Sep 13, 2022 Version 2

Tree Mapping for Leaf Collection Guidelines (Mont Mégantic only) V.2

DOI
dx.doi.org/10.17504/protocols.io.kxygxe97ov8j/v2

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DOI: https://dx.doi.org/10.17504/protocols.io.kxygxe97ov8j/v2

External link: http://www.caboscience.org

Protocol Citation: Anna L Crofts, Sabine St-Jean 2022. Tree Mapping for Leaf Collection Guidelines (Mont Mégantic only). **protocols.io https://dx.doi.org/10.17504/protocols.io.kxygxe97ov8j/v2**Version created by **Anna L Crofts**

Protocol status: Working
We use this protocol and it's working

Created: July 05, 2022

Last Modified: September 13, 2022

Protocol Integer ID: 66020

Keywords: canadian airborne biodiversity observatory, tree mapping for leaf collection guideline, leaf collection guideline, trees for leaf, foliar spectral reflectance measurement, forested study site, harvested leaf, foliar measurement, protocol for foliar measurement, tree mapping, tree, leaf, sunlit leaf, foliar functional trait, suite of foliar functional trait, study site in southeastern québec, species

Abstract

Here, we describe the protocol used by the **Canadian Airborne Biodiversity Observatory** (CABO) at Parc National du Mont Mégantic, a forested study site in southeastern Québec, to select trees for leaf-level measurements. Healthy, mature, fully sunlit leaves were harvested from permanently marked individuals distributed across the park and representing 23 species (n = 204). Harvested leaves were bulked per individual and foliar spectral reflectance measurements and a suite of foliar functional traits were quantified by the CABO foliar spectra/trait team based out of the Université de Montréal (protocol for foliar measurements described elsewhere). Additionally, height, diameter at breast height (DBH), and crown diameter were quantified for each individual. To facilitate re-location, individuals were positioned (horizontal accuracy < 2 m) and photographed. All data were collected using *Fulcrum*, a data collection application.

Attachments

PDF
Trimble DA2, Trimble...
320KB

PDF
LaserGeo, Haglof Swe...
2.4MB

PDF
Tagged Tree Summary....
180KB

Materials

- Cellphone with *Fulcrum* and Trimble Catalyst mobile apps installed (Cat S41, Caterpillar Inc.)
- Field Guide (LeBoeuf, M. 2016. Arbres et plantes forestières du Québec et des Maritimes. Éditions Michel Quintin.)
- Numbered aluminum tree tags
- Hammer and nails
- Flagging Tape
- Laser rangefinder with integrated tilt and compass sensors (LaserGeo, Haglof Sweden AB)
- Diameter at Breast Height (DBH) Tape
- High precision GPS (Trimble Catalyst DA1 antenna with Trimble RTX correction service, Trimble Inc.)

Equipment

Hammer and nails

NAME

-

BRAND

-

SKU

Equipment

Numbered Aluminium Tree Tags

NAME

-

BRAND

-

SKU

Equipment

S41

NAME

Cellphone

TYPE

CAT

BRAND

-

SKU

https://www.catphones.com/en-us/cat-s41-smartphone/

LINK

Equipment

Laser Geo

NAME

Haglöf Sweden

BRAND

-

SKU

http://www.haglofcg.com/index.php/en/products/instruments/height/554-laser-geo

LINK

Equipment

new equipment

NAME

Trimble Catalyst GPS, NTRIP precision subscription

BRAND

-

SKU

Troubleshooting

Before start

1. Field work within Parc national du Mont Mégantic requires a valid research permit. **Prior to field work obtain research permit and ensure permit is being carried during field work.**
- If working at a site other than Parc national du Mont Mégantic (*MtMeg-1*), create the site in Fulcrum prior to field work.
- If working in a project other than *2019-Crofts-PHD-UDES*, create the project in Fulcrum prior to field work.

2. **Ensure that the batteries** of the cellphone, LaserGeo, and Trimble Catalyst **are fully charged** prior to field work.

Tree Selection

1 Systematically select individuals that meet the leaf-level measurement requirements[1] across the majority of species that occur within the park[2]. Specifically, selected individuals should:

1. Have mature, healthy, and fully sunlit (exposed to >3hrs of sunlight per day) leaves,
2. Not exceed a height beyond harvesting capability (target leaves located ≤ 20 m above forest floor),
3. Be located within 30 mins, but ideally 15 mins, from the foliar spectra/trait team's mobile laboratory[2] and,
4. When possible, distribute selected individuals of the same species across the park (i.e., in both sectors and across the altitudinal gradient).

Figure 1. Sugar maple (*Acer saccharum*) individual selected for leaf collection along the Parcours du Soleil trail at Parc national du Mont Mégantic.

Note

[1] To meet leaf-level requirements, individuals selected for leaf harvesting were distributed along trails and roads within the park (Fig. 1).

[2] We aimed to select 10 individuals of abundant species and 5 individuals from less abundant species.

[2] Once foliar spectra/trait team's mobile laboratory is set-up, it preferably won't be moved for the day. Spectra/trait team can process ~ 50 individuals per day.

Tag Individual

2 For each selected individual, tag tree with a numbered aluminum tag (Fig. 2).

- Attach the numbered aluminum tag to the individual at breast height (~1.5 m) on the side of the trunk facing away from the trail.
- Partially hammer the nail on a downward angle into the individual's trunk, so the tag is not flush against the bark and the individual can continue to grow without growing around the tag.

