21ª CONFERENCIA INTERNACIONAL SOBRE PALMA DE ACEITE

21st International Oil Palm Conference

Measuring biodiversity and ecosystem service responses to oil palm management

Michael D. Pashkevich, Becky Heath, Sarah H. Luke, Anak A.K. Aryawan, Andreas D. Advento, Ribka S. Tarigan, Elfrin N. Amzi, Damayanti Buchori, Benedictus Freeman, Cicely A.M. Marshall, Julia Drewer, Jassica P. Dewi, Alex J. Dumbrell, Amy E. Eycott, Martina F. Harianja, Purnama Hidayat, Amelia S.C. Hood, Jamal Kabir, David J. Kurz, Daniel Lim, Eka Lupitasari, Godspower Major, Lourdes M. Medrano, Ikhsan Mohammad, Jamal Mukhlish, Mohammad Naim, Ana F. Palmeirim, Pujianto, Brogan Pett, Ricardo Rocha, Ari Saputra, Helena S. Shin-Clayton, Jake L. Snaddon, Soeprapto, Jake Stone, Suhardi, Jonathan H. Timperley, Valentine J. Reiss-Woolever, Rudi H. Widodo, Jean-Pierre Caliman, William A. Foster, Edgar C. Turner

fedepalma | cenipalma

The Biodiversity and Ecosystem Function in Tropical Agriculture (BEFTA) Programme

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21st International Oil Palm Conference

- International research collaboration of academics, palm oil industry, government, social enterprises and community partners
- Investigating how oil palm management influences biodiversity and ecosystem services
- Field activities currently in Indonesia, Malaysia, Liberia

PI: Ed Turner

Oil palm and biodiversity

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21st International Oil Palm Conference

- Oil palm plantations can harbour relatively high levels of biodiversity of many different species

QR codes across presentation take you to relevant free-to-access research articles

Oil palm and biodiversity

- Oil palm plantations can harbour relatively high levels of biodiversity of many different species
- This includes species of **conservation concern**, pest species and beneficial species

Psittacus timneh: The Timneh parrot, found in West African plantations feeding on palm fruits.

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Oil palm and biodiversity

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Bagworms: Lepidoptera larvae that damage palm frondlets through herbivory

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Cosmolestes picticeps: Assassin bug, which eats pests in Indonesian plantations

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Oil palm and biodiversity

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- Oil palm plantations can harbour relatively high levels of biodiversity of many different species
- This includes species of conservation concern, pest species and beneficial species
- **All of these species are affected by oil palm management**

Psittacus timneh: The Timneh parrot, found in West African plantations feeding on palm fruits.

Bagworms: Lepidoptera larvae that damage palm frondlets through herbivory

Cosmolestes picticeps: Assassin bug, which eats pests in Indonesian plantations

Monitoring biodiversity & ecosystem services in oil palm landscapes

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- Methods vary by species/service group
- Many methods are relatively simplistic, enabling effective monitoring without expert knowledge or skillsets
- Technology and AI are increasingly revolutionising monitoring of biodiversity and services

Camera traps - Mammals

© WWF

Motion-detected camera (photos & video)

White-bellied pangolin (Liberia)

Leopard cat (Indonesia)

Filipa Palmeirim

Agung Aryawan

Millie Hood

- Images identified by experts or – increasingly – artificial intelligence

Pitfall traps – Ground arthropods

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- Arthropods fall into traps, which are preserved in alcohol and identified using microscopes

Jonny Timperley

Romeo Weah

Baited pan trap - Pollinators

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Pollinators are attracted to bait, and preserved in yellow pan trap below

Captured pollinators identified using microscopes

- Novel method involving baited pan trap with half male oil palm inflorescence in anthesis stage

Megan Popkin

Martina Harianja

Flux chambers – Greenhouse gases

Ring in ground to not create microclimate

Lid for enclosure up to 1h samples at 0, 15, 30, 45 min

- Build up of concentration of GHG over time
- Samples taken with a syringe
- Flux calculation using ground surface area, volume & time
- Samples analysed in lab

Julia Drewer

Ribka Tarigan

Plant use – Ethnobotanical surveys

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- Survey plant biodiversity, and then interview local people to understand how they use different plant species

Cicely Marshall

Decomposition – leaf litter bags

- Mesh bags filled with 4 grams of chopped-up dried palm fronds. Bury in the ground and – after 40 days – assess change in weight.

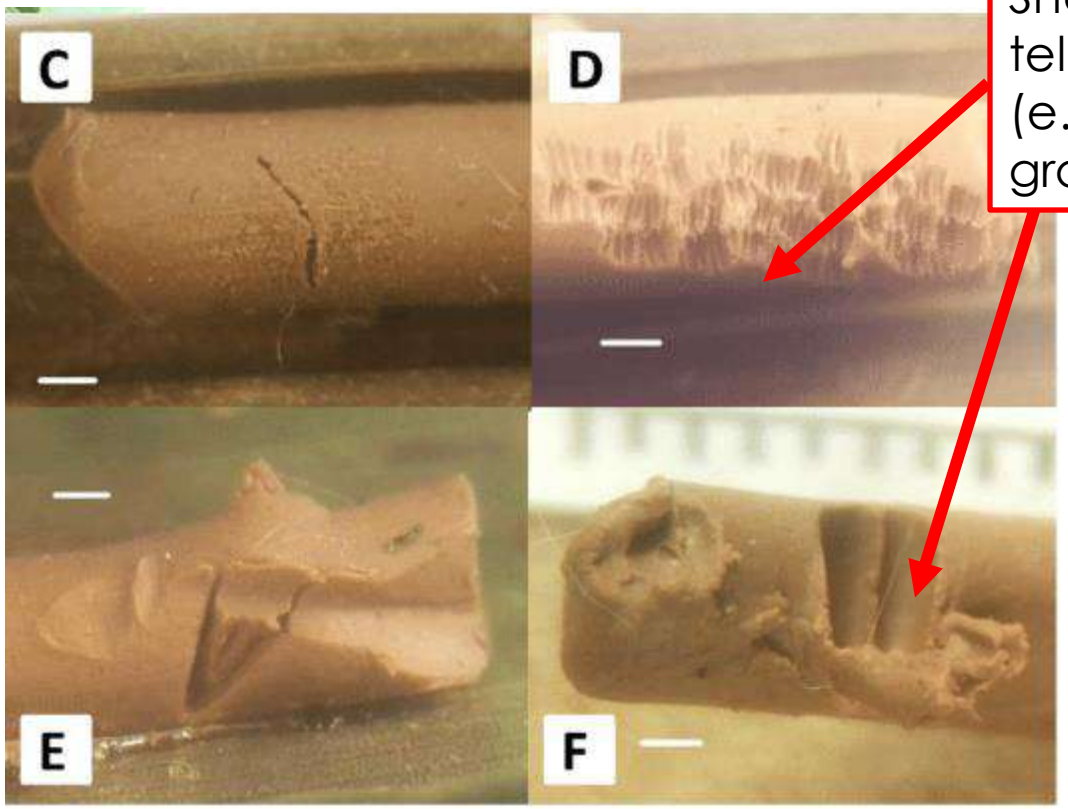
Amy Eycott

Adam Ashton-Butt

Predation – Plasticine caterpillars

Plasticine "caterpillars" glued to palm fronds

- "Caterpillars" of plasticine glued to palm fronds for three days. Predators bite the plasticine, and leave a bite mark



Shape of bite mark tells the predator (e.g., ant vs grasshopper vs bird)

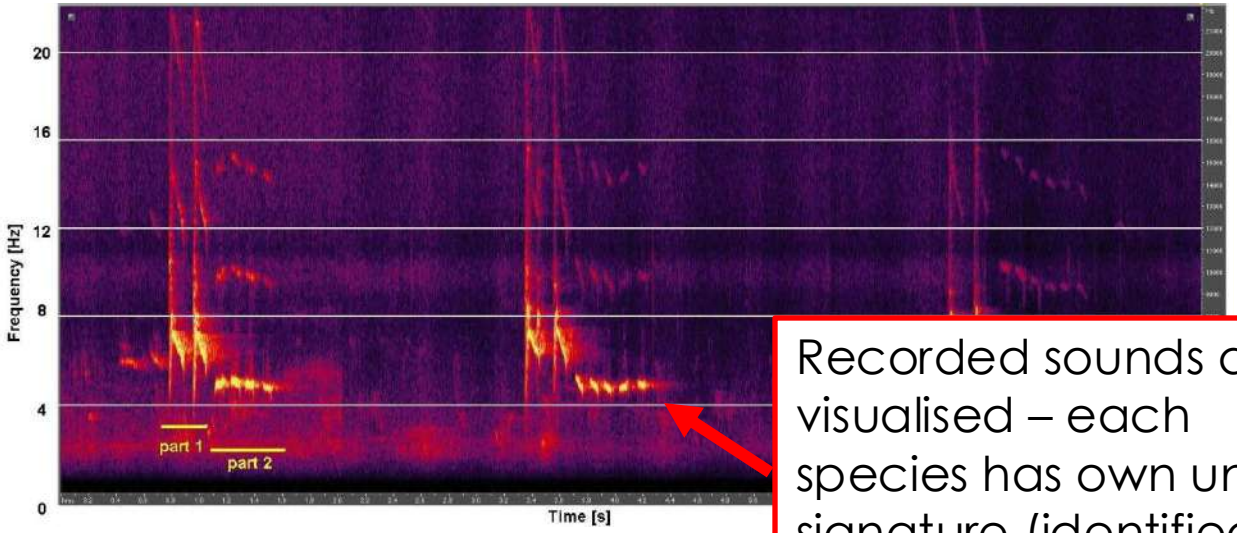
Helen Waters

Bioacoustics – Vocalising animals

Small microphone records sound in landscape

Becky Heath

- Bioacoustic recorders placed in field. Small microphone records all vocalizing animals, which are identified on computer



Recorded sounds are visualised – each species has own unique signature (identified by experts or AI)

LiDAR scanner - Vegetation complexity

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From maps, we can derive e.g. tree height, vegetation structural complexity, and level of canopy openness

Fires laser rapidly, creating 3D map of surrounding environment

Sacchi Shin-Clayton

Soil cores + metagenomics – Soil biodiversity

Extract soil using corer

Through labwork and bioinformatics, identify the species present

- From soil cores, can detect species present including fungi, bacteria, and other microbes

Alex Dumbrell

BEFTA has monitored more than 50 ecological indicators including:


Temperature


Biomass


Dung beetles


Flying insects


Soil macrofauna


Mammals


Dung removal


Crop damage


Soil chemical properties


Forest structural features


Frogs


Acoustics


Fish


Ground insects


Aquatic inverts


Spiders


Ground cover


Weather


Bats


Understory plants


Rats


Herbivory


Insect pest predation


Yield


Growth rates


Water quality


River structural features


Trees


Birds


Decomposition


Seed removal


Plant uses

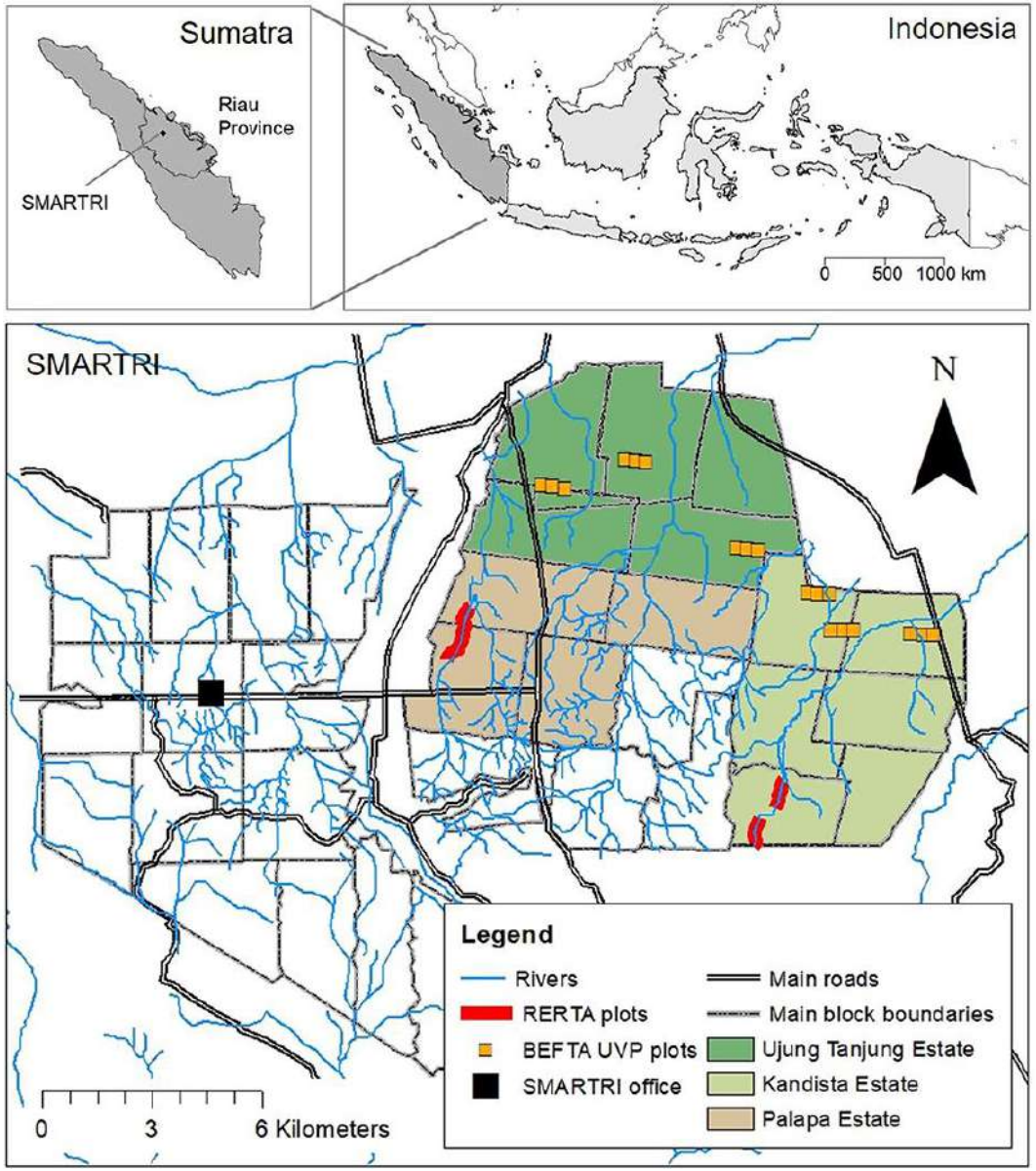
Biodiversity and Ecosystem Function in Tropical Agriculture Understory Vegetation Project (BEFTA-UVP)

