University of the Sunshine Coast Australia

Rainforest resilience at the frontiers of fire

Matt Mooney

Supervisors: A/Prof. Alison Shapcott and Prof. Andy Marshall

Matt Mooney
First-year PhD student at UniSC

Australia’s 2019-2020 “Black Summer” wildfires caused unprecedented damage to rainforest ecosystems, but also present a crucial opportunity for investigating rainforest fire resilience. Fires at rainforest edges are not uncommon but typically extinguish quickly under dense, closed canopies. Fire incursions further into rainforests typically require prolonged drought and severe fire weather, which are likely to occur more frequently under climate change. Fires in rainforest can dramatically alter forest structure and species composition, impacting ecosystem functioning and recovery. Given the increasing threat of fire, the resilience of fire-impacted rainforest is likely to be determined by the ability to quickly regain fire-suppressing properties. Where this is impeded by weeds or the influence of flammable species from dryer vegetation types, there is potential for the restricted distribution of rainforest to undergo further contraction.

This study will investigate the resilience of fire-affected rainforests by evaluating how the severity and scale of wildfire influence post-fire recruitment, especially at rainforest margins. Over the next year, we will conduct surveys in a number of National Parks including Lamington, Main Range and Mt Barney. Ecological succession theory will be used to assess the likely implications of early responses on the longer-term trajectory of rainforest vegetation communities. We hope to improve understanding of the factors which can promote or suppress rainforest post-fire recovery.

‘Black Summer’ fires in global context

- Prolonged drought, extreme fire weather
- Evidence of past rainforest fires associated with drought – Australia and globally
- Return intervals of thousands of years
- Current trend – increasing frequency
- **Climate is the major driver**

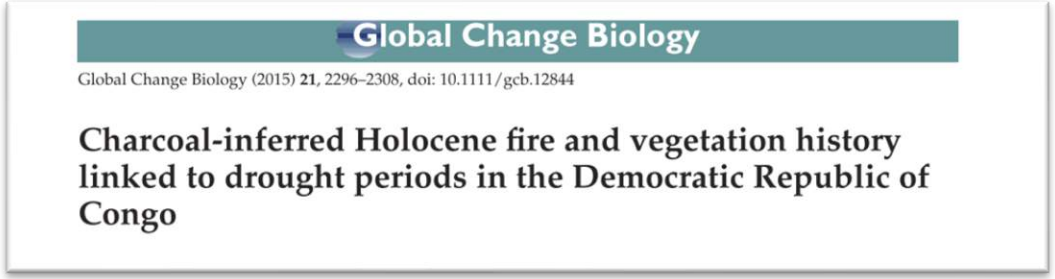
Report

Bruno Turcq, Abdelfettah Sifeddine, Louis Martin, Maria Lucia Absy, Francois Soubies, Kenitiro Suguio and Cecilia Volkmer-Ribeiro

Amazonia Rainforest Fires: A Lacustrine Record of 7000 Years

Although human influence dominates present-day Amazonian rainforest fires, old charcoal fragments, buried in

proposed that some disturbances, especially fires, had a profound influence on the survival and regeneration of plant communities. In Amazonia, knowledge of past fires, their regional extent,



Global Change Biology

Global Change Biology (2015) **21**, 2296–2308, doi: 10.1111/gcb.12844

Charcoal-inferred Holocene fire and vegetation history linked to drought periods in the Democratic Republic of Congo

Naturwissenschaften 76, 518 – 520 (1989) © Springer-Verlag 1989

Natural Rain Forest Fires in Eastern Borneo During the Pleistocene and Holocene

J. G. Goldammer

Forstzoologisches Institut der Universität, D-7800 Freiburg

Journal of Biogeography (1993) **20**, 357–372

Charcoal evidence of the spatial extent of the *Eucalyptus* woodland expansions and rainforest contractions in North Queensland during the late Pleistocene

M. S. Hopkins, J. Ash*, A. W. Graham, J. Head† and R. K. Hewett *Tropical Forest Research Centre, CSIRO Division of Wildlife and Ecology, P.O. Box 780, Atherton, Queensland 4883, *Department of Botany and Zoology, Australian National University, GPO Box 4, Canberra, Australian Capital Territory 2601 and †Quaternary Dating Research Centre, Australian National University, GPO Box 4, Canberra, Australian Capital Territory 2601, Australia*

Flammability feedbacks and boundaries

- Dynamic boundaries between rainforest and ‘flame forest’ – see review by Bowman (2000).
- Rainforest species suppress fire – shade out grasses, alter microclimate, moisture cycling, reduced litter, less flammable structure
- Fire incursion can stimulate fire-promoting species
- Rainforest not adapted to tolerate recurrent fire