To facilitate re-locating the individual for leaf collection, temporarily tag individual with flagging tape at breast height[1].

Figure 2. Photo of a tagged striped maple (*Acer pensilvanicum*) along a trail in Parc national du Mont Mégantic, where the aluminum tag is on the side of the trunk facing away from the trail. Note that this individually was not tagged in an ideal manner (i.e., aluminum tag is flush against the individual's trunk).

Note

[1] Remove flagging tape from individuals once leaves have been harvested and GPS locations have been updated.

Create Plant Record in *Fulcrum*

3 For each selected individual, create a plant record in *Fulcrum.*

- Create a plant record in *Fulcrum* by selecting **+ Record** within the **Plants** app (Fig. 3a,b).
- **TAP TO SELECT PROJECT**[1] and select the appropriate **Site**[2] (Fig. 3c).
- Answer *YES* to **Plant Tagged?** After selecting *YES,* additional fields will appear. Enter the **Tag ID** and assign **Tag Type** as *aluminum tag* (Fig. 3d,e).
- Under **Plant Photos** select the camera icon and take a picture(s) of the individual (Fig. 3e).

- If necessary, add additional comments under **Plant Remarks** (Fig. 3e).
- List the names of the surveyors who the plant was **First Observed By** (Fig. 3f).
- **UPDATE LOCATION WITH GPS**[3] - Latitude (degrees), Longitude (degrees), Horizontal Accuracy (m), and Altitude (m) fields will automatically be filled in when Update Location with GPS is selected (Fig. 3g).
- If needed, you can apply filters but regardless, select **VASCAN Taxon**[4] and choose a species from the drop-down list (Fig. 3h,i).
- After selecting the species, additional fields will appear. Enter the name of the surveyor who the plant was **Identified By** and select the **Identification Protocol** used (Fig. 3j). If necessary, add identification remarks.

