FINAL 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 30th October 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
Using an endemic blowfly as an indicator of genetic connectivity and diversity throughout Australian rainforests

1.2 ADMINISTERING ORGANISATION
University of Technology Sydney

1.3 PROJECT LEADER AND PARTICPANTS
Dr Nathan Butterworth
Dr Angela McGaughran (University of Waikato, New Zealand)

2. PROJECT DESCRIPTION & OBJECTIVES

2.1 100- Word Project Summary

Australian rainforests are naturally fragmented islands of biodiversity and are increasingly threatened by climate change, as shown by the 2019-2020 bushfires. Insects constitute the greatest proportion of rainforest biodiversity, yet we lack basic knowledge of their population structure and ecology. To address this, we used the endemic blowfly *Chrysomya latifrons* as a model to understand how rainforest populations are connected. We found high levels of gene flow, a lack of genetic structure between rainforests, and low genetic diversity – suggesting that some strongly dispersing flies can migrate between and connect isolated rainforests. Future research should now focus on poorly dispersing species.

2.2 Summary of original objectives (150 words max)

We aimed to perform extensive field collections throughout rainforest fragments and use genotype-by-sequencing (GBS) through the DarTseq™ platform to obtain genetic information (single nucleotide polymorphisms; 'SNPs'), targeting a species that is endemic to southeast Australia – *Chrysomya latifrons* Malloch 1927. This highly mobile species is frequently collected in

fragmented rainforests across a large (~1,000 km) geographic range. We expected that *Ch. latifrons* should show high levels of gene flow and limited genetic differentiation between adjacent rainforests. As we expected to observe only broad patterns of isolation by distance, any rainforest fragments inhabited by *Ch. latifrons* that did not meet these patterns were expected to reflect high levels of habitat isolation.

3. PROJECT OVER DURATION OF FOUNDATION GRANT

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

No

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).*

There were four major research plans and objectives: 1) To collect blowflies from rainforests along a 1,000 km transect between Byron Bay, NSW and Eden, NSW and to record locality and distribution information, 2) to extract genomic DNA from these flies for genetic sequencing, 3) to obtain genetic data for each individual from each population, and to use this data to understand how blowfly populations are connected between rainforests, 4) to produce a manuscript detailing how blowfly populations are connected between rainforests, and how this can inform general patterns of rainforest connectivity and conservation priorities.

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)

The project proceeded as planned but revealed startling results. We conducted the first ecological study of the blowfly *Chrysomya latifrons*, which is endemic to the rainforests of New South Wales, Australia. We collected 417 flies from 15 isolated rainforests and found unexpectedly low genetic diversity and a complete lack of genetic structure between populations – suggesting the presence of one large interbreeding population along 1,000 km of the east coast of Australia. These results highlight: (1) that *Chrysomya latifrons* inhabits every rainforest in NSW and undoubtedly plays an important role in these ecosystems – but that their low genetic diversity may cause them to struggle in a changing climate, (2) that strongly dispersing insects clearly have the capacity to migrate between isolated rainforests – likely carrying pollen, parasites, phoronts, and pathogens with them, and (3) that there is an urgent need to undertake similar studies on poorly dispersing rainforest insects, as they are likely to be the most fragmented and at even higher risk of local extinction. Overall, this highlights that some strongly dispersing insects may be maintaining high levels of connectivity between rainforest fragments, but that we need much more research to be directed towards the ecology of rainforest invertebrates.

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

No major difficulties arose that affected the research progress.

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)*

The research has been completed as of August 2021. The manuscript has been finished and is available on the preprint server BioRxiv. The manuscript is currently under review in the journal *Oecologia*.

Due to the primary finding that blowflies can easily disperse long distances between isolated habitats, this research has also spurred further grant applications and projects between Dr Nathan Butterworth (Australia) and Dr Angela McGaughran (New Zealand) to use blowflies as a model to understand the ecology and genetics of dispersal and biological invasions.

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)*

1. Butterworth NJ, Wallman JF, Johnston NP, Dawson BM, McGaughran A (2022) The blowfly *Chrysomya latifrons* inhabits fragmented rainforests, but shows no population structure. Under review in *Oecologia*. Biorxiv preprint: doi: 10.1101/2022.01.12.476129

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.*

Yes

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).*

The project has resulted in the training of an early career researcher (myself) in quantitative genomics and population ecology, with the guidance of Dr Angela McGaughran from the University of Waikato, New Zealand. This research is also forming the basis and evidence for a collaborative grant that aims to use blowflies as a model system for understanding the ecological and genomic basis of dispersal and

biological invasion.

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.*
Preparation of proposals for a collaborative grant between Dr Nathan Butterworth (Australia) and Dr Angela McGaughran (New Zealand). This research has revealed the widescale connectivity of blowfly populations, and their exceptional capacity to move between highly isolated habitats. This has led Dr Angela McGaughran (University of Waikato) and I to conduct further studies using blowflies as a model for the ecology and genomics of dispersal and biological invasion. As well as this, this project has formed the basis for a proposal to use cutting edge genomic tools to exploit the environmental DNA from blowflies as indicators of biodiversity. This has already led to the training of undergraduate and masters students and will be the basis of a SMART idea grant to be submitted in 2022.

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?

I have attached figures and images pertaining to the project in a separate document.