Alternative herbicide application

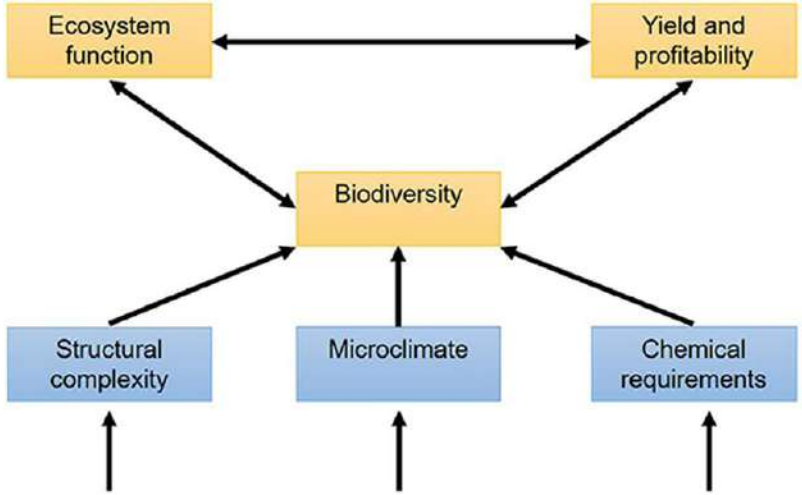
Understory vegetation management and its effects on ecosystems and productivity

Riau, Indonesia

Biodiversity and Ecosystem Function in Tropical Agriculture Understory Vegetation Project (BEFTA-UVP)



- Large scale experimental project in established oil palm
- Investigates the effects of understory plant complexity on environmental conditions, ecosystem functioning and yield



Changes in management

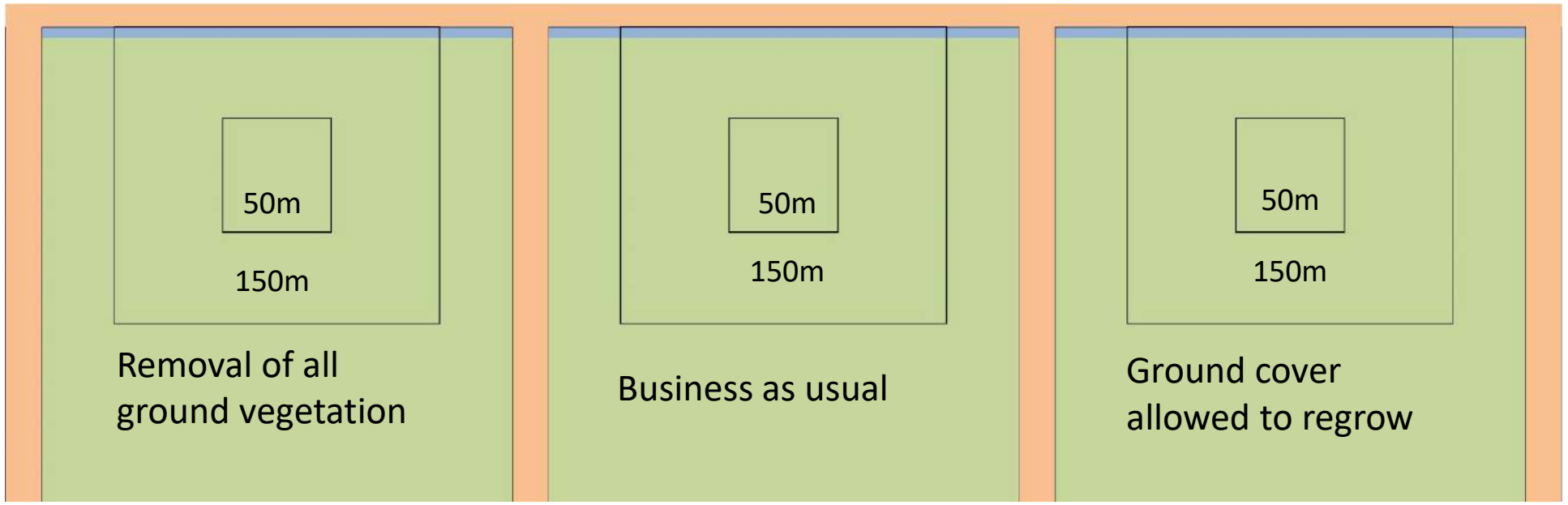
Luke et al (2020) *Frontiers in Forests and Global Change* 2.

smart agribusiness and food
smart research institute

Experimental setup: pre-treatment

Road

Ditch



Biodiversity and Ecosystem Function in Tropical Agriculture Understory Vegetation Project (BEFTA-UVP)

Experimental setup: post-treatment

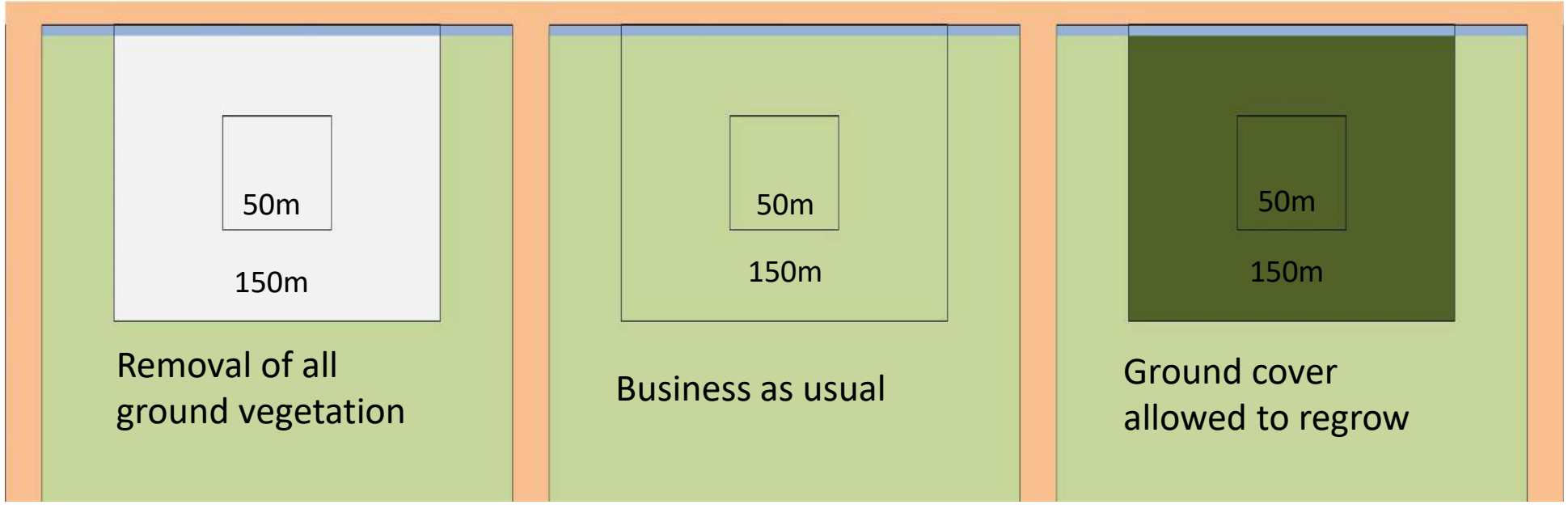
Road

Ditch

Reduced

Normal

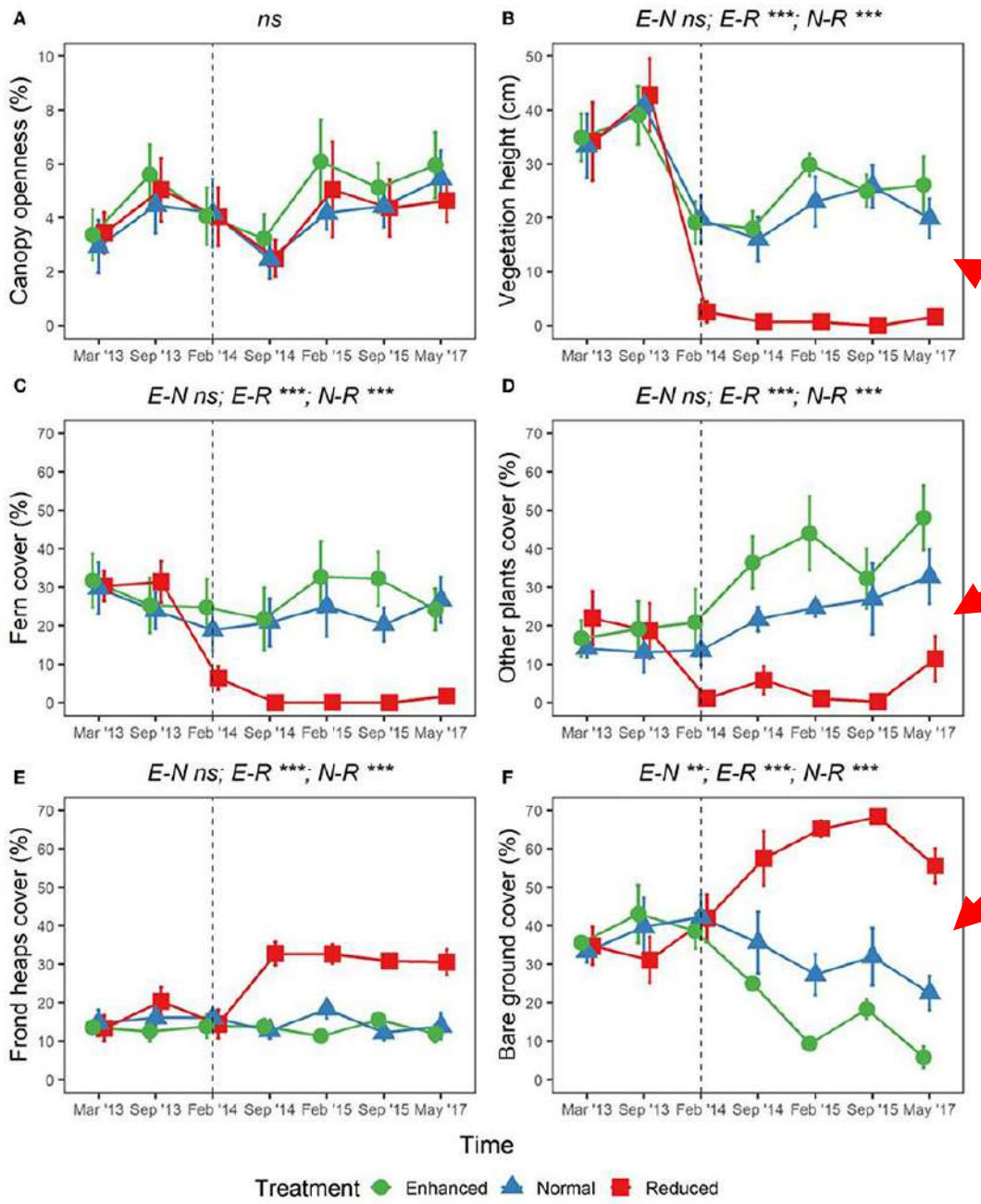
Enhanced



Biodiversity and Ecosystem Function in Tropical Agriculture Understory Vegetation Project (BEFTA-UVP)

Clear and immediate effects of understory management as a result of the treatment

Sarah Luke



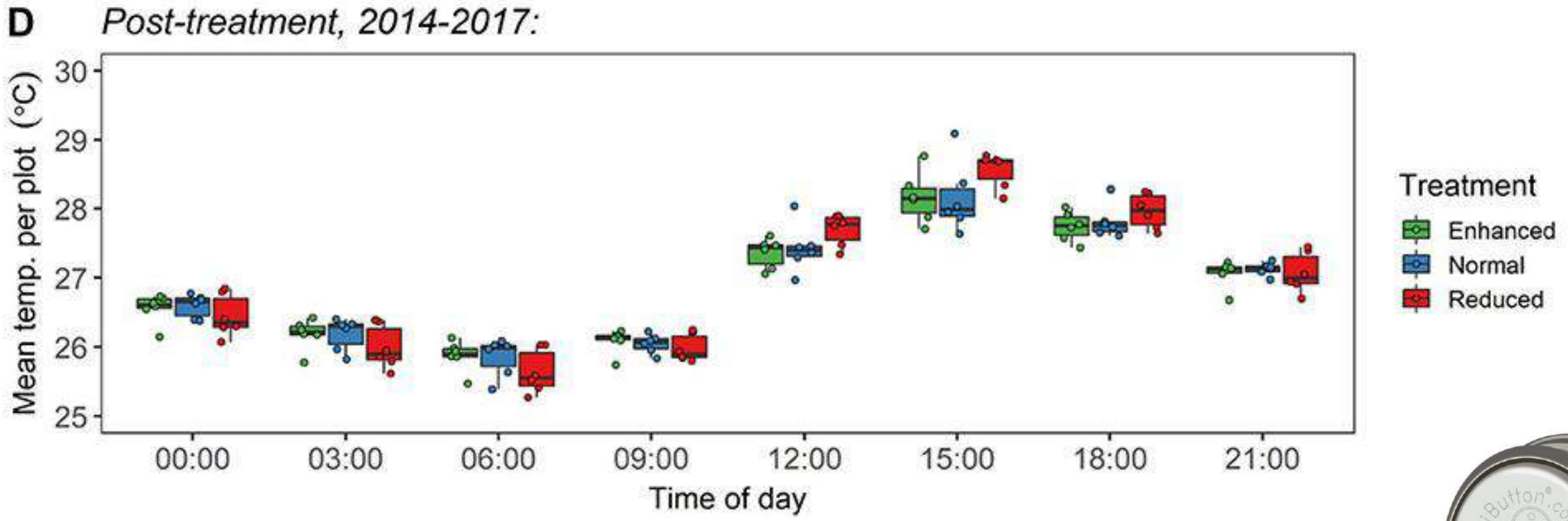
Differences in vegetation height and coverage as a result of treatment