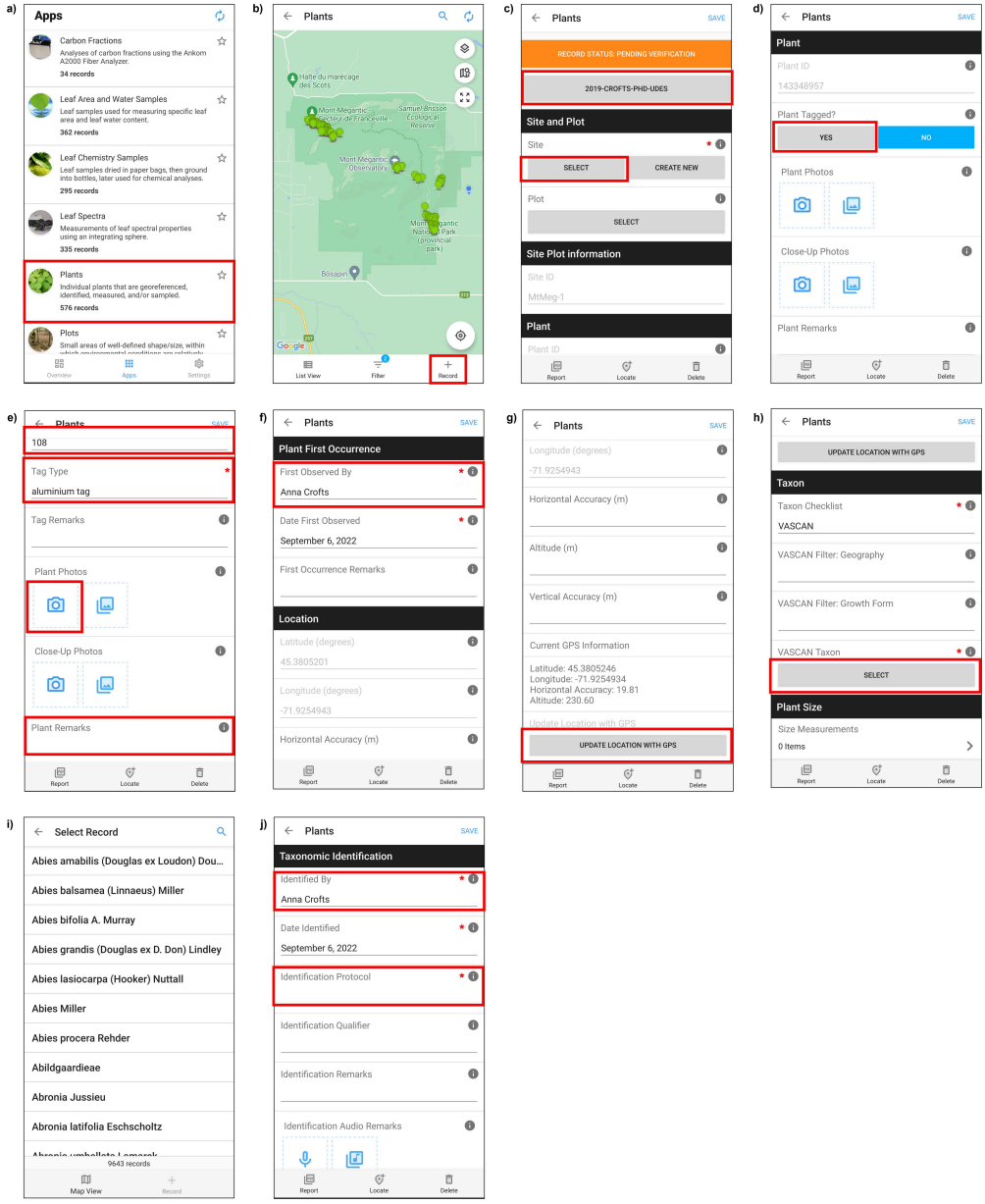

Figure 3. Screenshots from *Fulcrum* mobile application CABO account. To create a new record of a plant select the **Plants** app from the home page (panel a) and then within the **Plants** app select **+ Record** (panel b). **Tap to select project** that you are working with (here, project is already selected as *2019-CROFTS-PHD-UDES*) and select the appropriate **study site** (panel c). After answering *YES* to **Plant tagged**? (panel d), additional fields will appear. Enter the **Tag ID**, select *Aluminum tag* as **Tag Type**, and then select the camera icon under **Plant Photos** to add photos of the tagged individual (panel e). List the names of the surveyors who the plant was **First Observed By** (panel f). Then, **UPDATE LOCATION** [of the individual] **WITH GPS** (panel g). Next, select **VASCAN Taxon** (panel h) from the drop down list (panel i). After, selecting the appropriate species additional fields will appear. Enter the name of the surveyor who the plant was **Identified By** and the appropriate **Identification Protocol** (panel j). Red boxes have been added to screenshots to illustrate selections. Note that *Fulcrum* can be used via a mobile app or desktop website and that the two are organized differently.

Note

[1] Plants at Parc national du Mont Mégantic are assigned to the project 2019-CROFTS-PHD-UDES. If you are working within a different project, assign the project as appropriate.

[2] Parc national du Mont Mégantic is named MtMeg-1. If you are working at a different study site, you may need to create a new site record in the Sites app assessed from the CABO account's homepage.

[3] The GPS locations of plants positioned by the cellphone GPS will be ~3 m horizontal accuracy. Revisit tagged individuals to update their GPS location using a high precision GPS (detailed in Step 8 and see **Trimble GPS Protocol** for additional details).

[4] Tree species are selected from the Database of Vascular Plant Species Canada (VASCAN) list. For some species, the Latin names in VASCAN may differ from Latin names in field guides. In these cases, VASCAN is to be considered more up to date. If you run into a species identified from a field guide that doesn't appear in the VASCAN Taxon drop-down list in Fulcrum, look up the species on the **VASCAN website** to obtain the accepted species name.

Quantify Dendrometric Properities

4 For each selected individual, quantify height, diameter at breast height (DBH), and crown diameter.

4.1 In the individual's *Fulcrum* plant record, add plant size measurements.

- Select **Size Measurements** followed by **+ Record** (Fig. 4a,b).
- Select **Measurement Type** and then **DBH**, **Height**, and **Crown Diameter** followed by **DONE** (Fig. 4c,d).

The measurement fields will now appear (Fig. 4e).

