PROGRESS REPORT ON PROJECT SUPPORTED BY PADDY PALLIN SCIENCE GRANT

Instructions to Project Leaders for Completing This Form
Progress reports are required to be submitted 12 months after the start of the project, and then at 18-24 months as a final report . Grants usually begin on the 15TH September in the year in which the grant was awarded. Payment of the second grant installment is contingent upon the receipt of this material. Updates are to be provided during the tenure of the grant, and at the time the final report is submitted. Payment of the final grant installment is contingent upon receipt of the final summary which is to summarize the outcomes of the project during the tenure of the grant.

1. PROJECT IDENTIFICATION

1.1 PROJECT TITLE
Remote sensing of Greater Glider habitat-determinants for population and abundance estimations on a landscape-scale (title at application)

Predicting habitat suitability for greater glider (*Petauroides volans*) using remote sensing: implications for conservation planning (recent title)

1.2 ADMINISTERING ORGANISATION
The University of Melbourne – School of Ecosystem and Forest Sciences

1.3 PROJECT LEADER AND PARTICPANTS
Leader: Benjamin Wagner (PhD Candidate)
Supervisors: A/Prof. Craig Nitschke and Prof. Patrick Baker
Partners: Arthur Rylah Institute (ARI), DELWP, VicForests

2. PROJECT DESCRIPTION & OBJECTIVES

2.1 100- Word Project Summary

The project is investigating key determinants of greater glider (*Petauroides volans)* habitat selection and quality in southeastern Australia. The focus lies on the role of climate, forest structure and quality and distribution of foraging resources on and within the habitat of *P. volans*. To date these factors have been investigated only separately and at small scales. The project is integrating these drivers at the stand and patch-scale through new methodologies based on remote-sensing. Our novel approach should inform forest management and conservation planning and facilitate the development of a reserve network that maximizes habitat quality.

2.2 Summary of original objectives (150 words max)

The main problem this project seeks to address is that folivore habitat suitability is driven by foliar nutrition and chemistry, but knowledge on how these are distributed within occupied habitat and in the landscape is lacking. Understanding this distribution and what drives it is key to managing habitat sustainably and reducing the risk of degradation and species loss. It was far not possible to assess forest nutrition on a landscape scale or over the entire distribution of a folivore species. We are working towards developing applicable methods using UAV based multi-spectral remote sensing to predict forest nutrition and from

that *P. volans* habitat quality. Tackling the issue of identifying key habitat by its nutritional value using modern remote sensing methods allows for unique and implementable conservation approaches to protect the target and a cascade of associated species sharing its habitat over its range, while allowing for productive forestry operations elsewhere.

3. PROJECT OVER DURATION OF FOUNDATION GRANT

3.1 Have there been any changes to the project? If yes give details

This could include changes to the research Project resulting from funding from the Foundation being at a lower level than requested. By indicating changes to the budget , aims and research plan in the Report, you are requesting approval from the Foundation for a revision of the Project. A 'satisfactory' assessment of the Report and the Project by the Paddy Pallin Grants Committee means that the revision has been approved.

In the period covered by this report, no changes to the general concept or methods have been made. Since all data has been collected in 2018 and early 2019, most of the current period was spent analyzing data and compiling results. Changes in how the data was processed and handled have occurred, but these are not affecting the objectives of the project or any desired outcomes. Additional funding allowed for an increase in study sites for structural measurements, nutrient collection and UAV imagery acquisition. The number of sites in East Gippsland was increased from 15 to 30.

3.2 What were your research plans and objectives for the period covered by this report? (150 words max)

(The answer to this question should be consistent with the original Application or the preceding Progress Report).

The objectives since the submission of the last progress report in September 2018 were to finalize the ongoing field campaigns and conclude research for the first data chapter revolving around climatic influences on *P. volans* habitat in its main areas of distribution in Victoria. Finishing fieldwork required measurements in additional 25 study sites distributed over the landscape of East Gippsland, that were not finalized last year and included structural assessments, foliage and soil sample collection, night time spotlighting and UAV flights over each of the 30 study sites to acquire aerial multispectral imagery. Additionally, collected foliage and soil samples needed to be analyzed for total and digestible nitrogen. The conclusion of data chapter one required parametrizing and finalizing predictive models for *P. volans* presence and absence based on detailed climatic variables and using these models to predict to the landscape of East Gippsland, the Central Highlands and Strathbogie ranges.

