



Insect responses to restored riparian buffers in oil palm plantations in Indonesia

Sacchi Shin-Clayton, Andrew Bladon, Anak Agung Ketut Aryawan, Jean-Pierre Caliman, Purnama Hidayat, Damayanti Buchori, Sarah H. Luke & Edgar C. Turner



Background:

- Oil palm expansion is a major driver of tropical deforestation, with Indonesia as the top global producer.
- Riparian margins are among the most degraded ecosystems.
- The **Riparian Ecosystem Restoration in Tropical Agriculture Project (RERTA)** is a long-term, large-scale experiment, testing restoration strategies along riparian zones in oil palm plantations in Riau, Indonesia.
- Treatments include passive and active restoration across two replicate river margins (Figure 1).
- Riparian restoration revitalizes ecosystems and supports services like pollination for nearby crops.

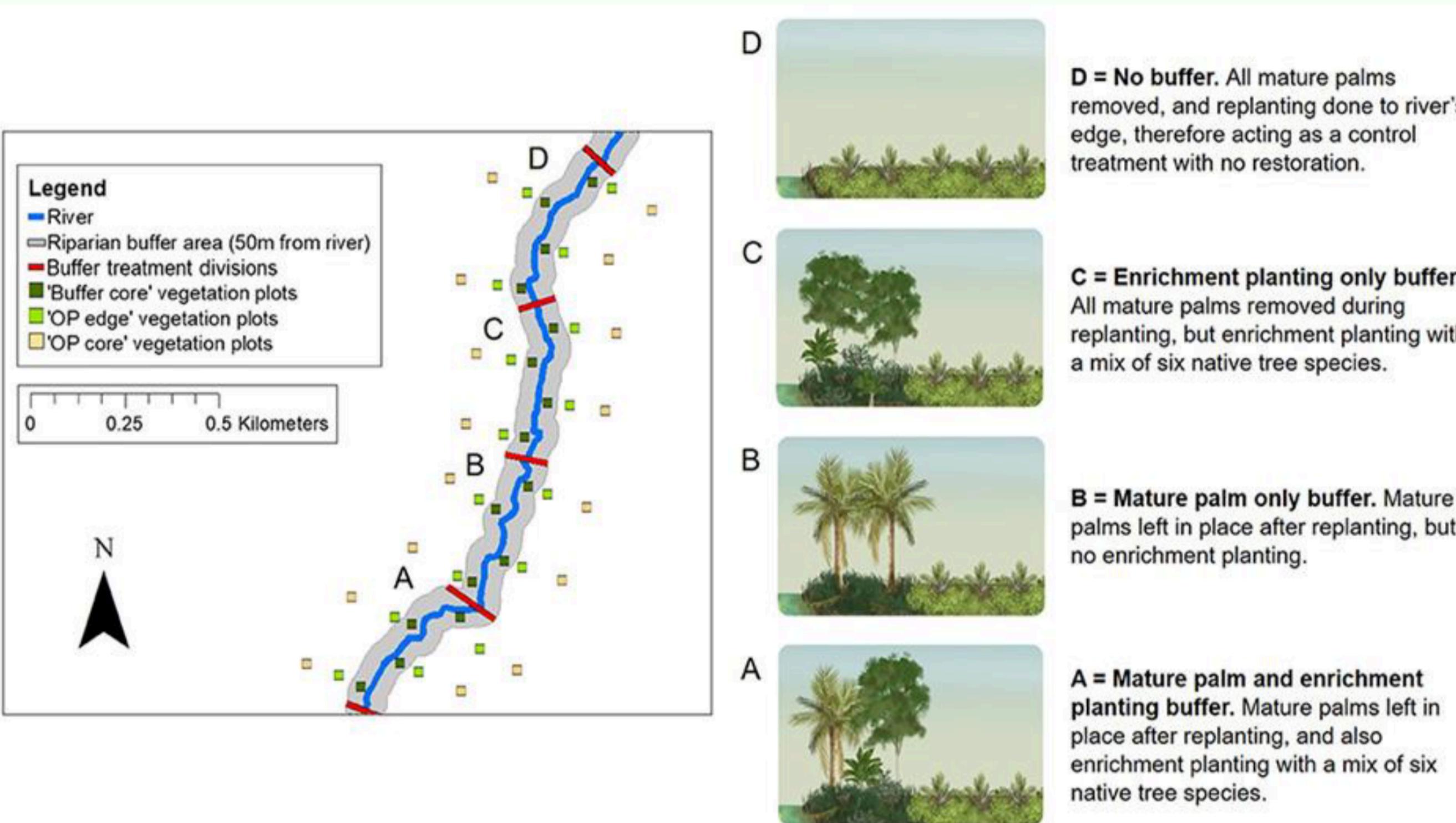


Figure 1: RERTA plot layout at river sites showing treatments (A–D) and 25 x 25 m vegetation plots (green/yellow squares) forming sampling triplets¹. Treatments were implemented during replanting at RERTA 1 (2018) and RERTA 2 (2019).