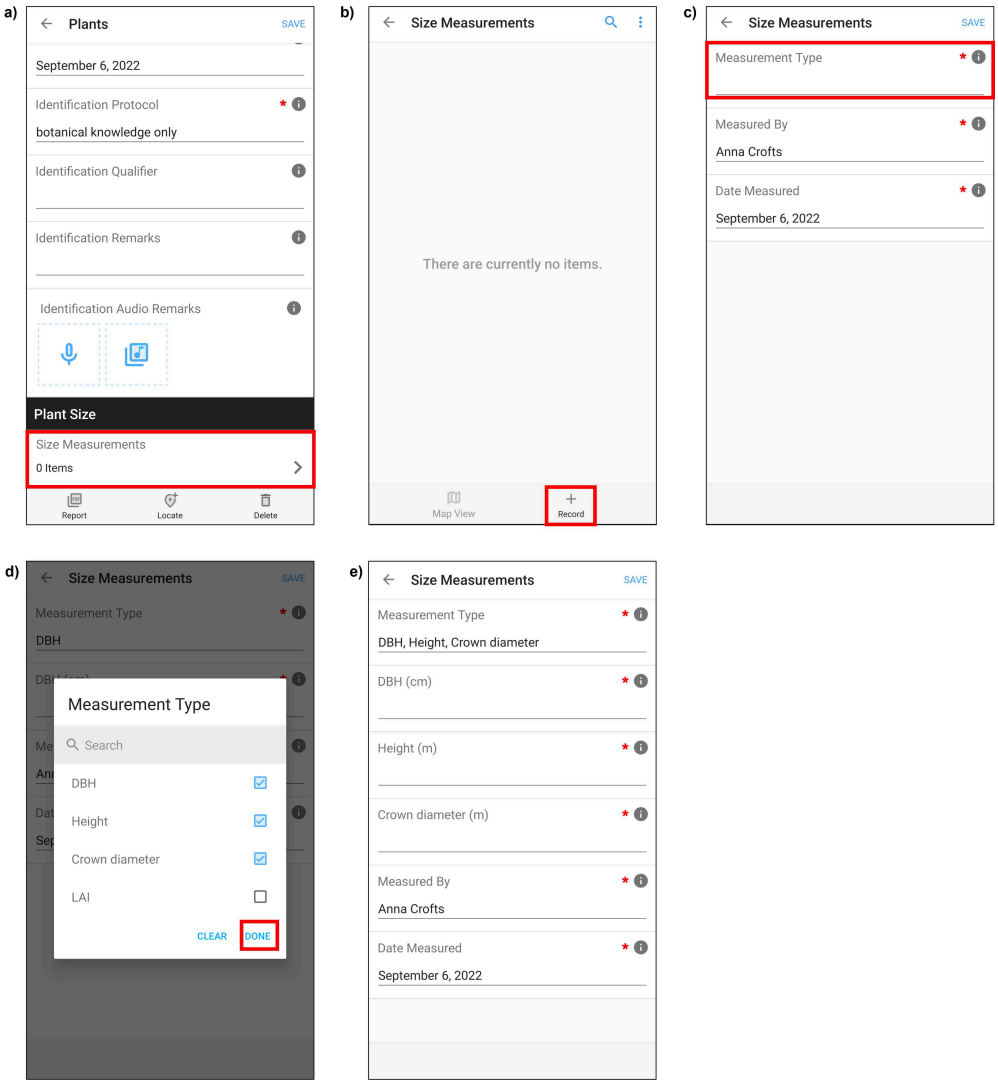

Figure 4. Screenshots from *Fulcrum* mobile application CABO account. To add size measurements to an individuals *Fulcrum* plant record, first select **Size Measurements** (panel a) and then **+ Record** (panel b). Then select **Measurement Type** (panel c) and select **DBH**, **Height**, and **Crown Diameter** followed by **DONE** (panel c). Afterwards, size measurement fields will appear (panel d). Red boxes have been added to screenshots to illustrate selections. Note that *Fulcrum* can be used via a mobile app or desktop website and that the two are organized differently.

4.2 Use DBH tape to measure individual's DBH.

- Measure DBH at ~1.5 m[1].
- Enter the DBH to **DBH (cm)** field in the individual's plant record in *Fulcrum* (Fig. 5)

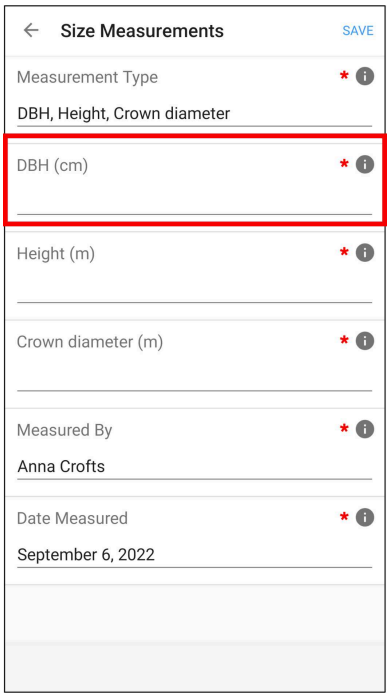

Figure 5. A screenshot from *Fulcrum* mobile application CABO account. Enter the DBH into the **DBH (cm)** field in the individual's plant record in *Fulcrum*. The red box has been added to screenshot to illustrate selections. Note that *Fulcrum* can be used via a mobile app or desktop website and that the two are organized differently.

Note

[1] If there is an obstruction at breast height (e.g., branch, scar tissue, forked stem), measure DBH above the obstruction.

4.3 Use LaserGeo to measure individual's height.

- To account for uneven ground, use the LaserGeo's **HEIGHT 3P** function that quantifies the height by measuring:
  1) Distance to the individual's trunk at eye-level,
  2) Angle to the base of the trunk, and
  3) Angle to the tip of the individual's crown[1,2,3,4] (Fig. 6a).
- Enter the height to **Height (m)** field in the individual's plant record in *Fulcrum* (Fig. 6b).

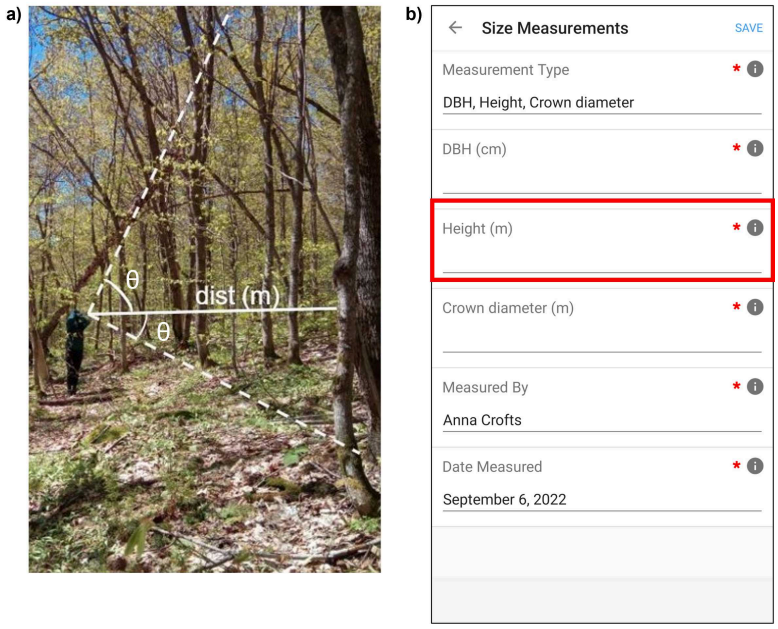

Figure 6. a) An annotated photo of a surveyor using the LaserGeo to measure the heigh of individual trees, by quantifying the distance to the individual at eye-level, the angle to the base of the trunk, and the angle to the top of the individual. b) A screenshot from *Fulcrum* mobile application CABO account. Enter the height into the **Height (m)** field in the individual's plant record in *Fulcrum* (panel b). The red box has been added to screenshot to illustrate selections. Note that *Fulcrum* can be used via a mobile app or desktop website and that the two are organized differently.

