

PLOT BASED INVENTORY (PBI) FIELD MANUAL

*Procedural and Technical Guidance for
Collection of Plot Based Inventory Data*

*Plot Based Inventory program administered by the Resource Assessment Program of the
Minnesota Department of Natural Resources.*

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Internal Policy Framework Information - Manual

This manual a procedural document of the Division of Forestry. This page summarizes relevant internal policy information.

Document approved by:

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SECTION 1: PLOT BASED INVENTORY (PBI) FIELD PROCEDURES GUIDE



Figure 1. Photo credit: Nikki Nutzhorn

Overview

Gathering information on forested landscapes is becoming more efficient due to advances in field collection and remote sensing technology. The advancement of remotely sensed data to collect landscape scale forest information is becoming well understood, but additional advancement in this area is an ongoing process. Remotely sensed data in the traditional sense may provide us with some insight on what we can expect to see within our area of interest but falls short on quantifying the details of what is in that area. While information on the heights observed via remote sensing, or the detailed elevation and terrain information produced can provide important insights, questions regarding stand characteristics like Basal Area, Volume, Quadratic Mean Diameter, and other information remain unanswered.

The plot-based inventory (PBI) system is a first of its kind in Minnesota and joins only a few other states that have taken on the challenge of creating a forest inventory system that is specifically built to couple with remote sensing data. This inventory can be coupled with Lidar data, photogrammetric information, satellite information and radar, with the potential to couple with other emerging data moving forward. This inventory system couples precise Global Positioning System (GPS) with appropriately detailed forest information to generate key forest inventory metrics such as quadratic mean diameter (QMD), average and total height, volume (cords or cubic feet per acre) and above ground biomass per acre (AGB), which can be converted to carbon and CO₂ equivalent. The list of forest metrics continues to grow as new research and techniques become available.

Many people ask why you cannot just use information generated by the Forest Inventory and Analysis (FIA) program, a plot-based system that is well distributed. FIA data can be used in some limited capacity with remotely sensed data, but the plot design was not specifically created to couple with remotely sensed data. The highly accurate GPS information needed is lacking and the smaller plot design produces significant edge effects, which are greatly reduced with PBI design. FIA is a national program, which cannot adapt to the needs of one state. Minnesota must be self-sufficient, as priorities and funding of the FIA program are not guaranteed into the future. The goal of PBI is stand level estimates of important forest metrics. Our research has shown that this level of detail requires a different approach to sampling and sampling intensity compared to what the FIA program currently and will likely offer into the future.

The PBI approach to producing forest metrics is operationally novel for the state of Minnesota and is meant to adapt to innovation. Using a system that is technologically focused means that as innovation in the remote sensing and computing space occurs, we can adapt our methods and continue to innovate, leading to efficiencies that will reduce or keep costs consistent.

One thing that will not change is the need for field foresters. On the ground collection of forest information is critical. Forest inventory measurements cannot be connected to remotely sensed data without the careful, diligent work of foresters in the field. This manual is a guide to the protocol of measuring trees within a fixed area that the Resource Assessment Program's research has shown is needed to create forest inventory models combining on the ground data and remote sensing data. This protocol is dynamic and as technology and methodologies change, so will the guidance.

Methodology – Field Work Procedures

Field Equipment Overview

Plot based inventory (PBI) requires the use of electronic field equipment to navigate to plot center, collect a high precision Global Positioning System (GPS) location, and collect the plot information via Survey123. There are a variety of equipment configurations that may occur between Mobile Device Options and GPS receivers. As with all technology, there are updates, changes to display and other moving pieces that will require more frequent updating. Please refer to the [Plot Based Inventory \(PBI\) Field Technology Guide](#) section for detailed use instructions for the combination of equipment you are using. If you cannot find the most current version of guidance for the technology you are using, please contact Resource Assessment and we will provide updated materials for your device. The [Plot Based Inventory \(PBI\) Field Technology Guide](#) section will outline some of the combinations of field equipment that Resource Assessment is commonly using for PBI data collection.

Basic information on Field Technology can be found in the following sections....

- **GPS Information** - [Plot Based Inventory \(PBI\) Field Technology Guide](#)
- **Mobile Device Information** - [Plot Based Inventory \(PBI\) Field Technology Guide](#)
- **Survey 123 Application** - [Plot Based Inventory \(PBI\) Survey123 Guide](#)

Instructions for 4Trees devices are included in the [Plot Based Inventory \(PBI\) Field Technology Guide](#) section and include one-time setup instructions for connecting the device to your GPS receiver. If your device is not included in the guide, or if you are having difficulty setting up your device for PBI plots, please contact Resource Assessment for assistance.

Maintaining GPS Receivers and Mobile Devices while in the field is of the utmost importance and all effort should be taken to ensure their security. These devices are not waterproof, so please use extreme caution in adverse conditions. Additionally, battery life of mobile devices in extreme cold is always a concern. Keep them warm when not in use and if needed, use hand warmers and extra insulation around the device to ensure operation throughout the day.

Other equipment that is needed to complete a PBI plot that is supplied by Resource Assessment includes 8 pink pin flags, a pink flagging roll, aerosol tree marking paint and tube paint. In the event you would like to use something other than what RA supplies, please contact us to discuss. See [Tree Level Data](#) for more information.

Field gear needed to conduct fieldwork is the sole responsibility of those conducting the plot.

Determining Plot Locations

Before you can measure plots, you will need to be provided with the plot location information. Please make sure you have obtained and have reviewed the provided spreadsheet and shapefile for the plot locations from Resource Assessment. This Excel spreadsheet will give you all the information you need to know about the ownership (i.e., state, federal, etc.), county code (i.e., Itasca 61), forest area (i.e.,

Hibbing), plot id, plot name (i.e., 137_99), and the Latitude and Longitude coordinates to find plot center. The shapefile will show you spatially where your plots are located. Once you have received both files, you can now begin to plan fieldwork.

Navigate to Plot

Once you have figured out your field logistics you can begin to navigate to plot center using a recreational grade GPS device. There are many options for navigating to plot center with recreational grade GPS devices. Make sure you are confident in your location prior to establishing the plot. Allow GPS to “settle” on a position and check your location against aerial imagery, looking for defined landmarks on a map to determine reasonable proximity to the original projected plot location.

Establish Plot Area

Once you feel confident in the location that you have navigated to you can proceed with establishing the plot center. Establish plot center by placing three pin flags. Hang flagging from the nearest possible overhead location to aid in center relocation.

Place one pin flag and hang flagging in each cardinal direction (0, 90, 180, and 270 degrees) at 37.2' from the center pin flags (horizontal distance), which will separate the plot into four quadrants. Additional flagging and pin flags can be used around the perimeter of the plot as a visual aid to help determine which trees will be tallied in the plot.

Place one pin flag at the GPS tripod location. Select a GPS location that is within a gap in the canopy, within the plot area (closest possible location to plot center) and provides the best satellite reception available. Once the location is selected, measure the Azimuth and Distance from the plot center to the GPS pin flag. Attach bipod to range pole and screw on external GPS unit. Level the bipod and turn on the GPS. Ensure the GPS is logging data by following the instructions for your GPS and Tablet combination outlined in the [Plot Based Inventory \(PBI\) Field Technology Guide](#) section.

Please, leave all pin flags at the cardinal directions, GPS, and plot center locations for QAQC relocation. See [APPENDIX A – PLOT DESIGN](#) for diagram. One Witness Tree is required in each of the 4 quadrants. For explanation of Witness Tree, see [Tree Level Data](#).

PBI Survey

The Survey123 Application is used to collect PBI data. Instructions for using Survey123 from downloading through plot submission can be found in the [Plot Based Inventory \(PBI\) Survey123 Guide](#) section of the Manual.

There are 5 pages on the PBI survey: Identification, Plot Images and Geospatial Information, Tree Level Data, Plot Level Data, and GPS Data. See the [Plot Based Inventory \(PBI\) Survey123 Guide](#) for step-by-step instruction for working with the 5 survey pages. The following sections outline measurement protocols for all survey fields.

Identification (Survey Page One):

Lidar Block Name: Enter the Lidar block, found on the spreadsheet or attribute table in the supplied shapefile. This will also customize the species list in subsequent tabs. Refer to provided spreadsheet and shapefile for Lidar Block information.

County Code: Enter the county for which the plot you are collecting data for is located in.

Plot ID Number: Enter the pre-assigned plot ID number, found on the spreadsheet or attribute table in the supplied shapefile.

Plot ID Sequence: Automatically generated with a combination of County Code and Plot Number.

Date: This field is automatically generated with the current date.

Time: This field is automatically generated with the current time.

Organization: Enter the organization the Surveyor(s) is affiliated with.

Number of People: Select the number of people measuring plot data for the plot.

- Status of Person 1 (repeat for all surveyors): Select role of surveyor 1.
- Surveyor1 (repeat for all surveyors): Select name of surveyor 1 (Select other if not present)

Note: If your name is not listed, please contact RA and it will be added to the survey.

Plot Images and Geospatial Information (Survey Page Two):

Device Type: Select the type of GPS device used at plot location.

Point: Record a GPS point using the mobile device. Tap the “cross-hairs” symbol when standing at plot center and it will collect the location of the survey. Refer to the map for accuracy. A coordinate is also displayed on the map. Check coordinate to assure collected location is within the proximity of your location. DO NOT edit this point in the office when making edits to the survey. This will result in the survey location moving. Contact Resource Assessment if you accidentally move a plot location when editing a survey.

You can also choose a point on the map, by selecting the “map” icon next to the “cross-hair”. You can then move the map to your location and drop the pin there. If you are not sure of your location on the map do not guess. Use the crosshair to find your location. If you have the latitude/longitude value for the plot from another device (a handheld Garmin for example) or recorded, you can enter the coordinates or move the map to the location.

Do you require technical Explanations? Toggle Yes on this button to reveal explanations for fields.

Turning on the explanations will only supply surveyor with additional information about fields. Use this selection if you are uncertain of information on the page.

Image North, East, South, West and Vertical:

To take Plot Images:

- Stand at plot center
- Determine Image direction (North, East, South, West, Vertical)
- Select the Camera Icon associated with the direction. Images can also be selected from storage by selecting the folder icon.
- Facing the selected image direction, at chest level, with the camera in landscape orientation, take a picture of the plot area.
- Try to have the pin flags and flagging visible in the picture.
- For the Vertical Image, face North, turn skyward and take a vertical picture straight up from plot center.
- Check the images to ensure they are of sufficient quality and are not blurry.

Tree Level Data (Survey Page Three):

Determine if a Tree will be measured on a PBI plot using the following protocol.

- All “LIVE” trees greater than 5.0 inches in diameter at breast height or DBH, (DBH is defined as diameter of bole 4.5 feet above ground level on the uphill side), that fall inside the 37.2-foot radius plot will be measured, regardless of lean angle.
- All “DEAD” trees greater than 5.0 inches DBH and that have a lean angle of less than 45 degrees from vertical (from the ground to breast height) will also be measured.
- Any “DEAD” status tree 4 feet or less in height will not be tallied.
- All borderline trees “LIVE or DEAD” will be measured to the centerline of the pith at the root collar.
- Trees are considered “DEAD” when a sample of the cambium at DBH contains no green cambium tissue.
- Leaning trees supported by other trees will be tallied if the lean angle is less than 45 degrees. “DEAD” stems with a lean angle greater than 45 degrees from vertical will be considered dead and “DOWN” and will not be tallied.
- Any tree that is separated from the stump though it may be supported by other trees will not be tallied.

