

So many Earthworms?



Deep burrowing earthworms (Wikimedia commons)

Objectives and Content of the Learning Activity

Through this learning activity, students will learn that in differently managed soils and various ecosystems, there are varying numbers of earthworms (quantity and biomass) as well as earthworm species (biodiversity). Based on their own investigations, students can make statements about the soil's condition. At the same time, they will learn about the three ecological groups of earthworms: deep burrowers, shallow burrowers, and surface dwellers. Connections to climate change will be explored.

Didactical Aspects

Learning activity is suitable for:

- age group 12 - 17

Time required:

- 8 lessons
- Combinable with other learning activities within a project week

Location:

- Field (meadow, cultivated fields), alternatively on school grounds

Connection to system thinking:

- Concepts and tools: system elements, systems, causal chains, cycle and interconnecting cycle
- Attitudes: Consider interrelationships, take into account the duration of effects, tracking changes

Lesson Sequence and Research Steps

Problem and Research Question

In general, more earthworms indicate better soil fertility. The number of earthworms and their species composition can vary significantly in different ecosystems depen-

ding on soil management and other practices (fertilization, pest control).

Students will extract earthworms from differently managed soils using a 0.35% mustard solution. They will categorize the animals into 3 ecological groups and determine the number of individuals as well as weigh them without harming them. Particularly interesting are comparisons of earthworm populations in soils of livestock pastures or meadows compared to cultivated soils. After field investigations, students can discuss the reasons for the differences.

Notes on Research and Documentation

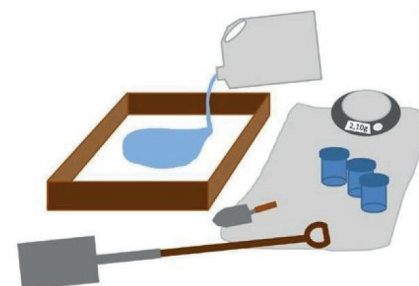
- Experiment cannot be conducted on very dry soils (too hard for worms to come up, found in deeper soil layers) or very wet or waterlogged soils (flooding damage).
- Alternatively, students can conduct the investigations on different areas on the school grounds (lawn, meadow, flower bed, hedge). This should be coordinated with the persons responsible for the grounds.
- On sunny and hot days, shade should be provided to prevent the earthworms from drying out. They should be released after the investigation.
- Students can record their observations on a research sheet. To practice typical research methodology, they should formulate questions and hypotheses before starting the field work (e.g., „there are more earthworms in the meadow than in the cornfield“) and document these questions in writing. A typical part of the research process is presenting, discussing, and comparing the results – also with information in fact sheets or textbooks. In this final part, it is desirable to discuss connections to climate change or biodiversity.

Notes on Material

- If the school lacks tools like spades, garden shovels, and grass shears, these can be borrowed from parents.
- Plastic containers, gloves, and films can be purchased from specialized suppliers or building centers. Field or kitchen scales can be found at household suppliers or laboratory equipment suppliers
- If a water source is available near the study site, each group only needs a 10-liter container that can be filled on-site for making the mustard powder solution. If not, each group will need 2 filled containers.
- Dry mustard can be available in grocery stores, it is cheaper to buy it in bulk online.
- The dry mustard solution is prepared in 2 steps: 1. In a PET bottle, 35g of dry mustard is added to 1 liter of lukewarm water and shaken. 2. The liter of 3.5% mustard solution is added to a container filled with 9 liters of water (0.35% solution). The first step is done at school, and the second step is done in the field. Caution: The solution burns in the eyes!
- Metal or wooden frames facilitate precise work in the field. If the school has a woodworking/metalworking workshop, the frames can be made there. Metal sheet frames are more stable and easier to drive into the ground.

Notes on Data Collection

- When comparing, for example, a meadow soil with a cultivated soil, it is scientifically important to have a minimum of 4 repetitions to capture the variation in earthworm numbers and calculate an average. The class is divided into 4-6 groups for this purpose. Each group performs one earthworm extraction per area; this provides the necessary repetitions as a class.
- Comparing a meadow or pasture with a cultivated area will likely show significant differences in earthworm populations. It is also interesting to compare two different meadows or two different cultivated fields.
- It is ideal if the compared ecosystems have already been harvested to minimize disturbance. Students should be instructed to minimize damage.
- The investigation process can also be documented with photos.



Prepared material for the extraction with the mustard solution



Prepared material provided for the extraction with a spade

Notes on Data Evaluation

When comparing different ecosystems, clear results should be visible:

- If the soils are different in structure, composition, moisture, etc., there will be differences (e.g., when comparing two meadow locations).
- The more soil cultivation, pest control measures, and machine operations on an area, the fewer earthworms there will be. The more undisturbed the soil (e.g., permanent grassland), the more earthworms and earthworm species there will be. Surface dwellers are usually absent from cultivated soils.
- The more dead plant material, compost, and plant growth, the more earthworms.
- If the data collection is conducted on a farm it is recommended to engage in dialog with the farmers in order to interpret the research results accurately.

Additional Teaching Notes

Other Offers in English:

- [Citizen Science](#) program about earthworms

Didactical Comment

Subject Background - Context

Earthworms are the architects of fertile soils. Their impact on the soil is diverse: they aerate the soil, improve its water absorption and drainage, break down dead plant parts, concentrate plant nutrients, promote the formation and stability of soil aggregates, and transport organic material to lower soil layers. Therefore, more earthworms and more species in a soil indicate better soil fertility, higher soil biodiversity, and better resistance to climate change impacts (e.g., heavy rain events). As earthworms transport organic material to deeper soil layers, they also help to sequester carbon in the soil, and therefore reducing atmospheric CO₂.

Comment on Assignment

The data evaluation allows for a rough assessment of the soil fertility of the examined soils. Students can look up values for cultivated and meadow soils in the internet. Further, the students can suggest measures to enhance the soils for earthworms (compost, cover crops, reduced soil cultivation) and discuss these. Graphical representation of the results is a possible ICT task. Quantity calculations can be done within mathematics. Students could collectively compose a short report.