Note

[1]LaserGeo's HEIGHT 3P function calculates height automatically from these three measurements.

[2] The taller the individual, the further the surveyor should be from its trunk for an accurate height measurement - aim to be ~ 10 m away.

[3] If an individual is growing on an angle, have the other surveyor stand below the tip of the crown and calculate the height from the distance to the other surveyor at eye-level, the angle to the other surveyor's feet, and the angle to the tip of the individual's crown.

[4] Before entering the height, check to make sure it is logical. If value seems improbable retake the measurement. Be sure there are no obstructions (i.e., shrubs) between you and the individual that may result in the wrong distance being measured.

4.4 Use LaserGeo to measure individual's crown diameter.

- Use the LaserGeo's **DME** function to measure the length of the longest crown diameter (Fig. 7a).

- Enter the crown diameter to the **Crown diameter (m)** field in the individual's plant record in *Fulcrum* (Fig. 7b).

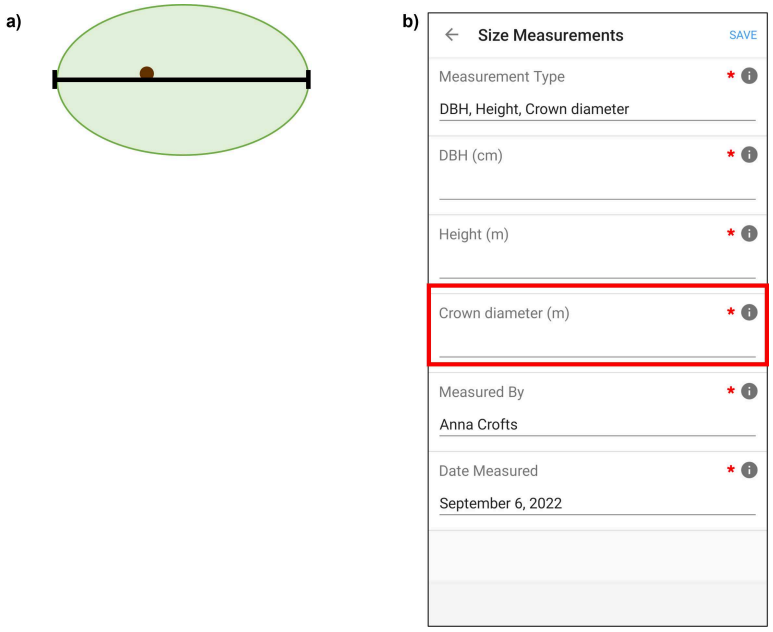

Figure 7. a) Schematic of an individual's crown, as modelled by an ellipse. The black line represents the longest crown diameter (i.e., the dimension to quantify) and brown circle represents the individual's trunk. b) A screenshot from *Fulcrum* mobile application CABO account. Enter the longest crown diameter into the **Crown diameter (cm)** field in the individual's plant record in *Fulcrum* (panel b). The red box has been added to screenshot to illustrate selections. Note that *Fulcrum* can be used via a mobile app or desktop website and that the two are organized differently.

4.5 Save individual's size measurements in the *Fulcrum* App.

- Select **SAVE**[1] once size measurements are complete (Fig. 8a).
- Exit Size Measurements by selecting the left arrow in the top left corner (Fig. 8b).

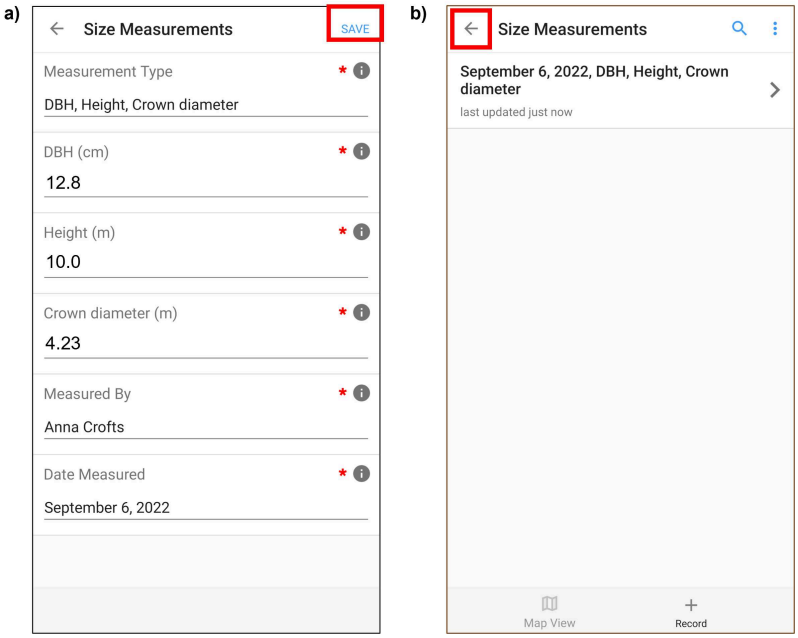

Figure 8. Screenshots from *Fulcrum* mobile application CABO account. Select **SAVE** to save the Size Measurements (panel a) and exit the size measurements by selecting the left arrow in the top left corner (panel b). The red box has been added to screenshot to illustrate selections. Note that *Fulcrum* can be used via a mobile app or desktop website and that the two are organized differently.