3.3 Did the research project proceed as planned? What have you achieved over this period? Outline the research findings to date (200 words max)

All fieldwork was completed in early 2019, including structural measurements, spotlighting, sample collection and UAV flights. Soil and foliage samples were analyzed for total nitrogen and foliage is additionally being analyzed for digestible nitrogen, which is a more complicated chemical process that requires artificial digestions of the sampling material using enzymatic material, thus taking a longer time. Our aim is to test weather total or digestible N can be better predicted using foliage reflectance and vegetation indices from aerial multispectral imagery. After receiving nutrient data for the samples we collected in the field, analysis of aerial imagery has commenced to identify our sampling trees in the imagery and extract reflectance values from each canopy. This data will then be used to build predictive models of foliar nitrogen. For predictive models of habitat suitability based on climate, all work has been finalized and well performing models have been achieved. Climatic predictors play important roles in identifying and predicting suitable habitat for *P.*

volans according to our findings, which are currently being prepared for publication. Additionally, it was found, that suitable habitat based on single variable thresholds has reduced (in some cases drastically) over the past 30 years.

3.4 Have you experienced any difficulties that have affected the progress of the research project? If yes give details (150 words max)

It was stated in the last progress report, that methods and results for chapter one (climate modeling) were to be finalized by the end of 2018. Unfortunately, due to discrepancies in the data used and problems with some initial modeling variables chosen, this was not possible and the analysis for this part of the project took longer than expected but has recently been finalized. Field work in the remote locations of our study sites as well as sample analysis also took longer than expected, so that most of the analysis of the nutrient-focused parts of the project are currently still taking place, rather than being written up as stated as a plan in the last report. Despite these difficulties, the project is still within its schedule and projected to be finalized by November 2020.

3.5 What are your research plans and objectives, including publication plans, for the coming year? (150 words max) *(Please note that in your next Report you should report progress against these plans and objectives)*

As all data collection and the analysis of the first data chapter is finalized, the next 12 months are entirely focused on the structural and nutritional analysis of collected data in our field sites in East Gippsland. Having received most of the initial nutrient data of our leaf samples (total nitrogen), we are now able to works towards one of the main objectives of this project: building predictive models for foliar nitrogen in mixed-eucalypt forests. The plan is also to publish modeling results for chapter 1 within the last months of 2019 and prepare coming results on nutrient modeling for publication by mid-2020. Additionally, two conference attendances to present results and new methodologies of the project are scheduled: at the IUFRO World Congress 2019 in Curitiba, Brazil and at the ESA Annual Conference in Launceston, Tasmania.

4. ACADEMIC OUTPUTS

4.1 Publications and other academic outputs directly related to this project. *(Please list all publications and those manuscripts accepted for publication, for the period covered by this report)*

<u>Past:</u>

06.02 – 07.02.18: Victorian Biodiversity Conference 2018, La Trobe University, Melbourne

- Poster presentation: '*Predicting habitat suitability for Greater Glider using remote sensing: Implications for landscape conservation planning'*

25.11 – 29.11.18: Ecological Society of Australia Annual Conference, Brisbane

- Poster presentation: '*Satellite-based remote sensing of southeastern Australian Greater Glider habitat for landscape-scale species distribution modelling*'

07.02.2019: Victorian Biodiversity Conference 2019, University of Melbourne, Parkville

- Oral presentation: '*Satellite-based remote sensing of southeastern Australian Greater Glider habitat for landscape-scale species distribution modelling*'

Upcoming:

October 2019: IUFRO World Congress 2019, Curitiba, Brazil

- Oral presentation: '*Predicting habitat suitability for greater glider (Petauroides volans) using remote sensing: implications for conservation planning'*

November 2019: ESA Annual Conference 2019, Launceston, Tasmania

- Oral presentation: '*Greater gliders like it cold and wet: Climatic aridity & extreme weather influence habitat suitability for an arboreal marsupial in southeastern Australia'*

Preparing for publication:

Wagner, B., Baker P., Stewart, S. B., Lumsden, L., Nelson, J., Bluff, L., & Nitschke, C.R. (2019). *Greater gliders like it cold and wet: Climatic aridity & extreme weather influence habitat suitability for an arboreal marsupial in southeastern Australia*. Unpublished manuscript.

4.2 Evidence of scholarly impact and contribution. Is there evidence that this research project is having/has had an impact in the research field or the broader public domain? *Include examples of formal training (PhD /Masters) as well as other training.*

As stated above, results have not been published yet but are prepared for publication and are planned to be submitted by the end of the year for the first data chapter of this project, revolving around habitat suitability models based on climate and extreme weather events. Methods and results were presented at multiple occasions at conferences or in the form of guest lectures or talks and a field practice within classes at the University of Melbourne and received positive feedback throughout. Interactions with the NESP Threatened Species Recovery Hub led to fruitful collaborations with Western Sydney Universities' Hawkesbury Institute for the Environment and researchers at the Australian National University interested in arboreal marsupial habitat requirements and physiology. Working together with experts in the field allowed for the application of novel and specialized methods in nutrient digestions and analyses, from which we expect promising results and interesting publications over the next year.