Luke et al (2020) *Frontiers in Forests and Global Change* 2

Biodiversity and Ecosystem Function in Tropical Agriculture Understory Vegetation Project (BEFTA-UVP)

Biodiversity and Ecosystem Function in Tropical Agriculture Understory Vegetation Project (BEFTA-UVP)

Mean soil temperatures over 24 hours not different between treatment, but Reduced plots 0.4°C warmer than other plots in hottest time of the day



Luke et al (2020) *Frontiers in Forests and Global Change* 2. doi: 10.3389/ffgc.2019.00075

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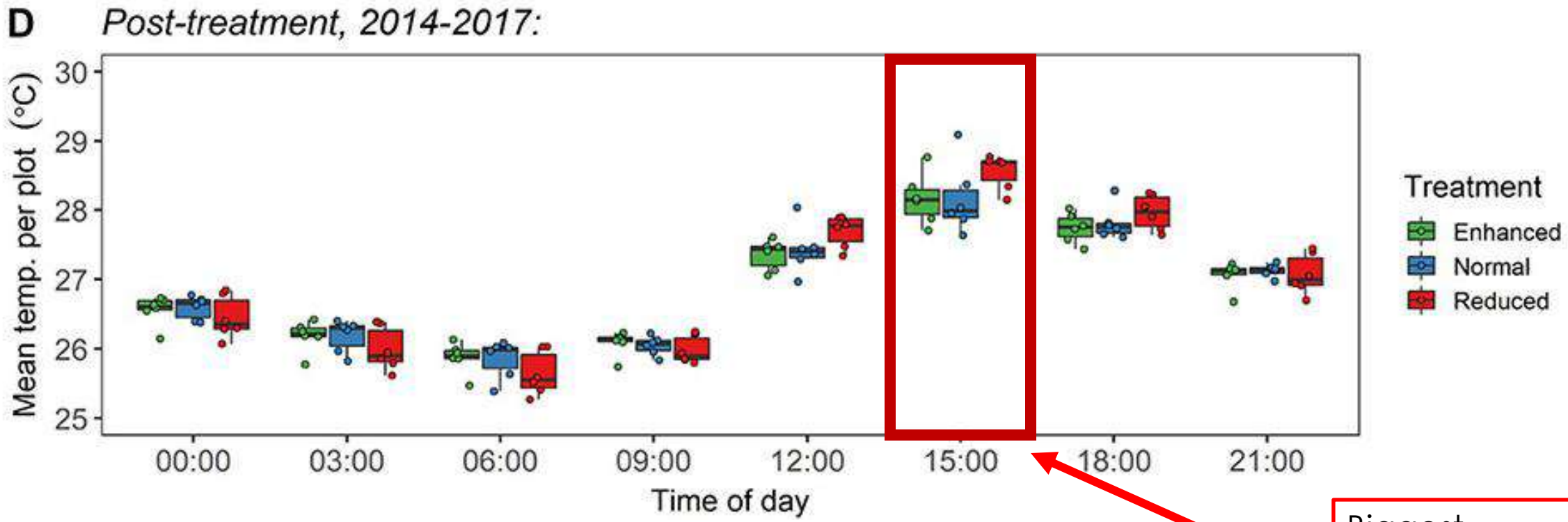


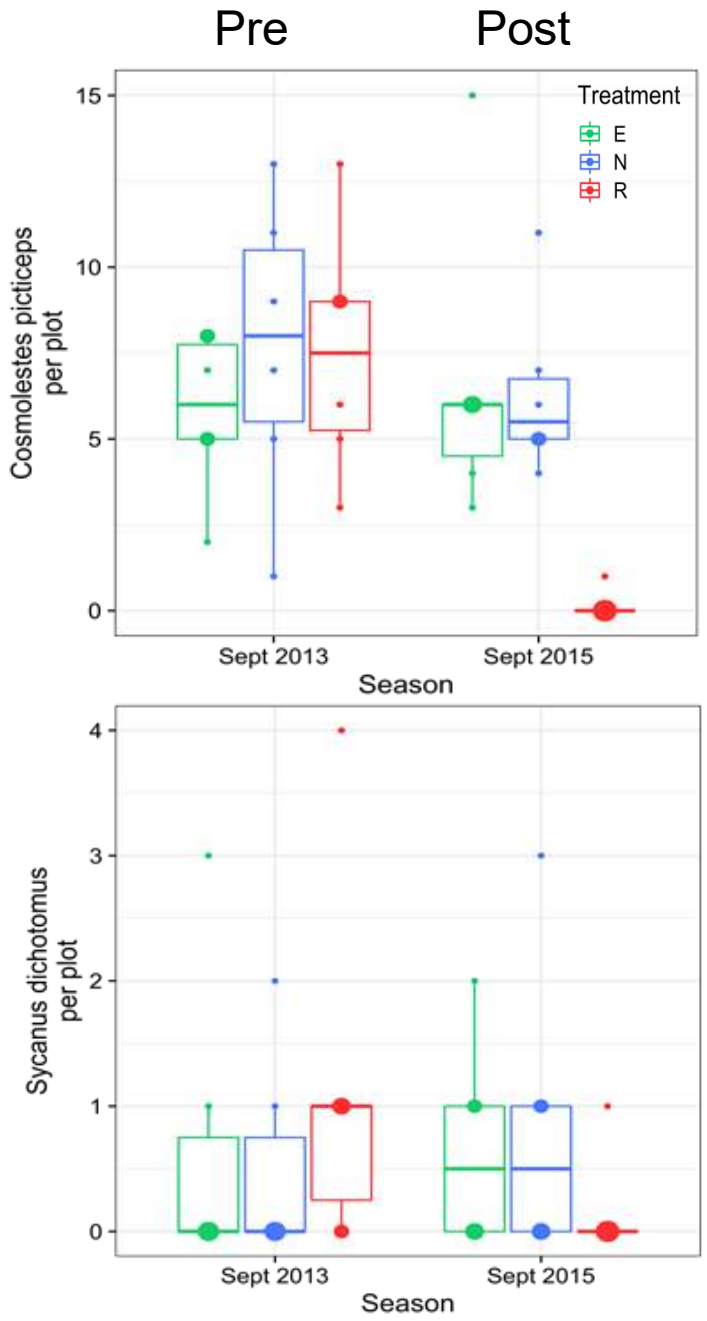
Biggest differences during the middle of the day (hottest time)

Luke et al (2020) *Frontiers in Forests and Global Change* 2. doi: 10.3389/ffgc.2019.00075

Abundance of assassin bugs lower in reduced plots post-treatment

Andreas Dwi Advento

Jake Stone



Fewer C. picticeps when vegetation is removed

Biodiversity and Ecosystem Function in Tropical Agriculture Understory Vegetation Project (BEFTA-UVP)

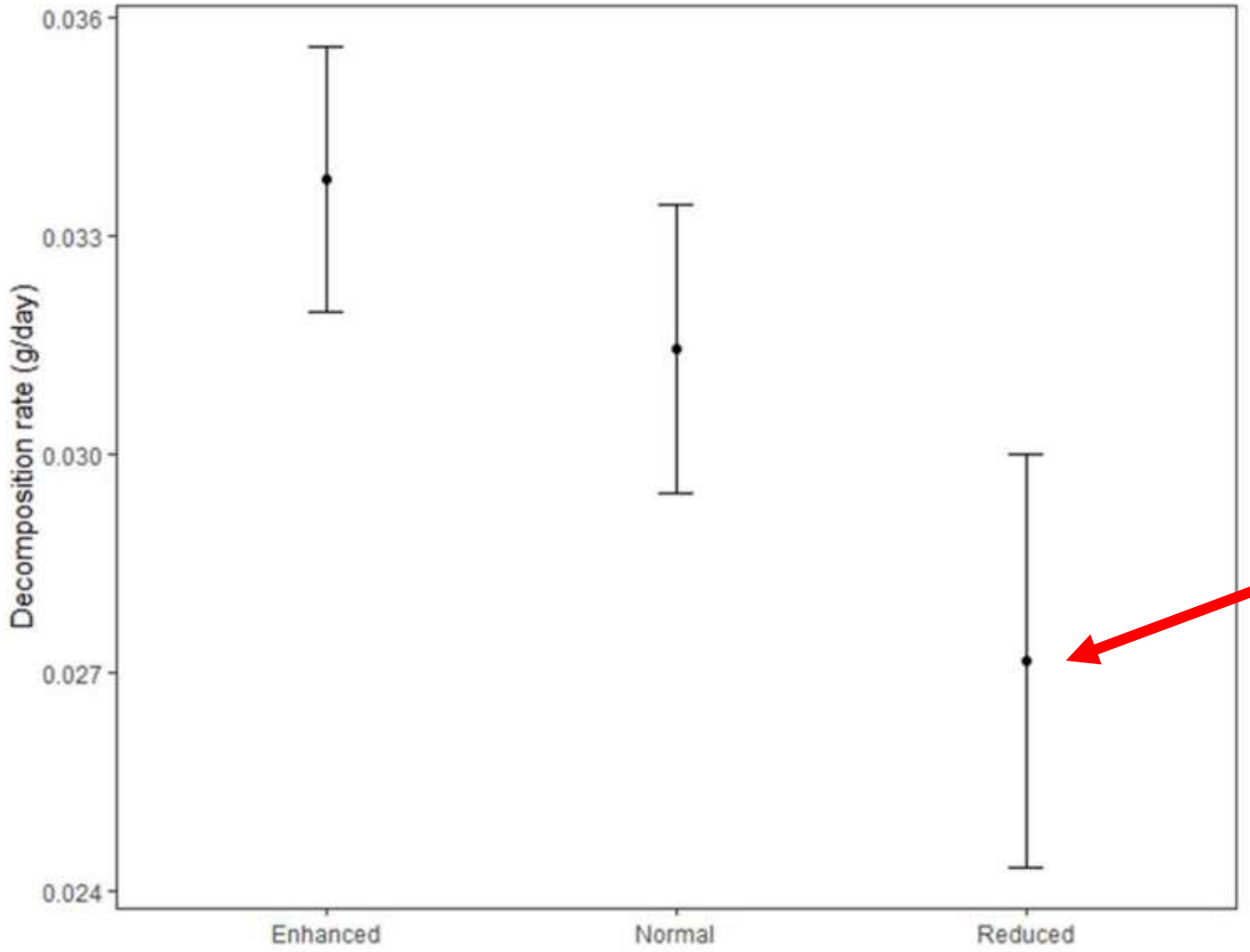
Stone et al (2024) Ecological solutions and evidence

Biodiversity and Ecosystem Function in Tropical Agriculture Understory Vegetation Project (BEFTA-UVP)

Litter decomposition over 30 days

Andreas Dwi Advento

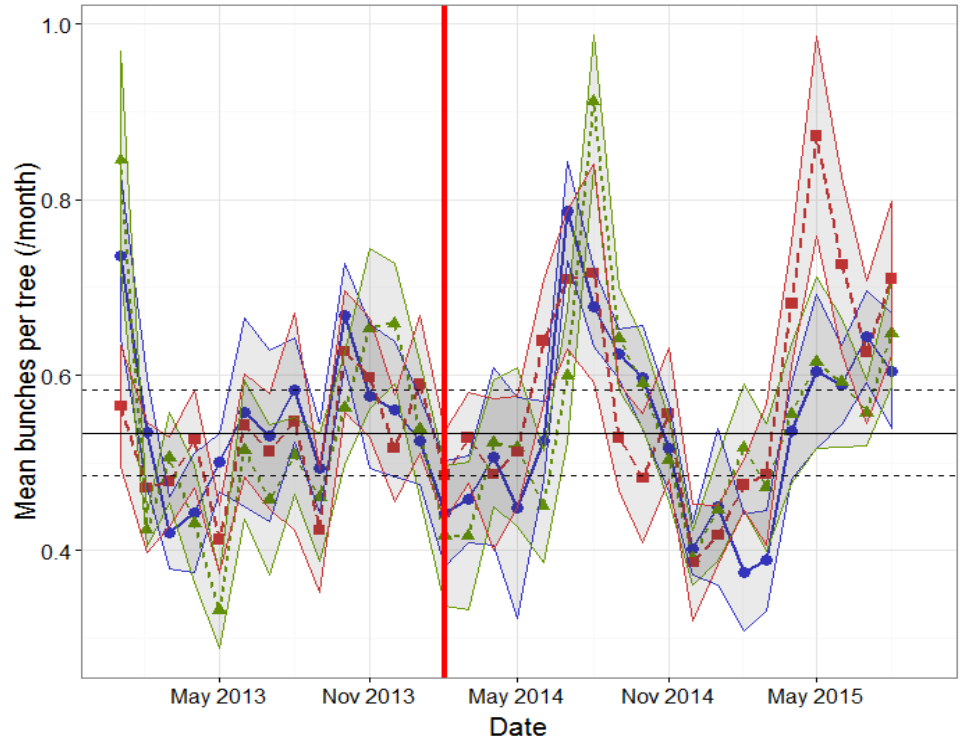
Adham Ashton-Butt

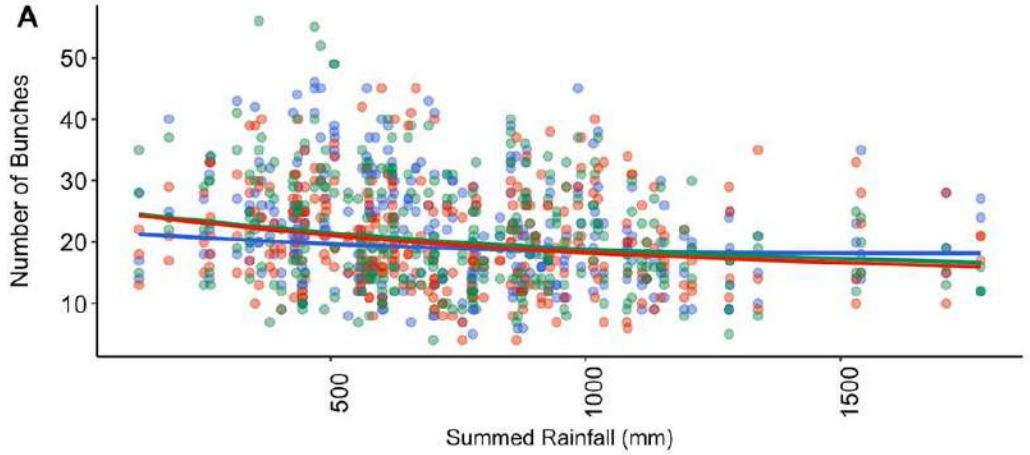


Lower levels of decomposition when vegetation removed

Ashton-Butt et al (2018) *Frontiers in Forest and Global Change*

No clear change in yield between plot types, but yield negatively affected by higher rainfall 1-5 months before harvest