Note

[1] Note that individual's size measurements will not be saved if any of the mandatory fields (denoted by the red asterisks) are left blanked or if the data are entered in a wrong format (e.g., no commas are accepted). If this occurs, the user will receive an **Error Saving** message detailing the mistakes. Do not choose **SAVE as Draft**, select **OKAY** to return to the individual's size measurements, fix any errors, and then **SAVE**.

Save *Fulcrum* Record

5

- **SAVE**[1] the individual's plant record in *Fulcrum* (Fig. 9a). This will return you to the Plants app (Fig. 9b).
- Sync[2] *Fulcrum* to upload the individual's plant record online by selecting the icon of two circular arrows. This icon will spin when synchronizing is in progress (Fig. 9b).

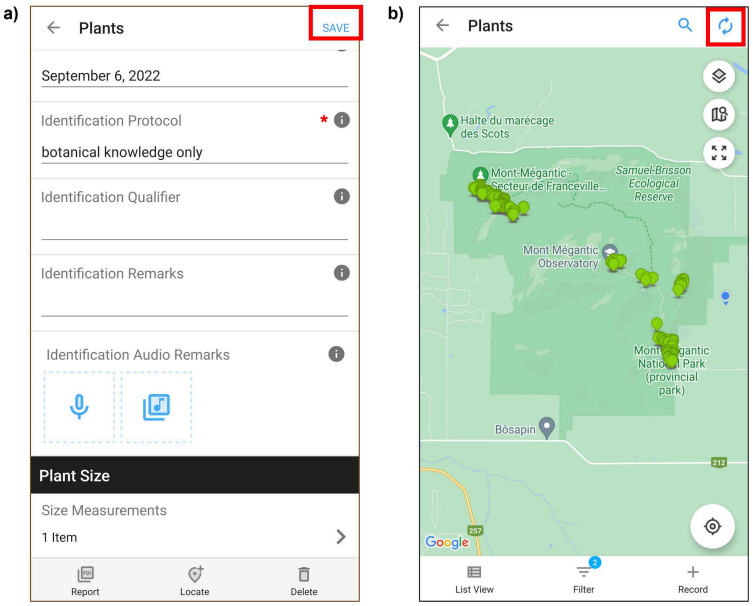

Figure 9. Screenshots from *Fulcrum* mobile application CABO account. Select **SAVE** to save the individual's plant record in *Fulcrum* (panel a). Sync *Fulcrum* to upload individual's plant record online by selecting the two circular arrows (panel b). Red boxes have been added to screenshots to illustrate selections. Note that *Fulcrum* can be used via a mobile app or desktop website and that the two are organized differently.

Note

[1] Note that individual's plant record will not be saved if any of the mandatory fields (denoted by the red asterisks) are left blanked or if the data are entered in a wrong format (e.g., no commas are accepted). If this occurs, the user will receive an **Error Saving** message detailing the mistakes. Do not choose **SAVE as Draft**, select **OKAY** to return to the individual's plant record, fix any errors, and then **SAVE**.

2 Some areas of Parc national du Mont Mégantic are not covered by cellular reception - be sure to sync Fulcrum once back in service.

Update GPS Position

6 Return to tagged individuals with Trimble Catalyst (Trimble Catalyst DA1 antenna with Trimble RTX correction service, Trimble Inc.) or alternative high-precision GPS to obtain more precise coordinates of sampled individuals. See **Trimble GPS Protocol** for step-wise details regarding how to use Trimble Catalyst.

- Within the **Plants** app in *Fulcrum* select the appropriate plant record (Fig. 10a,b).

- The Trimble Catalyst integrates with *Fulcrum*, select **UPDATE LOCATION WITH GPS**- Latitude (degrees), Longitude (degrees), Horizontal Accuracy (m), and Altitude (m) fields will automatically be filled in when Update Location with GPS is selected - once GPS connection is established and, ideally, horizontal accuracy is ≤ 2.0 m[1] (Fig. 10c).

- Select the **RECORD STATUS: PENDING VERIFICATION** in the plant's *Fulcrum* record and change the status to **VERIFIED.** The colour of the Record Status bar should change from orange to blue (Fig. 10d).
- **SAVE** the plant's record in Fulcrum. This will return you to the the **Plants** app (Fig. 10d).
- Sync[2] *Fulcrum* to upload the changes online by selecting the icon of two circular arrows. This icon will spin when synchronizing is in progress (Fig. 10e).