If yes, give details *(For instance, standard citation data on articles published in ISI journals, citations to books, re-publication, translations, reviews, invited keynote addresses, other invitations, newspaper/media/expert commentary).*

4.3 End-user interaction and other project outcomes If there are examples of the impact of this research Project not covered in item 4.2 above please provide details. *For example, introduction or modification of standards/protocols within an industry sector, preparation of proposals for funding from other agencies as a result of outcomes from this project.*

Ongoing research and findings of this project allowed for the continuous application for additional funding and we were successful in securing grants from the Wettenhall Environment Trust, as well as internal University scholarships and bursaries. These allowed for extending the scope and outreach of this project by e.g. increasing the sample size or attending conferences and workshops, providing networking opportunities. We are strongly coordinating with our project partners at DELWP, ARI and VicForests, who are conducting their own surveys and research project on *P. volans* habitat and are aiming to share our knowledge and results to inform stakeholders and policy makers, for a successful

integration of our findings into contemporary forest management and species conservation efforts.

5. ATTACHMENTS & OTHER MATERIAL

Please provide, as separate files, any figures, graphs, images and other material that cannot be included in this form. Please also provide updated material (text and images) that can be used to revise your project summary on the Foundation's web site. Please provide text in Microsoft Word format and images in JPEG format with a minimum size of 600 x 400 pixels. If this is the final project report, the web page summary must be updated to reflect the outcomes of the project. Is any material being forwarded as additional attachments?

Figure 1. Aerial view of one of our study sites in the mid-hills of East Gippsland close to Mount Jack. This area is dominated by *E. obliqua* and *E. sieberi* with many large hollow-bearing trees indicating structurally good habitat. Contradictory, during spotlighting surveys, no folivores were found, pointing towards a possibly nutrient-poor area.

Figure 2. A rare grey-white *P. volans* in the high country of East Gippsland near Bendoc feeding on a Gippsland Peppermint. Our surveys in this area came up with high numbers of greater gliders in the entire area and distribution models identify the region as a climatic refuge with cold and wet weather dominating throughout the year.

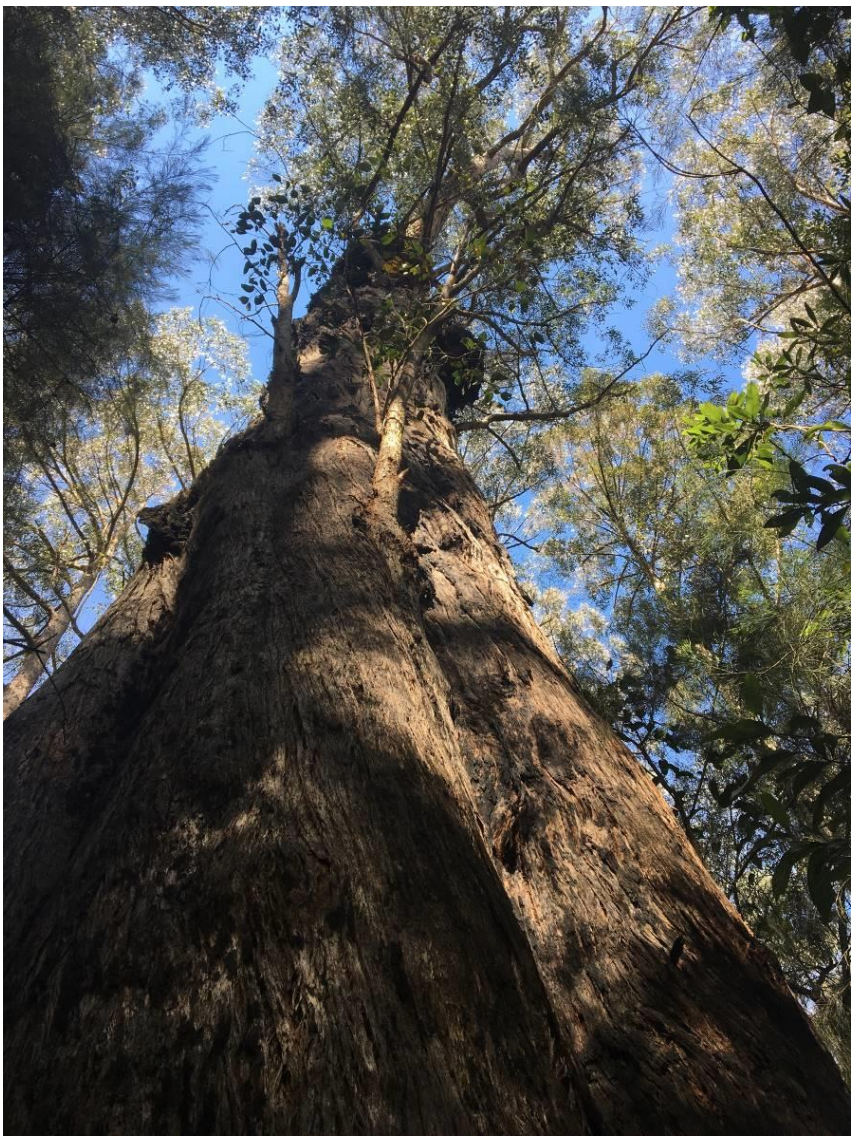

Figure 3. A giant messmate measured almost 60m in height and 300cm in DBH near the Arte River. These structurally diverse forests have only experienced selective logging in the past and have since developed into interesting habitat providing a lot of hollows and understory connectivity, as well as extremely diverse shrub and herb flora pool.