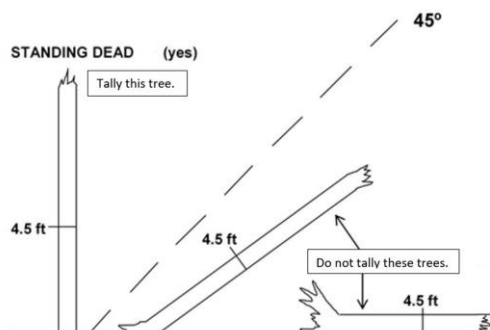


Figure 2. Trees greater than 45 degrees and at least 5.0 inch at 4.5 feet and are at least 4.5 feet in unbroken ACTUAL LENGTH are considered STANDING DEAD. Trees less than 45 degrees are not measured (source: FIA)

- Trees 5-inch DBH or greater (and at least 4.5 feet tall/actual length), with lean angle, greater than 45 degrees are considered “STANDING DEAD”. Trees with lean angle less than 45 degrees are not measured. They are considered “DEAD and DOWN”. [\(Figure 2\)](#)

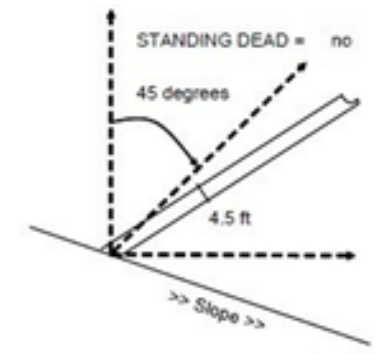


Figure 3. Tree is at least 5.0 inch at 4.5 feet and is at least 4.5 feet in unbroken ACTUAL LENGTH, but the lean angle from the vertical is more than 45 degrees are not considered STANDING DEAD (source: FIA)

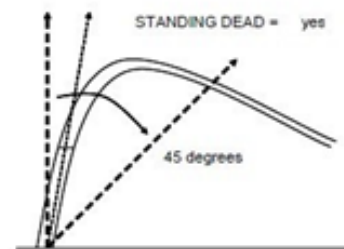


Figure 4. Tree is at least 5.0 inch at 4.5 feet and is at least 4.5 feet in unbroken ACTUAL LENGTH, and the lean angle from the vertical is less than 45 degrees is considered STANDING DEAD (source: FIA)

Fill in the following fields using the outlined protocol below as you collect your tree level data.

Trees Present: Indicate if there are any 5” DBH or greater trees present on the plot. If “No” continue to Plot Level Data. If “Yes”, an additional field titled **pbi.pbi.PBI_Tree_Data** and a “plus-sign” sign will appear. This field will be used to add tree records (detailed below).

Redundant “yes” statement to help preserve tree data: If trees are present, please select this button to assure no tree data loss. This acts as a double lock if you change the “Trees Present” value to “No”.

Do You require technical Explanations: Toggle “Yes” on this button to reveal explanations for fields. Turning on the explanations will supply surveyor with additional information about fields. Use this selection if you are uncertain of information on the page.

pbi.pbi.PBI_Tree_Data: To add a tree record tap the “plus-sign” to begin a new tree to the plot area. A section titled “Tree Level Data on Plot” will now be displayed.

Tree Number: Beginning from North (000 degrees) and continuing in a clockwise direction, number trees beginning with 1, 2, 3... etc. Use aerosol tree marking paint to mark the trees with their numbers to keep track of trees tallied. Note: If marking trees in a sensitive area (I.e., State Park), please refrain from using tree marking paint.

Tree Species: From the dropdown menu, select the species of the tree you are tallying.

Quadrant: Identify the tree's quadrant: (See [APPENDIX A – PLOT DESIGN](#) for diagram)

- Quad 1 (0-90 degrees)
- Quad 2 (91-180 degrees)
- Quad 3 (181-270 degrees)
- Quad 4 (271-360 degrees)

Tree Status: Identify the current tree status (Live codes 1-2, Dead codes 3-5). Identify tree status by chart below ([Figure 5](#)). For each tally tree (≥ 5 " DBH) record the code indicating the tree's status. Trees are considered "DEAD" when a sample of the cambium at DBH contains no green cambium tissue.

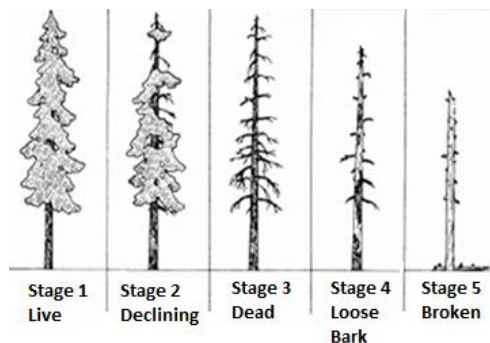


Figure 5. Tree decay status (source: USDA)

Table 1. Guidance in identifying tree decay classes (source: FIA).

Status	Status Description	Top	% Bark Remaining	Sapwood Presence/Condition	Heartwood Condition	Status 2 Description
1	1 - All Features Present	Pointed	100	Intact, Sound, No Decay, Hard, Original Color	Sound, Hard, Original Color	Live
2	2- Dieback begins from Upper and Outer portions of the tree	May be Broken	Variable	May be Sloughing; Minor Decay, Firm to Soft, Light Brown	Sound at Base, Incipient Decay in outer edge of upper bole, Hard, Light to reddish brown	Live, but Declining
3	3 – All Present	Pointed	Variable	Intact; Sound, Incipient Decay, Hard, Original Color	Sound, Hard, Original Color	Dead
4	4 – Few limbs, No Fine Branches	Broken	Variable	Sloughing; Advanced Decay, Fibrous, Firm to Soft, Light Brown	Sound at Base, Incipient Decay in outer edge of upper bole, Hard, Light to reddish brown	Dead Loose Bark
5	5 – Limb Stubs, or None	Broken	Less Than 20%	Sloughing; Fibrous, Soft, Light to reddish brown or gone	Incipient decay at base, Advanced decay in upper bole	Dead Broken

DBH: Record the diameter of all trees within the plot (37.2' radius) greater than or equal to 5.0-inch DBH (*Always round down to the nearest tenth of an inch*).

- If deformity, canker, swell or damage at DBH exists, follow up the stem until normal form resumes. If normal form is out of reach follow down the stem from DBH until normal form resumes, if neither case applies, estimate DBH to the best of your ability.
- Record diameter collection height if not taken at DBH in the Tree Remarks field (detailed below).
- If forked below 4.5' and above the one-foot stump as separate trees. From the pith intersection, measure up 3.5 feet and take DBH at that location. If forked at or above 4.5', measure as one tree. Estimates are only allowed if the tape cannot be passed between the stems of forks or if deformities exist. Individual trees can only fork once, ignore second fork. If a forked stem forks again before 3.5' up the fork, measure DBH below the second fork. See (Figure 6) and (Figure 7).

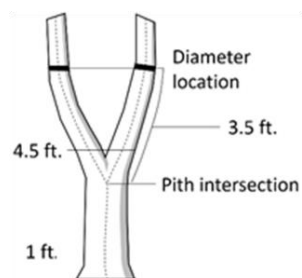


Figure 6. How to Measure Forked Trees (source: FIA)

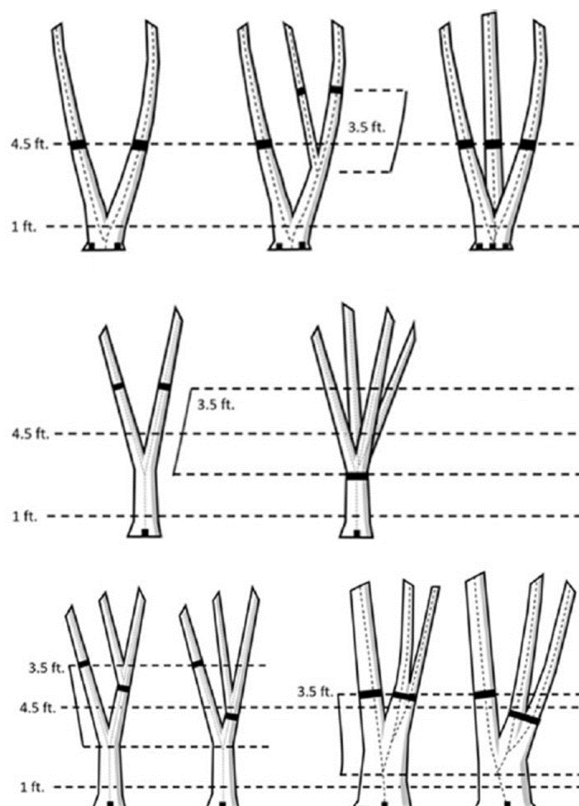


Figure 7. Summary of Where to Measure Diameter on Forked Trees (source: FIA)

Total Height: Measure and record the total height (bole length) of each tree, to the nearest foot. Height shall be measured from the ground to the highest live foliage/branch/point as accurately as possible.

Follow along the bole to measure the length of the tree, not the vertical height of the tree, see [\(Figure 8\)](#).

The length of the bole more closely represents actual volume. If the tree has significant lean or bends toward the top, bole length and vertical height can be significantly different. Lidar captures the vertical height of the tree, and the bole length measured on PBI plots is intended to provide more detail to volume estimation.

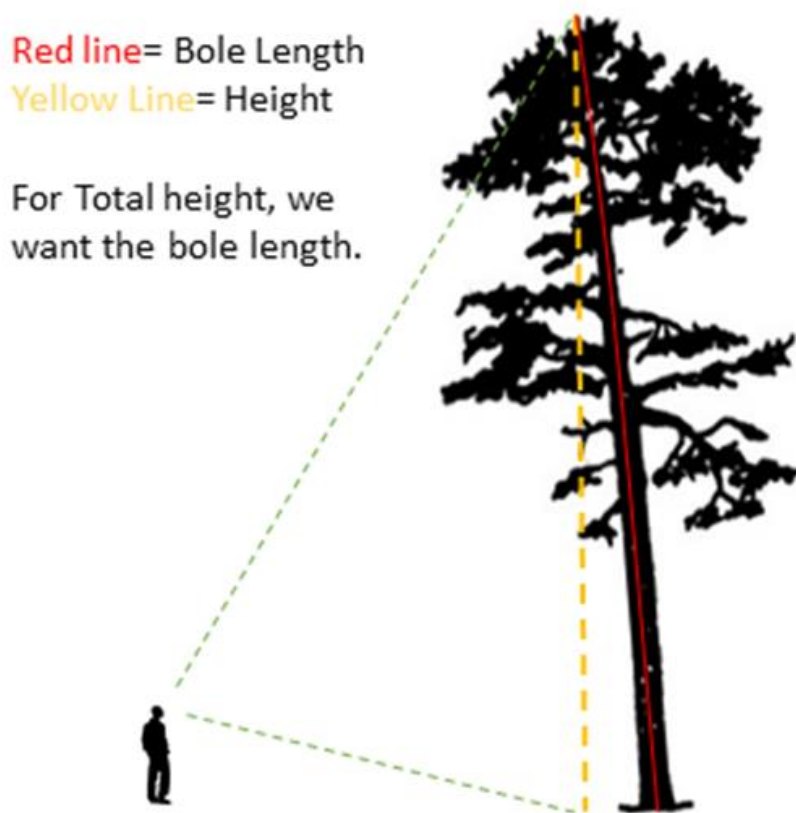


Figure 8. Measurement of Bole Height vs Total Height

Merchantable Height: Measure and record merchantable height of each tree, from ground along the length of the trunk to the 4-inch diameter, or last merchantable section of the tree. Do not stop sawlogs at 9 inches; follow all trees to the 4-inch top or merchantable break point.

