Supplementary

S1: Protocol for the spring sampling campaign

WATSON Sampling Instructions – Spring 2023 campaign

Before you go out:

- Where relevant, please make sure that you've **liaised with the appropriate colleagues of your team**. We prefer well established sites with existing data above new sites.
- Make sure that you have **permission** to access the site and take samples.
- **Collect and check metadata:** Please add as much metadata as possible using the following google doc: XXX
- Make sure that you have the necessary **equipment** (wood corer, exetainers, labelling tape and marker, soil auger or shovel, as well as a measurement tape to measure the DBH of the tree or depth of the soil sample), GPS (or map), tools for estimating tree height, as well as spirit or bubble level and mobile phone. 12 ml exetainers are supplied by Labco: XXX
- If you cannot organise all the equipment such as a 0.5 cm wood corer or exetainers in your country or from colleagues nearby, send asap a "**NEED EQUIPMENT**" email to X and Y.

During sampling in the field:

Make sure that your hands are dry during sampling and that you do this as quickly as possible to avoid evaporation from the stem and soil samples.

Tree stem sapwood samples: Take two to three stem sapwood samples of ~5 cm with a 0.5 cm wood corer from 3 spruce (*Picea abies*) trees and/or 3 beech (*Fagus sylvatica*) trees at breast height (i.e. we expect three vials (one for each tree) with two to three 5cm cores inside each). A minimum of two cores (more the better) are needed to get enough water for isotope analysis and to avoid isotope fractionations related to cryogenic extraction. The trees should be site-representative trees with a diameter at breast height (DBH) of at least 10 cm. Remove the bark of the tree cores with a knife but make sure to include the tissue of the outer tree rings!

Soil samples: Take a maximum of 5 soil samples at 0-10, 10-20, 20-30, 50-60, 80-90 cm at a location between the 3 (or 6) trees that you sampled. Litter should be removed for the soil sample at 0-10cm. Fill the exetainers for 50-80% with soil. In the case of a maximum soil depth of 30 cm, simply take 3 samples as indicated above. In the case of a maximum soil depth of 50 cm, take an additional 10 cm sample between 30 to 50 cm and note the exact depth (4 sample in total). In the case of maximum soil depth of 80 cm, take an additional 10 cm sample between 60 to 80 cm and note the exact depth (5 samples in total).

Close the sample vial: Please make sure the exetainer caps are tightly screwed on the vials. Hand tight is just fine but check that the rubber sealing in the cap is not overly bend. Seal the cap additionally with parafilm (or if you don't have parafilm use tape). Remember, evaporation is the enemy!

Label the sample: Please make sure that your samples are clearly labelled. The label should include country (2-letter), site code (3-letter), sampling date (yymmdd), soil/tree species, and depth/number (e.g. CH_WSL_230525_Soil_20-30, or CH_WSL_230525_Beech_1). Double-check with metadata.

Take photos: For all pictures, please use your mobile phone. Please use the back and not the front camera (the latter typically provides photos at lower resolution compared to the one on the back)! Take a (1) representative landscape photo of each site, (2) representative photos of each tree, as well as (3) representative photos of the canopy. The latter will be analysed by us for obtaining the crown gap fraction as a rough estimate of tree vitality on your site (description below). And of course, take pictures of yourself 😉.

Label and upload photos: Please make sure that your photos are clearly labelled for landscape (e.g. CH_WSL_230525_Beech_Landscape), trees (CH_WSL_230525 _Beech1), canopy

(CH_WSL_230525_Beech_Lab or CH_WSL_230525_Beech_1m_N) and yourself (CH_WSL_230525_Beech_Fun1). Upload your photos on google drive: XXX

After sampling:

- Store all samples in a fridge (~4°C). Don't freeze them!
- Send your vials as soon as possible to the following address: XXX.