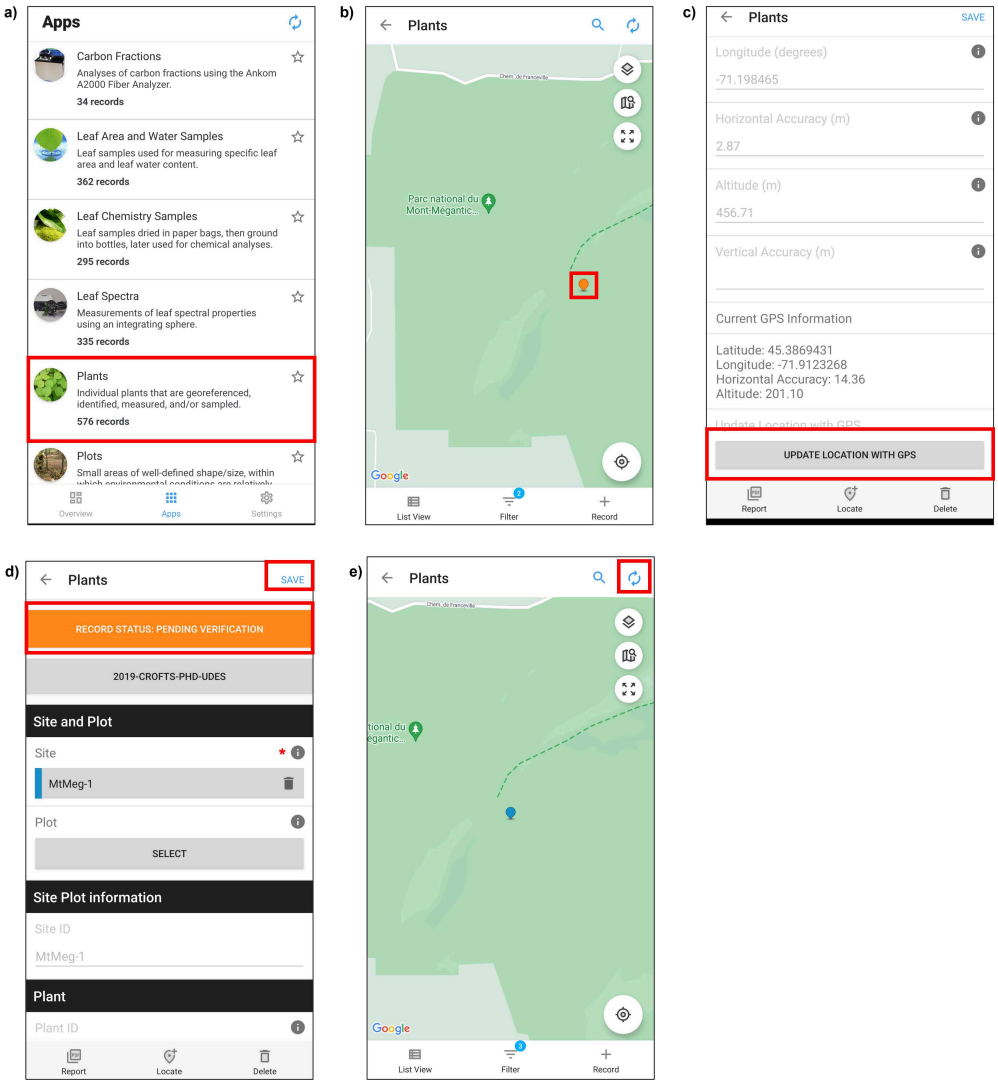

Figure 10. Screenshots from *Fulcrum* mobile application CABO account. Select **Plants** app (panel a) and then, select the appropriate plant record (panel b). Once GPS connection is established and the accuracy is ≤ 2.0 m, select **UPDATE LOCATION WITH GPS** (panel c). Then select **RECORD STATUS: PENDING VERIFICATION** and change it to **VERIFIED** (panel d). **SAVE** the record's updates (panel d) and sync *Fulcrum* by selecting the two circular arrows (panel e). Red boxes have been added to screenshots to illustrate selections. Note that *Fulcrum* can be used via a mobile app or desktop website and that the two are organized differently.

Note

[1] Trimble Catalyst requires mobile data for on demand RTX correction service. In some areas of Parc national du Mont Mégantic there is no cellular reception and centimeter precision will therefore be unobtainable. In these circumstances, obtain most precise coordinates as possible (likely between 1 m and 2 m).

[2] Some areas of Parc national du Mont Mégantic are not covered by cellular reception - be sure to sync Fulcrum once back in service.

Download Plant Record Data

7 Using the *Fulcrum* desktop website,

- In CABO's *Fulcrum* account, select **Export Data** as indicated by a downward facing arrow (Fig. 11a)
- Select the **File Format**, in **Apps** select *Plants*, in **Projects** select *2019-CROFTS-PHD-UDES* or alternative, and then select **NEXT** (Fig. 11b).
- Review **Export** summary and select **CONFIRM** to download (Fig. 11c).