Crown Canopy Class: Determine and record the current crown class for each tree. Values: Remnant, Dominant, Co-dominant, Intermediate, Overtopped. See [APPENDIX D – CROWN CLASS DIAGRAMS](#).

The following is a systematic approach to assigning crown class:

- Determine the midpoint of the canopy of the neighboring trees
- Determine the height to the top of the crown
- Determine where the crown is receiving direct light
- Determine how crowded the crown is

Once the above items have been evaluated, a combination of each will be used to assign CCC:

If the top of the crown is **below the midpoint**, consider the amount of light received:

- If it receives no light, code “Overtopped”
- If it receives some light but is very crowded, code “Intermediate”

If the top of the crown **reaches the midpoint**, consider light received and how crowded it is:

- If it receives no light, code “Overtopped”
- If it receives some light but is very crowded, code “Intermediate”
- If it receives some light and is somewhat crowded by similar crowns, code “Co-dominant”

If the top of the crown **extends above the general level**:

- If it receives significant light, and is **taller** than the average trees, code “Dominant”
- If it receives significant light, and is **not taller** than the average trees, code “Co-Dominant”

If the crown has **no neighbors** (lone tree in an open area), or is a **mature tree left standing** in an area previously cleared, it should be called a “Remnant”

***Witness Tree:** Choose and monument one witness tree per quadrant. Witness trees should be the best-formed, longest-lived, dominant tree within each quadrant greater than 5” DBH. Paint these trees with a roughly 2” Diameter “X” at 4.5’ (DBH), using tube tree paint, and facing plot center. These trees will be used for QAQC and revisitation purposes. Selecting the option for “Yes” under “Witness tree” will add additional fields to the survey.

- **Azimuth (0-360°):** Measure from plot center to pith of the tree at the base.
- **Distance:** Measure the horizontal distance to the nearest 1/10th foot from the plot center to the pith of the tree. Keep the tape level (0% slope) between the plot center and the tree. This may require lifting or lowering the tape at either end if measuring on a hill. When direct horizontal distance cannot be accurately measured due to steep terrain, apply slope correction to the measurement (see [APPENDIX B - HORIZONTAL SLOPE CORRECTION](#)).

***Site Index Tree:** A minimum of one site index tree per plot shall be measured. Site Index trees shall be one of the four Witness trees that exist on the 37.2’ radius plot. Select a Site Index tree that represents the main species of the plot when possible. Select a dominant or co-dominant tree that is free to grow and free from defects, disease, edge effect, poor form and is not suppressed, leaning, or a remnant tree. Selecting the option for “Yes” under “Site Index Tree” will add an additional field to the survey.

- **Ring Count:** Core tree at DBH and record ring count encountered at DBH. Do not add establishment years to ring count.

**Exceptions for Witness and Site Index Trees: If there are not trees present greater than 5” DBH, then no Witness or Site Index Trees will be recorded. There may be exceptions where you may collect a site index tree that is not also a witness tree due to having large, remnant trees that do not represent the main species, but are present in the quadrant alongside the largest, free to grow example of a tree of the main species for site index measurement. Your witness tree may be the large remnant, while the site index tree may be the large free to grow tree that represents the main species. In this case, please record one as a witness tree and the other as a site index tree. Mark the site index tree with an “S” and follow the witness tree protocol above.*

Remark: Note anything about the tree that you feel we should know. Include such things as: forks, broken/dead tops, leaning or windblown, etc.

Continue to add trees as you encounter them clockwise around the entire plot.

Plot Level Data (Survey Page Four):

Do You require technical Explanations: Toggle “Yes” on this button to reveal explanations of fields. Turning on the explanations will supply surveyor with additional information about fields. Use this selection if you are uncertain of information on the page.

Plot Description: Identify the hydromorphic status of the plot area

- **Xeric:** Dry, nutrient poor (Snow Covered option as well)
- **Hydric:** Poorly drained, nutrient rich or poor (Snow Covered option as well)
- **Mesic:** Well-drained, nutrient medium to rich (Snow Covered option as well)
- **Unknown:** Hydromorphic status unknown (Snow Covered option as well)

Forester Estimated Coverture: From the dropdown menu, identify the covertype of the area represented on the plot. Do not consider covertype condition outside of the plot area.

Confidence in Estimation: On the sliding scale, identify the confidence of your covertype estimation. This will allow for identifying additional evaluation that may need to be done. Do not assign 100% confidence unless you are sure of the covertype.

How many regen species are there? From the sliding scale, identify the number of species 4.9” or less you see on the plot. Additional fields for Regeneration will now be displayed.

- **Regen Species 1-10:** From the dropdown menu select the regeneration species beginning with highest / most abundant species and working down to shortest / rarest species on the plot.
- **Regen Species X Size:** Identify the average size of each species of regen within the plot area. If there are multiple size classes present of the same species, only record the single most representative size class for an individual species. (0-0.9”, 1-2.9”, 3-4.9”)
- **Regen Species X Density:** Estimate the density of each regen species from the drop-down menu (1: 0-10 stems/plot; 2: 11-20 stems/plot; 3: 21-30 stems/plot; 4: 31-40 stems/plot; 5: 41-50 stems/plot; 6: 50-100 stems/plot; 7: 101-300 stems/plot; 8: 301-600 stems/plot; 9: 601-1000 stems/plot; and 10: 1000+ stems/plot).
- **Regen Distribution:** Identify the distribution of each species of regen on the plot
- (1: Distributed throughout the plot; 2: Distributed in clusters in the plot; and 3: Single cluster within the plot).

Plot Remark: Record any remarks regarding the plot condition. Include access issues, disease, hazards, unique conditions, seasonality, relocation hints, windthrow, etc. *Note: There is a 140-character limit in this field.*

GPS Data (Survey Page Five)

Prior to beginning data collection on the plot, GPS logging should have been initiated. Refer to the [Plot Based Inventory \(PBI\) Field Technology Guide](#) for instruction on logging the GPS location and saving the resulting file.

Do You require technical Explanations? Toggle Yes on this button to reveal explanations for fields. Turning on the explanations will supply surveyor with additional information about fields. Use this selection if you are uncertain of information on the page.

Device ID: Use the drop-down menu to select the device used. If your device is not listed, match the device Item Asset# ID# as closely as you can or select “Don’t Know” from the list.

If your device is not listed, please contact Resource Assessment and it will be added to the survey. You can also add your Device to the Plot Remarks for reference until added to the list.

Distance from Plot Center to GPS: Record the horizontal distance to tenths of feet (XX.X feet) from plot center to the GPS. Horizontal distance is measured by keeping the tape level (0% slope) between the center pin and the GPS. This may require lifting or lowering the tape at either end if measuring on a hill

Azimuth from Plot Center to GPS: Record the azimuth in whole degrees (XXX°) from plot center to GPS.

Zipper Folder: Select the “paper clip” attachment icon to find and attach the folder you would like attached to the survey.

Submitting the Plot

Upon completion of the five survey tabs, submit the plot data by clicking the checkmark in the lower right-hand corner of the Plot Data Form.

Many of the fields are marked with a *red* asterisk. These are required fields. Survey123 requires you to complete these fields before you can submit the plot. It is recommended to carefully check the data and completely fill out each tree before moving on to the next.

There will be a prompt to “Send Now”, “Continue Survey”, or “Save this Survey in the Outbox”. If you have reviewed and have no changes to make, have a connection that allows submission, and want to send, select “Send Now”. If you are not ready to submit the survey, select “Save this Survey in the Outbox”. *You will not see the option to “Send Survey” if you do not have a connection that allows for submitting the plot.*

Before You Leave the Plot Area

Check list:

- Four witness trees are painted
- Site index tree data was collected and painted
- Pin flags and ribbon left to monument plot and GPS location
- Survey123 forms are completed and saved to the Outbox or Sent.
- Do I have the GPS, tablet, and tripod?

QAQC

The QAQC protocol is a process of re-measuring plot data and conducting an evaluation of the data collected. RA commits to measuring approximately 10% of all plots collected within a fiscal year. This may be a simple analysis of the database as plots are submitted to look for inconsistencies or missing data or may be a field check of collected data to assess quality.

The purpose of Quality Assurance sampling is to identify trends in data collection that may result in inaccuracies of resultant model relationships and correct them on an individual and collection wide scale. Understanding what an acceptable level of error vs. a problematic level looks like can be difficult.

Resource Assessment has developed a table for tolerances and standards that outlines measured values, the tolerance for error in the measurement, the percentage of time that measurement is expected to be within tolerance, the type of inventory data and whether the value is evaluated in a field or office setting.

Refer to the table below for tolerances for each measurement.

Table 2. QAQC Standards and Tolerances

label	Tolerance	Percent of the time	Type	Evaluated by field visit
Lidar Block Name	No Error	100%	Plot	Yes
County Code	No Error	100%	Plot	Yes
Plot ID Number	No Error	100%	Plot	Yes
Plot ID Sequence	No Error	100%	Plot	Yes
GPS Plot Center	<= 2 meters HA	100%	GPS	No
Trees Present	No Error	100%	Plot	Yes
Tree Count	No Error, 2/10ths of a foot standard for missed or added	100%	Plot	Yes
Tree Species	1 tree per plot, no error on genus	100%	Tree	Yes
Quadrant	1 tree for trees within +/-5 degrees of 90,180,270,360 degrees	100%	Tree	Yes
Tree Status	1 class error for living status and dead, no errors between live class and dead class	60%	Tree	Yes
DBH	plus/minus 2/10ths of an inch for status 1 & 2, +/- 0.5 inch for status 3-5	95%	Tree	Yes
Total Height	plus/minus 10% of RA re-measure, all status codes	100%	Tree	Yes
Merchantable Height	plus/minus 20% of RA re-measure, live trees only status code 1 & 2	100%	Tree	Yes
Crown Canopy Class	No Error for dominant, 90% on the remaining non dominant	100%, 90%	Tree	Yes
Azimuth	plus/minus 10 degrees	100%	Witness Tree	Yes
Distance	plus/minus 1 foot <36.2, 2/10ths of a foot for >36.2	100%	Witness Tree	Yes
Ring Count	plus/minus 10% of ring count	100%	Site Index Tree	Yes
Run TOST test to look at equivalence	Must find no evidence for dissimilarity in one of the tests (DBH or Height)	100%	Plot	No

SECTION 2: PLOT BASED INVENTORY (PBI) FIELD TECHNOLOGY GUIDE



Figure 9. Trimble R2 GPS Receiver (Left), Samsung Galaxy Tab A Mobile Device (Bottom) and PBI Plot Area (Top)

Introduction

The accuracy and usability of Plot Based Inventory (PBI) is largely dependent upon continued development of technology. Changes in technology are continuous and provide new opportunities for efficiency, accuracy, and dependability.

