# Biomass of ground-dwelling arthropods in remnant compared to regenerated secondary temperate forests

Catherine A. Farrell, Carmela M. Buono, Kirsten M. Prior

Binghamton University, State University of New York
Biological Sciences Department, Invasion Ecology Lab

## INTRODUCTION

Northeast North American (NA) forests have experienced extensive clearing due to agriculture and forestry (*Fig. 1*), creating a dominance of regenerated, or secondary forest growth (Flinn & Marks 2007). Historical **forest clearing** alters ecosystem properties in regenerated forests, including soil conditions and species composition (Dyer 2010; Buono et al., 2023).

**Ground-dwelling arthropods** (GDA) perform essential ecosystem functions, including decomposition and nutrient cycling (*Fig. 2*). The abundance and richness of GDA are altered in forests that have been previously cleared (Perry, et. al, 2018), which further alters ecosystem functions. Measuring biomass of GDA in remnant compared to secondary forests may uncover changes in species composition, selection pressures, and secondary production.

**Habitat factors** of regenerated forests may contribute to the mechanisms of change in GDA communities. Canopy openness, plant cover type, and soil conditions influence the survival and reproduction of GDA species (Perry, et. al, 2018).

***Fig 1.*** Abandoned agriculture land. Photo credit: senslandlab.com.

***Fig 2.*** An American carrion beetle performing ecosystem services.

## QUESTIONS

**Question 1:** How does the biomass of GDA in secondary forests differ from that of remnant, or in-tact forests?

**Question 2:** Are there habitat characteristics that correspond with a variation in biomass between and within primary and secondary forest types?

## METHODS

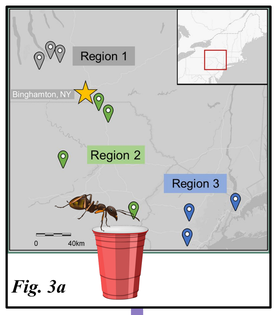



***Fig 3a***

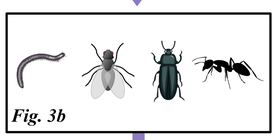


***Fig 3b***

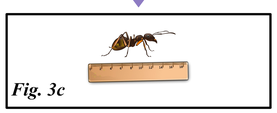


***Fig 3c***

1. **Pitfall traps** were set in 5 plots, each in 3 transects (2 traps/plot) at 10 paired primary and secondary forests in NY, NJ, and PA (*Fig. 3a*). (Buono et al. 2023).

2. **GDA** were **sorted** to Order and **photos for each trap** were taken (*Fig. 3b*).

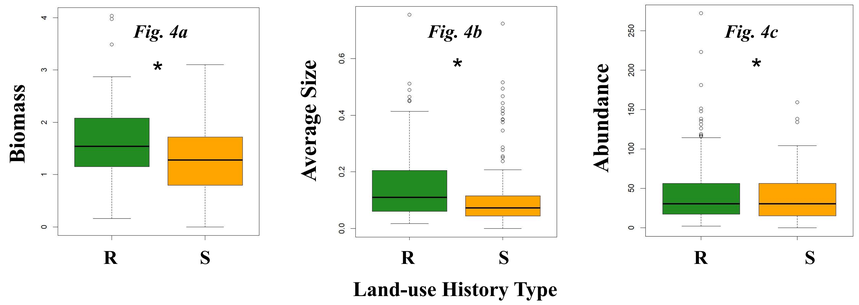
3. Individuals were **counted**, **surface area** was measured as a **proxy for biomass,** and **average size of individuals** was calculated for all GDA in traps and the dominant 6 taxonomic groups using image J. (*Fig. 3c*).

4. **Analyzed** biomass, count, and average size using mixed effect models and **box plots.**

5. **Correlation analysis** of biotic and abiotic **habitat features** (collected from plots) (Buono et al. 2023) with corresponding GDA data.

## RESULTS

### Total GDA




### Top GDA Taxonomic Groups

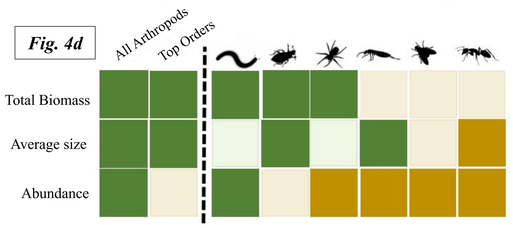



***Figure 4d.***
A visual representation of the biomass, average size of individual, and abundance of all GDA (Fig. 4a-c), the top 6 taxonomic groups combined, and each separately (millipede, beetle, spider, springtail, fly, and ant). Green squares represent significantly higher values ($P < 0.05$) in remnant than secondary forests and orange squares mean significantly higher values in secondary. Lighter squares show trends that were not significantly different.

