Outdoor investigation

Throughout the National Improvement Framework for 2024, outdoor learning, sustainable development and global citizenship are mentioned as part of learning for sustainability and the potential benefits it has for reducing the poverty-related attainment gap, overcoming barriers to attainment and identifying improved/positive educational outcomes for learners. SSERC have looked at more opportunities to bring learners outdoors and engage in STEM activities that are linked to learning for sustainability.

**PART A: Measuring air pollution**

**Aim**: To investigate the effect of distance from road on air pollution deposits on tree trunks.

Fine particulate matter (PM) is a common air pollutant that represents a major threat to public health. PM can arise from vehicle diesel exhaust, brake dust and rubber tyre particles, which can then be deposited onto the surface of vegetation, including trees, reducing its concentration in the air. Research has shown that urban tree planting significantly lowers the concentration of PM in the atmosphere, particularly during rush hour, and improves air quality by 126% [1].

This investigation, adapted from the Field Studies Council, is well-suited to a site where there is an environmental gradient, with trees planted at increasing distance from a busy road into a green space. Ideally, trees will be regularly spaced, of the same age and species.  This protocol could also be extended to look at the effect of air pollution on lichen growth.

**References:**

[1] Riondato, E., *et al.* (2020), *Investigating the effect of trees on urban quality in Dublin by combining air monitoring with i-Tree Eco model*, Sustainable Cities and Society, 61, 102356.

**Materials required (per pair):**

|  |  |
| --- | --- |
| 5 m tape measure | Hand lens |
| Flexible measuring tape | Scissors |
| Sellotape | Results table |
| Device with sound sensor |  |

**Method – choosing a fieldwork site**

Criteria for this fieldwork site ideally will include:

* trees of same age and species
* trees close to a busy road
* trees planted a considerable distance from a busy road for comparison.

**Method - taking measurements**

1. Identify a sampling zone of trees, of the same species. Carry out a tree count. Use random sampling to identify four trees within this zone to sample.
2. Cut 7 cm of sellotape and stick it to the tree on the aspect facing the road. Position the tape 1.4 m from the ground. Leave the sellotape for 10 seconds, then remove it.
3. Transfer the sellotape to the data collection sheet (Site 1: Tree 1-4).
4. Repeat steps 2-3 on three additional trees identified at this “road-side” location.

1. Move to a sampling site further away from the road. Measure the distance from the road. Estimate the number of trees at this distance and carry out random sampling to select 4 trees. Repeat Steps 2-3 (Site 2: Tree 1-4).

**Reference – Carbon deposits**

A graph paper with a grid

Description automatically generated

|  |  |
| --- | --- |
| Site 1: Distance from road ( m) Tree 1  A graph paper with a grid  Description automatically generated | Site 2: Distance from road ( m) Tree 1  A graph paper with a grid  Description automatically generated |
| Site 1: Distance from road ( m) Tree 2  A graph paper with a grid  Description automatically generated | Site 2: Distance from road ( m) Tree 2  A graph paper with a grid  Description automatically generated |
| Site 1: Distance from road ( m) Tree 3  A graph paper with a grid  Description automatically generated | Site 2: Distance from road ( m) Tree 3  A graph paper with a grid  Description automatically generated |
| Site 1: Distance from road ( m) Tree 4  A graph paper with a grid  Description automatically generated | Site 2: Distance from road ( m) Tree 4  A graph paper with a grid  Description automatically generated |

1. How many squares (out of 18) contain air pollution deposits (these should be black and not green; green marks will be moss/lichen)? Record this number in the Results table below. Compare to the reference square at the top – this shows carbon deposits.

**Results - Raw**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Distance from road (m)** | **Abundance of soot particles  (number of quadrat squares containing soot / 18)** | | | | |
| **1** | **2** | **3** | **4** | **Mean** |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

**Results - Processed**

|  |  |
| --- | --- |
| **Distance from road (m)** | **Mean abundance of soot particles (%)** |
|  |  |
|  |  |

**PART B: Measuring concentration of glucose in grass – Silage on the Farm**

**Aim**: To investigate the effect of time of day on sugar content of grass.

This investigation was developed following a conversation with a teacher at Bell Baxter High School, who had an AH Biology pupil interested in understanding the sugar content of grass and how that relates to the production of silage. Implementing such protocols can help farmers understand the optimal time to cut grass for the production of a quality silage to feed livestock through the winter.

Research suggests that midday is the best time of day to cut grass for this purpose. Can we replicate this finding? What is the best month of the year in Scotland? Does the weather affect sugar content? Does the exposure of light in a field affect sugar content of grass? Does soil moisture levels affect sugar content? All these questions can be addressed using this simple protocol, and potentially link to changing conditions with climate change.

**Materials (per pair):**

|  |  |
| --- | --- |
| 0-10% BRIX scale refractometer | small plastic beaker |
| Garlic press | Scissors |
| Random number generator | Pipette |
| Trundle wheel | Long tape measure |
| Small collection pot for grass squeeze | Blue roll |
| Bijou of 3 cm3 water |  |

**Method:**

The basic method requires a suitable open field and selecting 10 representative sample sites. The sample sites should be determined using a random sampling protocol. Small samples of grass should be “harvested” from each location, using the scissors, added to the plastic jug. The samples should be well mixed and then a sample squeezed to collect a liquid sample that can be added to the refractometer.

|  |  |  |
| --- | --- | --- |
| **Pair** | **X (m)** | **Y (m)** |
| 1 | 18 | 13 |
| 2 | 17 | 17 |
| 3 | 3 | 15 |
| 4 | 10 | 16 |
| 5 | 12 | 10 |
| 6 | 10 | 17 |
| 7 | 13 | 18 |
| 8 | 6 | 9 |

* + 1. In pairs, use a random number generator to determine an X/Y coordinate within a 20 m x 20 m sampling site (see table right).

A screenshot of a computer

Description automatically generated

* + 1. Using scissors, harvest a sample of grass and add it to the collection pot. Mix the grass with the water in the bijou.
    2. Squeeze the sample of grass through the garlic press, collecting liquid passing through the garlic press into the plastic beaker.
    3. Use a plastic pipette to transfer a sample of the grass liquid onto the refractometer. Record the sugar content of the grass sample.

***BRIX scale***

Refractometers are pieces of apparatus that provides a measure of concentration based on refraction. As light enters the liquid at an angle, it changes direction, the angle of which is correlated with concentration of solute in a liquid. 1% Brix is equivalent to 1 g of sucrose in 100 g of solvent.

**Results**

*Independent Variable -* Time of day: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
| **Sample site** | **Glucose concentration (BRIX scale %)** |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |
| 7 |  |
| 8 |  |
| 9 |  |
| 10 |  |