# Earthworms as double-edged swords for organic matter turnover from forest floor to mineral soil – a mesocosm experiment with labeled beech litter

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## Earthworms and forest floors

As the direct **interface** between atmosphere and mineral soil the forest floor can be **vulnerable** to alterations due to climate change or forest management. It can represent a crucial organic matter (OM) pool, which can serve as an important **source for soil OM formation** via bioturbation or leaching within forests. While earthworms may **enhance OM mineralization** via increased microbial activity, they may simultaneously **elevate OM stabilization in aggregates** as particulate or mineral-associated OM. In this study, we will test this potentially opposing impact of earthworms in **beech** (*F. sylvatica* L.) forests **on limestone.**

## Methods

- Soils, forest floor and earthworms sampled from two sites with different mull-type forest floors in the **Swiss Jura Mountains** (Table 1)
- Incubation of **beech litter (300 g $m^{-2}$)** with combination of local earthworm species for one year (*Lumbricus terrestris* L., *Octolasion cyaneum* S.)
- **Isotopic enrichment** of input beech litter mixture:
  1406 ‰ $^{13}C$, 170 ‰ $^{15}N$ & 208 ‰ $^{2}H$
- **Respiration** measurements of $^{13}CO_2$ (first every three days, then weekly or bi-weekly)
- **Leaching** and subsequent dissolved OM (DOM) collection after artificial rain events every month ($DO^{13}C$, $DO^{15}N$, $^{2}H_2O$)
- **First harvest** of 1/3 of the mesocosms after four months, **final harvest** after 12 months, backup either for failed mesocosms or to extend the investigation period for another year (Figure 2)
- **Fractionation** of harvested forest floor and mineral soil into density fractions
- Extraction of **plant available nutrients**
- **Neutral lipid fatty acids extraction** from earthworms

| Site | Forest floor type (KA 6) | Soil type (WRB) | Altitude (masl) | Precipitation (1991-2020) (mm $a^{-1}$) |
|---|---|---|---|---|
| Lägern | Typical L-Mull | Rendzic Leptosol | 680 | 930 |
| Weissenstein | Typical F-Mull | Rendzic Leptosol | 1250 | 1500-1700 |

**Table 1. Site characteristics**
(KA 6 = Bodenkundliche Kartieranleitung (6. Auflage), WRB = World Reference Base for Soil Resources 2022, masl = meter above sea level)

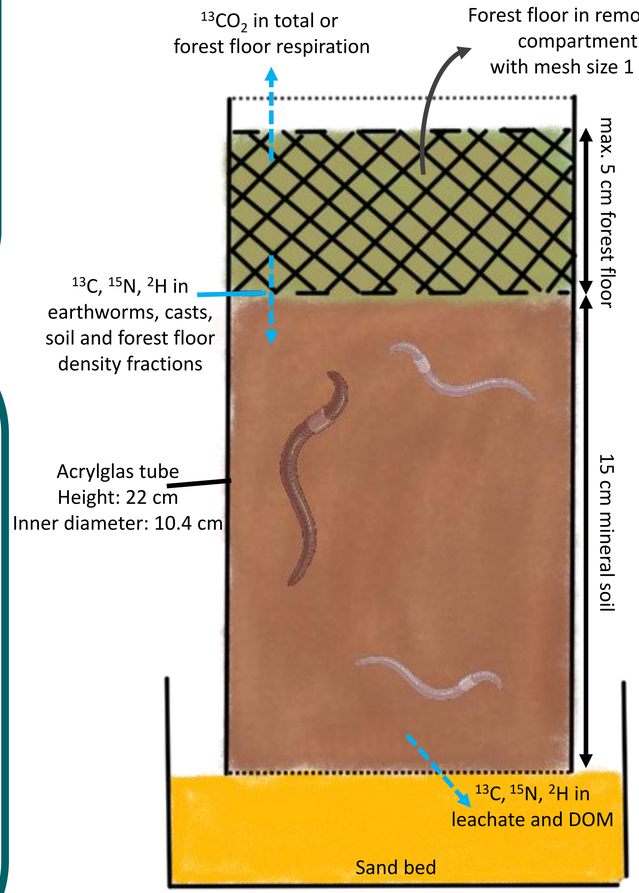


**Figure 1. Schematic overview on mesocosm design and measured fluxes and pools**

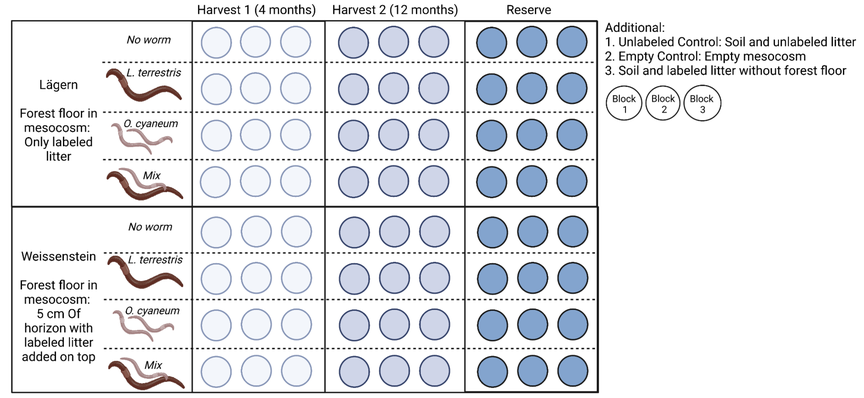


**Figure 2. Treatment and replication scheme**

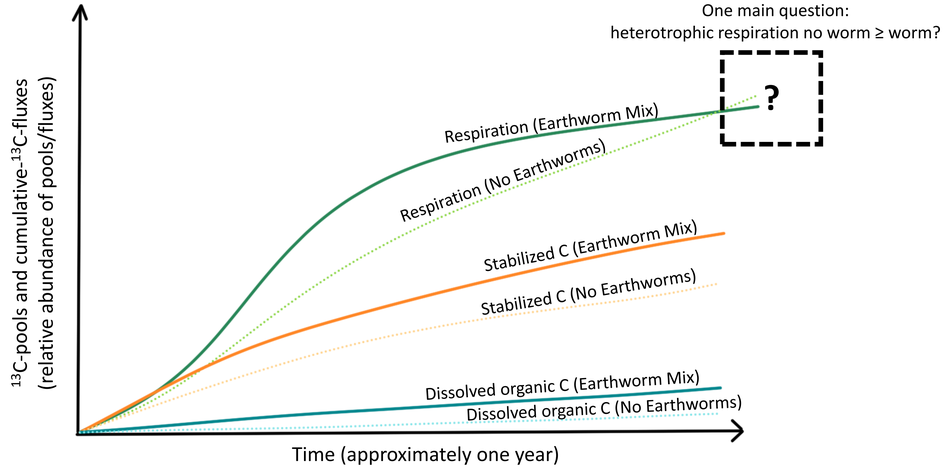


**Figure 3. Hypothesized development of $^{13}C$ in different fluxes and pools of the no worm and worm mix treatments**

## Expected results:

- Cumulative heterotrophic respiration will converge over time between no worm and mixed worm treatments
- Mixed treatments will have the highest amount of stabilized C
- More C and N will be allocated deeper into the mineral soil in treatments with *L. terrestris* present, due to its vertical burrows
- Vertical burrows facilitate a DOM loss or transfer deeper into the mineral soil due to preferential flow

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References and Credits:
- Forest floor classification: humusformen.de
- Figure 1.: Worms created with BioRender
- Figure 2.: Created with BioRender

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