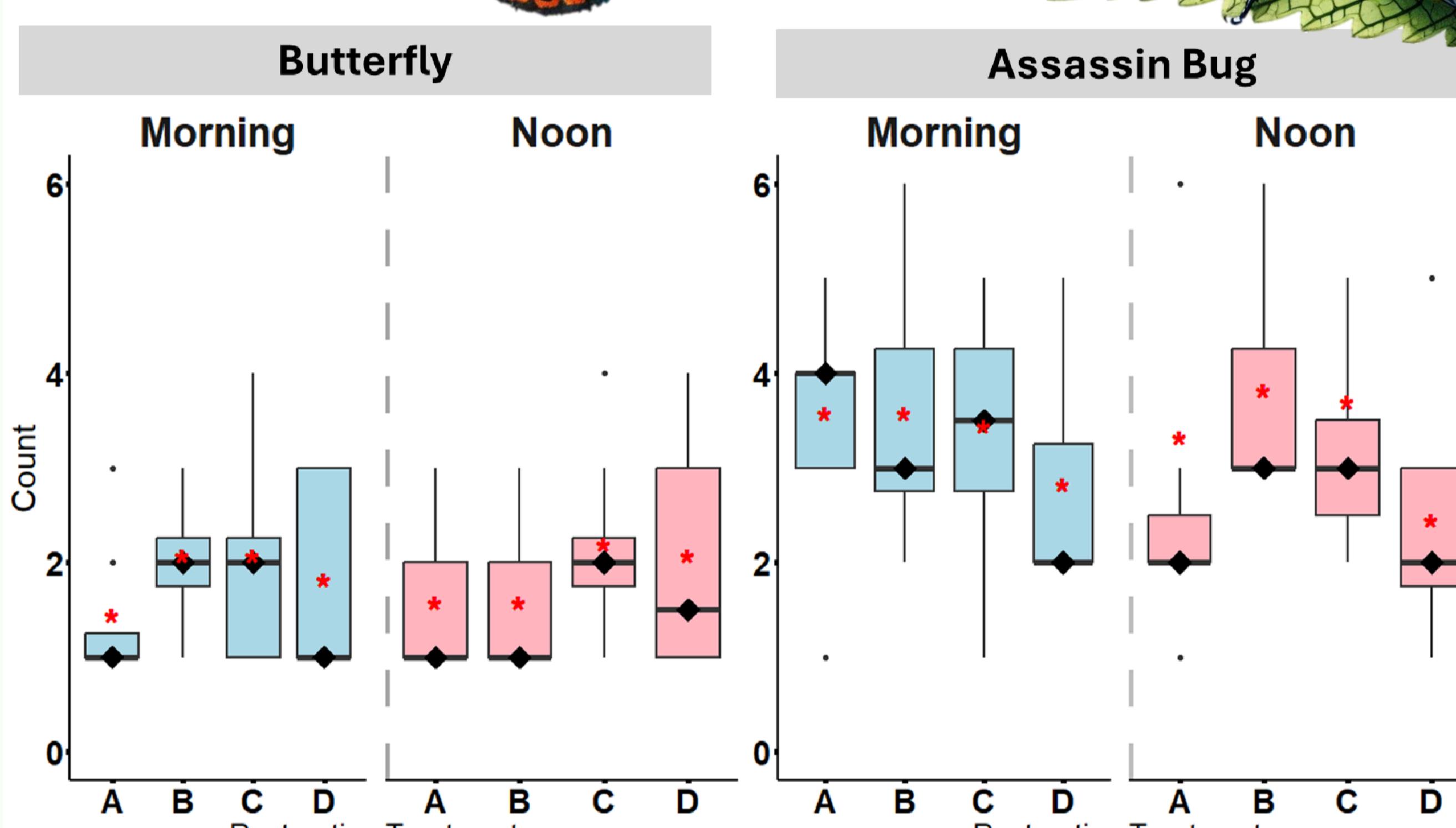