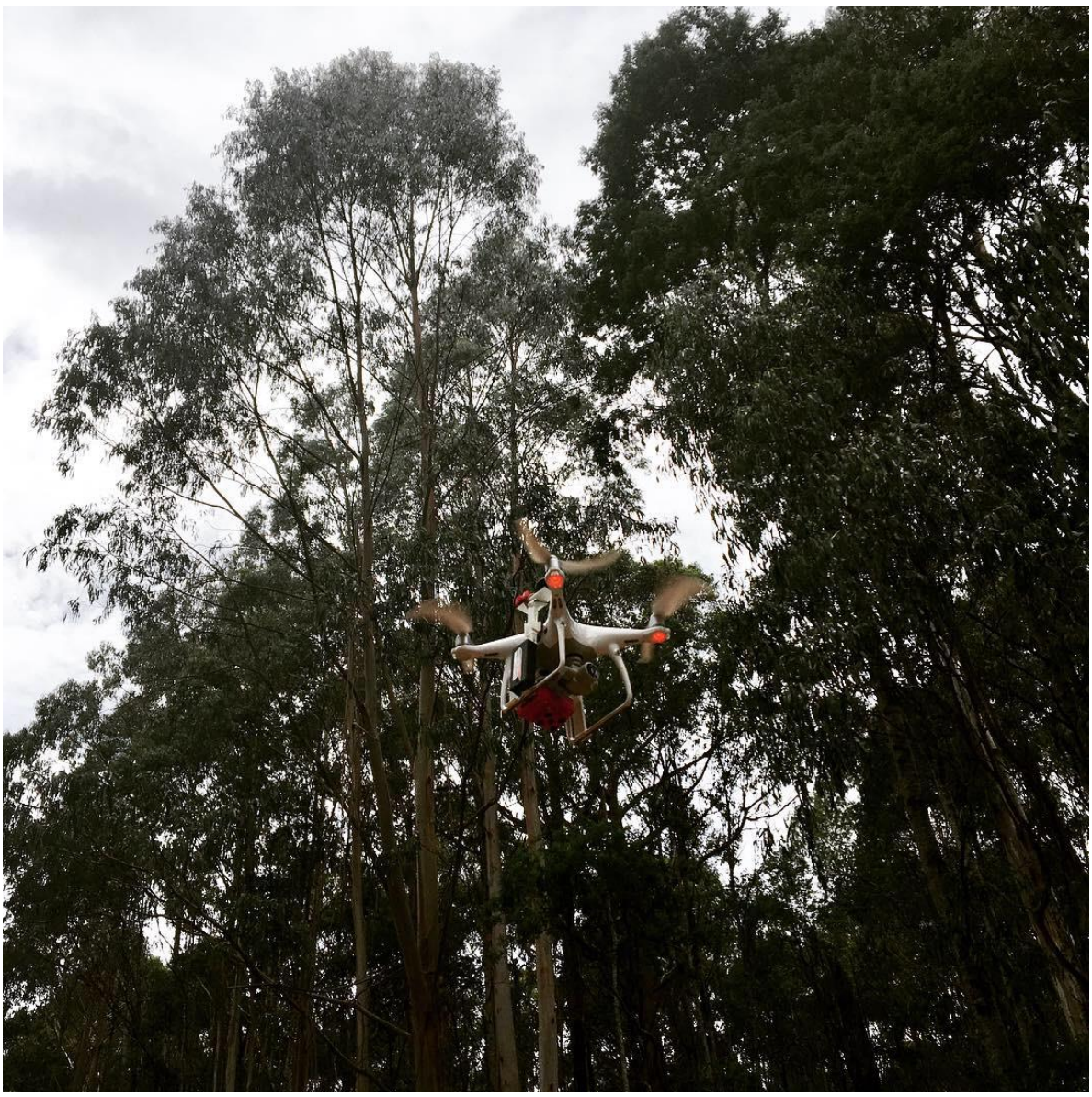

Figure 4. Our multirotor UAV, modified to carry a multispectral camera, lifting off to capture imagery of one of our study sites near Mount Jersey