Popkin et al (in prep)

Biodiversity and Ecosystem Function in Tropical Agriculture Understory Vegetation Project (BEFTA-UVP)

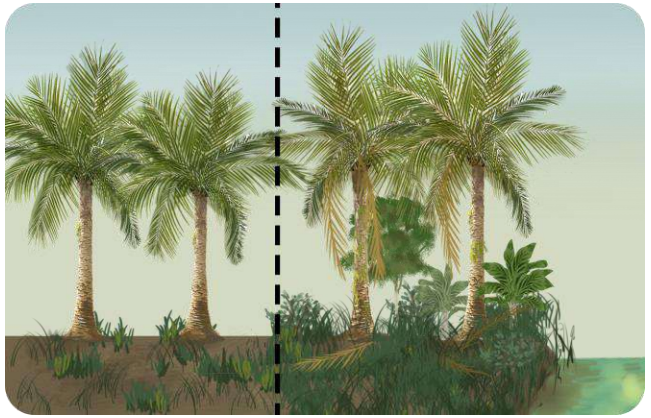
Biodiversity and Ecosystem Function in Tropical Agriculture Understory Vegetation Project (BEFTA-UVP)

Riparian Ecosystem Restoration Tropical Agriculture

Alternative herbicide application

Understory vegetation management and its effects on ecosystems and productivity

Riau, Indonesia



Restoring riparian areas & oil palm replanting

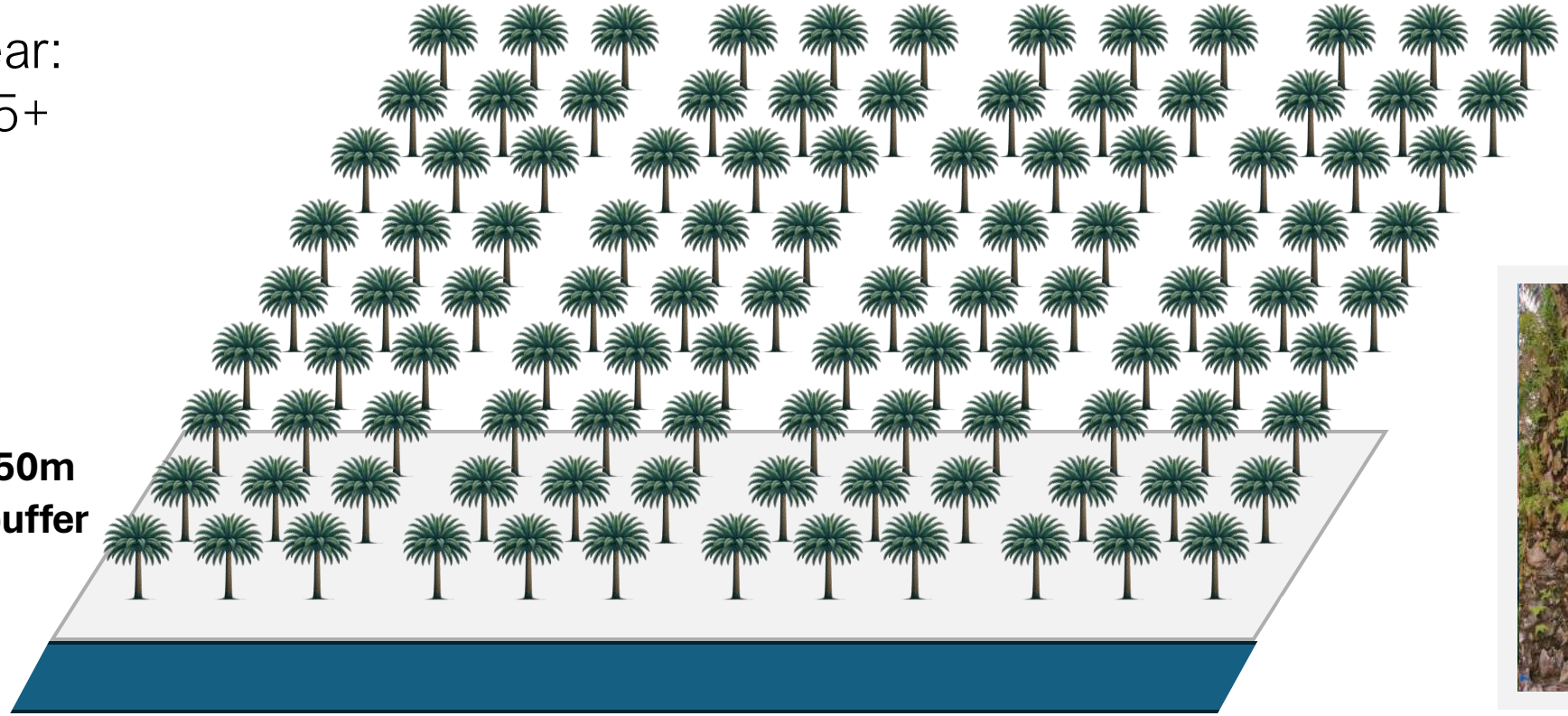
Identifying the best ways to restore river margins in oil palm at the time of replanting

Riau, Indonesia

Experimental setup: Pre-treatment

Riparian Ecosystem Restoration Tropical Agriculture

Year:
25+



sinarmas

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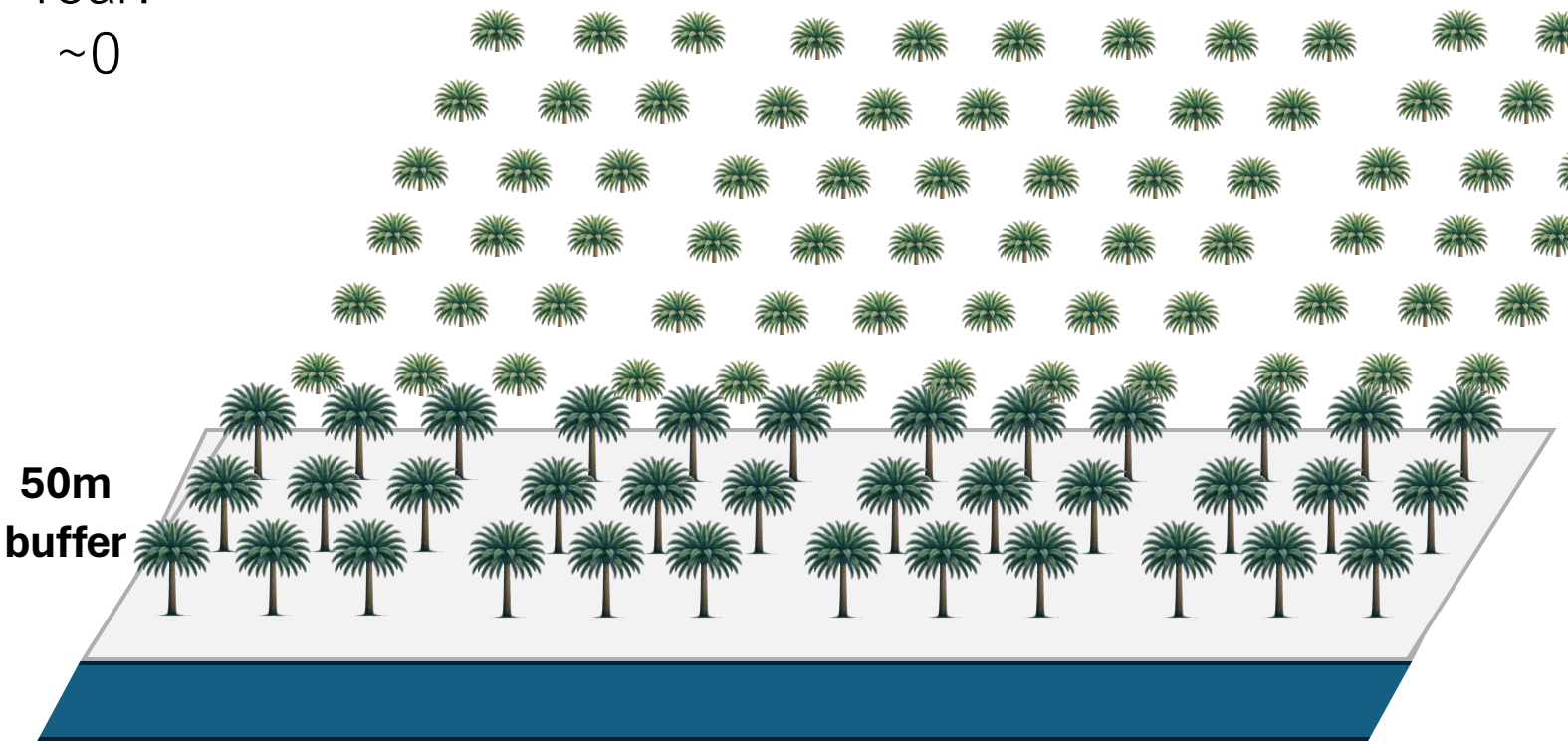
Business-as-usual replanting & riparian management in GAR plantations

Riparian Ecosystem Restoration Tropical Agriculture

Year:
~0



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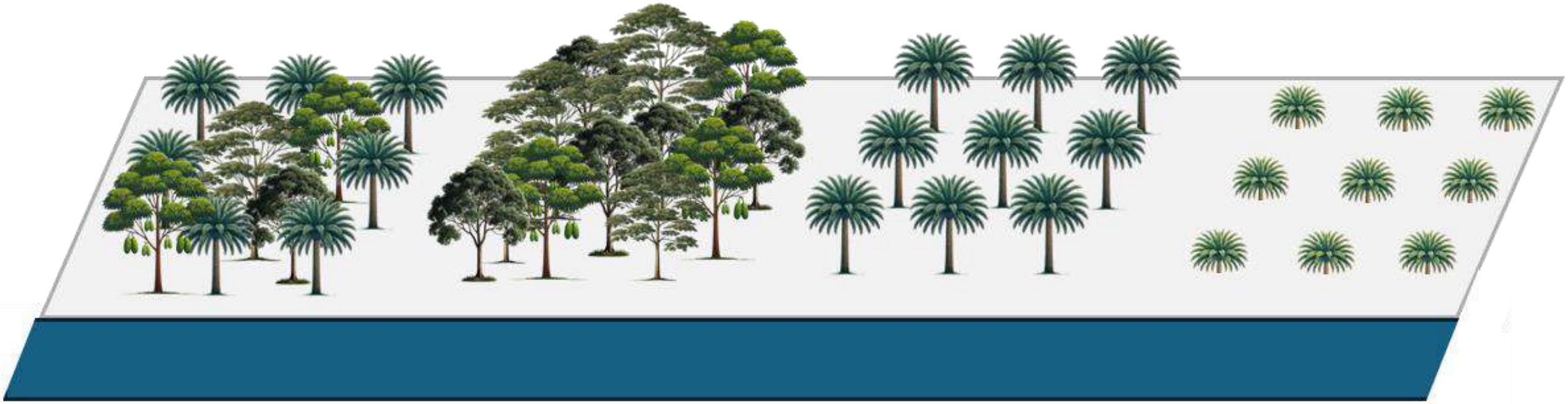
RERTA experimental treatments

Riparian Ecosystem Restoration Tropical Agriculture



Mature palms + enrichment

Enrichment only

Mature palms only

No restoration

sinarmas

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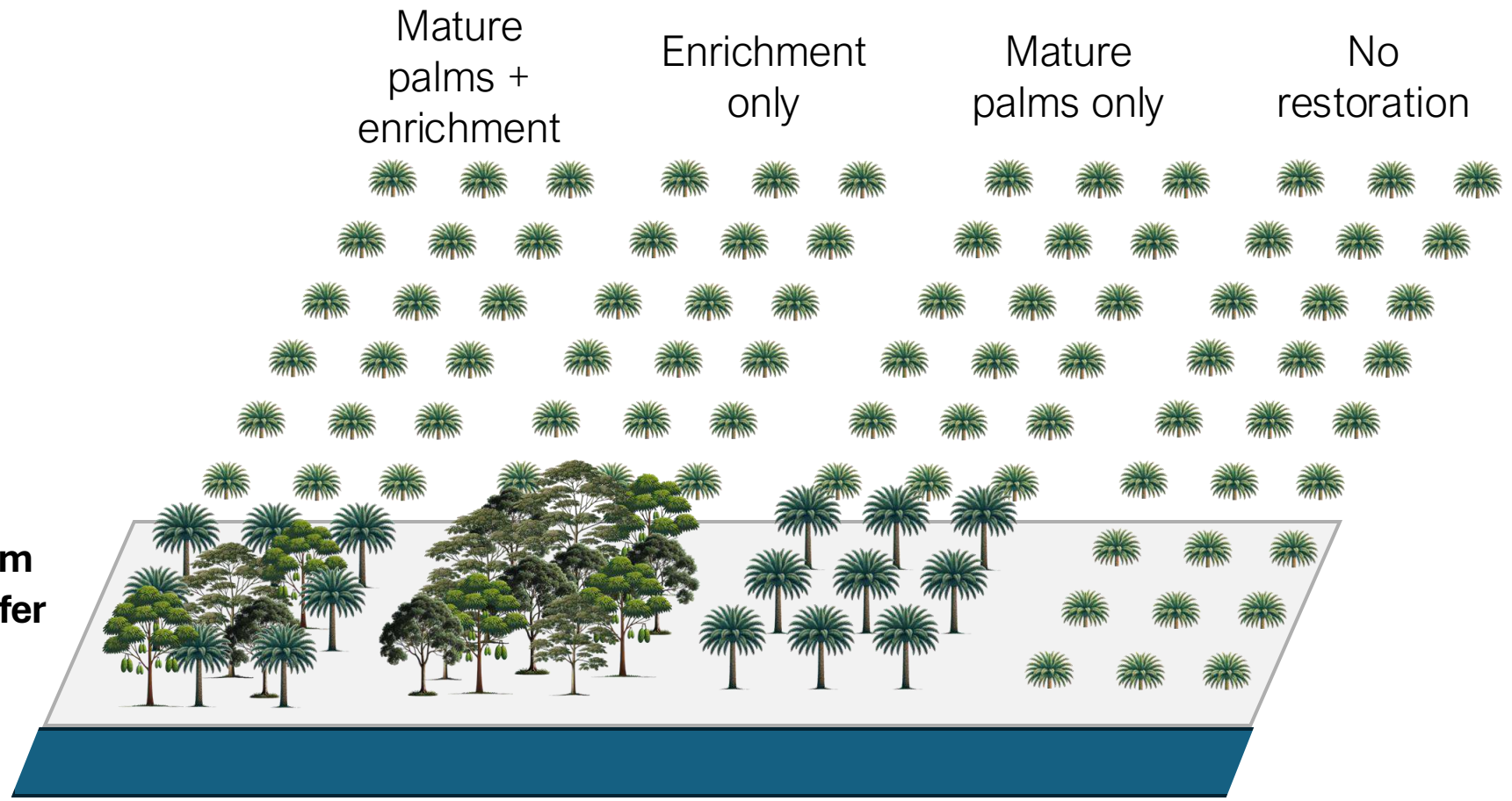
Experimental setup: Post-treatment