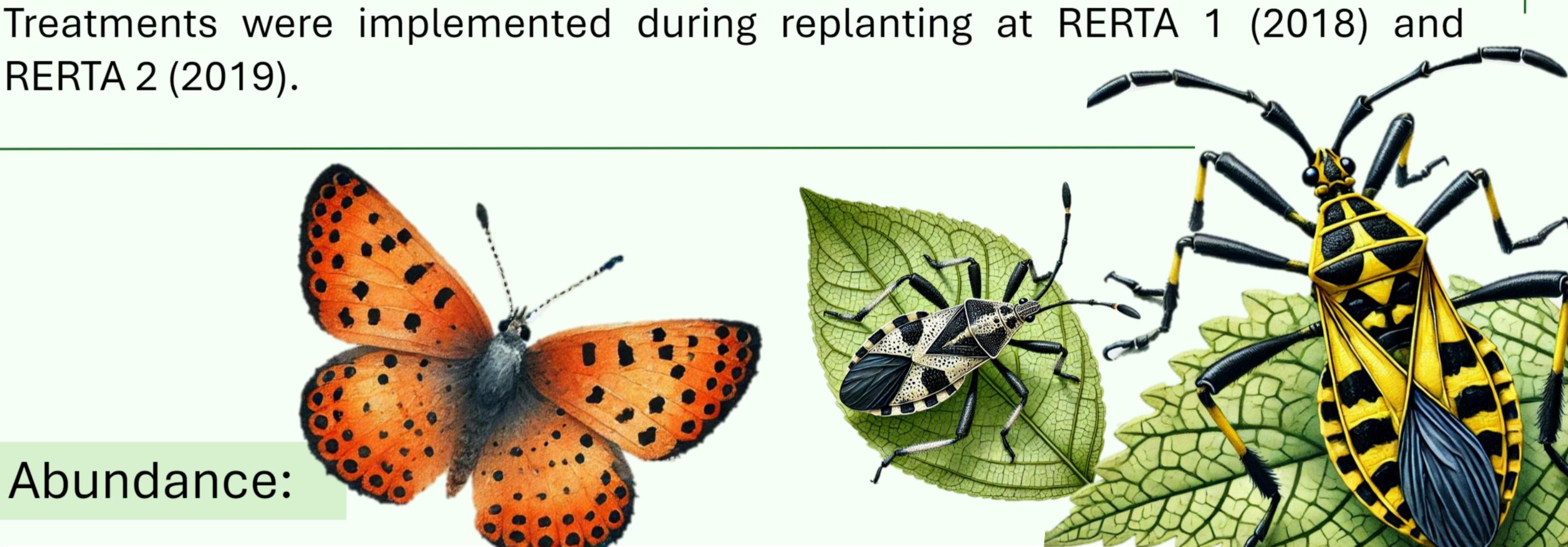


