Develop a Habitat Action Plan (HAP) that creates green roof areas that mimic natural habitats of target species. Some city councils already have recommended HAPs that apply to local insects, birds, animals and plants.
Planting	• Where possible, use native species. • Any non-native species used should be non-invasive. • Select plant species that are suitable for use by target fauna species. • Select grasses and herbaceous plants that produce numerous seed heads that can provide energy sources for migratory birds.	• If the roof area is large enough, merge two or three similar habitats to broaden the value of the green roof as habitat for invertebrates and birds. This can often be achieved by having a different habitat on different roof elevations, creating a mosaic of habitats. • Avoid creating too many different habitats on a single green roof to avoid the risk of habitat areas being too small to be of value to attract target species. • An alternative approach to planting is to allow roofs to self-colonise, thus allowing natural communities and local biodiversity to occur there. • Pre-grown vegetation mats are not recommended for use on wildlife and biodiverse roofs. These mats have limited and prescriptive species groups and provide resistance to insects attempting to burrow into the sand underneath.
Substrate	• Store substrate on the building site before using it on the green roof. This allows organisms in the local soils inoculate the substrate before it is transferred to the roof. • Incorporate local materials (compost, porous materials) in substrate blends. • Vary substrate depths and drainage regimes to create a mosaic of microhabitats on and below the soil surface that can facilitate colonisation by a more diverse flora and fauna. • Vary substrate depths by adding berms and mounds, bare areas, and physical substrate connections to enhance species movement. This promotes landscape and biological heterogeneity.	• Add sand and create sand mounds. Ordinary sand or builders' ballast can be used to create either sand beds or sand mounds for insect species (especially native bees and wasps). Mounds should not be higher than the top of the nearest roof landscape component.
Structure	• Add bird boxes, bat boxes and bee houses, as desired. • Add snags (tree limbs), rocks and stones for terrain variation and moisture retention. • Add depressions to collect rainwater for short periods.	• Add trees: dead, stripped of bark and laid on the roof to provide perches for birds (they may need to be secured to the roof). • Add log piles, each log no more than 600 mm in length, stacked on top of each other to provide nesting for insects and perches for birds. Stacks should be no more than 350 mm high.

Plate 6. Example of a green façade, Platinum Apartments, Melbourne CBD.
***Source*: Fytogreen Pty Ltd http://fytogreen.com.au/green-facades-planter-boxes/**

Ledges

Long, broad ledges, especially those providing shelter from the wind and the rain, and provide a good view of the surrounding landscape, are popular with avian urban dwellers and many urban utiliser species. Ledges that are often used by birds are window ledges, shallow open horizontal (or near-horizontal) stormwater drains, and broad horizontal facades that are sheltered by overhangs. Birds use these locations for some or all of the following activities, depending on the species: roosting; resting; feeding; courting and mating; nesting; avoiding predators; and as vantage points from where they can observe the surrounding landscape. Ledges that are high above the ground are preferred by most species that use them because they are less likely to be subject to anthropogenic and associated disturbances, provide more expansive views of the urban landscape, and are often sheltered better than lower ones. Favoured ledges are also usually located within viewing distance of the closest reliable food source.

Most bird species that use building ledges are communal species which scavenge on food scraps left by humans, or which are deliberately fed by humans. Communal species that commonly use ledges in the Sydney Central Business District (Sydney CBD) include Sulphur-crested Cockatoos (*Cacatua galerita*), Little Corellas, Rainbow Lorikeets (*Trichoglossus moluccanus*), Feral Pigeons, Welcome Swallows, European Sparrows, Common Mynas and Common Starlings. While most building ledges are usually not broad enough to accommodate Australian White Ibises (*Threskiornis moluccanus*) and Silver Gulls (*Chroicocephalus novaehollandiae*), these species will use flat, low roof areas and canopies for loafing and as vantage points that allow them to observe and seize nearby food scraps.