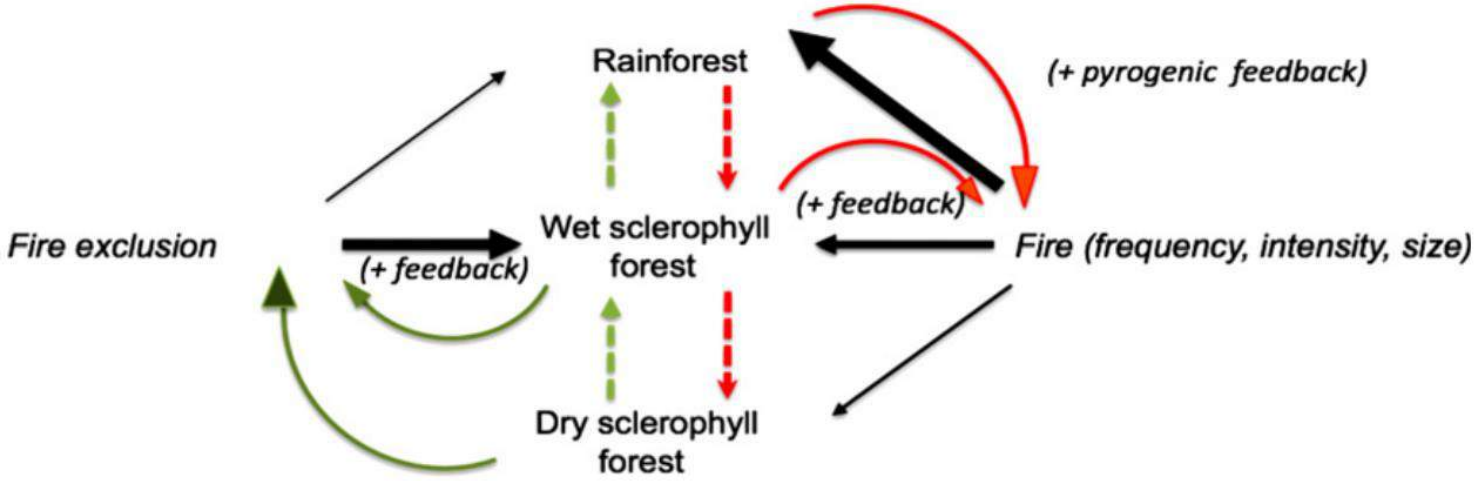


Fig 1. Conceptual model of alternate states driven by vegetation-fire interactions. Original source Knox and Clarke (2012).

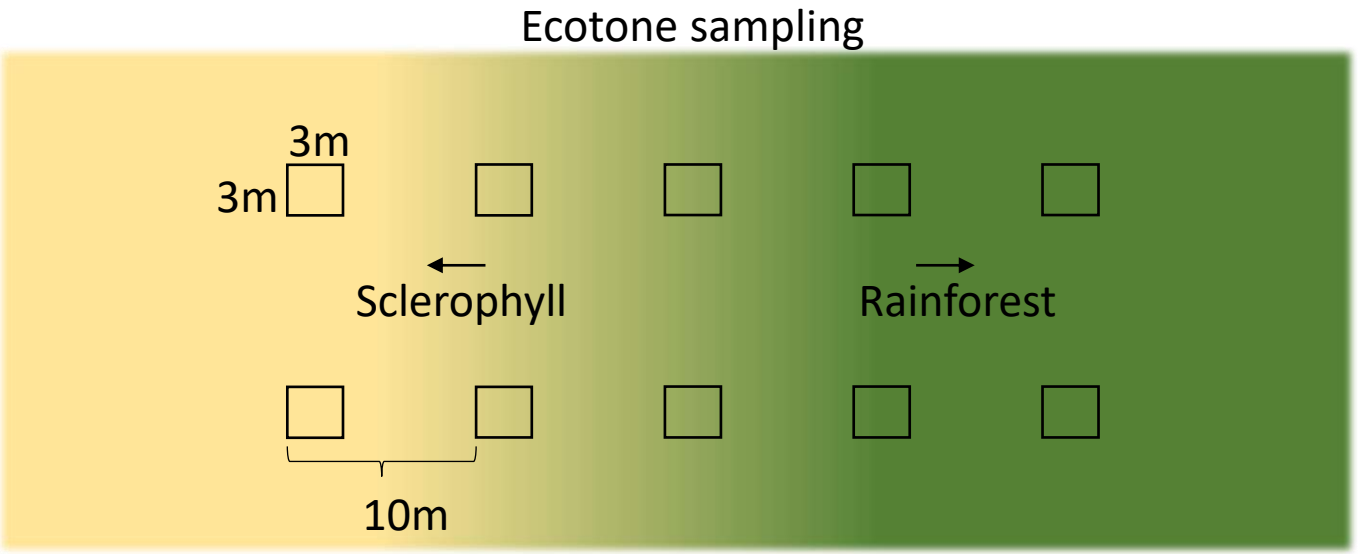
Fire resilience of rainforest – the problem

- RESILIENCE: ability to resist state changes
- Many species can survive fire BUT ecosystem resilience still uncertain
- Weeds? Flammable vegetation?
- Resistance to future fire likely to determine resilience

Study 1: Ecotone dynamics

Does proximity to sclerophyllous vegetation impact the composition of recruitment?