Figure 3: Boxplots of butterfly (A, n = 110) and assassin bug (B, n = 209) abundance across treatments (A, B, C, D), grouped by time of day (Morning: 8:00–11:00, Noon: 12:00–15:00). *mean, ♦ median.

Butterfly Behaviour:

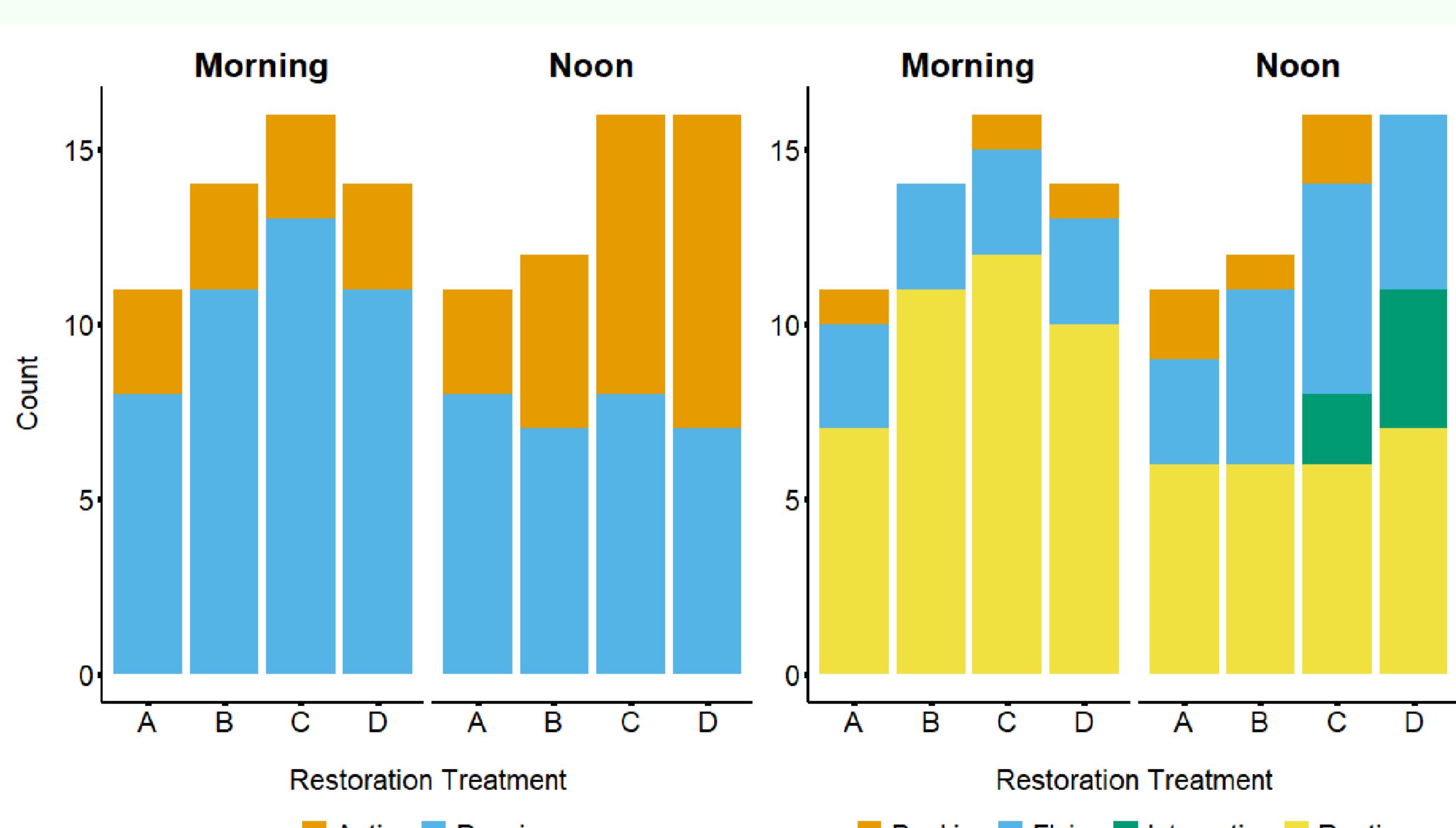


Figure 4: Stacked bar graphs showing butterfly activity (active: Flying/Interacting; passive: Resting/Basking) on the left and specific behaviours (Basking, Flying, Interacting, Resting) on the right.

Methods:

- Walked the perimeter of each buffer core's sub-vegetative plot (25 x 25 = 100 m transect) and noted any butterflies and assassin bugs seen within a 5m cube.
- For butterfly observations, we noted behaviour (flying or landing, interacting, basking, or resting).
- Recorded substrate each butterfly landed on (leaf litter, branch, fern, flower), and whether the substrate was shaded or in the sun.
- Repeated these protocols at two points during the day: in the morning (8:00 – 11:00) and afternoon (12:00 – 15:00).

Research Questions:

- Have alternative restoration approaches (A, B, C, D) led to differences in **butterfly and assassin bug abundance**?
- Do butterflies **select different habitats** (shaded/ sunny) or vegetative substrates, depending on treatment (A, B, C, D) or time of day (morning/ noon)?
- Are the butterflies exhibiting different **behaviours** according to treatment (A, B, C, D) or time of day (morning/ noon)?

Butterfly Habitat Selection:

