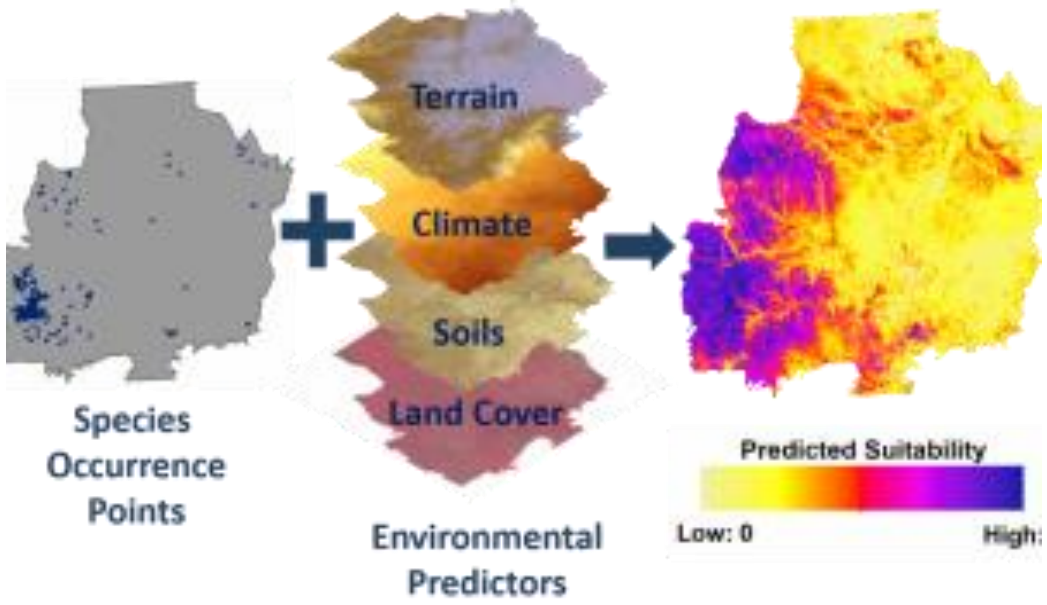
Out of sight, out of mind:
Finding our forgotten forest folivores

by Emmeline Norris

Background

Lithograph of Bennett's tree kangaroo (Smit 1894)

- Wet Tropics experiences high temperatures, primary productivity, and biodiversity
  - Species have narrower thermal tolerances (Reside et al. 2014; Storlie et al. 2014; Burley et al. 2018)
- Rainforest folivores particularly susceptible to increased temperatures (Reside et al. 2014)
  - Distributions limited by microclimate and foliage quality (Hilbert et al. 2001; Meade et al. 2018)
- Bennett's tree kangaroo (BTK) vulnerable to habitat loss from rainforest contraction (Hilbert et al. 2001)
  - Restricted distribution north of Daintree River (Flannery et al. 1996)