Riparian Ecosystem Restoration Tropical Agriculture

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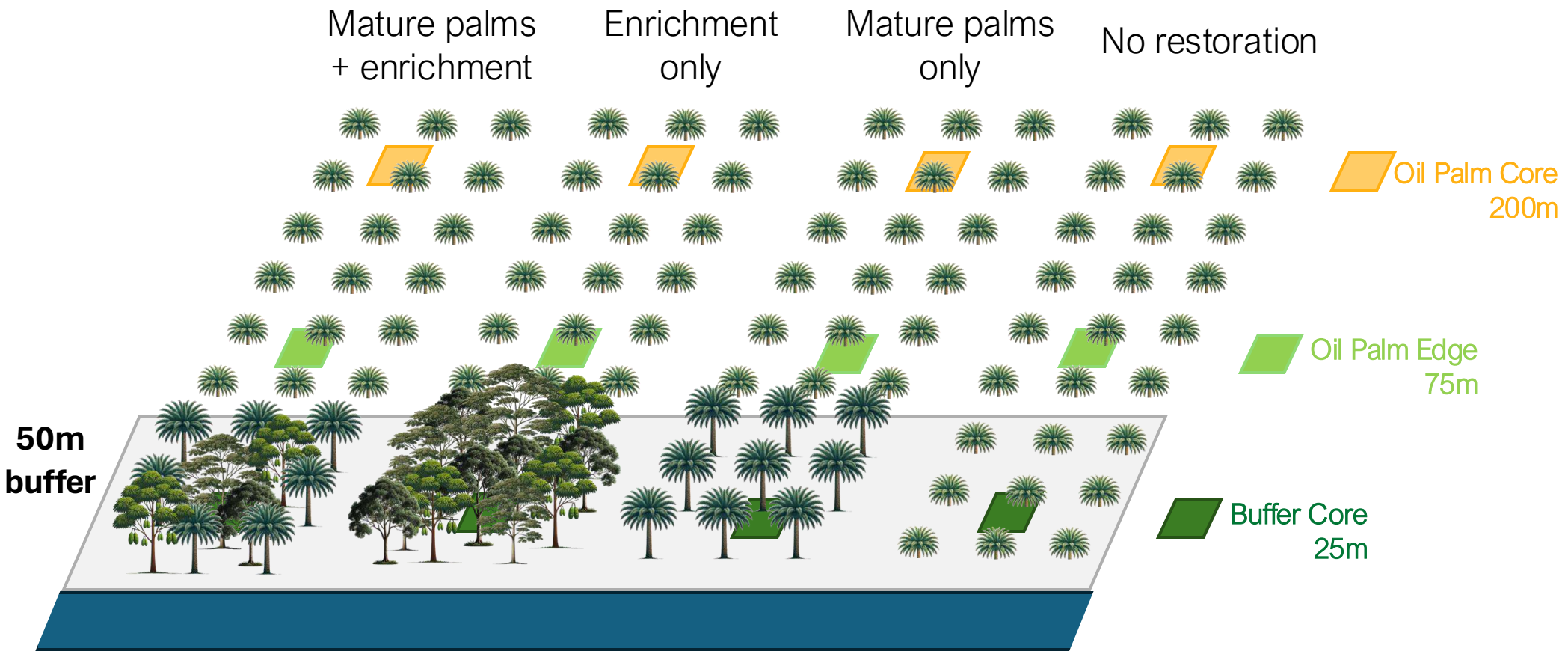
Monitoring at three locations relative to buffers

Riparian Ecosystem Restoration Tropical Agriculture



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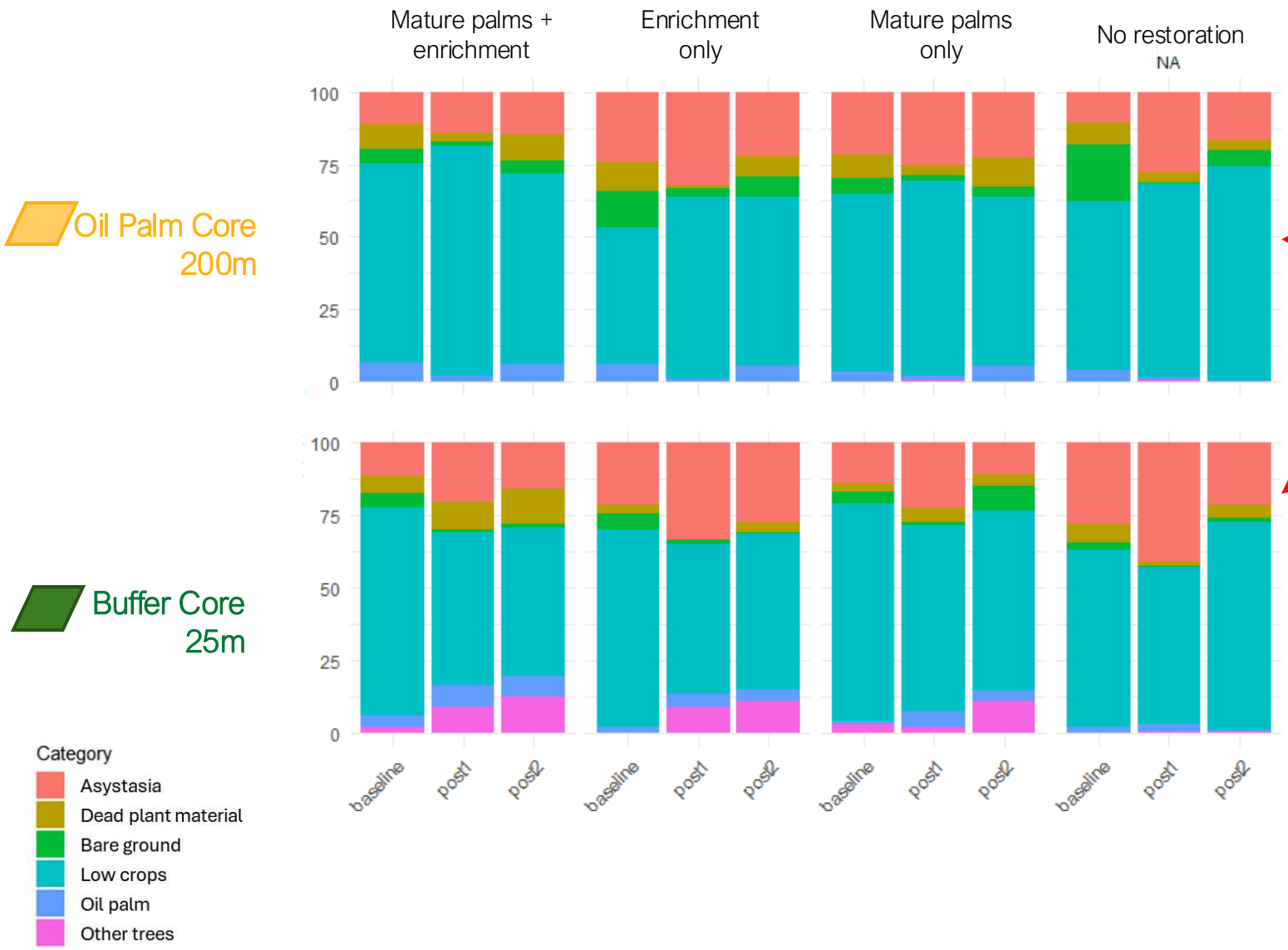
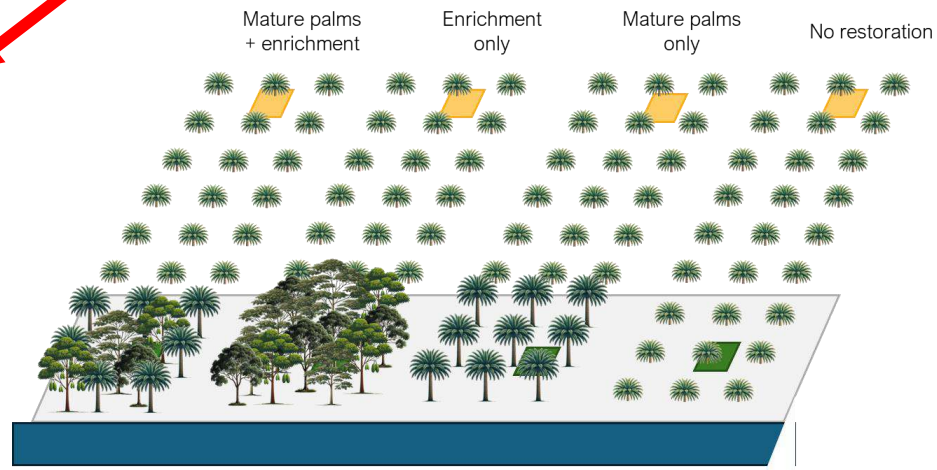
Treatments change vegetation composition

Riparian Ecosystem Restoration Tropical Agriculture



No changes in vegetation composition outside buffer. Changes within buffer caused by treatment



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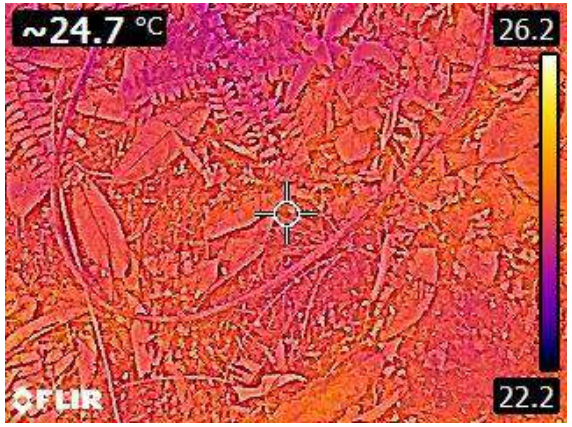
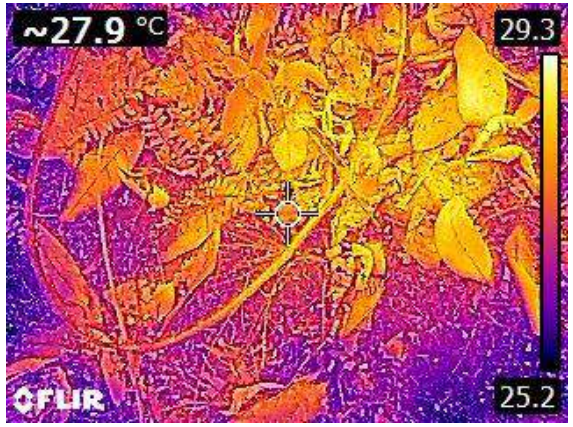
Maintaining riparian buffers mitigates cross-day fluctuations in temperature

Riparian Ecosystem Restoration Tropical Agriculture

Buffer maintained



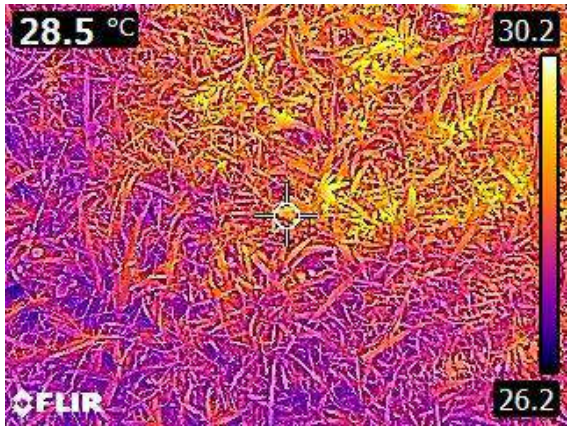
Morning



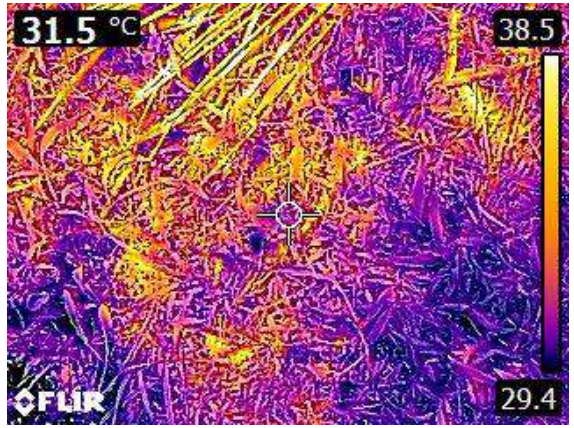
Afternoon

The shaded margin has lower temperature fluctuations between morning and afternoon.

No buffer (replanting to river)



Morning



Afternoon

The control margin has close to a 10◦C range in the afternoon and a higher overall average temperature.