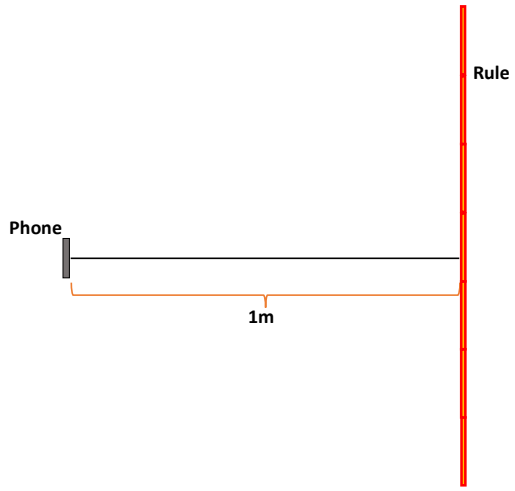
  Please **pack them nicely** in a box with some bubble wrap and double check that the labels are readable. Add a paper copy of the **import licence (attached to email)**.

- Send an email to X and Y to confirm that you have sent the samples. Double-check again the metadata and tick the box for "sent".

Instructions for taking canopy photos

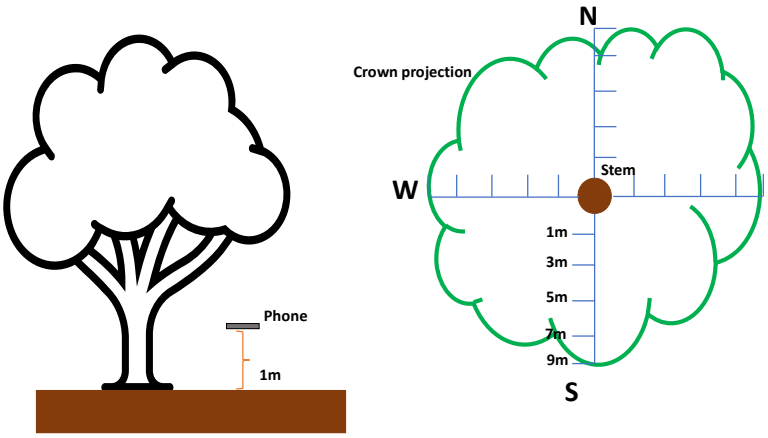
In the office/lab:

We need to know the field of view of your mobile phone camera. Put your phone horizontally with the back camera upward at 1 meter distance from a ruler and take a photo. Use a smartphone app or a physical bubble level to achieve a prober level. Make sure that meter divisions are clearly visible in photo.



In the field:

Put your phone horizontally with the back camera upward underneath a representative tree of each site and species, approximately above 1 m from the soil surface. Use a smartphone app or a physical bubble level to achieve a prober level. Take photos at 1- and 5-meters distance to the stem. Repeat this procedure for 3 opposite directions (North, South, East or West). In total a **minimum of 6 photos** are needed (i.e., 2 photos per direction). To improve the estimate, additional photos at 3-, 7- or 9-meters distance to the stem or at the fourth direction are highly welcome.



Recommendations: Avoid direct sun radiation on the crown and camera. The best conditions are met when the sky is homogeneously cloudy (as this provides a homogeneous background), or at least when the sunlight is shaded by clouds.

S2: Protocol for the summer sampling campaign

WATSON Sampling Instructions – Summer 2023 campaign

Before you go out:

- Make sure that you have **permission** to access the site and take samples. We prefer well **established sites** with existing data above new sites. We hope that everyone who participated in the first spring sampling campaign will participate again but also welcome people from selected countries who could not participate in the spring.
- Select a sampling day with nice weather and sample in "dry conditions", i.e. in the absence of rain or fog so that trees transpire actively. Avoid sampling during dusk and dawn.
- **Check and update metadata:** We have now updated our metadata sheet so that is suits the next sampling campaign. So please fill out the remaining "gaps" if possible using the following google doc: XXX
- Make sure that you have the necessary **equipment** (0.5 cm wood corer, exetainers, labelling tape and marker, soil auger or shovel, as well as a measurement tape to measure the depth of the soil sample and if you are participating for the first time the DBH of the trees), GPS (or map), tools for estimating tree height, as well as spirit or bubble level and mobile phone. 12 ml exetainers are supplied by Labco: XXX
- Packages with exetainers (and wood corer) are on the way those contributors, who had no exetainer during the first campaign! If you cannot organise all the equipment such as the 0.5 cm wood corer or exetainers from colleagues in your country or nearby, send asap a "**NEED EQUIPMENT**" email to X and Y.