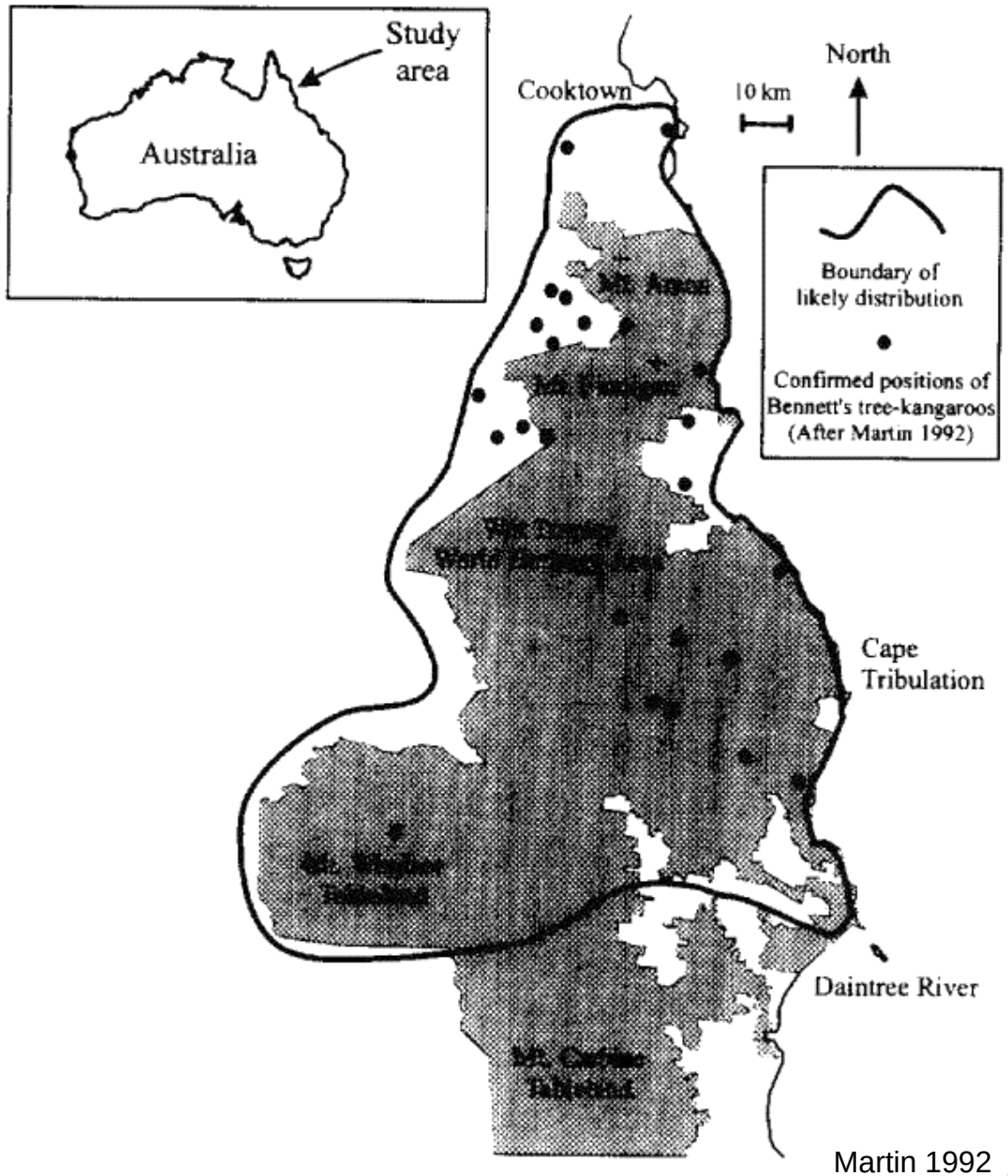


NatureServe n.d.

Aim: Assess how biotic & abiotic environmental variables (e.g. temperature, biomass) differ between upland and lowland rainforest in BTK habitat

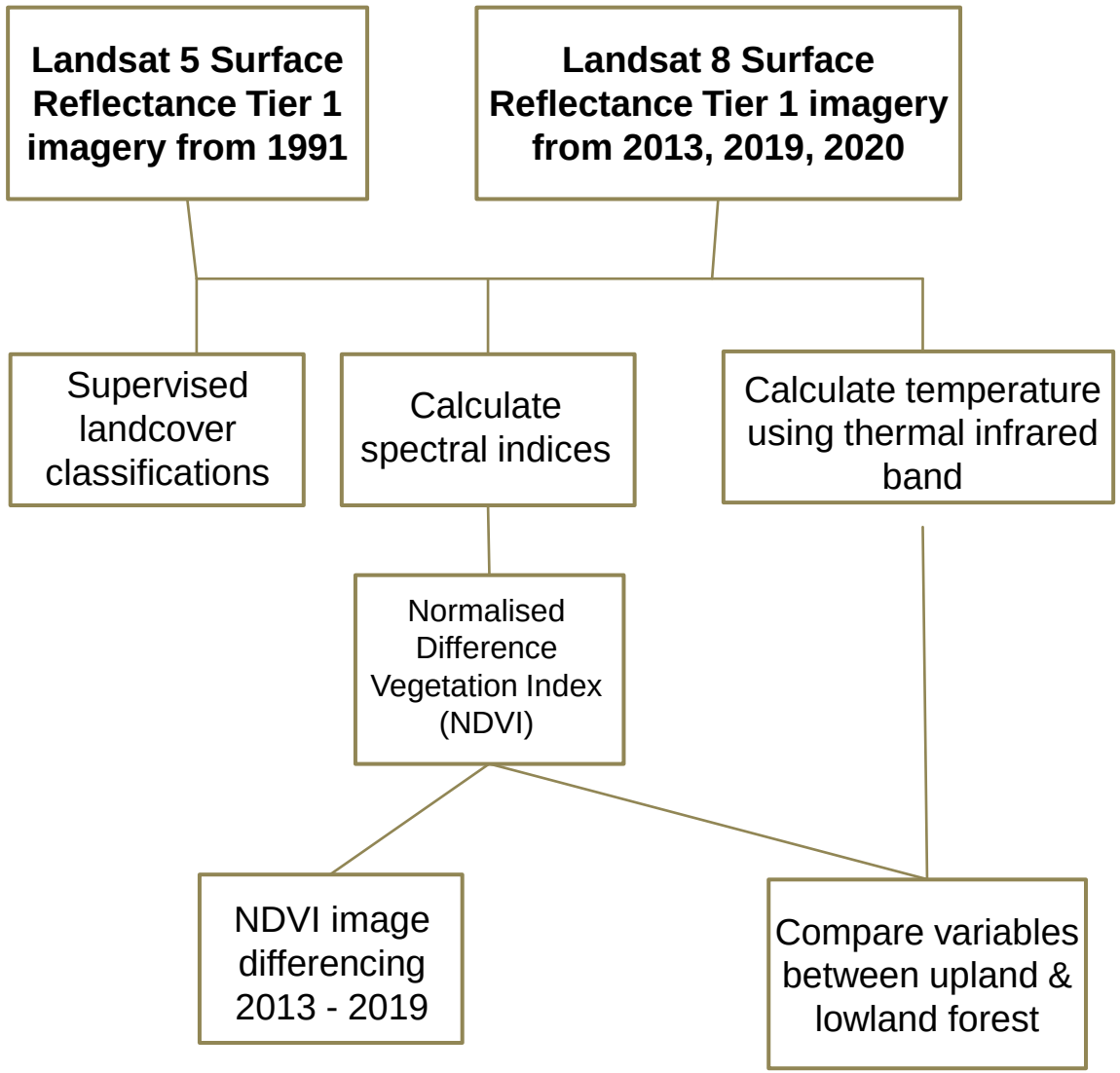
Predictions: Upland rainforest has lower temperatures, greater biomass, and healthier vegetation than lowland rainforest