Ledges are also important as brief resting areas for migrating and dispersing birds, particularly small passerines. While some cities are along established migratory pathways of many bird species, particularly in Europe, North America and the east coast of Asia, many individual birds are blown into cities by strong winds while migrating or dispersing, or are attracted by artificial light at night (ALAN). Individuals in this latter group are usually exhausted and disorientated and ledges provide them with the opportunity to rest before continuing their journey. However, ledges are alien environments to most, if not all, passerines, and they are at risk of being preyed upon by aerial predators, rodents and cats (*Felis catus*). Therefore, they only generally rest on a ledge for a few seconds, sometimes for a few minutes, before taking flight again, provided they have the energy. Some of the more unusual passerines that I have observed on window ledges of multistorey buildings in the inner part of

Sydney CBD include the Silvereye (*Zosterops lateralis*), Yellow-faced Honeyeater (*Caligavis chrysops*) and Brown Honeyeater (*Lichmera indistincta*), the latter two species not usually recorded within inner areas of Greater Sydney. The last European Blackbird (*Turdus merula*) I observed in the Sydney CBD was in 1994, when it landed for no more than five seconds on a sixth-storey window ledge of an office building in Bathurst Street.

Arthropodivorous birds often glean spiders and moths from the edges of windows, either by hovering in flight, performing a quick snatch and grab, or landing on a ledge and reaching over to the prey item. This is more common on windows of houses or ground-level apartments, especially where there are gardens. However, I have occasionally seen medium-sized passerines such as Red Wattlebirds (*Anthochaera carunculata*) and Noisy Miners use lower-storey window ledges in the Sydney CBD for this purpose.

Raptors worldwide recorded nesting on ledges of occupied city buildings include Lesser Kestrel (*Falco naumanni)*, American Kestrel (*F. sparverius*), European Kestrel (*F. tinnunculus*), Madagascar Kestrel (*F. newtoni*), Seychelles Kestrel (*F. araea*), Australian Kestrel (*F. cenchroides*), Lanner Falcon (*F biarmicus*), Lagger Falcon (*F. jugger*), Orange -breasted Falcon (*F. deiroleucus*) and Peregrine Falcon (*F. peregrinus*) (Newton 2010). Individuals of many of these species nest on ledges of cliff-faces or in caves in natural habitat areas, and building ledges provide similar nesting habitat. Nests are usually located on a horizontal ledge on one of the upper storeys of tall buildings, and which is in a sheltered location that is also secure from predators (Plate 7). Broad ledges also provide locations for city raptors to feed on prey (Plate 8), away from anthropogenic and other disturbances, as well as ideal vantage points from which to search for prey in the surrounding landscape. Although I am not aware of Brown Falcons (*F. berigora*) and Black-shouldered Kites (*Elanus axillaris*) nesting on building ledges, they are two additional Australian raptor species that I have observed using ledges or roofs of buildings located near the urban fringe while they are consuming their prey.

Plate 7. Peregrine Falcon feeding chicks on ledge of a tall building in Melbourne CBD.
***Source*: Saddler (2017). Birds iView: Streaming Falcons in the City (The Wheeler Centre Website, published 30 October 2017) https://www.wheelercentre.com/notes/bird-s-iview-streaming-falcons-in-the-city**

Plate 8. Peregrine Falcon feeding on a Feral Pigeon on a ledge of a tall building in the Sydney CBD.

Raptors in urban environments generally breed earlier and have larger brood sizes than conspecifics in rural environments (Kettel *et al.* 2017). However, some raptor species also fledge fewer young, caused by a lack of prey and, in some cases, increased anthropogenic disturbances. Raptors that prey on small mammals in urban environments are most likely to be least successful at fledging young (e.g. Australian Kestrel), whereas those that normally prey on medium-sized urban-dwelling birds (e.g. Feral Pigeons, Rainbow Lorikeets) are more successful (e.g. Peregrine Falcon). For instance, Sumasgutner *et al*. (2018) determined that Eurasian Kestrels rely heavily on voles as a dietary item in natural habitats, whereas city populations prey heavily on insects, leading to malnutrition and hormonal stress in nestlings. Anthropogenic disturbances in urban areas (e.g. traffic and construction activities) can lead to elevated stress hormone levels in breeding American Kestrels and an increased rate of nest abandonment (Strasser & Heath 2013). Therefore, urban environments, particularly inner-city areas, can be an ecological trap for some raptor species.