Collection of PBI data also requires the ability to collect high accuracy GPS data, as well as accurate plot and tree level information on a mobile data recorder. The collection of GPS data also requires a connection between the GPS receiver and the mobile device. Not all GPS and mobile devices are compatible with each other, but there are a variety of combinations that can be used together. The combinations utilized by Resource Assessment are outlined in this guide.

This guide also aims to provide the user an up-to-date version of applicable guidance. Software and application versions may change frequently. The change in versions may not change the guidance for using them, but some updates will result in display, setting and instruction step changes, requiring the guide to be updated at a more regular interval.

For DNR employees, current versions of guidance will be made available on the [DNR PBI Equipment Teams Channel](#) and links to all relevant documents can be found on the [DNR PBI Equipment SharePoint](#) site.

Contact Resource Assessment if you would like to be added to the Teams Channel

Additionally, updated versions to the guidance will be made available to partners and contractors upon request. If significant changes are made to parts of the technology guidance, updated user guides will be sent to those partners that are using the applicable devices.

Please contact Resource Assessment for access to updated guidance.

Available Technology

Mobile Device Overview

There are a growing number of options available when collecting mobile data. Currently Resource Assessment will provide guidance to the subset of mobile devices that are being managed by RA staff.

The basic requirement for mobile device compatibility with PBI plot collection is that the device can run Survey123 and is compatible with the collection of GPS data using established GPS receivers. If you are planning on using a mobile device that is not included in this guidance and still meets the requirements above, please contact RA to confirm the use of the device.

Available devices may run a variety of operating systems including Android, iOS, and Windows systems. Compatibility of GPS receiver and Survey 123 has been pre-determined and tested.

The following Devices will be covered in the guide.

- [Samsung Galaxy Tab A](#)
- [iPad mini generation 5/6](#)
- [iPhone generation 11/12/13](#)

Samsung Galaxy Tab A

Samsung Galaxy Tab A devices are available from Resource Assessment and will generally be used by contractors and partners. DNR staff should use 4Trees Devices, when possible, but may use Tab A devices as needed.

Update to most currently available Android version on devices prior to using the guide. As updated versions become available, changes to instructional guidance will follow.

See below for general locations of Samsung Galaxy Tab A features. ([Figure 10](#))



Figure 10. Image showing the locations of the necessary features of the Samsung Galaxy tablet

iPad Mini Generations 5/6 (4Trees Devices)

iPad minis are used by DNR staff and are NOT provided by Resource Assessment. Follow user guides for setting up your device for use on PBI plots. Steps for installation of appropriate applications are included in this guide.

This user guide will cover instructions based on use with an iPad mini sixth generation device. The instructions for an iPad mini 5th generation should follow the same workflow. Update to most currently available iOS version on devices prior to using the guide. As updated versions become available, changes to instructional guidance will follow.

See below for general locations of iPad Mini features. ([Figure 11](#))

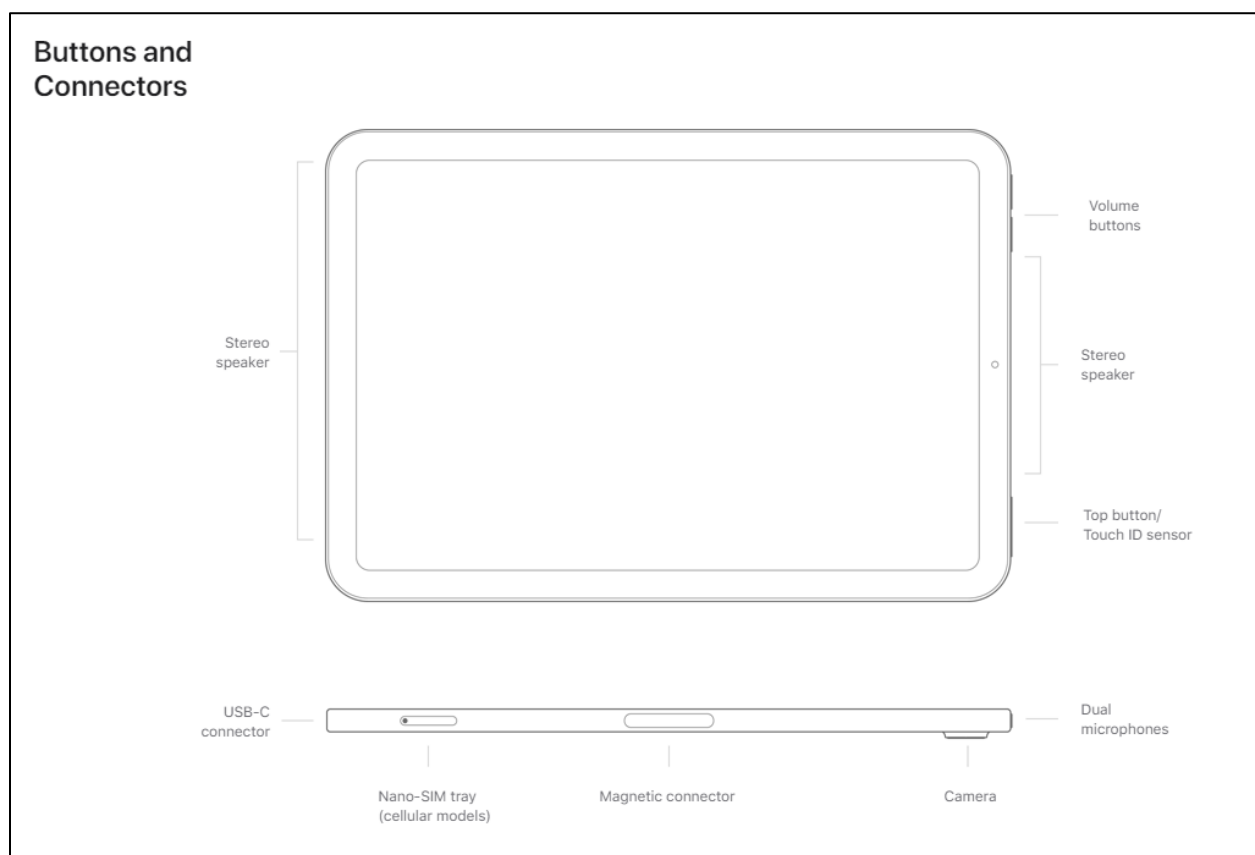


Figure 11. Image showing the locations of the necessary features of the iPad mini 5/6

iPhone Generations 11/12/13 (4Trees Devices)

iPhones are used by DNR staff and are NOT provided by Resource Assessment. Follow user guides for setting up your device for use on PBI plots. Steps for installation of appropriate applications are included in this guide.

Update to most currently available iOS version on devices prior to using the guide. As updated versions become available, changes to instructional guidance will follow.

See below for general locations of iPhone features. ([Figure 12](#))

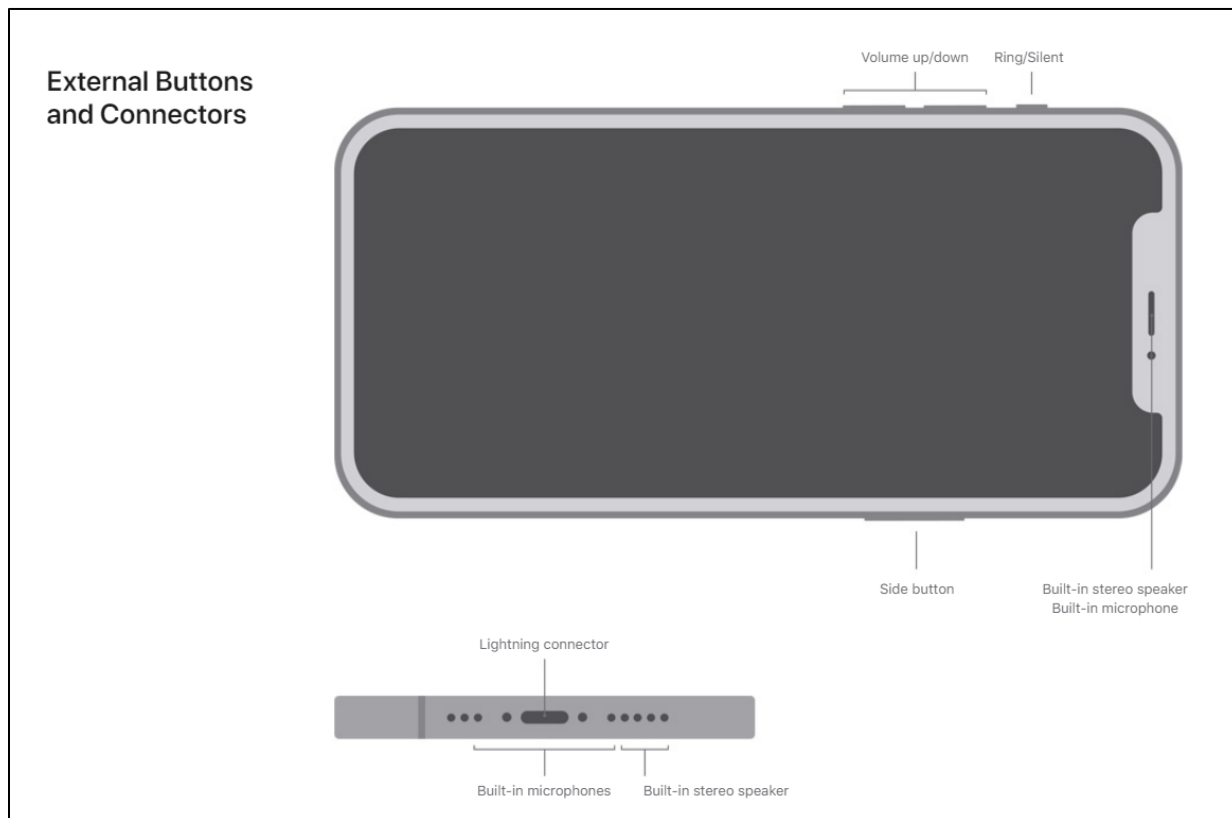


Figure 12. Image showing the locations of the necessary features of the iPhone generation 11/12/13

GPS Overview

High accuracy GPS data collection is the foundation of PBI, and collection of accurate and correctly formatted GPS locations is essential to modeling Forest Inventory Data. There are a variety of options for collecting GPS data on PBI plots. Guidance will be provided on a subset of devices used and recommended by Resource Assessment. Additional devices may provide the necessary GPS precision for PBI plots. Please check with Resource Assessment for more information on your GPS and its use on PBI plots.

Available GPS receivers are compatible with a variety of operating systems including Android, iOS and Windows based systems. Compatibility with these systems has been pre-determined and tested. When using a new device, assure compatibility and test workflows prior to going into the field. Testing products and workflows before going into the field could potentially save the user a lot of time and frustration.

The following GPS Receivers will be outlined in this guide.

- [Emlid Reach RS2](#)
- [Trimble R2](#)

The *Emlid Reach RS2* and *Trimble R2* act as mobile “hotspots” that can be connected to your mobile device in the field. A standard operation would be to connect to the device from your tablet using the Wi-Fi connection, identifying the unit from the list of available networks, and connecting to the device in the same way you would connect to any other Wi-Fi network. Refer to GPS Setup instructions for your device for further detail on connecting your GPS to a mobile device.

Once your mobile device is connected to your receiver you will be able to connect to an application or a URL to complete the collection of your location and download the resultant files.

Your downloaded files will attach to the Survey123 application and be sent to Resource Assessment over a Wi-Fi or data connection (Cannot use GPS connection to submit plots).