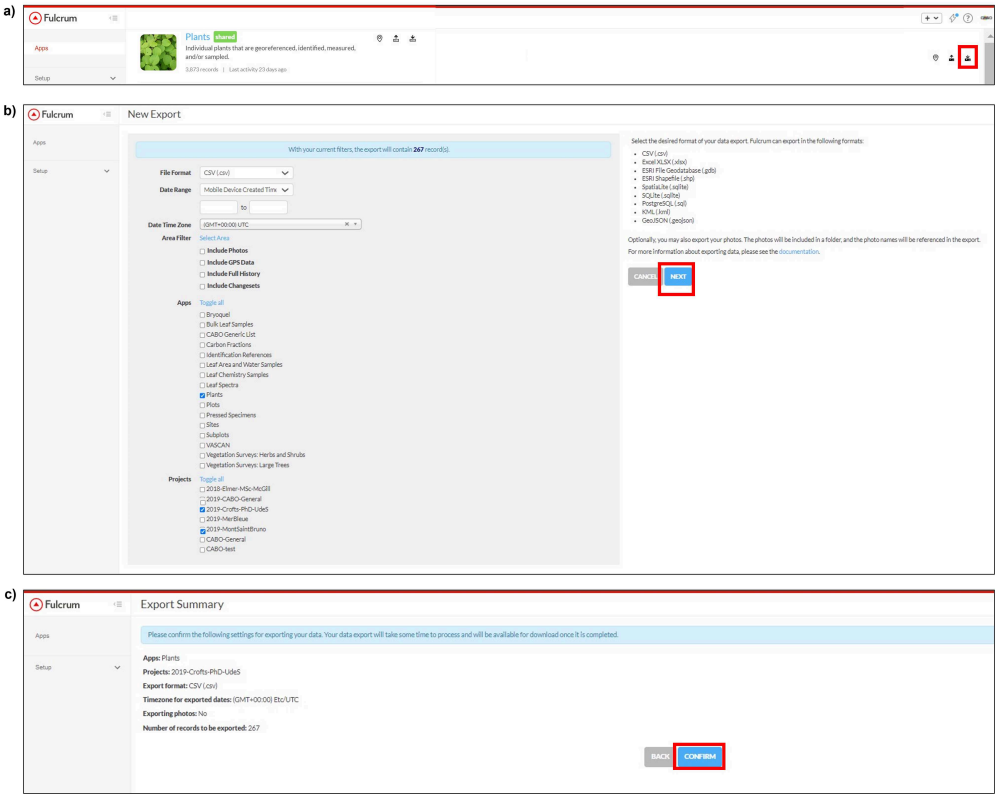

Figure 11. Screenshots from the *Fulcrum* desktop website CABO account. To download the plant recors, select **Export Data** as indicated by a downward facing arrow (panel a), choose the file format you prefer, and select *Plants* in **Apps** section and select the **Projects** of which you wish to download the data and select **NEXT** (panel b). Review the Export Summary and select **CONFIRM** to download data (panel c).

Submit Plant Record Data

8 Once the foliar sampling campaign is complete and data has been checked, change the status of all plants to 'Submitted' in *Fulcrum*.

- Within the **Plants** app in *Fulcrum* select plant records (Fig. 12a,b).
- For each plant record, select the **RECORD STATUS: VERIFIED** in the plant's *Fulcrum* record and change the status to **SUBMITTED**. The colour of the Record Status bar should change from blue to green (Fig. 12c). Then **SAVE** the changes in *Fulcrum*. This will return you to the Plants app (Fig. 12c).
- Once the status of all appropriate plant records have been changed, Sync *Fulcrum* to upload the changes online by selecting the icon of two circular arrows. This icon will spin when synchronizing is in progress (Fig. 12d).

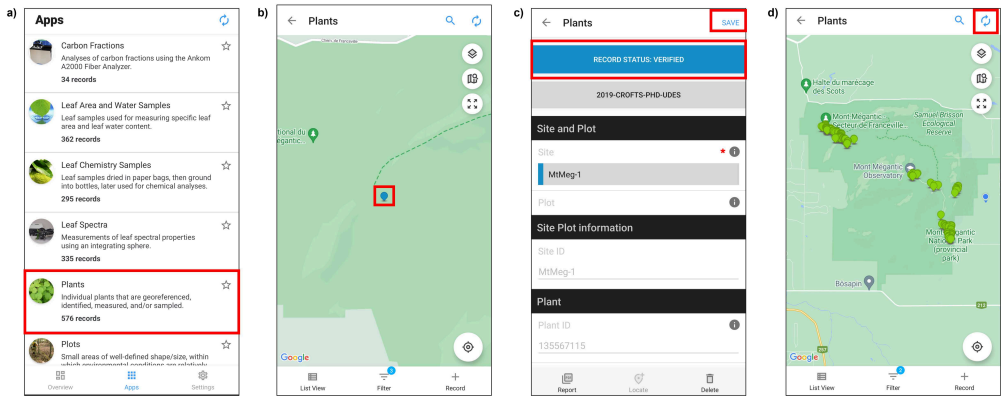

Figure 12. Screenshots from *Fulcrum* mobile application CABO account. Once the foliar sampling campaign is complete and data has been checked, change the status of all Plant records to Submitted. Select **Plants** app (panel a) and then, select the appropriate plant record (panel b). In the record, select **RECORD STATUS: VERIFIED** and change it to **SUBMITTED** (panel c). Note that the colour of the record status bar will change from blue to green. Select **SAVE** to save the plant record in *Fulcrum* (panel c). Once the record status of all plant records are Submitted, sync *Fulcrum* to upload changes online by selecting the two circular arrows (panel d). Red boxes have been added to screenshots to illustrate selections. Note that *Fulcrum* can be used via a mobile app or desktop website and that the two are organized differently.