Methods

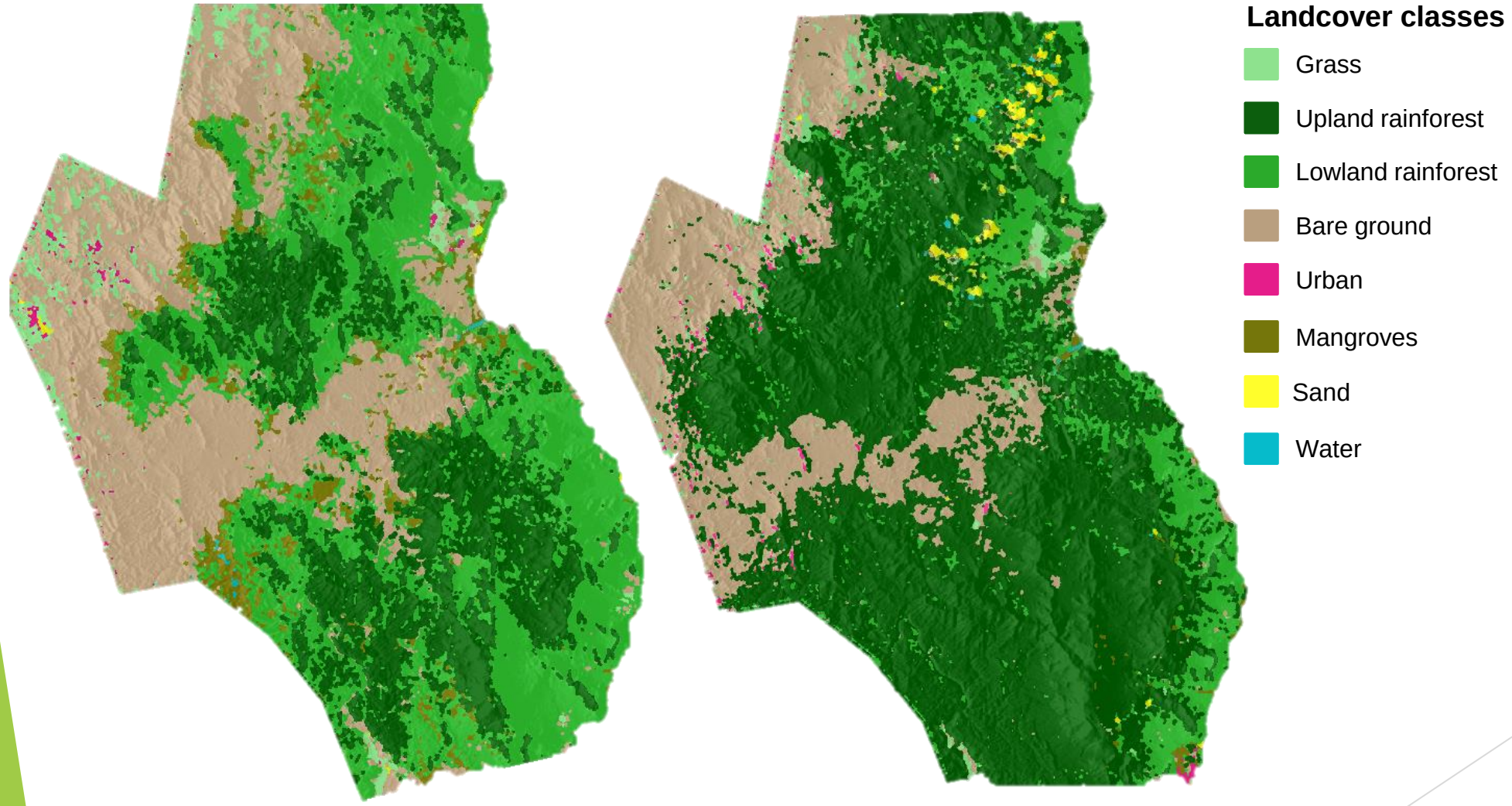


Martin 1992

Methods


Landsat 5 Surface Reflectance Tier 1 imagery from 1991
Landsat 8 Surface Reflectance Tier 1 imagery from 2013, 2019, 2020
Supervised landcover classifications
Calculate spectral indices
Calculate temperature using thermal infrared band
Normalised Difference Vegetation Index (NDVI)
NDVI image differencing 2013 - 2019
Compare variables between upland & lowland forest