THE BAD: COLLISION RISK AHEAD!

Overview

There are currently no reliable estimates of bird mortality resulting from collisions with glass or other transparent panes in buildings in Australia. However, between 365 and 988 million birds are estimated to be killed annually in the United States (Loss *et al*. 2014), and between 16 and 42 million birds in Canada (Machtans *et al*. 2013) from building collisions. The British Trust for Ornithology estimates that building collisions kill about 30 million birds per year in the United Kingdom. In the United States, low-rise office and other commercial buildings, and stadiums are responsible for 56% of mortalities, 44% at residences, and less than 1% at high-rise buildings (skyscrapers). Bird mortality is much higher at low- and high-rise buildings during bird migration periods, whereas the reverse is the case at residences (Klem 1989; Dunn 1993; O'Connell 2001; Klem *et al.* 2009; Borden *et al.* 2010; Machtans *et al.* 2013).

Birds collide with glass during the day and at night. Daytime collisions can occur when a transparent pane physically obstructs a narrow flight path (e.g. the space between two neighbouring buildings), especially when a bird can see suitable habitat or the sky on the opposite side of the pane (Ross 1946; Klem *et al.* 2009). Birds also collide with panes that reflect landscape features that attract birds, such as vegetation, food sources, potential perches (e.g. building ledges), or the sky (especially clouds) (Banks 1976; Klem 2006). These types of collisions are normally associated with the lower levels of multistorey buildings (Gelb & Delacretaz 2006). The number of daytime collisions is also positively correlated with glass surface area because more landscape and sky features can be reflected by larger panes (Gelb & Delacretaz 2009; Hager *et al.* 2008, 2013; Klem *et al*. 2009; Loss *et al.* 2019).

Collisions at night are most pronounced during migration; migrating birds are often active at night, mainly to avoid predators or to navigate using star patterns (Drewitt & Langston 2008). This impact is greatest when there is low cloud cover and birds are forced to fly at lower altitudes (Newton 2008; Longcore *et al.* 2012). Artificial light at night can have a "beacon effect", attracting migratory birds and, if emitted from a window, can disorientate birds or give them the impression that they can fly through to the interior of the building (Machtans *et al*. 2013). There is a similar risk for resident birds, including those which are normally active during the day, because artificial light can attract nocturnal aerial insects (e.g. moths, beetles) in large concentrations, which attract birds that prey on them, increasing the risk of those birds striking glass panes. Bird mortality at night is positively correlated with the amount of light emitted from windows (Evans Ogden 2002; Zink & Eckles 2010).

A few bird species of conservation significance due to their declining populations are particularly vulnerable to collisions with glass panes, e.g. six migratory passerine species in North America (Loss *et al.* 2014). In Australia, species that fly fast and low (e.g. parrots, honeyeaters and owls) are particularly vulnerable to striking transparent panes. Three species of conservation significance which have been recorded striking windows in NSW are Swift Parrots (*Lathamus discolor*) (Pfennigwerth 2008), Powerful Owls (*Ninox strenua*) (Dr Beth Mott, BirdLife Australia, *pers. comm*.) and Regent Honeyeater (*Anthochaera phrygia*) (*pers. obs*., Robb College, University of New England, Armidale, 1986). But perhaps the most surprising record is a juvenile White-bellied Sea-eagle (*Haliaeetus leucogaster*) which collided with a high-rise building at Circular Quay in February 2017 (Plate 9).