During sampling in the field:

Make sure that your hands are dry during sampling and that you do this as quickly as possible to avoid evaporation from the stem and soil samples.

Tree stem sapwood samples: Take two to three stem sapwood samples of ~5 cm with a 0.5 cm wood corer from 3 spruce (*Picea abies*) trees and/or 3 beech (*Fagus sylvatica*) trees at breast height (i.e. we expect three vials (one for each tree) with two to three 5 cm cores inside each). A minimum of two cores (more the better) are needed to get enough water for isotope analysis and to avoid isotope fractionations related to cryogenic extraction. The trees should be -representative trees for the site with a diameter at breast height (DBH) of at least 10 cm. **Remove the outer/inner bark** of the tree cores with a knife **but** make sure to **include the tissue of**

the outer tree rings! Avoid sampling the heartwood! If you can, please keep the **core intact** because we plan to determine isotope in the 2023-ring.

Soil samples: Take a maximum of 5 soil samples at 0-10, 10-20, 20-30, 50-60, 80-90 cm at a location between the 3 (or 6) trees that you sampled. Litter should be removed for the soil sample at 0-10cm. Fill the exetainers for 50-80% with soil. In the case of a maximum soil depth of 30 cm, simply take 3 samples as indicated above. In the case of a maximum soil depth of 50 cm, take an additional 10 cm sample between 30 to 50 cm and note the exact depth (4 samples in total). In the case of maximum soil depth of 80 cm, take an additional 10 cm sample between 60 to 80 cm and note the exact depth (5 samples in total).

Close the sample vial: Please make sure the exetainer caps are tightly screwed on the vials. Hand tight is fine but check that the rubber sealing in the cap is not overly bend. Seal the cap additionally with parafilm (or if you don't have parafilm use tape). Remember, evaporation is the enemy!

Label the sample: Please make sure that your samples are clearly labelled. The label should include country (2-letter), site code (3-letter), sampling date (yymmdd), soil/tree species, and depth/number (e.g. CH_WSL_230525_Soil_20-30, or CH_WSL_230525_Beech_1). Sticky labels on top (first 3rd of the exetainer, underneath the cap) are preferred. Avoid handwriting with a text marker directly on the glass vial to avoid losing the "label" during sample handling. Double-check with metadata.

Take photos (optional): Only perform this task if you are new to the WATSON sampling campaign or if there was a significant change in the vegetation on your site between spring and summer. However, new fun pictures or site pictures are always welcome as we can use them for various presentations! Double-check with metadata.

For all pictures, please use your mobile phone. Please use the back and not the front camera (the latter typically provides photos at lower resolution compared to the one on the back)! Take a (1) representative landscape photo of each site, (2) representative photos of each tree, as well as (3) representative photos of the canopy. The latter will be analysed by us to obtain the crown gap fraction as a rough estimate of tree vitality on your site (description below). And of course, take pictures of yourself 😉.

Label and upload photos: Please make sure that your photos are clearly labelled for landscape (e.g. CH_WSL_230525_Beech_Landscape), trees (CH_WSL_230525 _Beech1), canopy (CH_WSL_230525_Beech_Lab or CH_WSL_230525_Beech_1m_N) and yourself (CH_WSL_230525_Beech_Fun1). Upload your photos on google drive: XXX.

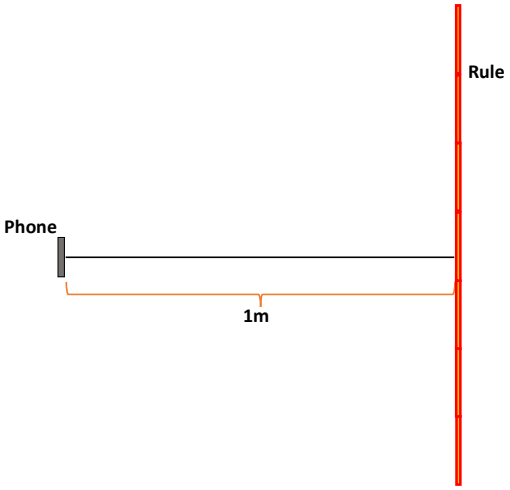
After sampling:

- Store all samples in a fridge (~4°C). Don't freeze them!
- Please **pack them nicely** in a box with some bubble wrap and double check that the labels are readable. Add a paper copy of the **import licence (attached to email)**.
  Send your vials as soon as possible to the following address: XXX
- Double-check again the metadata and tick the box for "sent".
- Double-check whether all "gaps" in the metadata are filled and all pictures are uploaded.