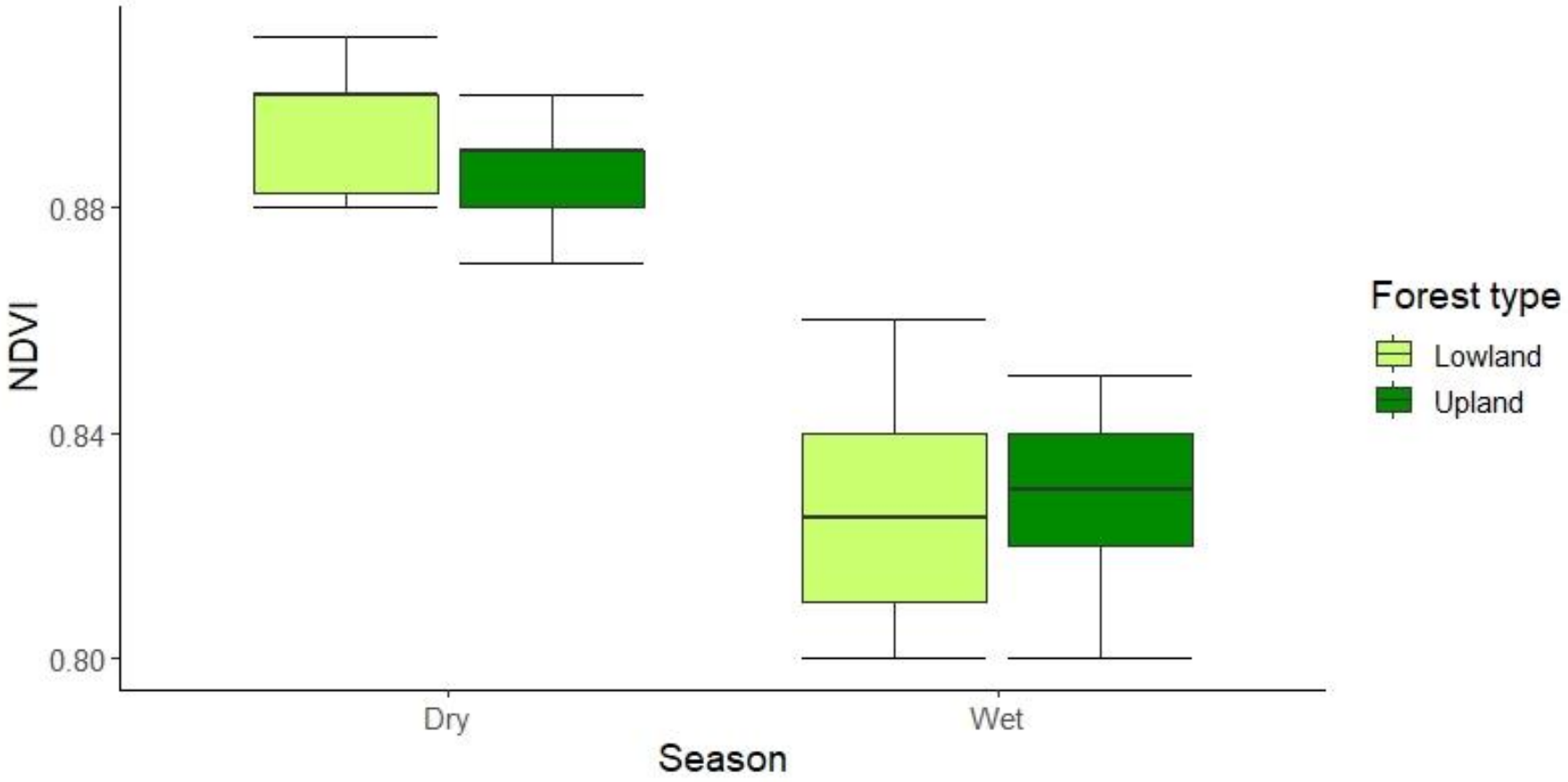
Supervised Land-Cover Classifications



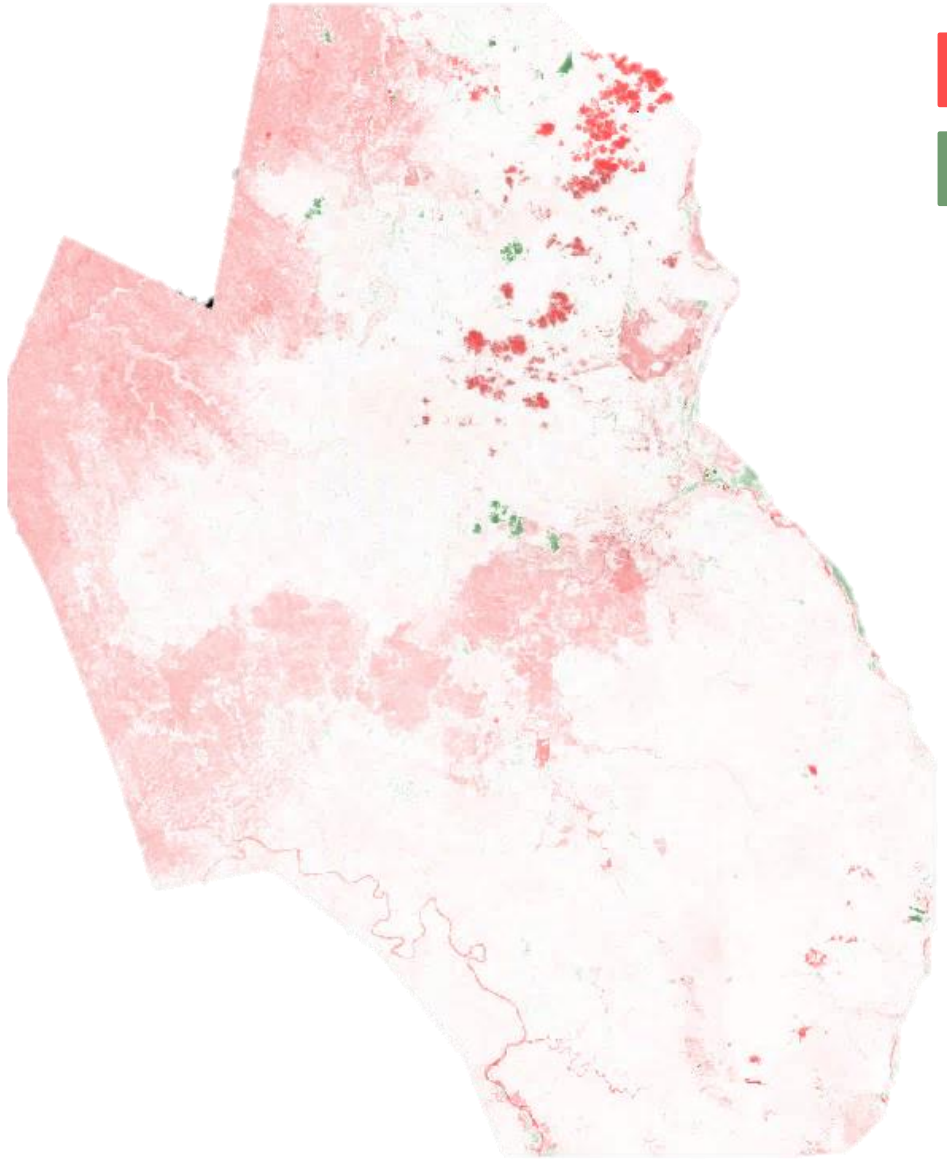
Landsat 5
09/10/1991