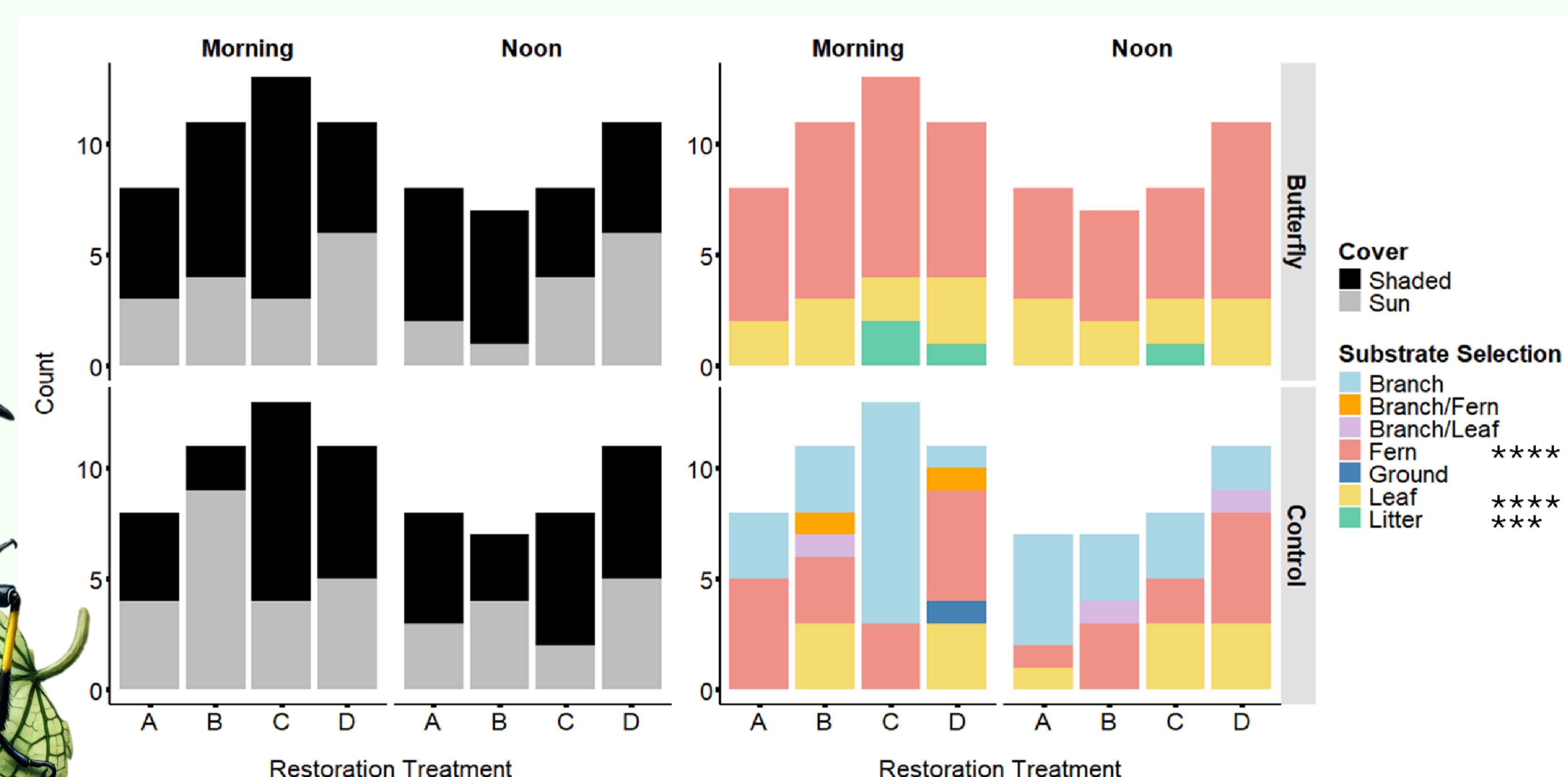


Figure 2: Stacked bar graphs showing butterfly habitat selection (n = 77) by cover type (left) and substrate (right), grouped by treatment (A, B, C, D), time of day (Morning: 8:00–11:00, Noon: 12:00–15:00), and control points.

Results:

- Butterfly selection for **cover type did not differ** between treatment areas or control points (Fisher's exact test, $p = 0.5069$, Fig. 2).
- Butterflies showed **no difference** in substrate selection **between treatment areas but differed significantly from control points** (Fisher's exact test, treatment $p = 0.9501$, and control $p < 0.0001$, Fig. 2). Post hoc analysis revealed a significant preference for ferns, leaves, and litter, indicating they favoured specific substrates over those in the margin but chose similarly across treatments.
- Butterfly and assassin bug **abundance levels did not differ** between restoration treatments or with time of day (Fixed effect model, interaction between treatment & time of day, Butterfly: $n = 110$, LR Chisq = 0.78062, Df = 3, $p > 0.05$, assassin bug: $n = 209$, LR Chisq = 0.4294, Df = 3, $p > 0.05$, Fig. 3).
- Butterfly **activity levels and behaviour did not change** between restoration treatments or by the time of day (Fisher exact test, activity $p = 0.2281$, and behaviour $p = 0.3152$, Fig. 4).

Conclusion:

- Alternative restoration treatments had no clear effect on either butterfly or assassin bug abundance and behaviour.
- Previous restoration studies have estimated that riparian margins may take 40-plus years to become like secondary forests, indicating that more time may be required before restored river margins develop distinct insect communities^{2,3}.

References:

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