Instructions for taking canopy photos (Optional)

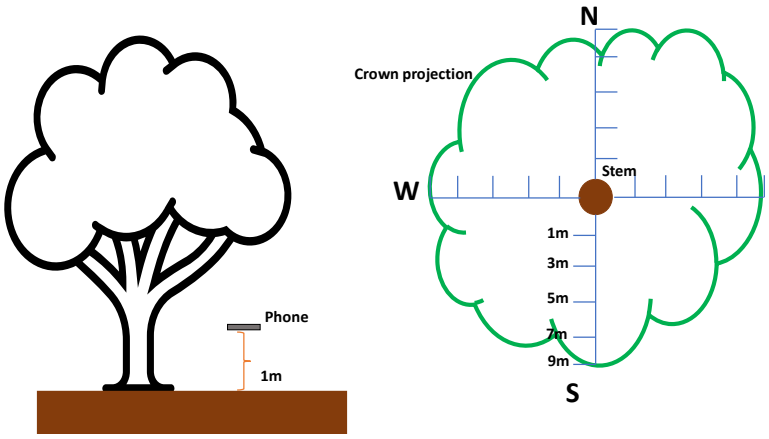
In the office/lab:

We need to know the field of view of your mobile phone camera. Put your phone horizontally with the back camera upward at 1 meter distance from a ruler and take a photo. Use a smartphone app or a physical bubble level to achieve a prober level. Make sure that meter divisions are clearly visible in the photo.



In the field:

Put your phone horizontally with the back camera upward underneath a representative tree of each site and species, at approximately 1 m above the soil surface. Use a smartphone app or a physical bubble level to achieve a proper level. Take photos at 1- and 5-meters distance to the stem. Repeat this procedure for 3 opposite directions (North, South, East or West). In total, a **minimum of 6 photos** are needed (i.e., 2 photos per direction). To improve the estimate, additional photos at 3-, 7- or 9-meters distance to the stem or at the fourth direction are highly welcome.



Recommendations: Avoid direct sun radiation on the crown and camera. The best conditions are met when the sky is homogeneously cloudy (as this provides a homogeneous background), or at least when the sunlight is shaded by clouds.

S3: Determination of the canopy gap fraction and canopy cover

The average canopy cover, i.e., the proportion of the forest floor that is covered by the vertical projection of the tree crown, was determined for each sampling site from non-hemispherical photographs taken with a phone camera that was levelled with a spirit level. For each tree, photos were generally taken at different distances from the tree (1, 3, 5 m from the stem) in 2 to 4 opposite directions (North, East, South, West). Most of the pictures were taken during the spring campaign but for some sites, pictures were taken during the summer campaign or during both campaigns.

To standardize the photos from different devices, the field of view (F_{oV}) for each phone was measured by taking a photo of a ruler placed one meter away from the camera. F_{oV} is given by:

$F_{oV}=2\ \tan^{-1}(L)$ Eq. 1

where L is the length of the ruler [m] in the picture.

Using the F_{oV}, a circular area with a radius of one meter was selected in the center of the image (to avoid overlap between the different pictures). The blue band (b) was extracted from each RGB image to differentiate between the pixels of the sky (high values of the blue band) and biomass (lower values of the blue band). The threshold to distinguish between pixels of the sky and biomass was set manually for each picture. The blue band images were converted to binary images with a value of 0 for biomass, and a values of 1 for the sky. Canopy cover (C) was then calculated via based on the difference in the number of biomass pixels with a value of 0 (P_0) and the number of pixels with the sky with a value of 1 (P_1) (Llorens and Gallart, 2000):

$$C = P_0/(P_0+P_1) \qquad \text{Eq. 2}$$