Landsat 8
05/09/2019

Seasonal NDVI Values in Upland vs. Lowland Rainforest



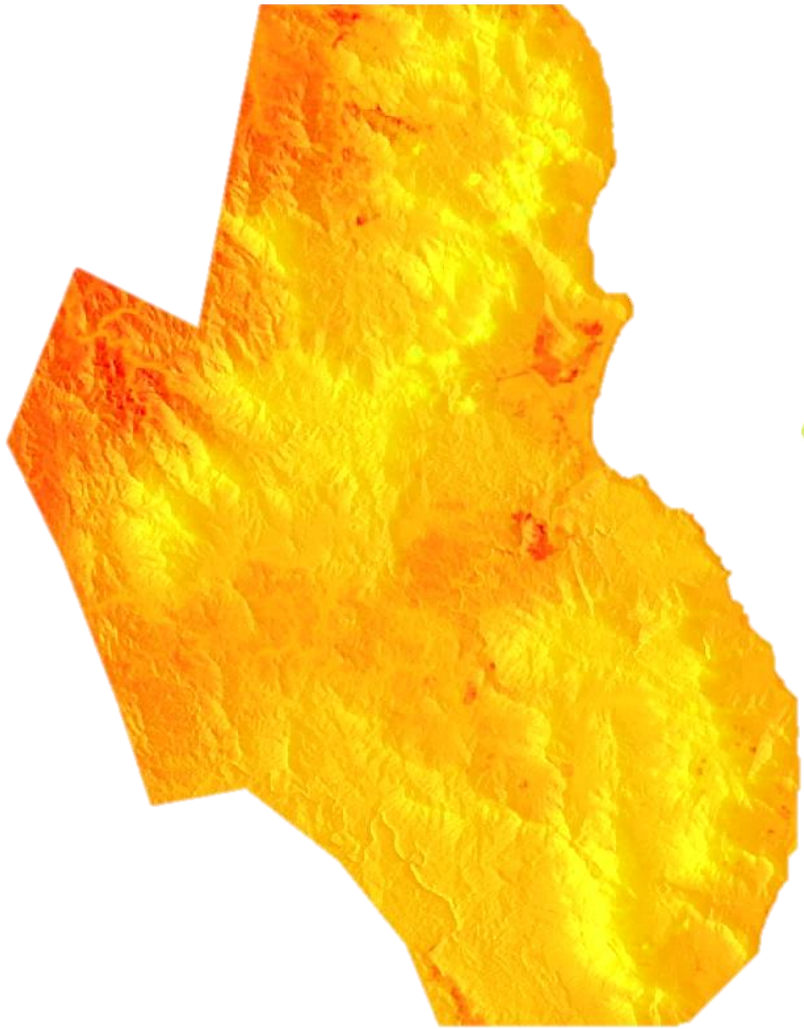
δNDVI: 2013 – 2019