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Emlid Reach RS2

The Emlid Reach RS2 is currently the most used GPS unit deployed for PBI plot collection. GPS collection with the Emlid is achieved through connection to the internal Wi-Fi produced by the unit and connects through an application that is stored on the mobile device.

The Emlid Reach RS2 is compatible with all the listed mobile devices and the instructions for each device remain relatively constant due to the application-based workflow. Update the application to the most current version for this guidance.

See below for general locations of Emlid Reach RS2 features. ([Figure 13](#))

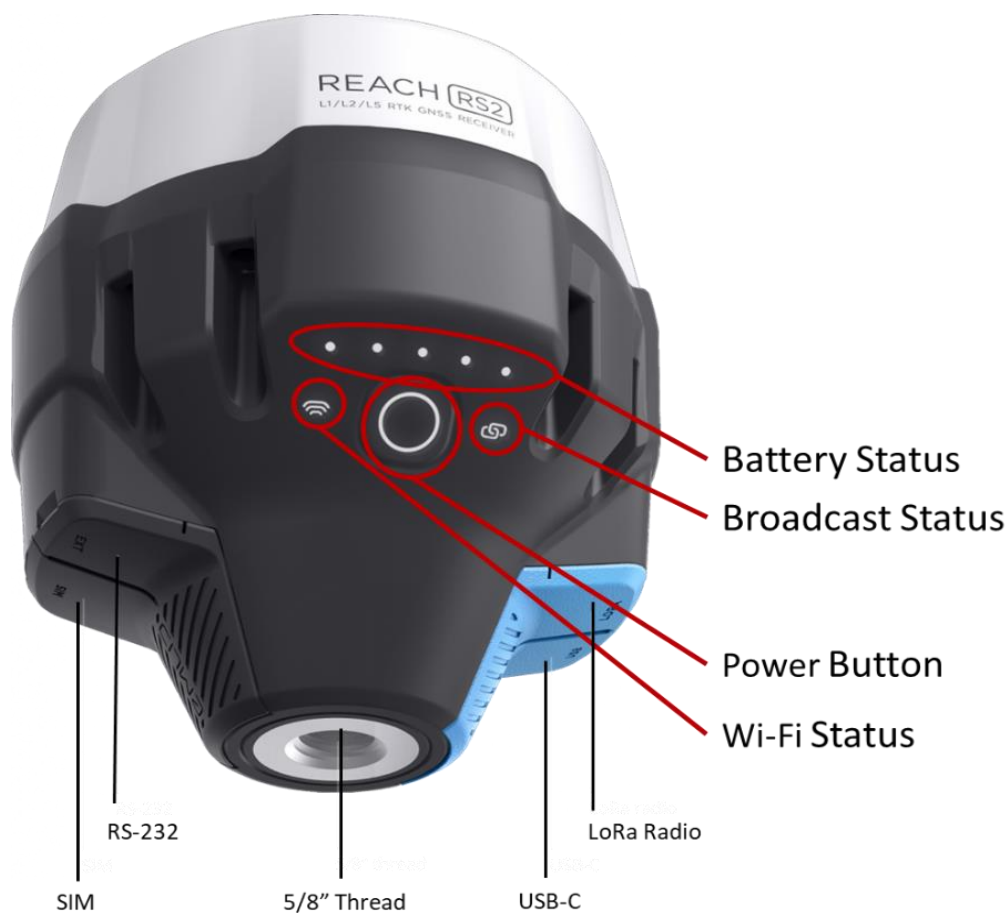


Figure 13. Image of the Emlid Reach RS2 GPS with red circles showing the button functions and connection ports

Trimble R2

The Trimble R2 is currently used as a GPS unit deployed for PBI plot collection. GPS collection with the R2 is achieved through connection to the internal Wi-Fi produced by the unit and connects through a URL that can be stored on the device for accessing the receiver.

Trimble also offers software options for connecting with and recording data from GNSS receivers. Those options are not covered in this guide. If using an alternate workflow than outlined, please contact Resource Assessment to confirm the workflow prior to collecting GPS Coordinates.

The R2 is compatible with all the listed mobile devices and the instructions for each device remain relatively constant.

See below for general locations of Samsung Galaxy Tab A features. ([Figure 14](#))



Figure 14. Image of the Trimble R2 GPS showing the button functions and connection ports

Workflows

Within this section steps for setting up and updating your device will be outlined. The guidance in this section includes downloading the correct applications or URL locations for completing PBI plots, managing the settings for the GPS and mobile devices prior to collection, collecting and downloading GPS data, and attaching and submitting downloaded data with Survey123.

The following sections within the Workflow document can be found within this guide. Refer to the Table of Contents for links to the sections within the document or select the corresponding links provided below:

[Getting Started with your mobile device\(s\)](#)

- [Understanding your mobile device](#)
- [Check for and install updates](#)
- [Set up accounts and download Applications](#)

[Emlid Reach RS2 GPS SET-UP](#)

- *Instruction covers All Devices*

[Trimble R2 GPS SET-UP](#)

- *Instruction covers All Devices*

[Emlid Reach RS2 – GPS FIELD OPERATION](#)

- [Plot GPS Establishment](#)
- [Samsung Galaxy Tab A Download Instructions](#)
- [iPad Mini Download Instructions](#)
- [iPhone Download Instructions](#)

[Trimble R2 – GPS FIELD OPERATION](#)

- [Plot GPS Establishment](#)
- [Samsung Galaxy Tab A Download Instructions](#)
- [iPad Mini Download Instructions](#)
- [iPhone Download Instructions](#)

[Attaching downloaded GPS files to Survey123](#)

- [Samsung Galaxy Tab A](#)
- [iPad mini generation 5 or 6](#)
- [iPhone 11,12 or 13](#)

Getting Started with your mobile device(s)

Understanding your Mobile Device

- Getting started with using a mobile device begins with understanding the device. Please refer to the links below for User Manuals for all the mobile devices outlined within this Guide.
 - iPad mini 5 or 6
 - [*iPad mini \(5th generation\)*](#)
 - [*iPad mini \(6th generation\)*](#)
 - iPhone 11, 12 or 13
 - [*iPhone 11*](#)
 - [*iPhone 12*](#)
 - [*iPhone 13*](#)
 - Samsung Galaxy Tab A
 - [*Samsung Galaxy Tab A User Guide*](#)
- Once you have become familiar with your device, please make sure to check the device in an office setting on a reliable Wi-Fi connection for updates.

Check for and install updates

- ✓ Requires Wi-Fi connection
- ✓ Make sure battery is charged prior to updating your device.
- ✓ Allow for sufficient time to complete updates
- ✓ If you have collected PBI data prior to update, send all collected data prior to updating.
- Instructions for updating devices can be found below.
 - iPad mini (5 or 6)
 - [*Update iOS on iPad - Apple Support*](#)
 - iPhone (11, 12, 13)
 - [*Update iOS on iPhone - Apple Support*](#)
 - Samsung Galaxy Tab A
 - [*Check for a software update on your Galaxy phone or tablet \(samsung.com\)*](#)

Set up accounts and download Applications

- iPad mini (5 or 6)

Access and Device Setup

- For DNR staff, the use of 4Trees devices for PBI collection is preferred
- Contractors and other partners are free to use their own iOS devices
- The guidance will cover instructions for more common versions of iOS devices that are currently deployed within the DNR
- With iOS devices, you will need to have an Apple ID

- The assumption is made that your device is fully set up and updated to the most current iOS version. For questions on 4Trees device management contact DNR MNIT staff

Download Applications from the App Store

- Find the App Store by returning to the home screen and selecting the App Store icon
- Search for and download the following apps to the device if not already installed
 - **ArcGIS Survey123**
 - **ReachView3** (If using Emlid Reach RS2 Receiver)
 - **Avenza Maps** (Optional)
 - **Google Chrome** (Needed for connection to Trimble R2)
- Following installation, organize the applications on your home screen for ease of access

Setting up file path for downloads (*Figure 15*)

- From your home screen, navigate to your files icon and open your device storage
- Navigate to “On my iPad”
- Add a new folder by pressing on the blank area of the screen and holding down until a banner comes up
- Select “New Folder”
- Name the Folder “PBI_GPS”

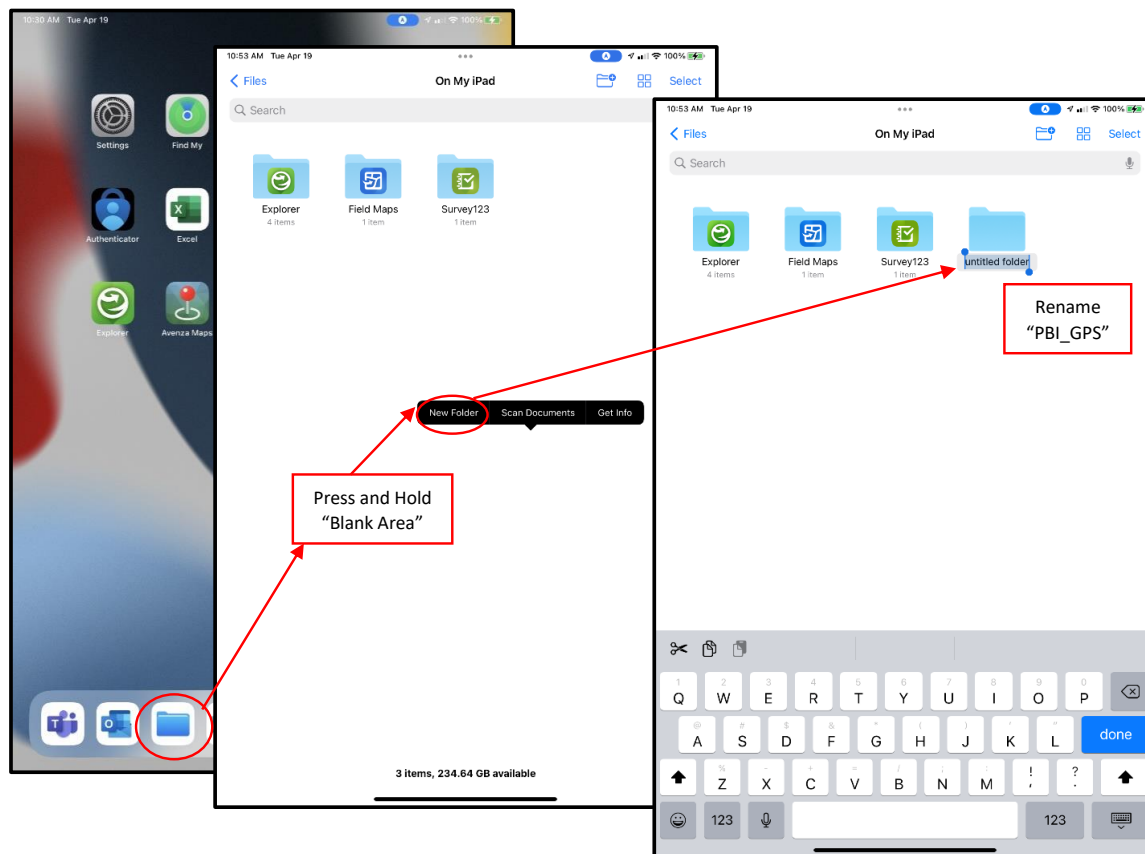


Figure 15. Images of the workflow for creating a folder on an iPad mini 5/6 with red circles and arrows showing the workflow.