Sacchi Shin-Clayton

sinarmas

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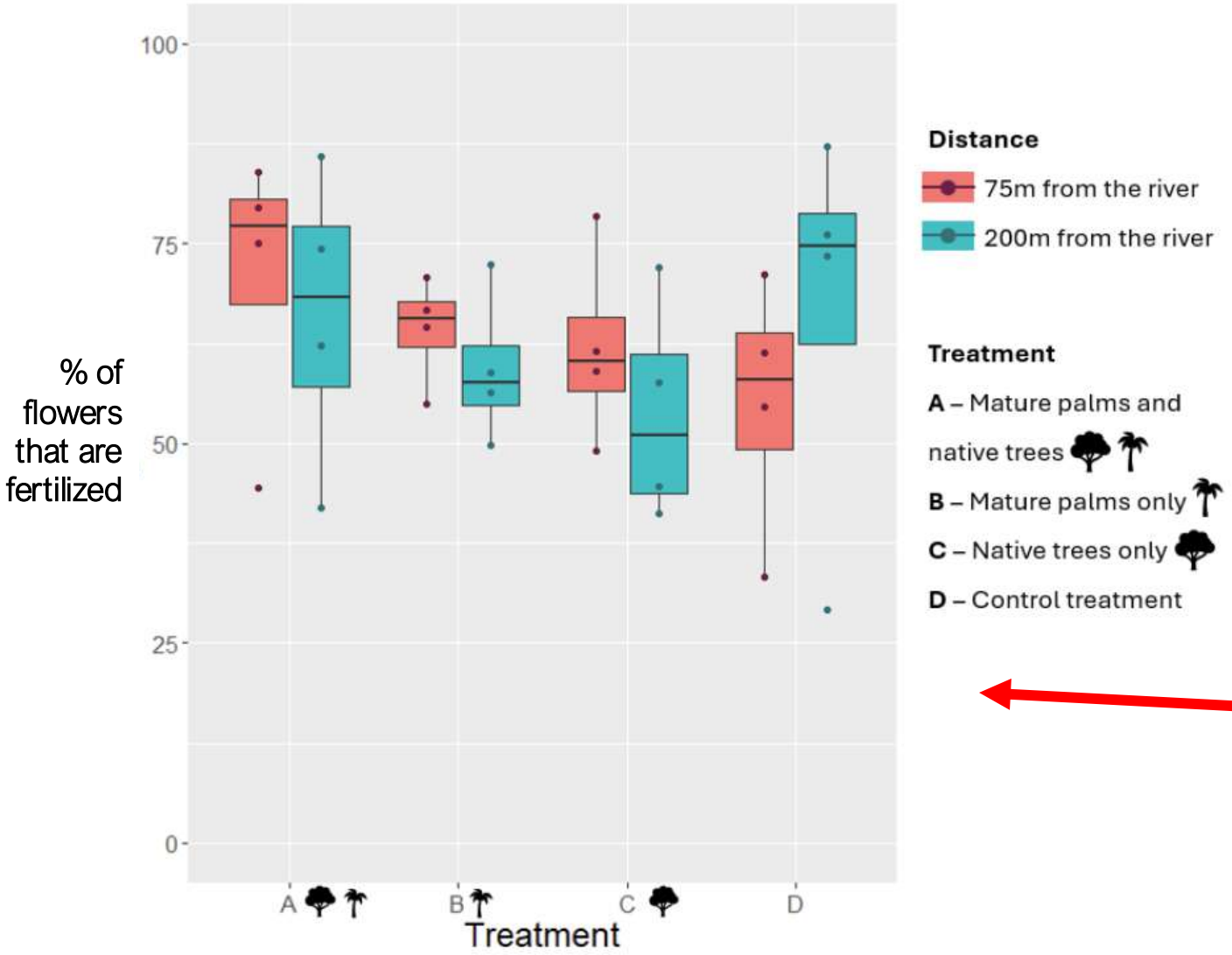
Buffers do not negatively affect ecosystem services in neighboring plantations



Daniel Lim

Buffer treatments do not affect fertilisation of oil palm flowers (i.e., no negative effect on ecosystem services)

Biodiversity and Ecosystem Function in Tropical Agriculture Understory Vegetation Project (BEFTA-UVP)

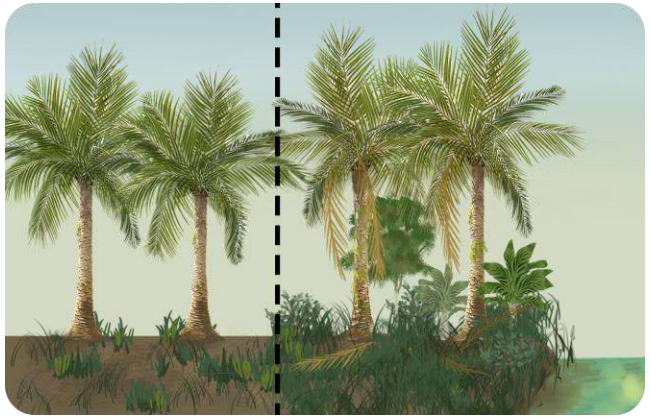
Riparian Ecosystem Restoration Tropical Agriculture

SOPWA Sustainable Oil Palm in West Africa

Alternative herbicide application

Understory vegetation management and its effects on ecosystems and productivity

Riau, Indonesia



Conservation within small reserves & replanting

Identifying the best ways to restore river margins in oil palm at the time of replanting

Riau, Indonesia

Comparing industrial and traditional management

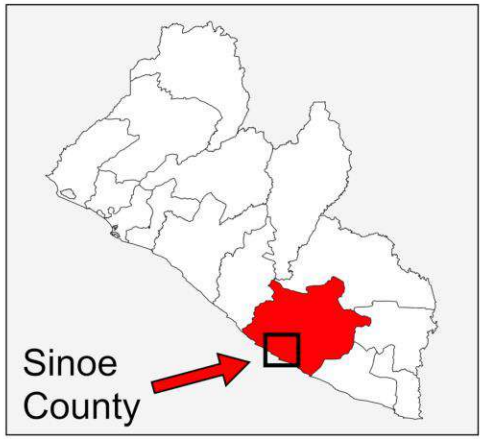
Traditional African approaches to oil palm cultivation and effects on nature and society

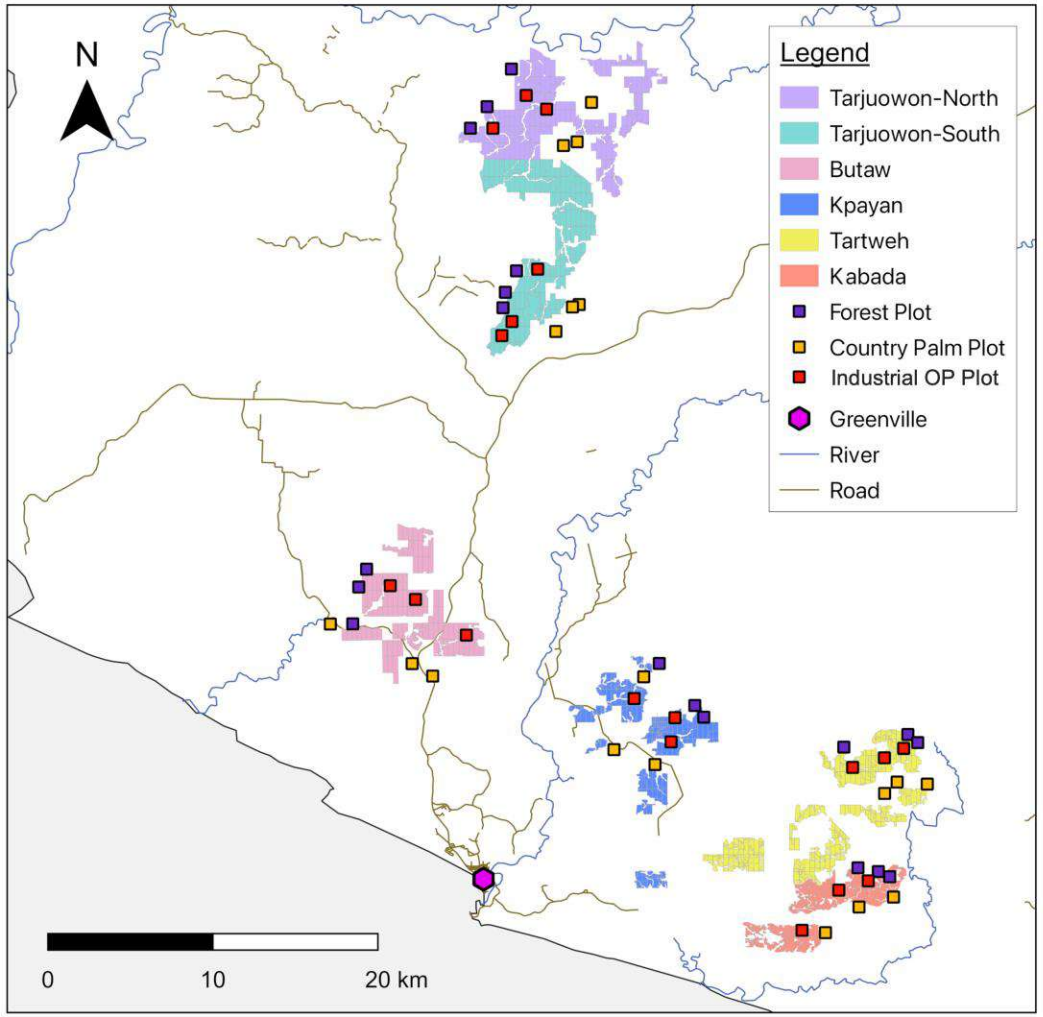
Sinoe, Liberia

The Sustainable Oil Palm in West Africa Project

SOPWA
Sustainable Oil Palm in West Africa

- Field-based study with plots in and around six oil palm plantations in Sinoe County, Liberia