Minimising the Collision Risk

The first step in the process of minimising the risk of bird-building collisions in relation to new building projects is for an ornithological consultant to conduct a Bird Collision Risk Assessment (BCRA) in consultation with the architect, property owner, construction team and local council. This takes into account bird species that are potentially at risk at colliding with the building, the location of the building in relation to potential flyways and habitat areas of these species, the surrounding urban landscape and features within it that may divert bird movements towards the building or attract larger numbers to the locality, features of the building that could potentially pose a collision risk, and predicted temporal changes (seasonal and longer-term) in collision risk levels. The BCRA also identifies the nature and magnitude of bird-building collision risks and recommends measures for reducing or avoiding them, and details a monitoring program for assessing and reporting on the effectiveness of these strategies. It is highly preferable that this is done early in the project design stages, because it is much easier and less expensive to choose a different building location, modify the building design and/or proposed building materials than making changes when the building has been completed or is close to completion. Unfortunately, this advice is often not sought until just prior to or after the start of building construction. Therefore, there is a significant need for local governments in Australia to recognise bird-building collisions as a potentially significant environmental problem, and for them to incorporate into their planning regulations the need for BCRAs as part of the development application process for all building projects.

Specific building design and building management strategies to reduce the risk of bird collisions depend very much on the location of the building, the landscape context and the target species in need of assistance. However, general strategies relating to glass panes, light pollution and bird trap reduction in the design of new office and other commercial buildings, modifying existing workplace buildings, and homes are shown in Table 2.

Plate 9. Australian Museum Instagram of a White-bellied Sea-eagle that had collided with a high-rise building at Circular Quay, Sydney (February 2017).

The Ugly: Debauchery, Excrement, Vandalism and Gluttony!

Pest Bird Species

Modern city buildings are becoming more sophisticated in design which, in general, makes them less suitable as locations for pest birds to accumulate in large numbers. However, older buildings, such as historic buildings, factories and commercial premises are vulnerable to pest birds because they have sheltered niches, crevices and ornamental facades that are ideal nesting and roosting habitats.

Pest bird species associated with buildings in cities and towns of south-eastern Australia can be categorised into three broad categories: colonial nesting and/or roosting species, the food scavengers, and the vandals. The *colonial* *nesting and roosting* birds are those that form large colonial groups and use buildings for roosting, large-scale breeding (the "*debauchery*"), shelter and resting, social bonding with conspecifics, protection from potential predators, and as vantage points from where they can view the surrounding landscape. This category comprises Feral Pigeons, European Sparrows, Common Starlings and Welcome Swallows. Urban roosting and nesting colonies of Australian White Ibises usually occur in natural wetlands (vegetated islands or banks), but also nest in stormwater basins that have vegetated islands. However, smaller nesting and roosting colonies of ibises can occur in tall trees (especially in tall palm trees) in landscaped areas adjacent to office buildings and other commercial premises (Plate 10). This is especially so when more individuals seek refuge in urban areas during prolonged droughts. In this situation, the palm fronds provide suitable nesting and roosting sites, the height of the trees provide protection from potential predators such as cats, urban foxes and dogs, and the taller height of the adjacent buildings provide some protection from extreme weather (e.g. strong winds). *Food scavengers* are birds that scavenge on food scraps that people have left in accessible outdoor areas such as outdoor cafes and restaurants, picnic areas and garbage bins (Plate 11). While all colonial and roosting species, except for the Welcome Swallow, are food scavengers, additional species such as Silver Gulls, Little Corellas, Australian Ravens, Rainbow Lorikeets, Common Mynas and Noisy Miners use rooftops, ledges and canopies of buildings as vantage points from which to search for food scraps. *Vandals* are birds that have strong, sharp bills and chew wooden exteriors of buildings, tear structures made of soft and tearable material (e.g. canvas, plastic insulation around electric cables), or tear up turf at sports stadiums and in urban parks. Sulphur-crested Cockatoos, Little Corellas and, to a lesser extent, Rainbow Lorikeets are building vandals that occur in the larger cities and towns of south-eastern Australia. Galahs (*Eolophus roseicapilla*) are vandals that normally occur closer to the urban fringe, but may move into inner-city areas as individuals displaced from natural habitat areas build up in urban areas after extensive habitat clearance, bushfires or during prolonged drought periods.