- iPhone (11,12,13)

Access and Device Setup

- For *DNR staff*, the use of 4Trees devices for PBI collection is preferred.
- *Contractors* and other partners are free to use their own iOS devices.
- The guidance will cover instructions for more common versions of iOS devices that are currently deployed within the DNR.
- With iOS devices, you will need to have an Apple ID.
- The assumption is made that your device is fully set up and updated to the most current iOS version. For questions on basic operations and management of 4Trees devices contact DNR MNIT Staff.

Download Applications from the App Store

- Find the App Store by returning to the home screen and selecting the App Store icon.
- Search for and download the following apps to the device if not already installed.
 - **ArcGIS Survey123**
 - **ReachView3** (*If using Emlid Reach RS2 Receiver*)
 - **Avenza Maps** (Optional)
 - **Google Chrome** (Needed for connection to Trimble R2)
- Following installation, organize the applications on your home screen for ease of access.

Setting up file path for downloads

- Refer to instructions highlighted in the iPad mini 5/6 section for guidance
 - i. iPhone and iPad devices operate on iOS operating systems and workflows should largely mirror each other. If significant deviation from the workflow is identified, an update to the section will be considered. Contact Resource Assessment for questions.

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- Samsung Galaxy Tab A

Access and Device Setup

- Galaxy Tab A requires a Gmail account for downloading applications
 - *DNR staff* may create an Area account – (**DO NOT USE A PERSONAL ACCOUNT**)
 - Create a Gmail account using the instructions below
 - [Create a Gmail account - Gmail Help \(google.com\)](https://www.google.com/help/gmail/create-account)
 - *Contractors* will use the following account information
 - **Email:** mn.dnr.ra@gmail.com
 - **Password:** **CONTACT RA FOR PASSWORD**
 - Once you have determined your account, navigate to your settings, open the icon for Google Services and sign into your Gmail account ([Figure 16](#))
 - There will be additional prompts for terms of agreement and other settings. Once you are through the prompts you will be logged in and ready to download Applications

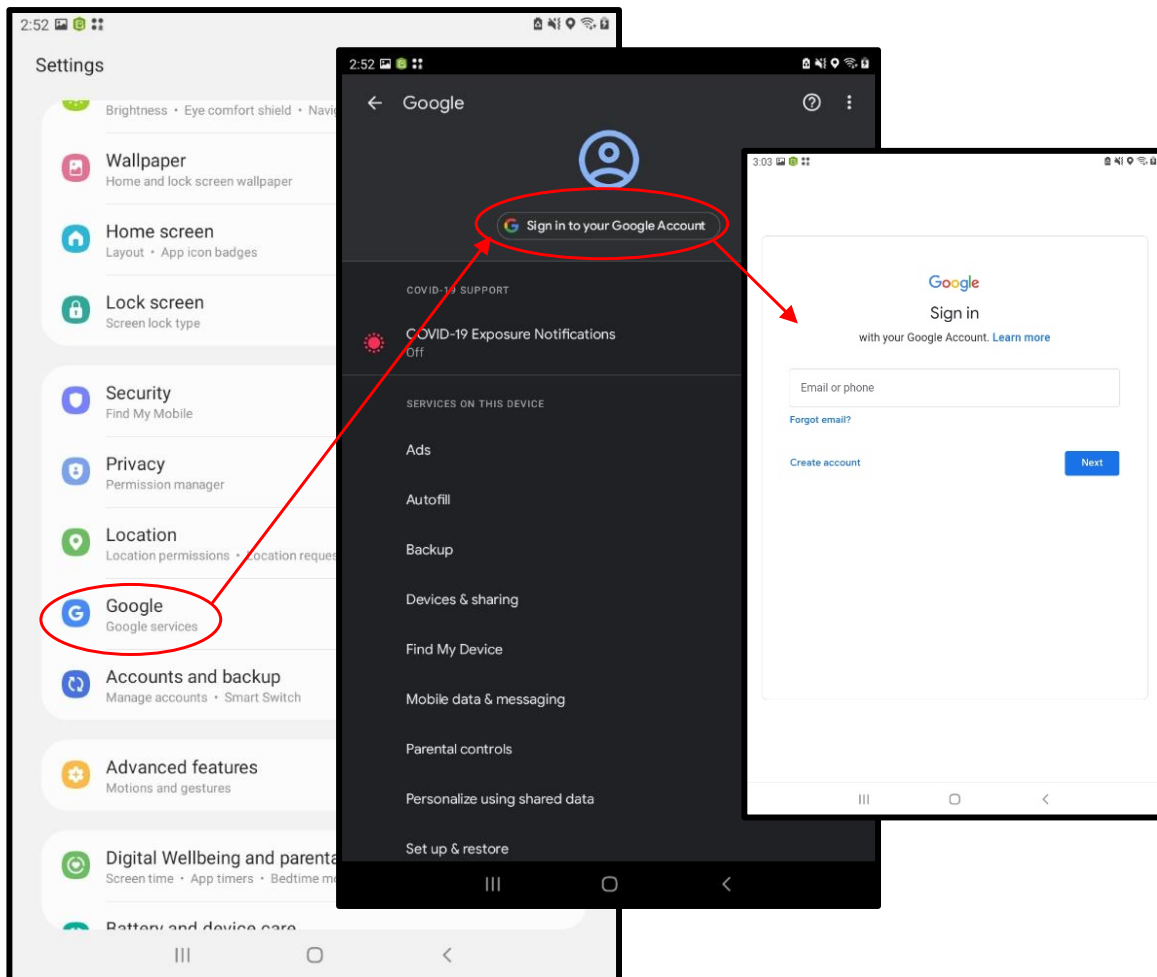


Figure 16. Images of the workflow for signing into google account on Samsung Galaxy Tab A with red circles and arrows showing the workflow.

Download Applications from the Play Store

- Find the Play Store icon by returning to the home screen, swiping up from the bottom of the home screen and selecting the play store icon
- Search for and download the following apps to the device if not already installed
 - **ArcGIS Survey123**
 - **ReachView3** (If using Emlid Reach RS2 Receiver)
 - **File Manager: free and easily** (For managing GPS Downloads)
 - **Avenza Maps** (Optional)
 - **Google Chrome** (Needed for connection to Trimble R2)
- Following installation, organize the applications on your home screen for ease of access

Setting up file path for downloads ([Figure 17](#))

- Open **File Manager: free and easily** following application downloads
 - i. From your home screen, navigate to File Manager and open your device storage
 - ii. You may use a different file manager application if you have a preference
- Select the File icon in the upper right part of the screen
- Select the three dots icon to the far-right side of the screen
- Select “Create Folder”
- Name the Folder **PBI_GPS**
- Select “OK” to create the folder
- This will be the folder that stores your GPS downloads for Survey 123

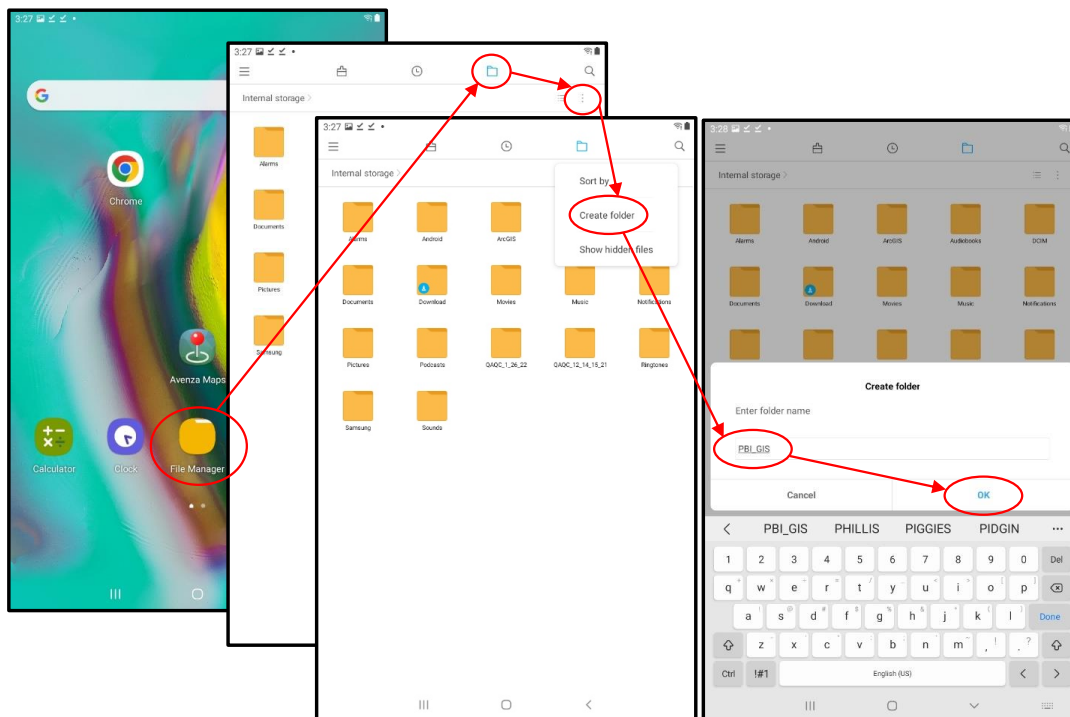


Figure 17. Images of the workflow for creating a folder on a Samsung Galaxy Tab A with red circles and arrows showing the workflow.

Emlid Reach RS2 GPS SET-UP

This section will cover instructions for connecting to and adjusting the settings for your Emlid GPS Reach RS2 Receiver. All covered devices will follow the same instruction set for this setup. Application versions may result in different displays. Update to the most current version through the firmware update instructions, or re-install the Application, or search for Application updates on your mobile device.