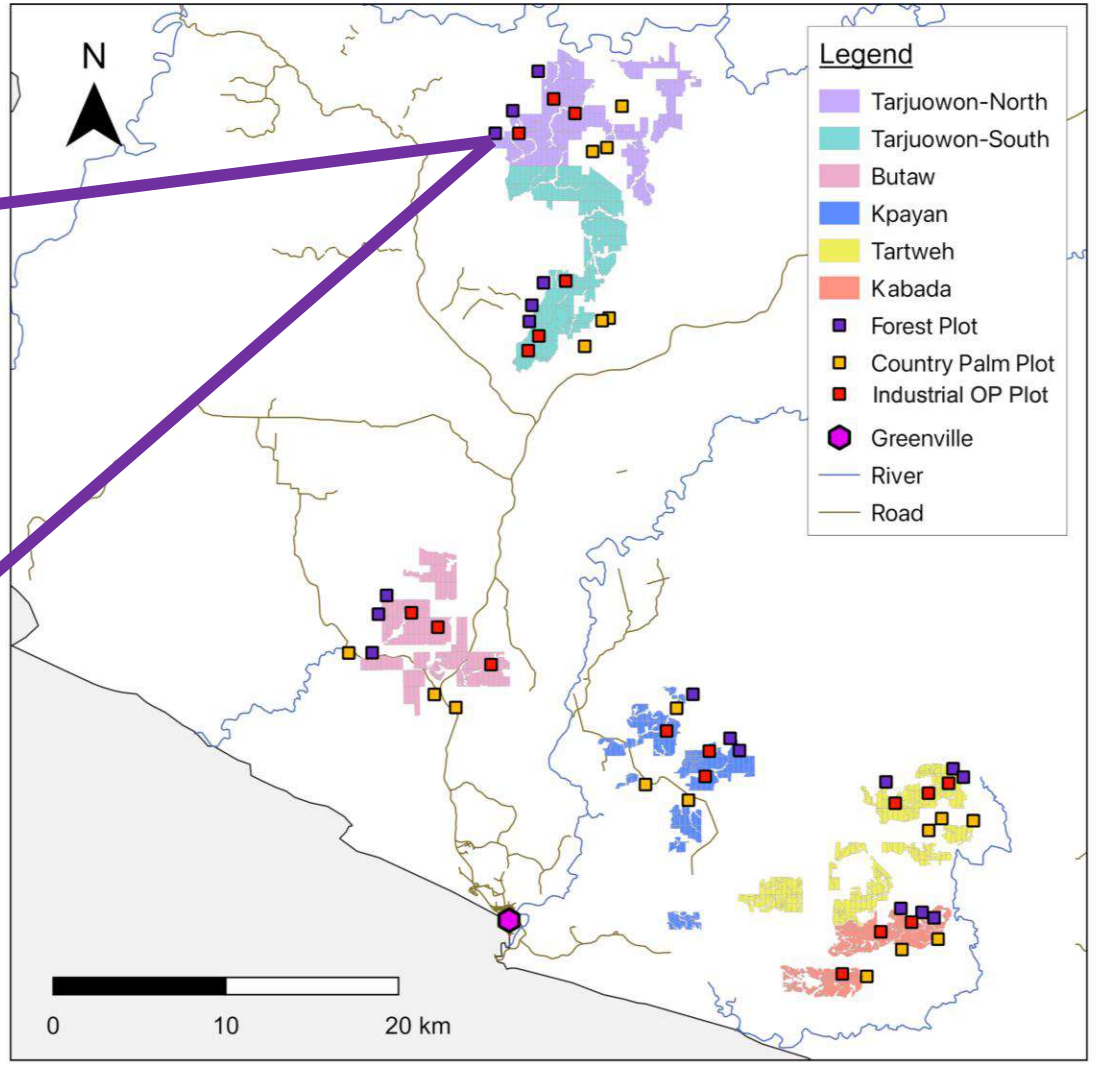
GVL GOLDEN VEROLEUM LIBERIA

Pashkevich *et al.* (2024). *Sci. Tot. Env.*

The Sustainable Oil Palm in West Africa Project

SOPWA
Sustainable Oil Palm in West Africa

Rainforest: Natural habitat



Pashkevich *et al.* (2024). *Sci. Tot. Env.*

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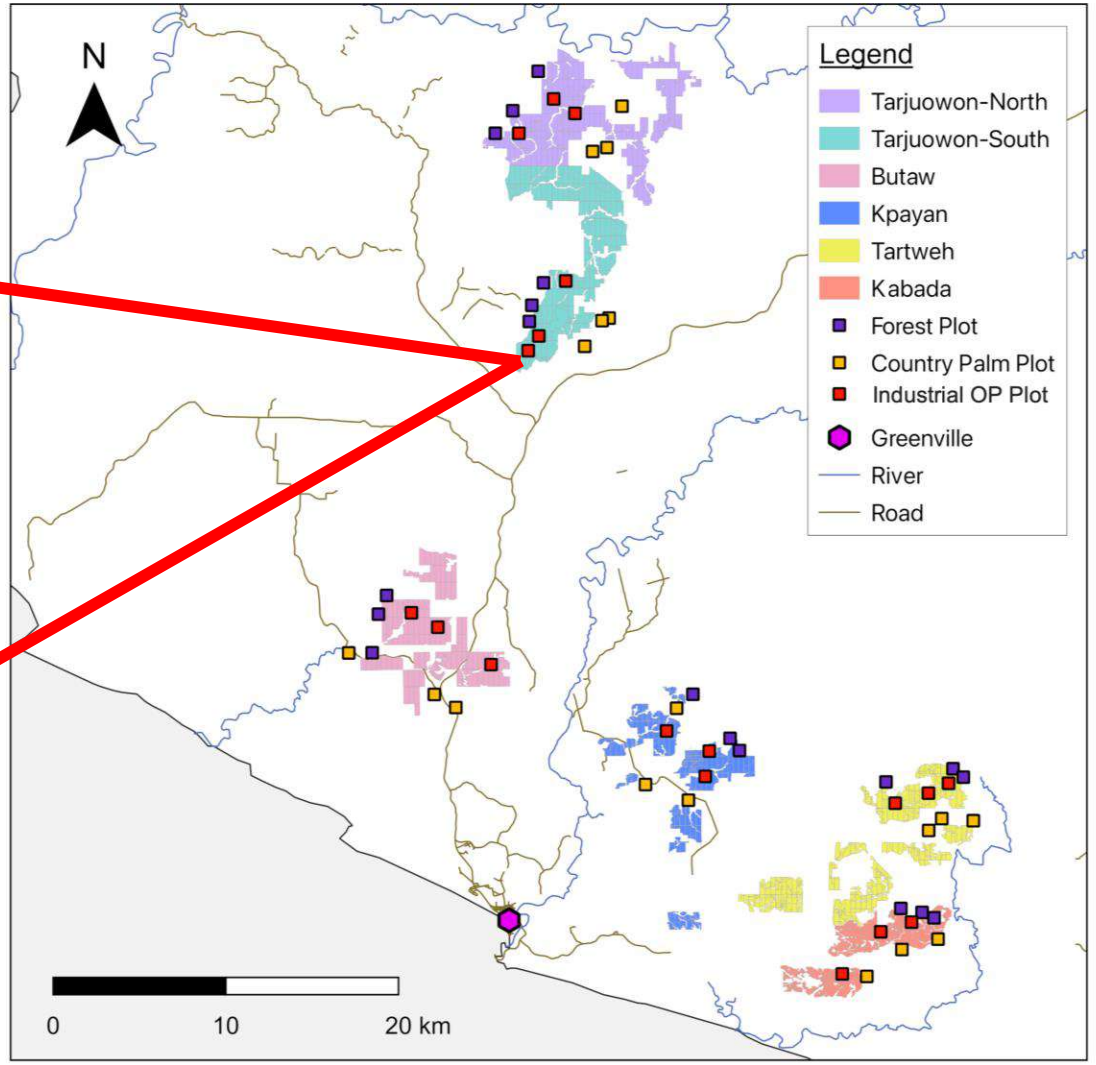
The Sustainable Oil Palm in West Africa Project

SOPWA
Sustainable Oil Palm in West Africa

Industrial oil palm



Pashkevich *et al.* (2024). *Sci. Tot. Env.*

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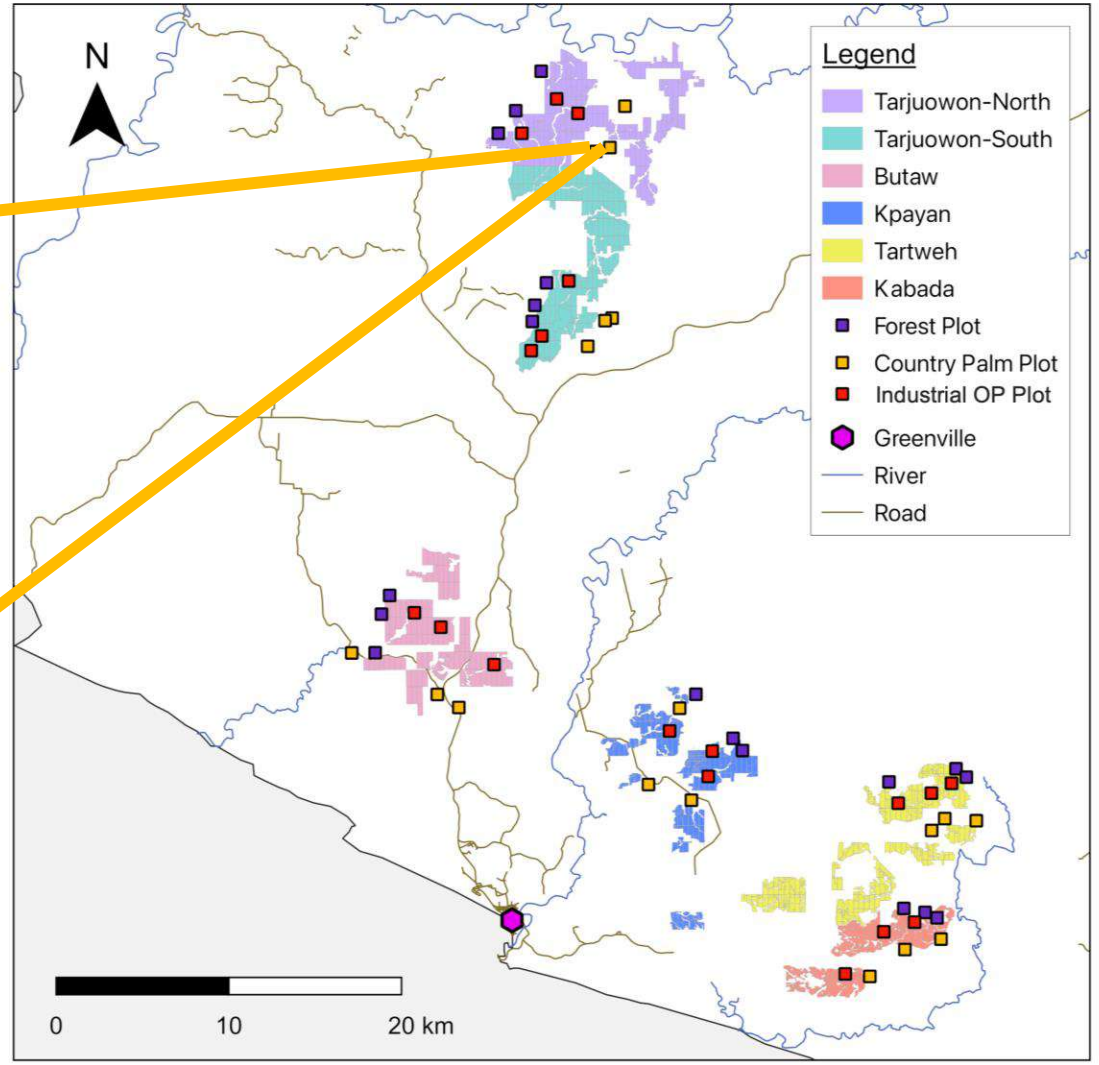
The Sustainable Oil Palm in West Africa Project

SOPWA
Sustainable Oil Palm in West Africa

Country palm



Pashkevich *et al.* (2024). *Sci. Tot. Env.*

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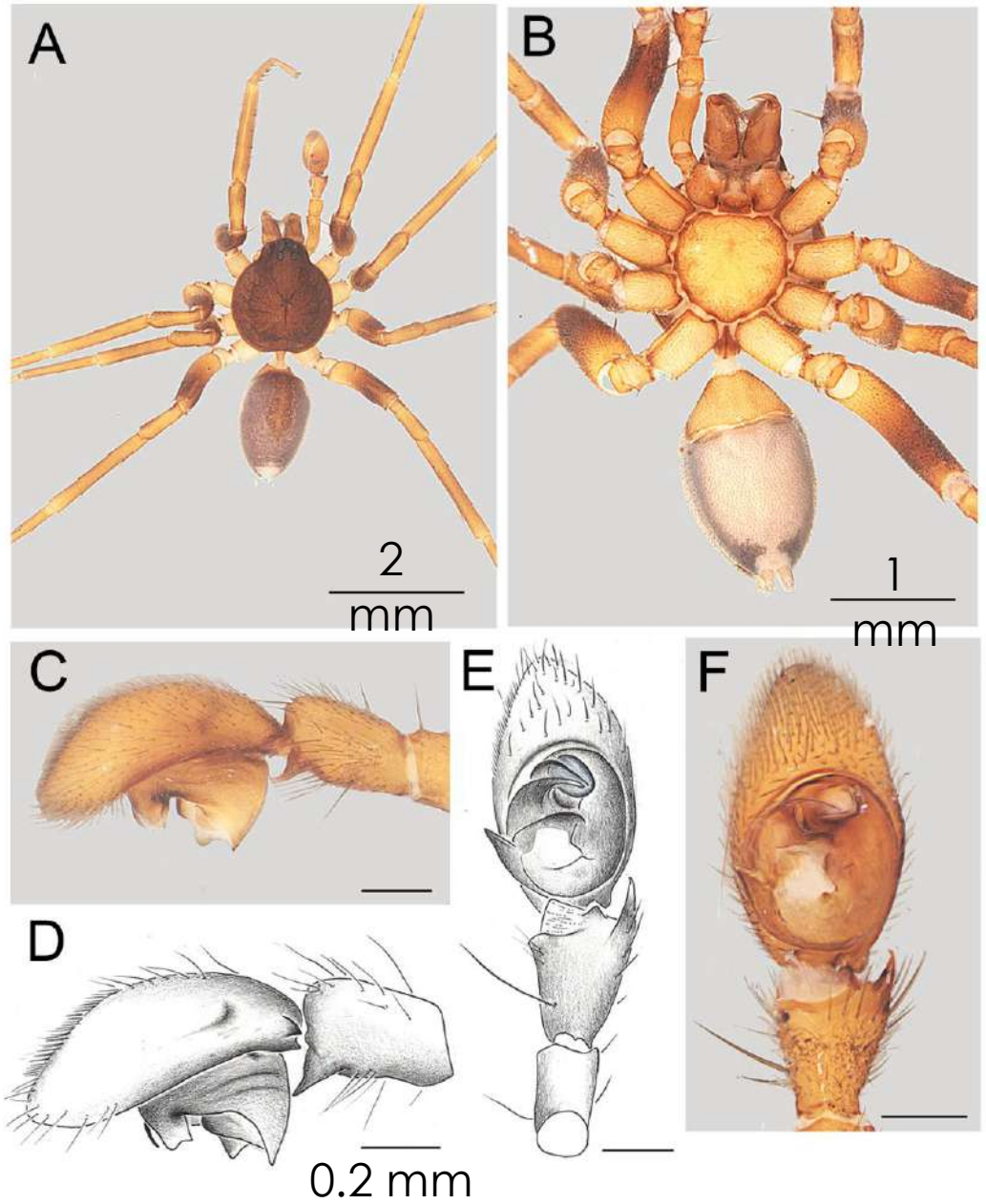
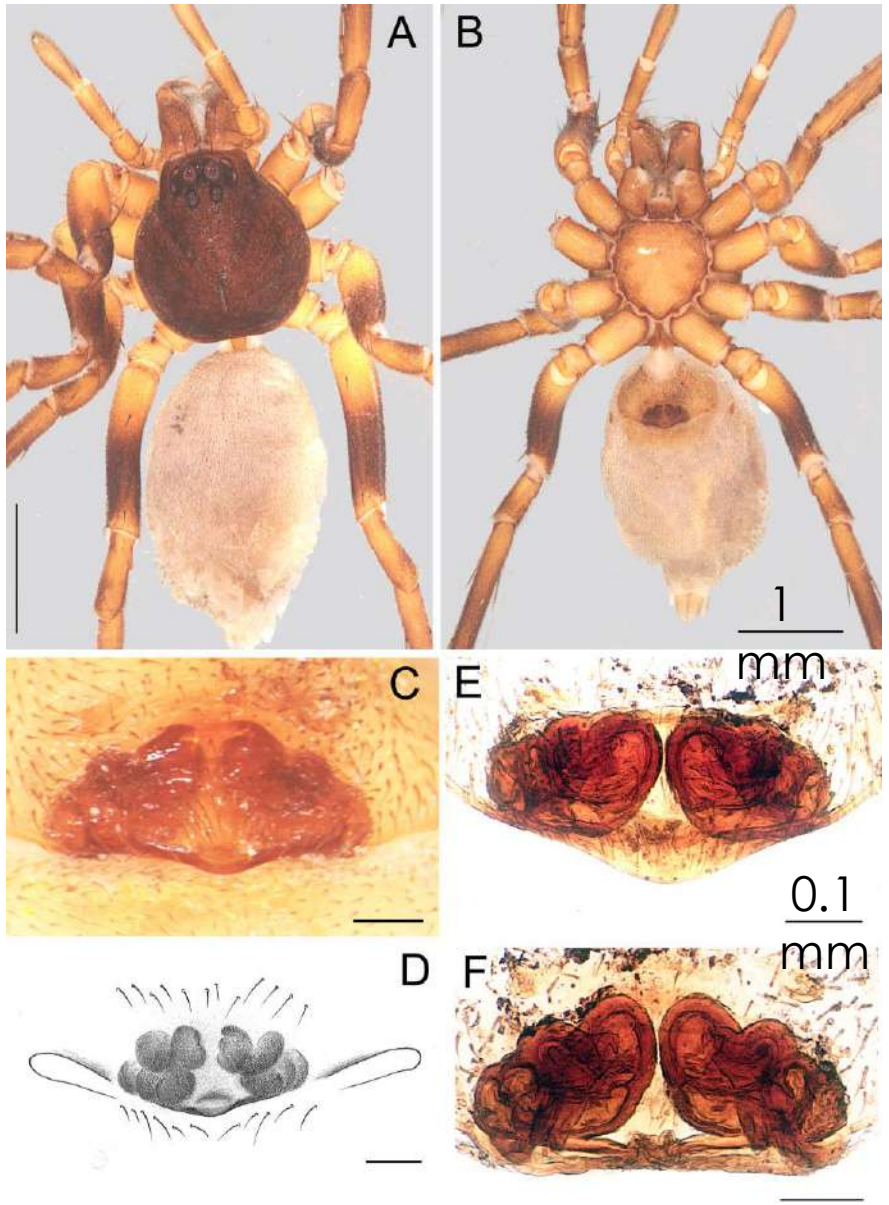
Crinopseudoa kru: Named after the kru people in Sinoe County