Plate 10. Australian White Ibises nesting in tall palm trees adjacent to a multi-storey commercial building in Gladesville, Sydney in October 2019. *Photo by S. Ambrose.*

Colonial Nesting and Roosting Species

An individual Feral Pigeon produces around 12 kg of excreta (droppings) annually (Kösters *et al*. 1991) and a single building or other urban structure can accommodate several hundred pigeons at any one time if there is sufficient habitat and nearby food resources (the "*poo*" problem). Accumulations of acidic droppings from pest birds on buildings, paved areas, monuments and infrastructure (e.g. bridges) are unsightly, corrosive to building materials (Del Monte & Sabbioni 1986; Dell'Omo 1996), and contain pathogenic fungi and bacteria that cause histoplasmosis, chlamydiosis, cryptococcosis, and other lung diseases in humans (Haag-Wackernagel 2005). For instance, Feral Pigeons harbour at least 110 types of pathogenic microorganisms (Haag-Wackernagel & Moch 2004), but only seven of these have been passed onto humans, some of which have caused human fatalities (Haag -Wackernagel & Moch 2004; Haag-Wackernagel 2006). These diseases can also be transmitted onto other feral, domestic and native bird species. Debris from roosting flocks can build up, causing gutters and drains to block, damage to roofs and other structures, and creating potential fire hazards.

Building Management	General Strategy	Specific Mitigation Measures
Glazing: New Buildings	Minimise quantity of glass.	Avoid continuous expanses of monolithic, clear glass, especially near grade where vegetation may be reflected.
	Increase visibility of glass.	• Use adhesive film, acid-etch or frit patterns to create visual noise which breaks up the transparency of glass and prevents a bird from perceiving it as clear or fly-through. • Use bird-friendly pattern designs: high-contrast and dense-spacing. • Apply patterns to exterior surfaces of the glass (interior surfaces may be less visible to birds). • Focus on applying the glazing to glass panes in the critical zone for collisions: up to the fourth floor of a building, or the height of neighbouring vegetation (whichever is greater). • Make bird-friendly glass pattern design compatible with the overall design of building. • Integrate bird-friendly glass pattern design with shading, viewing and privacy benefits of the building occupants.
	Block reflections of surrounding vegetations and sky.	• Utilise exterior screens, architectural mesh and grilles to block reflections of the vegetation and sky, and break up transparency. • Combine bird-friendly objectives with solar shading, increased thermal comfort, and additional rain and wind screening.
	Be wary of bird attractants and take simple, appropriate measures.	• Avoid planting vegetation that can be reflected by glass panes. Birds are more likely to fly into glass panes that are within 2 to 20 m from vegetation. • Avoid interior plants near windows.
	Design building elements and landscapes that minimise bird collisions.	• Avoid constructing dangerous fly-through conditions for birds (e.g. glass balustrades, glass skywalks) in clear paths that birds use for flying towards the sky or habitat areas.
Glazing: Existing Commercial Buildings	Increase the visibility of glass.	• Existing glazed surfaces: use adhesive film patterns to create visual noise, and which breaks up the transparency of the glass and the perception by birds that it is clear to fly through. • Replaced windows and glazed surfaces: use same mitigation measures to increase visibility of glass in new buildings.
	Block reflections of surrounding vegetations and sky.	• Same mitigation strategies as for new buildings.
Glazing: Existing Homes	Increase the visibility of glass.	• Use patterned window film or tape on glass to create visual noise, and which breaks up the transparency of the glass and the perception by birds that it is clear to fly through. • Place wind curtains or strings no more than 10 cm apart outside windows. The wind curtains transform glass surfaces into an obstacle for birds to fly through, as well as creating visual noise.