1. When you first get your Emlid Reach RS2, start by turning it on. To power on the GPS, press and hold the power button for 3 seconds (until the Wi-Fi, connection, and power lights are white)

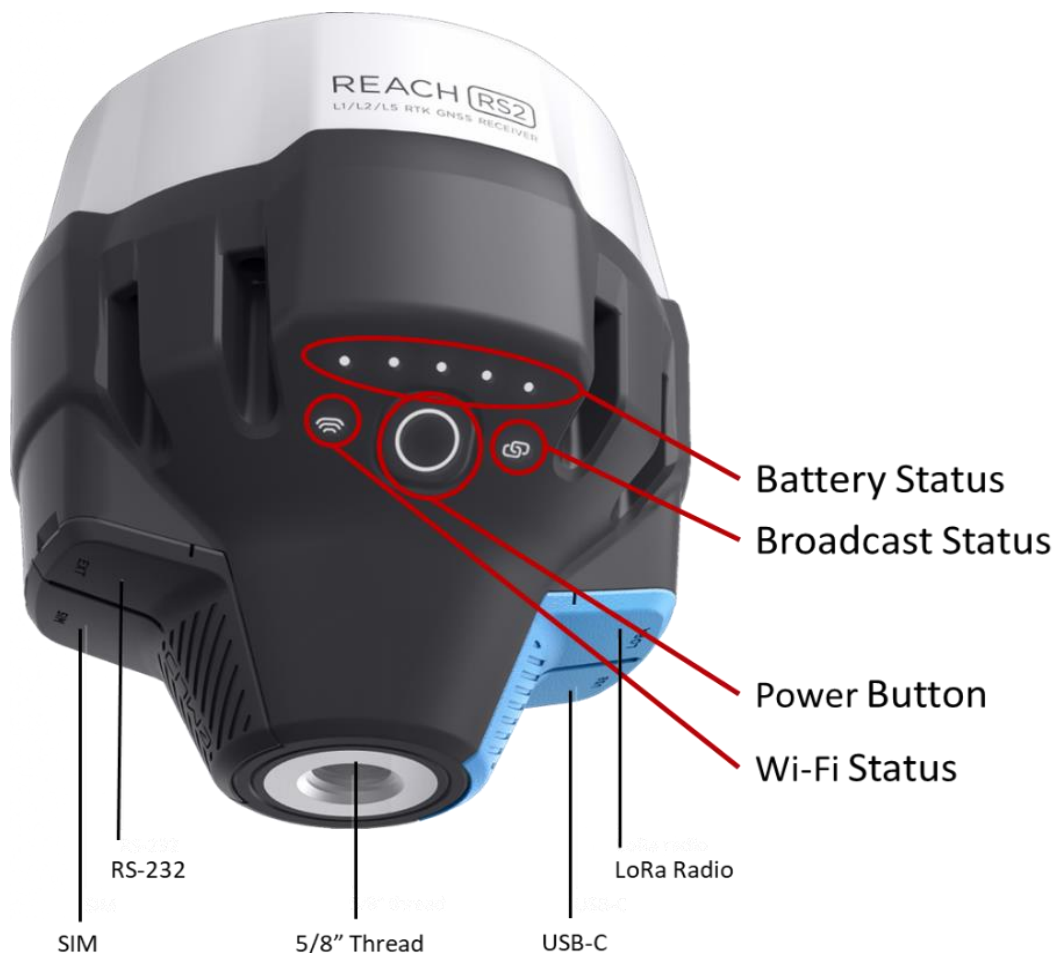


Figure 18. Image of the Emlid Reach RS2 GPS with red circles showing the button functions and connection ports

2. Notice the lights that start blinking on the GPS:
 - a. **Battery Status:** Number of status lights indicates amount of battery life remaining
 - b. **Broadcast status*:** This lets you know if the GPS is broadcasting base corrections
**(If the light is blue, contact RAP before using)*
 - c. **Wi-Fi Status:** This lets you know if the GPS is connected to a Wi-Fi device
 - solid blue - (connected)
 - blinking white - (looking for Wi-Fi signal)
 - solid white - (broadcasting Wi-Fi signal)

3. When the Wi-Fi Status light turns white and the battery status lights stop blinking, you can connect a device to the GPS:
 - a. Power on your mobile device
 - b. Navigate to Wi-Fi settings and connect to the GPS like you would any Wi-Fi network
 - i. For Resource Assessment managed GPS receivers
 1. Tap **GPS_XX:XX:XX** - (GPS sequence will vary)
 2. Enter Password (if prompted): **emlidreach**
 - ii. For **NON**-Resource Assessment managed GPS receivers
 1. locate your named device and enter credentials if prompted
4. Once connected to the GPS, open the **ReachView 3** application you downloaded previously
 - a. Open the **ReachView 3** application
 - b. Upon opening the app, you will see the Refresh button in the right-hand corner spinning and gray. When the connection to your GPS is made, the symbol will turn blue, and you will see the following “Receivers” screen display. ([Figure 19](#))

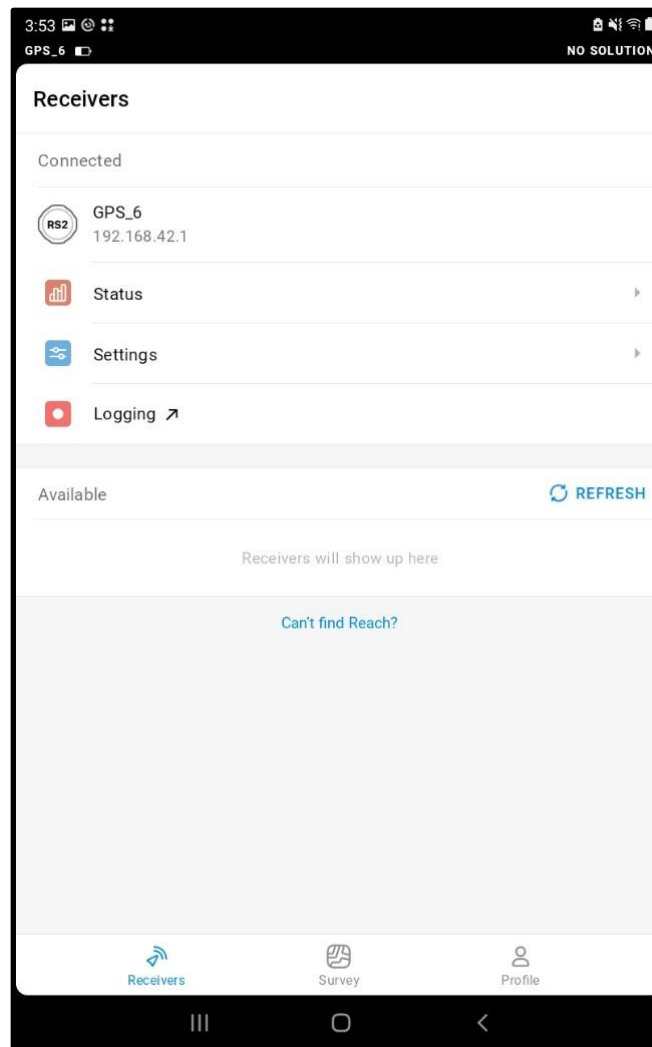


Figure 19. Image showing Reachview3 Application Home screen

5. Check for updates to Emlid GPS firmware ([Figure 20](#))
 - a. From the main Display, check for GPS updates
 - i. Select **Settings->General->Firmware updates**
 1. If updates are available, install them
 - a. Be patient and let the update run. If update is stalled for an extended period (>15 min), go back, and begin again
 - b. Following update, restart the GPS and tablet and reconnect
 2. Check for GPS firmware updates frequently

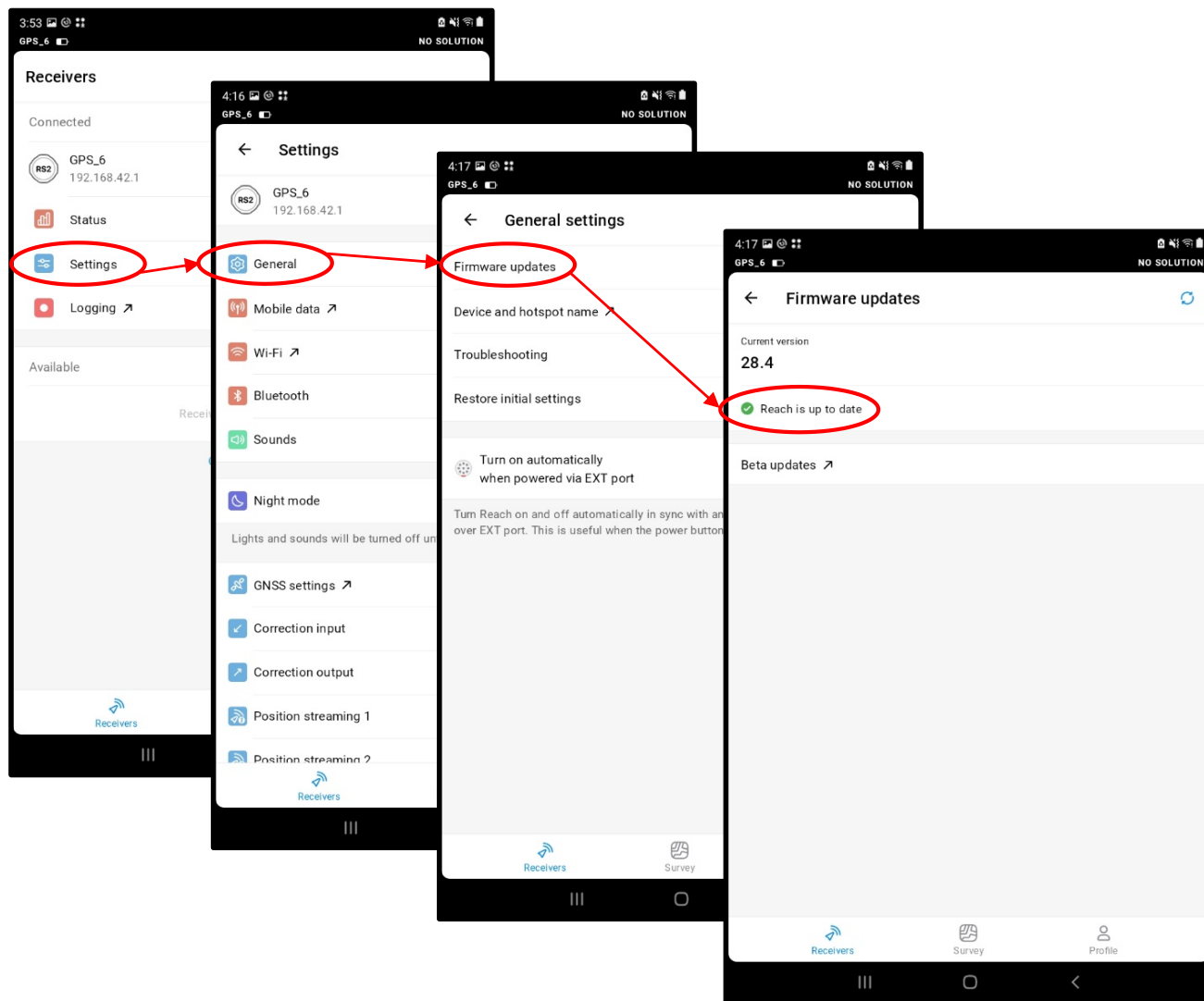


Figure 20. Figure showing ReachView 3 workflow for updating firmware with red circles and arrows showing the workflow.