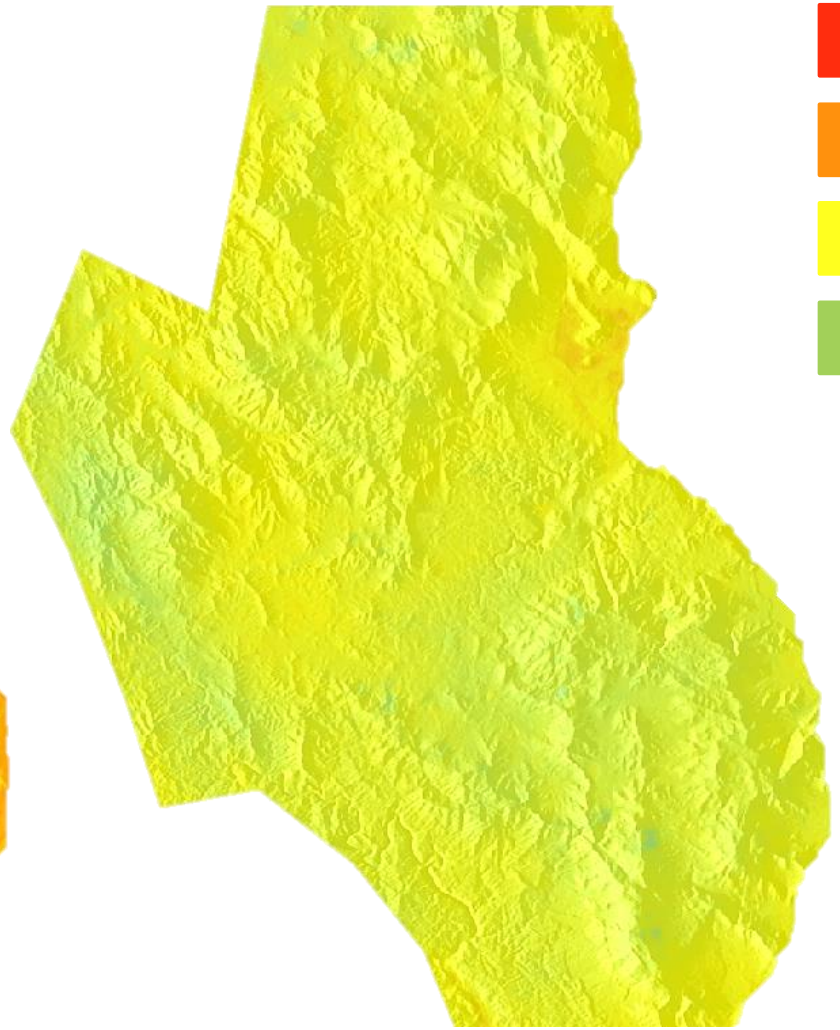


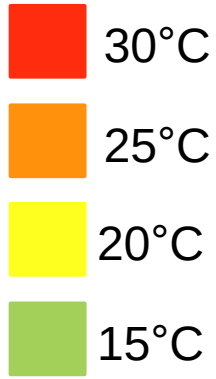
Decreased NDVI

Increased NDVI

Land Surface Temperature (°C)