Building Management	General Strategy	Specific Mitigation Measures
	Block reflections of surrounding vegetations and sky.	• Apply exterior window screens and nets to block reflections of the surrounding vegetation and sky, and to make the windows more visible to birds.
	Be wary of bird attractants and take simple, appropriate measures.	• Move interior plants away from windows. • Locate bird feeders and water bowls within 0.5 m of the window. This will reduce the risk of a bird building up enough momentum to injure or kill itself if it hits a glass pane.
Bird Trap Reduction	Reduce the risk of birds becoming trapped while exploring potential nest sites around buildings.	• Use screens to secure enclosed spaces, e.g. ducts, pipes, and intake and exhaust vents.
Light Pollution Reduction	Reduce light trespass from interior sources.	• Use minimum wattage fixtures appropriate for internal use. • Switch off lights or draw blinds after hours to reduce light pollution. • Install motion-sensitive lighting, especially in lobbies, walkways and corridors. • Install automatic light operating systems that are programmed to turn interior lights off after working hours. • If the building is used in the evening, ensure that only the rooms in the building that are being used are illuminated. • Use lighting systems that cast artificial light downwards instead of towards windows or internal reflective surfaces.
	Reduce light trespass from exterior sources	• Use minimum wattage fixtures appropriate for external use. • Reduce light spill through targeted lighting and shielding. • Use artificial light that has wavelengths around the yellow/green part of the spectrum in preference to white, red or blue light. Blue light physically damages retinal photoreceptors in birds' eyes and disrupts circadian and circannual cycles in wildlife. UV light attracts insects that are active at night (e.g. moths), which has the potential to attract birds to windows. Red light attracts a broad range of bird species during the migratory period.

Birds' nests can also block air vents, causing damage to air-conditioning units and other rooftop machinery, and/ or harbour ectoparasites (e.g. mites and ticks) and attract other pests (e.g. cockroaches and rats) that become indoor pests. Nests can also soak up a lot of moisture (e.g. from dew, rain if exposed to the weather, regurgitated food delivered to the nest, excretion by nestlings and parent birds, leaked contents of broken eggs). Water-laden nests and accumulated droppings can permanently stain and even break up the structure of porous building materials.

Roosts and colonial nesting in enclosed spaces can create difficulties for tradesman and technicians to access services amenities such as electric cabling, water and sewage pipes, communication cables and ventilation ducts that occur in these spaces. This is a particular problem in open-access buildings with service amenities hidden behind floating ceilings, and in concrete road and railway bridges that have thermal expansion joints (open gaps) in service tunnels that run underneath road or railway surfaces (Plate 12). These types of locations are particularly attractive to Feral Pigeons because they provide a warm environment for roosting and nesting, free from a lot of human disturbances, and aerial predators.

Owners of buildings with ongoing bird pest problems have higher building insurance premiums to cover the costs of cleaning and repairing the damage caused by birds, and often need elevated public liability insurance to cover the risk of respiratory illnesses in people, and injury to people slipping on a build-up of droppings on hard surfaces.

Plate 11. Rainbow Lorikeets scavenging on food scraps at an outdoor café in the Sydney CBD. *Photo by Stephen Ambrose.*

The Vandals

Avian vandals can cause significant physical damage to building exteriors (Plate 13), and electrical and telephone outages by chewing cables (Plate 14). In doing so, they put humans and themselves at risk by exposing live electrical wires ("the ugly").

There is an emerging trend in world cities to construct mid- to high-rise city buildings out of wood fibre harvested from forests. The rationale of architects behind this concept is that materials that are currently used in most construction projects are extracted, smelted, sintered, or synthesised through intensive fossil-energy based industrial processes with huge environmental (carbon) footprints.

Plate 12a) and b). Adult (left) and nestling (right) Feral Pigeons surrounded by dense accumulations of droppings in a service tunnel of a concrete road bridge near Newcastle, NSW. *Photos by Stephen Ambrose.*

Plate 13a) and b). Sulphur-crested Cockatoos (above) chewing and (right) tearing exterior building features.