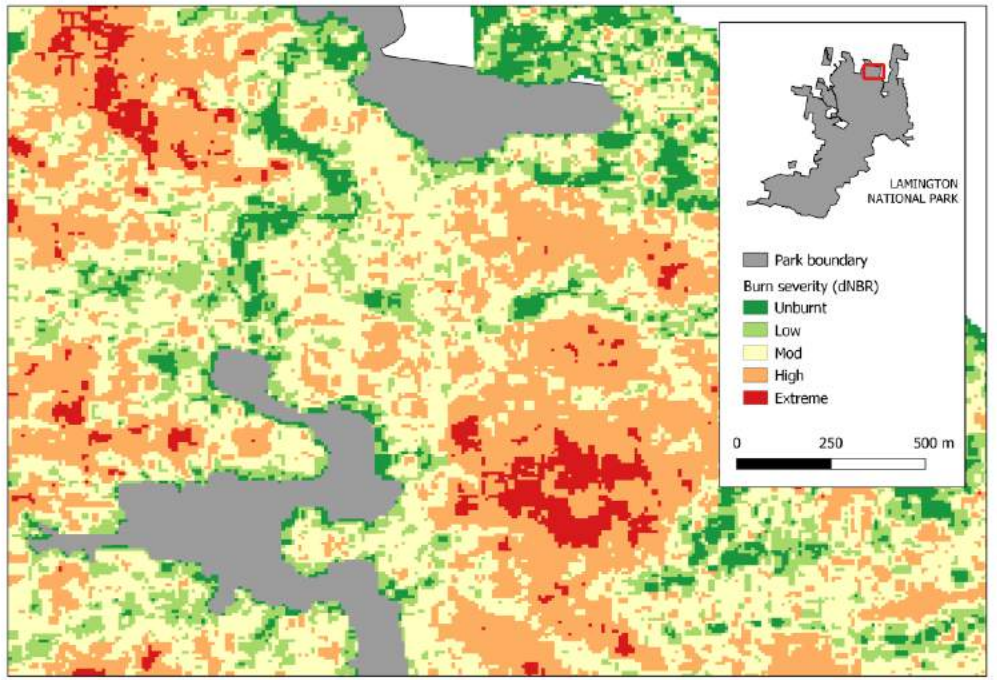
- Sampling ecotones impacted by high severity burns (canopy damage)
- Lamington, Main Range, Mt Barney
- Spatial scale of boundary dynamics
- Trajectory of response



Study 2: Influence of burn severity/patch size

Is the post-fire response of rainforest influenced by the spatial patchiness (size/shape) or severity of burns?

- Sampling core burnt rainforest
- Permanent plots for long term monitoring
- Rate of recovery



Expected outcomes

- Variability of response with:
  - Proximity to sclerophyllous vegetation
  - Burn severity
  - Burn patch size
  - Presence of weeds
- Early signs of adverse response, potential tipping points
- Establish network suitable for ongoing monitoring of longer term dynamics – understanding where and how quickly contraction occurs

Thank you!

- Data collection – 2023
- Write-up 2023-24
- Submission ~mid 2025

References

- Bowman, D., G. J. Williamson, R. K. Gibson, R. A. Bradstock and R. J. Keenan (2021). "The severity and extent of the Australia 2019-20 Eucalyptus forest fires are not the legacy of forest management." Nature Ecology & Evolution 5(7): 1003-1010.
- Bowman, D. M. J. S. (2000). Australian rainforests islands of green in a land of fire. Cambridge, UK, Cambridge University Press.
- Goldammer, J. G. and B. Seibert (1989). "Natural rain forest fires in Eastern Borneo during the Pleistocene and Holocene." Die Naturwissenschaften 76(11): 518-520.
- Hopkins, M. S., J. Ash, A. W. Graham, J. Head and R. K. Hewett (1993). "Charcoal Evidence of the Spatial Extent of the Eucalyptus Woodland Expansions and Rainforest Contractions in North Queensland During the Late Pleistocene." Journal of Biogeography 20(4): 357-372.
- Hubau, W., J. Van den Bulcke, J. Van Acker and H. Beeckman (2015). "Charcoal-inferred Holocene fire and vegetation history linked to drought periods in the Democratic Republic of Congo." Global change biology 21(6): 2296-2308.
- Knox, K. J. E. and P. J. Clarke (2012). "Fire severity, feedback effects and resilience to alternative community states in forest assemblages." Forest ecology and management 265: 47-54.
- Turcq, B., A. Sifeddine, M. L. Absy, F. Soubies, K. Suguio and C. Volkmer-Riberio (1998). "Amazonia rainforest fires: a lacustrine record of 7000 years." Ambio 27(2): 139-142.