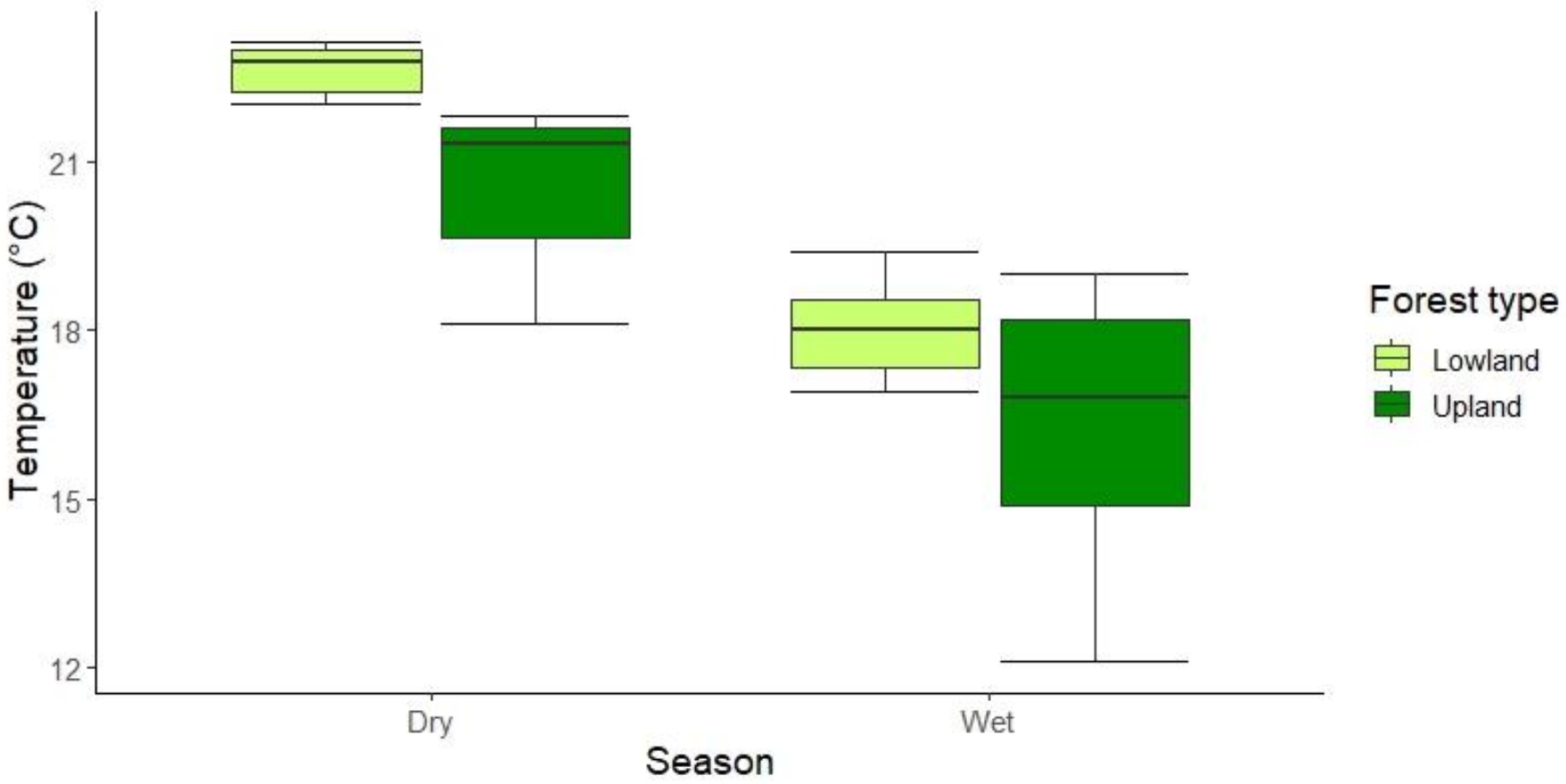




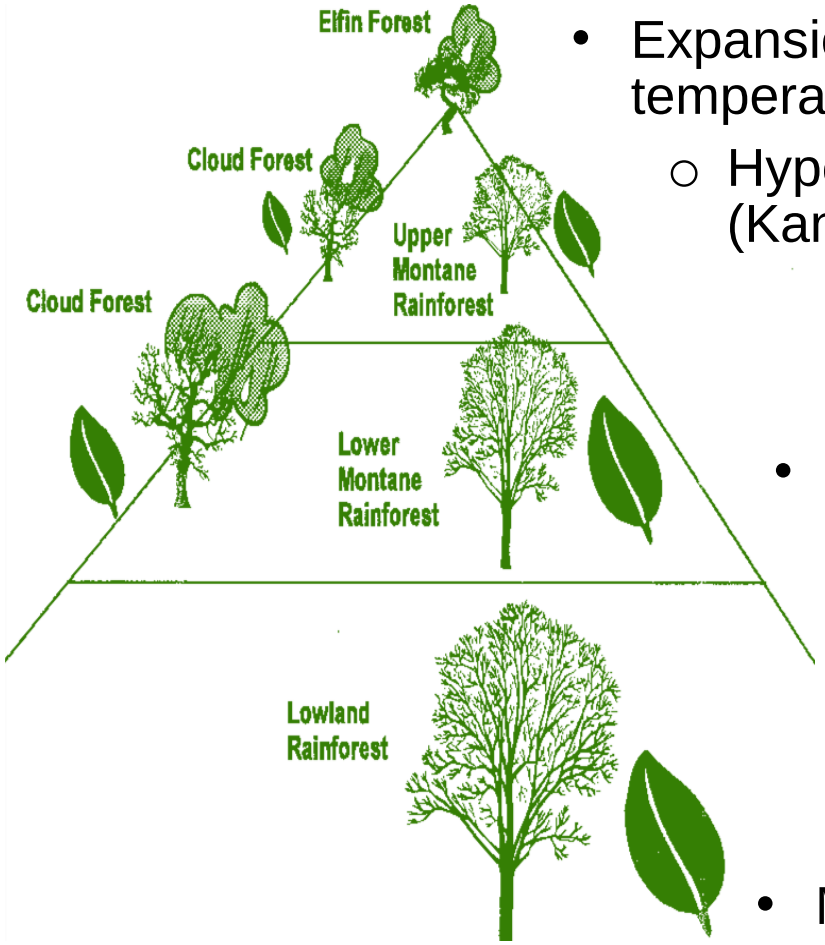
05/09/2019
Dry season

15/03/2020
Wet season

Seasonal Land Surface Temperatures in Upland vs. Lowland Rainforest



Discussion



Ecotone delineation in tropical montane rainforests (Foster 2001)

