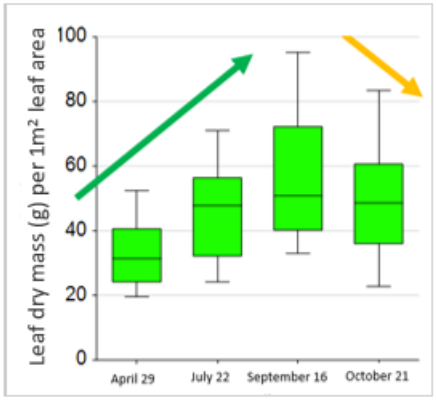
Carbon Activity - How Leaves Lose Weight

Students will learn:
- How and why leaves "lose weight" during autumn.
- How much carbon a tree stores in its leaves.



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Basic information

The leaves of trees not only get bigger during the year, but also change their color and thickness. During spring and summer, the leaves get bigger, greener and thicker. From late summer to autumn, on the other hand, they "lose weight" and the green color changes to shades of yellow and red.

The color change is caused by the breakdown of green chlorophyll which allows us to see the yellow and red pigments that are "masked" by chlorophyll in summer. The weight loss is caused by "recycling" of water and nutrients (the tree pulls all it can from the leaves into the trunk and roots and stores it for the winter time and for the next season). The trend of leaf weight gain and loss is shown in the graph.

Approximately 45-50% of the dry leaf weight consist of carbon. Most of the carbon in the leaves (mainly in the form of cellulose) remains in the leaves in autumn and is lost by the tree. However, some of the carbon is taken away from the leaves by the tree (as sugars) and the amount of carbon stored in the leaves thus decreases as the autumn begins.

How leaves lose weight - a learning activity

Time and place: 30 minutes in the classroom (+ time in advance to collect and dry the leaves), after drying the leaves 20 minutes for weighing and calculation)

Materials: leaves from the studied tree, scales (if you don't have very accurate scales, weigh more leaves), paper (for which you know the weight or grammage).

Students observe the autumn leaf change on the selected tree. They know that the leaves colour changes in autumn. But does their weight also change? Do they lose weight? How can students find out?

Collect leaves from the tree you observe while they are still green. **Determine the area of the leaves** (separately for each leaf). You can use different methods, for example:
- Draw a leaf on a piece of paper that you have weighed or whose grammage you know. Cut out the leaf of the paper and weigh it. Calculate the area using cross-multiplication.
- Weigh the leaf. Cut out a shape whose area you can easily calculate and weigh it. Calculate the area of the sheet using cross-multiplication.

After determining the area, **dry the leaves**. Different water contents in each leaf would distort your results. **Weigh the dried leaves** and record the weight. **Divide the weight of the leaf by two** (approximately 50% of the weight of the leaf is made up of carbon) to get the weight of the carbon stored in the leaf. Convert the result to a value for $1m^2$.

Repeat the measurements several times during the autumn, especially when you notice a change in leaf color on your tree. Compare the results at the end. How has the weight and therefore the thickness of the leaves changed? How much carbon was fixed in the leaves at the beginning and end of the measurement? How much carbon did the tree recycle from the leaves and stored for the winter? The difference in weight corresponds to the amount of carbon that the tree has recycled from the leaves and stored for the winter.

Follow-up activity for older children and more time

If you have time for further exploration, you might try thinking about the question: **"How can we find out how much carbon is lost by the tree during green-down?".**

How do you recalculate the result for one or a few leaves to a larger part of the tree? The so-called **Leaf Area Index (LAI)** is used for this calculation. This can be defined as the leaf area occurring over a certain unit of soil surface.

LAI = leaf area in m^2 / soil area in m^2

How do you do that?

Wait until most of the leaves have fallen from your tree. Choose an area of $1m^2$ under the tree. Collect and weigh the leaves from this area. Use data from an autumn measurement to calculate the area of these leaves (ratio of leaf area to leaf weight in g/m^2).

The leaves do not fall directly under the tree - it is possible that some of them have already been taken away or some of the leaves have flown in from another tree. The result of your research will therefore only give you a rough idea of how much carbon is stored in the leaves.

In reality, calculating LAI is a challenging scientific activity. Its determination provides important information for determining many biological and physical processes such as photosynthesis, transpiration or carbon flux and is used in many ecological and climate models.