### Correlation with Habitat & Abiotic Factors

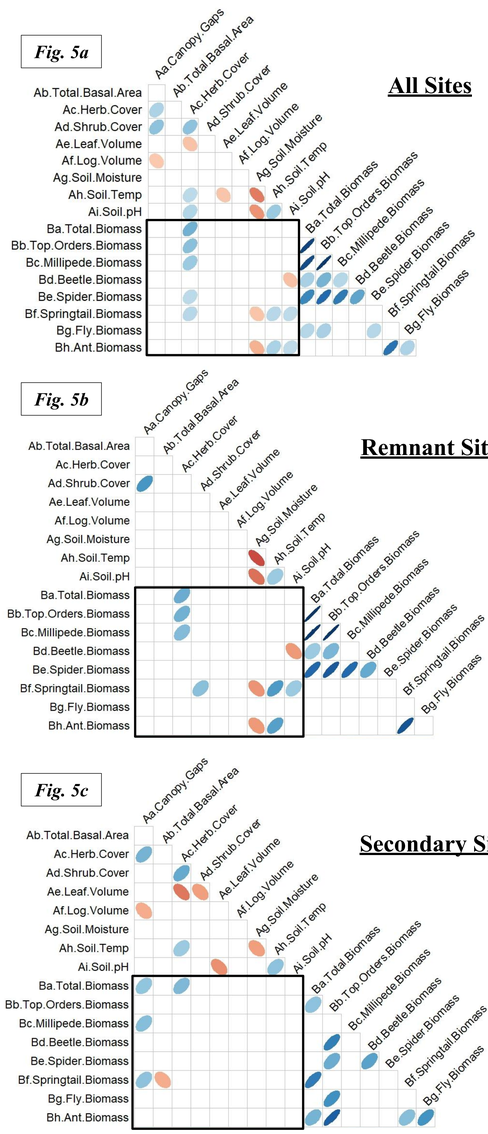



***Figure 4 (above) .***
Box plots of a) total GDA biomass, b) average size of individuals, and c) abundance between remnant (R; green) and secondary (S; orange) forest sites. Linear & generalized linear mixed effect models (with site as a random effect) were performed, (*) < 0.05. Data was log-transformed for biomass and average size before plotting.

***Figure 5.***
Correlation analysis plots of a) all sites, b) only remnant sites, and c) only secondary sites. Correlation coefficients were calculated between all 17 variables, and significant relationships are shown ($P < 0.05$). Positive relationships are blue, and negative relationships are red, with darker colors and thinner ellipses representing stronger correlations. Habitat features (Ab - Ai) are compared to biomass data (Ba - Bh) and are depicted within the black square on each table.

## KEY POINTS & CONCLUSIONS

**There is a higher biomass of ground-dwelling arthropods in remnant forests than in previously cleared secondary forests (*Fig. 4a*)**, influenced by increased abundance and a larger body size of GDA (*Fig. 4b,c*).

- ➔ **Millipedes, beetles, and spiders all have higher biomass at primary sites** (*Fig. 4d*).
- ➔ **Millipedes** occur in higher abundances and are known to be associated with non-disturbed, older forests (Koivula, 2011).
- ➔ **Beetles** have larger body sizes in remnant forests, which is likely a result of differences in community composition. Radin et al. (undergraduate thesis) found more Carabidae, which are often large, in samples from remnant forests. Carabids are also associated with old-growth forests (Schreiner et al. 2012).
- ➔ **Springtails, flies, and ants did not have increased biomass in remnant forests**, all having higher abundances in secondary forests (*Fig. 4d*).

**GDA biomass is positively related to herbaceous plant cover (*Fig. 5*)** and there is more ground herbaceous cover in primary forests (Buono et al. 2023).

- ➔ Previous studies have found that the **understory does not recover well** in eastern NA secondary forest (Flinn & Marks 2007), and we show that this may contribute to lower GDA biomass.
- ➔ **Soil temperature, moisture, pH** influence the GDA biomass, but these factors do not differ between forest types (Buono et al. 2023).
- ➔ More abiotic factors influence biomass in remnant forests than in secondary, disturbed forests.
- ➔ Other factors, such as the inability to disperse to previously cleared forests may influence biomass in secondary forests.

**Future efforts** will continue to explore the relationships between biomass and habitat features by running linear models and model selection or path analysis. **Future studies** should be completed to identify the species of GDA within remnant compared to secondary forests to determine whether composition is driving changes in biomass.

## ACKNOWLEDGEMENTS & REFERENCES

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