- Expansion of upland forests predicted with increasing temperatures & rainfall (Hilbert 2001)
  - Hyperspectral sensors can detect foliar chemistry (Kanowski 2001; Rao et al. 2008; Arellano et al. 2015)
- Lower upland NDVI may reflect small leaves, low structural complexity (Pettorelli et al. 2011)
  - Fluorescence indices can detect fine-scale changes in greenness (Irteza et al. 2020)
- Mountain-tops are thermal refugia (Reside et al. 2014)
  - Cloud forests & mountain-top endemics prone to effects of global warming (Meade et al. 2018)

Conclusion

Orphaned Bennett's tree kangaroo joey at JCU's Daintree Rainforest Observatory (Larson 2018)

- Species occurrence data required to build habitat suitability models (Oeser et al. 2020; Valerio et al 2020)
- Drone-mounted thermal cameras will facilitate tracking elusive arboreal mammals (Kays et al. 2019)
- BTK monitoring vital to understand population viability and ability to cope with environmental change

“…it's better to fail while striving for something wonderful, challenging, adventurous, and uncertain than to say, ‘I don't want to try because I may not succeed completely.’”

- Jimmy Carter

Thank you.

References

Arellano P, Tansey K, Balzter H, Boyd DS (2015) Detecting the effects of hydrocarbon pollution in the Amazon forest using hyperspectral satellite images. Environ Pollut 205:225-239

Burley HM, Mokany K, Laffan SW, Williams KJ, Metcalfe D, Murphy HT, Ford A, Harwood TD, Ferrier S (2018) Primary productivity is related to niche width in the Australian Wet Tropics. Global Ecol Biogeogr 27:1300-1313

Flannery TF, Martin R, Szalay A, Schouten P (1996) Tree kangaroos: a curious natural history. Reed Books, Port Melbourne

Foster P (2001) The potential negative impacts of global climate change on tropical montane cloud forests. Earth Sci Rev 55:73-106

Hilbert DW, Ostendorf B, Hopkins MS (2001) Sensitivity of tropical forests to climate change in the humid tropics of north Queensland. Aust Ecol 26:590-603

Irteza SM, Nichol JE, Shi W, Abbas S. (2020) NDVI and fluorescence indicators of seasonal and structural change in a tropical forest succession. Earth Syst Environ 1-7

Kanowski J (2001) Effects of elevated CO2 on the foliar chemistry of seedlings of two rainforest trees from north-east Australia: implications for folivorous marsupials. Aust Ecol 26:165-172

Kays R, Sheppard J, Mclean K, Welch C, Paunescu C, Wang V, Kravit G, Crofoot M (2019) Hot monkey, cold reality: surveying rainforest canopy mammals using drone-mounted thermal infrared sensors. Int J Remote Sens 40: 407-419

Larson J (2018) Bennett's tree kangaroo joey. Online image. Available at https://www.johanlarsonphotography.com/ [Accessed 18 November 2020]

Larson J (2020) Bennett's tree kangaroo. Online image. Available at https://www.johanlarsonphotography.com/ [Accessed 4 November 2020]

Martin R (1992) An ecological study of Bennett's tree-kangaroo (Dendrolagus bennettianus). WWF World Wide Fund for Nature, Sydney

Meade J, VanDerWal J, Storlie C, Williams S, Gourret A, Krockenberger A, Welbergen JA (2018) Substantial reduction in thermo-suitable microhabitat for a rainforest marsupial under climate change. Biol Lett 14:1-5

NatureServe (n.d.) HSM inputs and the principal output: a map of the probability of suitable habitat for an at-risk species. Online image. Available at https://www.natureserve.org/conservation-tools/habitat-suitability-modeling [Accessed 4 November 2020]

Oeser J, Heurich M, Senf C, Pflugmacher D, Belotti E, Kuemmerle T (2020) Habitat metrics based on multi-temporal Landsat imagery for mapping large mammal habitat. Remote Sensing in Ecology and Conservation 6:52-69

Pettorelli N, Ryan S, Mueller T, Bunneield N, Jedrzejewska B, Lima M, Kausrud K (2011) The Normalised Difference Vegetation Index (NDVI): unforeseen successes in animal ecology. Clim Res 46:15-27

Rao NR, Garg PK, Ghosh SK, Dadhwal VK (2008) Estimation of leaf total chlorophyll and nitrogen concentrations using hyperspectral satellite imagery. J Agr Sci 146:65-75

Reside AE, Welbergen JA, Phillips BL, Wardell-Johnson GW, Keppel G, Ferrier S, Williams SE, VanDerWal J (2014) Characteristics of climate change refugia for Australian biodiversity. Aust Ecol 39:887-897

Smit J (1894) Bennett's tree kangaroo. Online image. Available at https://upload.wikimedia.org/wikipedia/commons/3/32/Bennett%27s_Tree-kangaroo.jpg [Accessed 4 November 2020]

Storlie C, Merino-Viteri A, Phillips B, VanDerWal J, Welbergen J, Williams S (2014) Stepping inside the niche: microclimate data are critical for accurate assessment of species' vulnerability to climate change. Biol Lett 10:1-4

Valerio F, Ferreira E, Godinho S, Pita R, Mira A, Fernandes N, Santos SM (2020) Predicting microhabitat suitability for an endangered small mammal using Sentinel-2 data. Remote Sens 12:1-18