Brogan Pett

Male specimen



Female specimen

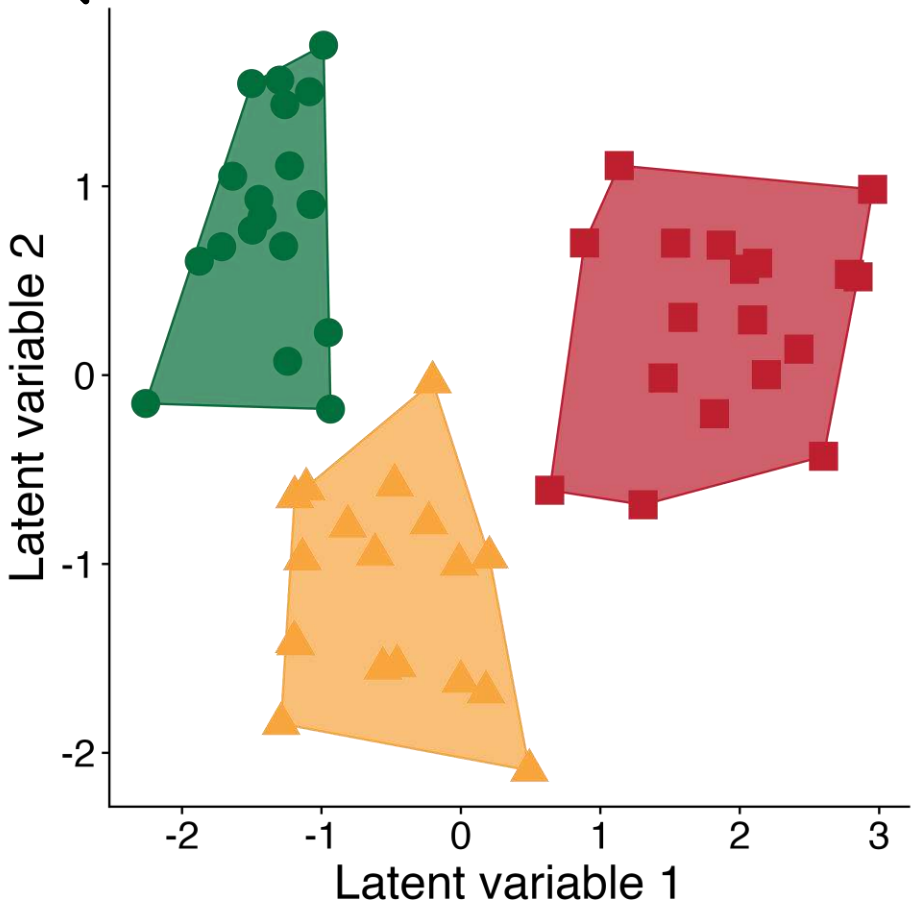


Pett *et al.* (2024). *Zootaxa*

Oil palm cultivation changes biodiversity, and impacts differ between cultivation systems

SOPWA
Sustainable Oil Palm in West Africa

Birds



Differences in community composition (relative abundance), visualised as ordinations derived from Bayesian species distribution models

- Rainforest
- Country palm
- Industrial oil palm

Benedictus Freeman

Oil palm cultivation changes biodiversity, and impacts differ between cultivation systems

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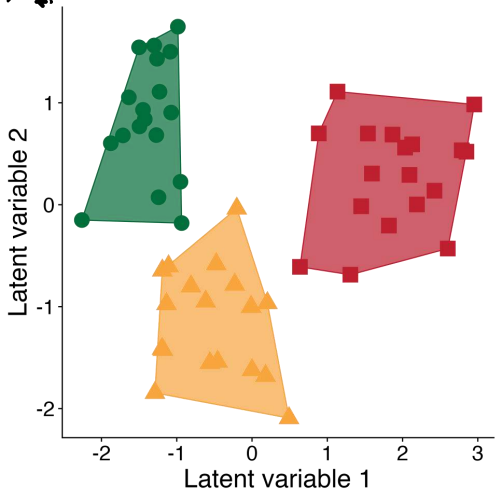
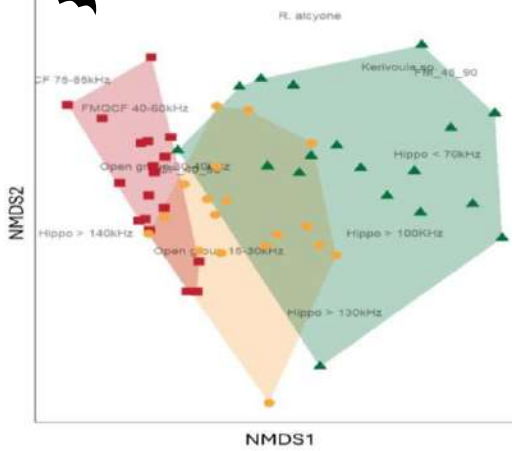
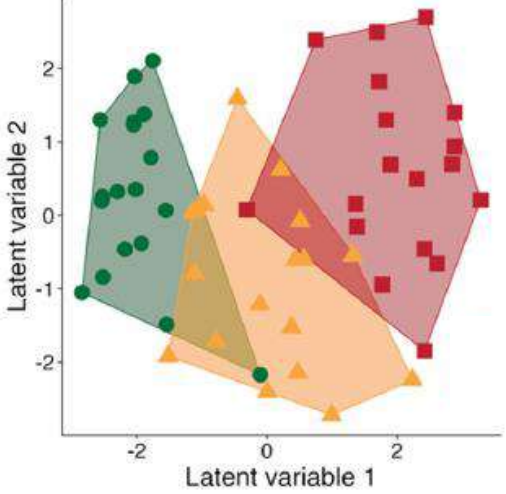


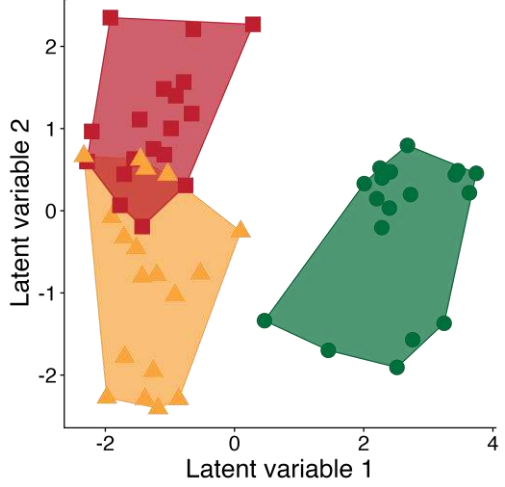
Bats



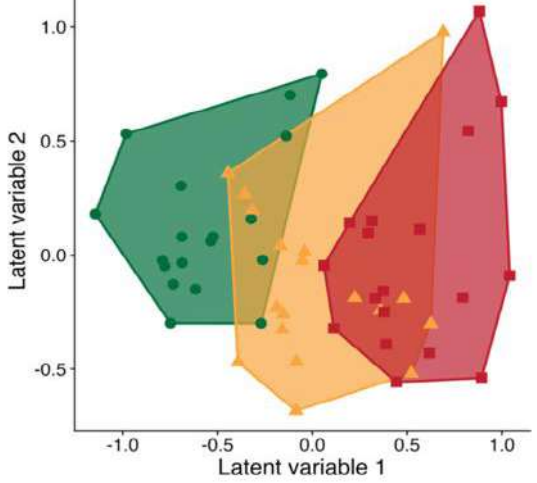
Spiders



Plants



Insects



Each system supports different communities of species, and **industrial oil palm is most unlike the rainforest**

- Rainforest
- Country palm
- Industrial oil palm

Biodiversity and Ecosystem Function in Tropical Agriculture Understory Vegetation Project (BEFTA-UVP)

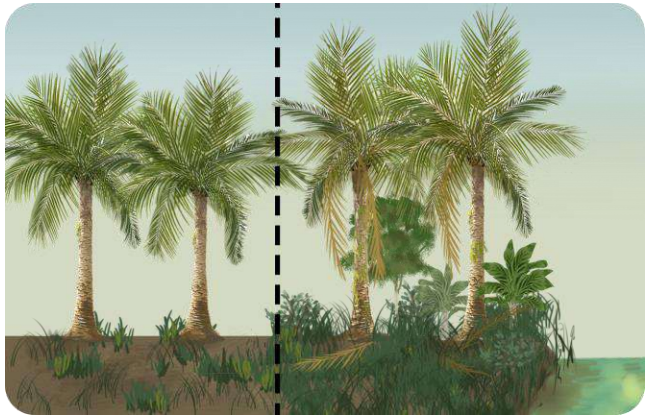
Riparian Ecosystem Restoration Tropical Agriculture

SOPWA Sustainable Oil Palm in West Africa

Alternative herbicide application

Understory vegetation management and its effects on ecosystems and productivity

Riau, Indonesia



Conservation within small reserves & replanting

Identifying the best ways to restore river margins in oil palm at the time of replanting

Riau, Indonesia

Comparing industrial and traditional management

Traditional African approaches to oil palm cultivation and effects on nature and society

Sinoe, Liberia

Conclusions

- Effective monitoring is required to understand how management affects biodiversity in oil palm

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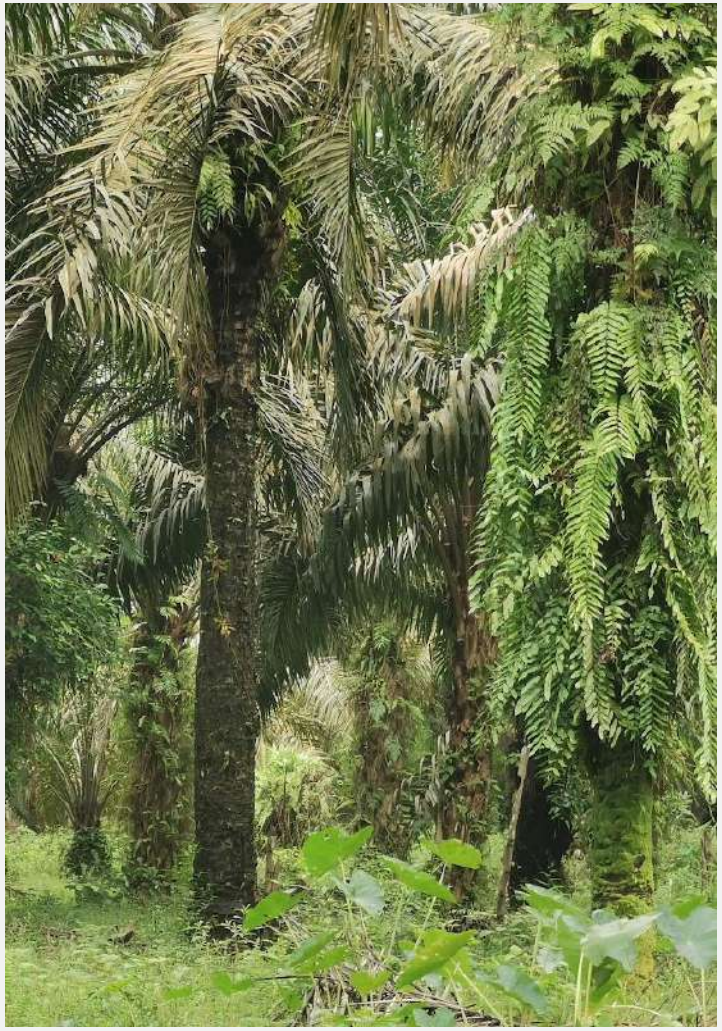

Conclusions

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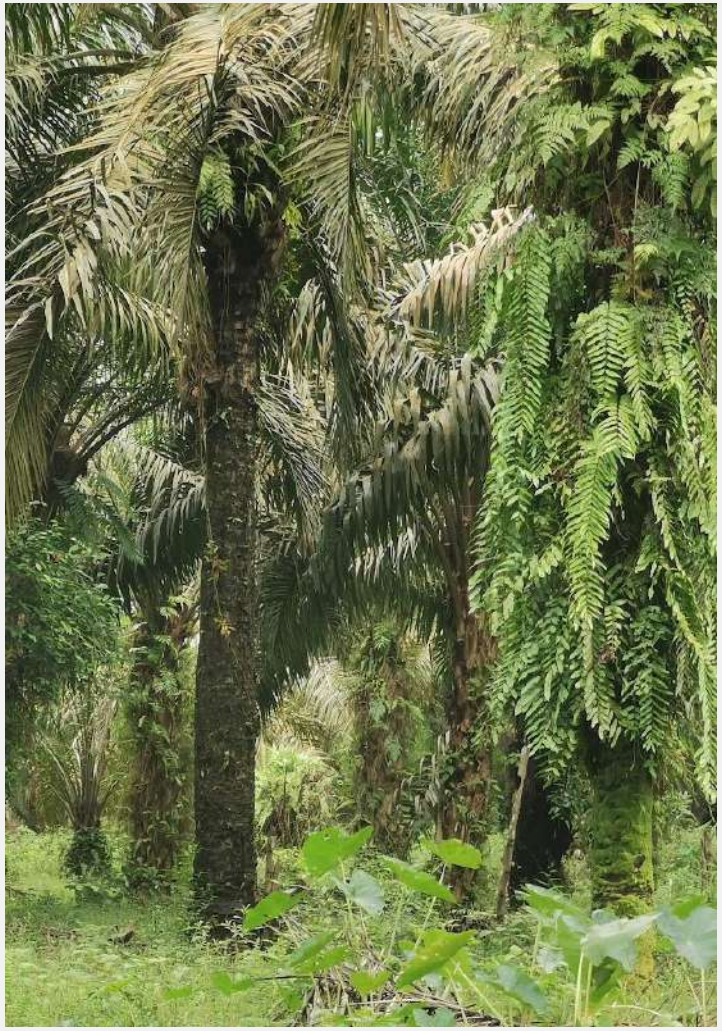
- Effective monitoring is required to understand how management affects biodiversity in oil palm
- BEFTA shows that industry-academic collaboration can lead to more-sustainable oil palm management (proven using data-driven approaches)



Conclusions

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- Most BEFTA research has occurred in Southeast Asia – potential for new socioecologically-valuable research in Central/South America

Conclusions

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- Most BEFTA research has occurred in Southeast Asia – **potential for new socioecologically-valuable research in Central/South America**

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Muchas gracias
Terima kasih
Kiitos paljon
Thank you

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