Plate 14. Little Corellas chewing electric light cables above an outdoor shopping mall in Liverpool, NSW. *Photo by Stephen Ambrose.*

The forest is a natural carbon sink, absorbing carbon dioxide (CO_2) through the process of photosynthesis and storing it as molecular carbohydrates in the woody matter and soils of the forest biome. Wood fibre harvested from forests continues to sequester carbon until it is re-released as CO_2 during the aerobic decay or combustion of the material. Therefore, the claim is that timber building acts a carbon sink for the duration of its existence (Organschi et al. 2016). To an ecologist, this is not entirely satisfactory because if mature trees are removed to construct timber buildings, then there are fewer trees for photosynthesis and transpiration, as well as a reduction in the amount of habitat available for biodiversity. Even if the wood fibre is harvested from fallen timber and understorey layers as part of forest-thinning, this can have significant biodiversity impacts. Nevertheless, timber buildings are beginning to appear in Australian cities, either as concrete, steel and glass buildings with wooden facades, e.g. the existing Darling Exchange Building (Plate 15) or as high-rise buildings with a timber framework, e.g. the proposed Atlassian Timber Tower (Plate 16), both in the Sydney CBD.

One major risk that city timber buildings potentially face in Australia (eastern Australia, in particular) is physical damage from chewing by vandal birds such as Sulphur-crested Cockatoos, Little Corellas and, to a lesser extent, lorikeets. This is not an issue in Northern Hemisphere cities, where parrots and cockatoos are absent apart for small, established feral populations. But all major Australian cities have resident psittacine populations which swell in size periodically under unfavourable climatic conditions or when habitat in nearby natural areas has been cleared. Although there has not yet been any obvious significant damage to modern timber buildings in the Sydney CBD, flocks of Sulphur-crested Cockatoos (in particular) fly over and through the city each day, and timber window frames of some historic buildings have been chewed significantly by them. Advice I normally give clients in these construction projects is that parrots and cockatoos will eventually discover city timber buildings, it may be tomorrow, it may be in 10 years, but they will find them.

Food Scavengers

Food scavengers that do not roost or nest in buildings still pose the same environmental health risks as those species that do use buildings for these purposes. This is because they normally scavenge scraps in outdoor locations where humans consume food and discard garbage ("gluttony"). They roost in relatively large communal groups close to locations where there are reliable supplies of food scraps. For instance, Rainbow Lorikeets, Common Mynas and Common Starlings usually roost in planted trees in nearby streets, plazas or adjacent to large buildings. Silver Gulls often roost on floating pontoons, coastal islands or artificially-created islands in man-made wetlands. Australian White Ibises roost in tall trees adjacent to buildings or in parkland, or on natural or artificial islands in urban wetlands or stormwater detention basins. Large communal groups roosting in trees produce large accumulations of droppings, which can be unsightly and slippery if deposited on paving, brickwork or bitumen, and corrosive if deposited on parked vehicles.

Food scavenging bird populations tend to increase in size because of the abundance of food and reduced predatory pressure (Martin et al. 2010). However, a diet based on food scraps is nutritionally-inadequate, which can reduce individual bird's body condition and lifespan (Shochat 2004), smaller clutch sizes, and chick development (Cowie & Hinsley 1988; Smith & Carlile 1993; Pierottii & Annett 2001).

Minimising the Impacts of Pest Birds

The overall principle for reducing bird pest issues on and around city buildings is the same as for a BCRA. That is, the need to confer with the property owner, architect, construction engineers and local council early in the building design stage for the purpose of producing a Bird Pest Management Strategy (BPMS). The BPMS identifies bird species that may potentially become a pest on or around the building, documents the distributions and abundances of pest bird species in the locality, assesses the likelihood of local populations of these species colonising the building and areas around it, identifies the specific features of the development that would potentially attract pest birds, proposes the most effective strategies for controlling the potential bird pest problems, details a monitoring program for assessing and reporting on the effectiveness of these strategies. Once again, it is important for the ornithological consultant to have input early on because it is easier and less costly for an architect to incorporate design features that would deter or prevent pest birds from using the building than it is getting rid of the pests once they have taken up residence. In reality, though, most BPMSs are requested by the property owner or manager late in the building process, or even after pest birds have taken up residence post-construction.

There is a broad range of devices and materials on the market for deterring pest birds from using buildings, some more effective than others. They can be categorised into main groups: (a) physical excluders (electrified track systems, nets, bird spikes and bird wires); (b) acoustic repellents (electronic sound devices, propane-fired cannons); (c) visual repellents (e.g. floodlights, laser lights, optical gels, streamers and flashtape); (d) olfactory and taste repellents; and (e) licenced bird traps. Patrol flights by raptors (eagles or falcons), orchestrated by falconers, are often used to scare pest birds from sports stadiums prior to a major event; while this occurs in most Australian states and territories, it is disallowed in NSW. Implementation of an effective waste management strategy is also vitally important in making buildings and their landscaped areas less attractive to pest birds.

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Plate 15. The Darling Exchange in the Sydney CBD with a timber façade wrapped around the main body of the building. *Source:* Hirsch, M. (2019). A whopping 29 more venues are now open for business in Darling Square (TimeOut, 6 August 2019) https://www.timeout.com/sydney/news/a-whopping-29-more-venues-are-now-open-for-business-in-darling-square-080619

Plate 16. Atlassian timber tower building proposed for the Sydney CBD
Source: O'Sullivan (2020). Sydney to become home to the world's tallest 'hybrid timber" tower (Sydney Morning Herald, 25 June 2020) https://www.smh.com.au/national/nsw/sydney-to-become-home-to-world-s-tallest-hybrid-timber-tower-20200624-p555ln.html

"Non-ECA promotional material presented in the ECA Newsletter does not necessarily represent the views of the ECA or its members."

Advertising Opportunities with the ECA

Website:

- **$200 for a banner**
- **$300 for company name with some detail and a link**
- **$500 for company name within box, logo, details and web link**

All website packages run for one financial year and include a small ad in any newsletter produced during the financial year.

Newsletter:

- **$100 for a third of a page**
- **$250 for a half page**
- **$500 for a full page**
- **$1 / insert / pamphlet**

Advertising is available to service providers of the Ecological Consulting industry. The ECA will not advertise a consultant or their consulting business.

If you wish to advertise, please contact the ECA administrative assistant on admin@ecansw.org.au.

Contributions to the Newsletter, Volume 47

Contributions to the next newsletter should be forwarded to the administration assistant Amy Rowles admin@ecansw.org.au by the **31st of August 2021.**

- Articles may be emailed in WORD, with photos included or referenced in an attached file as a jpg. Please save any figures as a jpg, so they can be easily transferred to the newsletter format.
- Please keep file size to a minimum, however there is no limit on article size (within reason)
- Ensure all photos are owned by you, or you have permission from the owner
- Ensure that any data presented is yours and you have permission from your client to refer to a specific site (if not please generalise the location).
- All articles will be reviewed by the editorial committee, and we reserve the right to request amendments to submitted articles or not to publish.
- Please avoid inflammatory comments about specific persons or entity

The following contributions are welcome and encouraged:

- ◊ Relevant articles
- ◊ Anecdotal ecological observations
- ◊ Hints and information
- ◊ Upcoming events
- ◊ Recent literature
- ◊ New publications (including reviews)
- ◊ Photographs

ECA PHOTO COMPETITION ENTRIES

TOP LEFT: Male Hooded Robin, from near Coonabarabran. *Addy Watson.*

ABOVE: Superb Lyrebird caught by a camera trap. *Andrew Lothian.*

CENTRE: Bull Ant. *Ryan Herbert*

RIGHT CENTRE: Pink Flannel Flower. *Tim Johnson*

ABOVE and BELOW: *Geraldene Dalby-Ball.*

RIGHT: Sturt Desert Pea. *Brian Wilson.*

ECA PHOTO COMPETITION ENTRIES

TOP RIGHT: Golden Fungi. *Geraldene Dalby-Ball.*

RIGHT: Small-leaved tamarind fruit. *Ian Colvin*

ABOVE: Splendid Fairy-wren. *Steve Sass.*

LEFT: Pink Flannel Flowers. *Tim Johnson*

RIGHT: *Thysanotus tuberosus.* *Isaac Mammot.*