6. Manage Settings

- There are a series of settings that need to be adjusted to the GPS receiver prior to data collection. If you have already been collecting data, check these settings on a frequent basis and assure they have not been changed or reset because of an update
 - a. Check Correction and Position Settings ([Figure 21](#))
 - i. Go to **Settings**
 - ii. Scroll to bottom of screen and confirm the status of the following fields and change if necessary
 1. Correction input: Off
 2. Correction output: Off
 3. Position streaming1: Off
 4. Position streaming2: Off

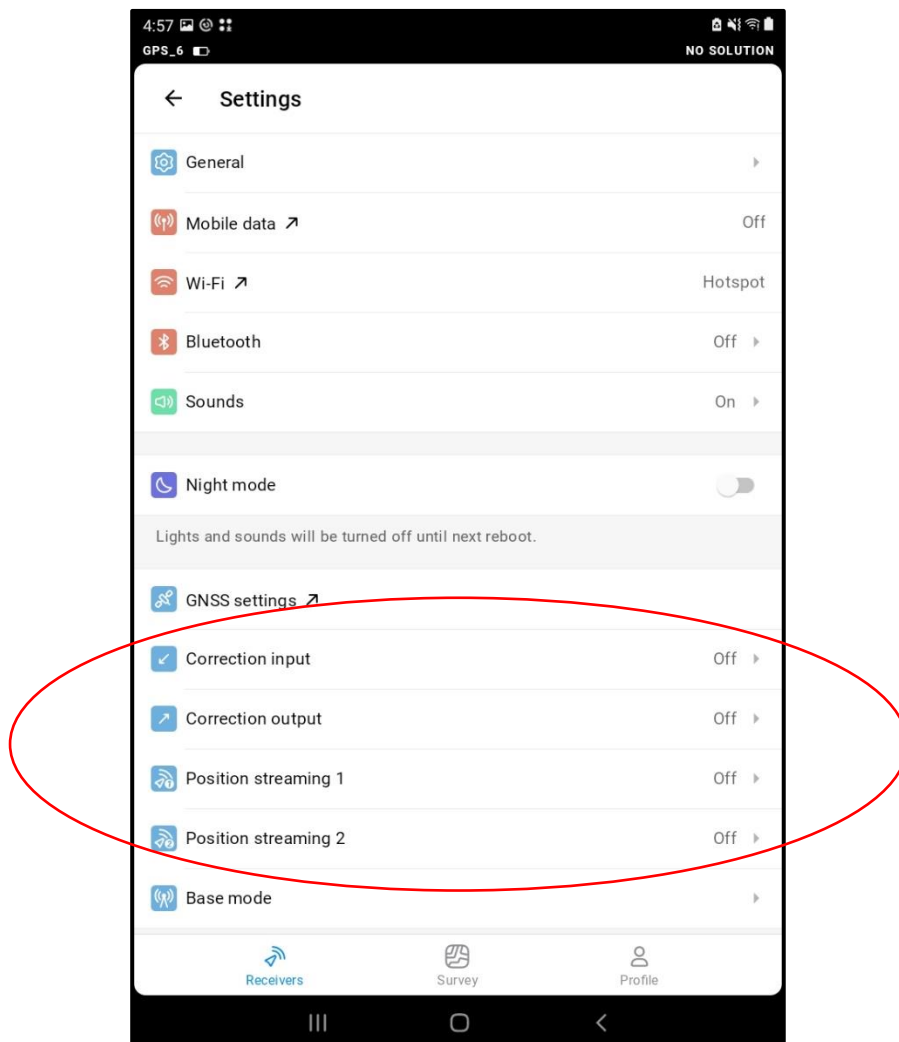


Figure 21. Figure showing correction and position settings turned to off with red circle around target settings.

- b. Check Base Mode Settings ([Figure 22](#))
 - i. From Settings select **Base Mode** at the bottom of the screen
 - ii. Select Configure to open settings for editing and confirm the status of the following fields and change if necessary
 1. Coordinate Entry Method: Average SINGLE
 2. Averaging Time: 2 Minutes
 - iii. Select Save to execute changes

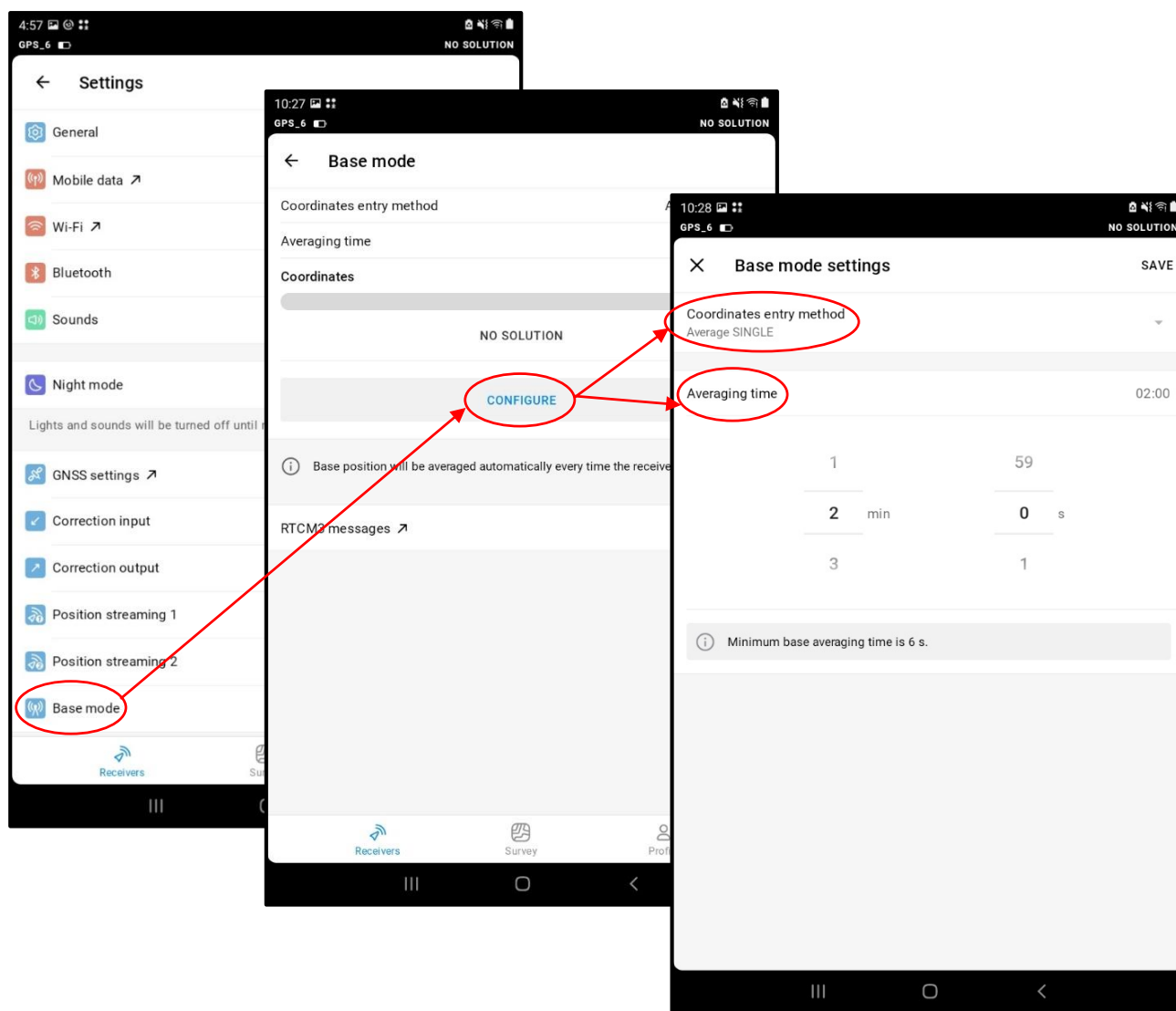


Figure 22. Figure showing the workflow for updating Base Mode Settings in the ReachView App with red circles and arrows showing the workflow.

c. Update GNSS Settings ([Figure 23](#))

i. Go to **Settings>GNSS settings** and confirm the status of the following fields and change if necessary

1. Position Mode: Static
2. Elevation mask angle: 15°
3. SNR Mark: 35
4. GNSS select: GPS and GLONASS
5. Update rate: 1Hz

ii. Select Apply to execute changes

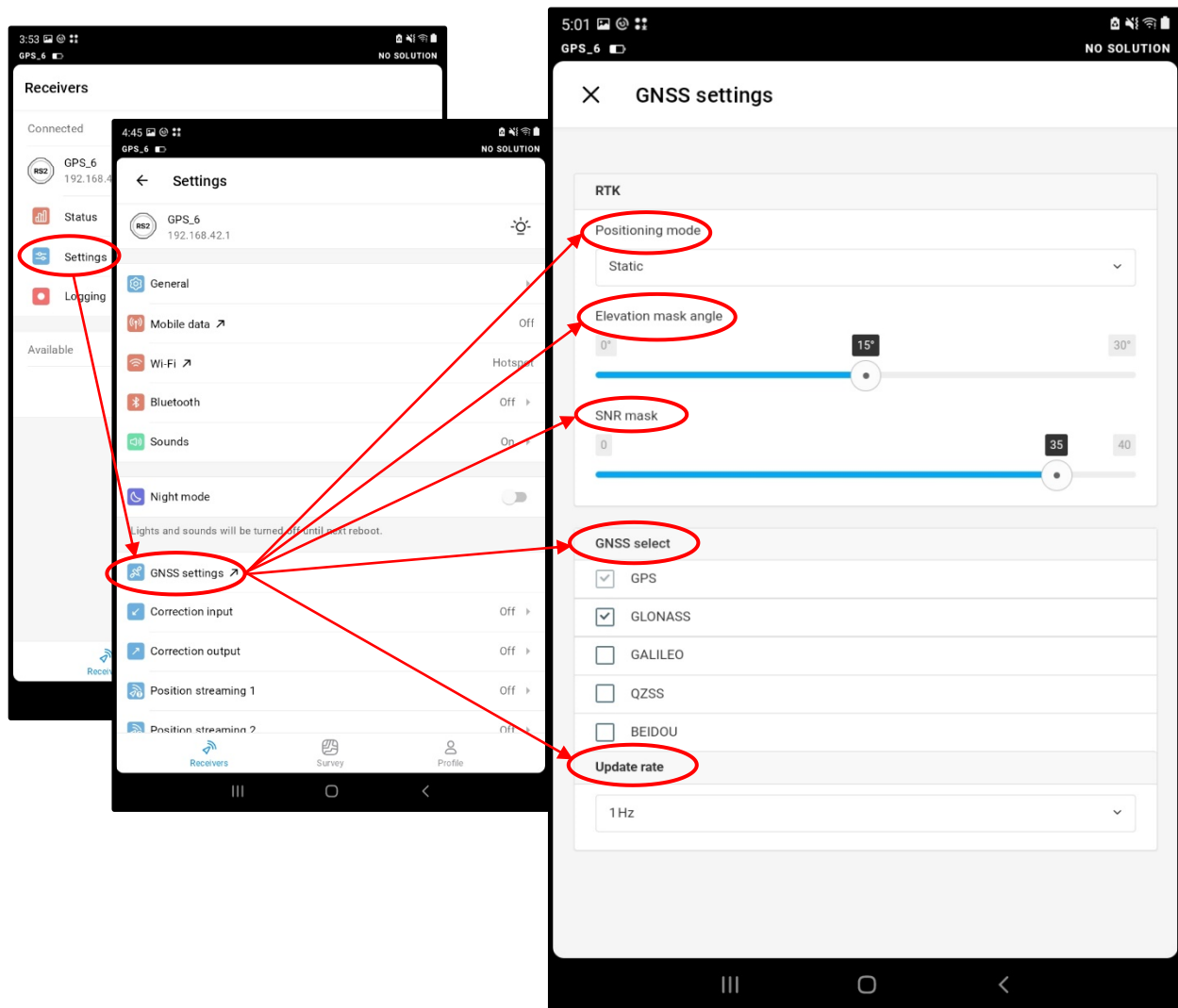


Figure 23. Figure showing the workflow for updating GNSS Settings in the ReachView App with red circles and arrows showing the workflow.

- d. Update Logging Settings ([Figure 24](#))
 - i. From the main Display, check logging settings
 - ii. From Main Display Go to **Logging>Settings (In Raw Data Field)** and confirm the status of the following fields and change if necessary
 1. Settings Header: Set to Custom
 2. Format: RINEX 2.10
 3. Satellite Systems: GPS and GLONASS
 4. Logging Interval: 1s
 5. Use Antenna Height: Toggle Off
 6. Marker Name: Blank
 7. Automatically Start Recording when receiver is turned on: Toggle On
 - iii. Select Apply to execute changes

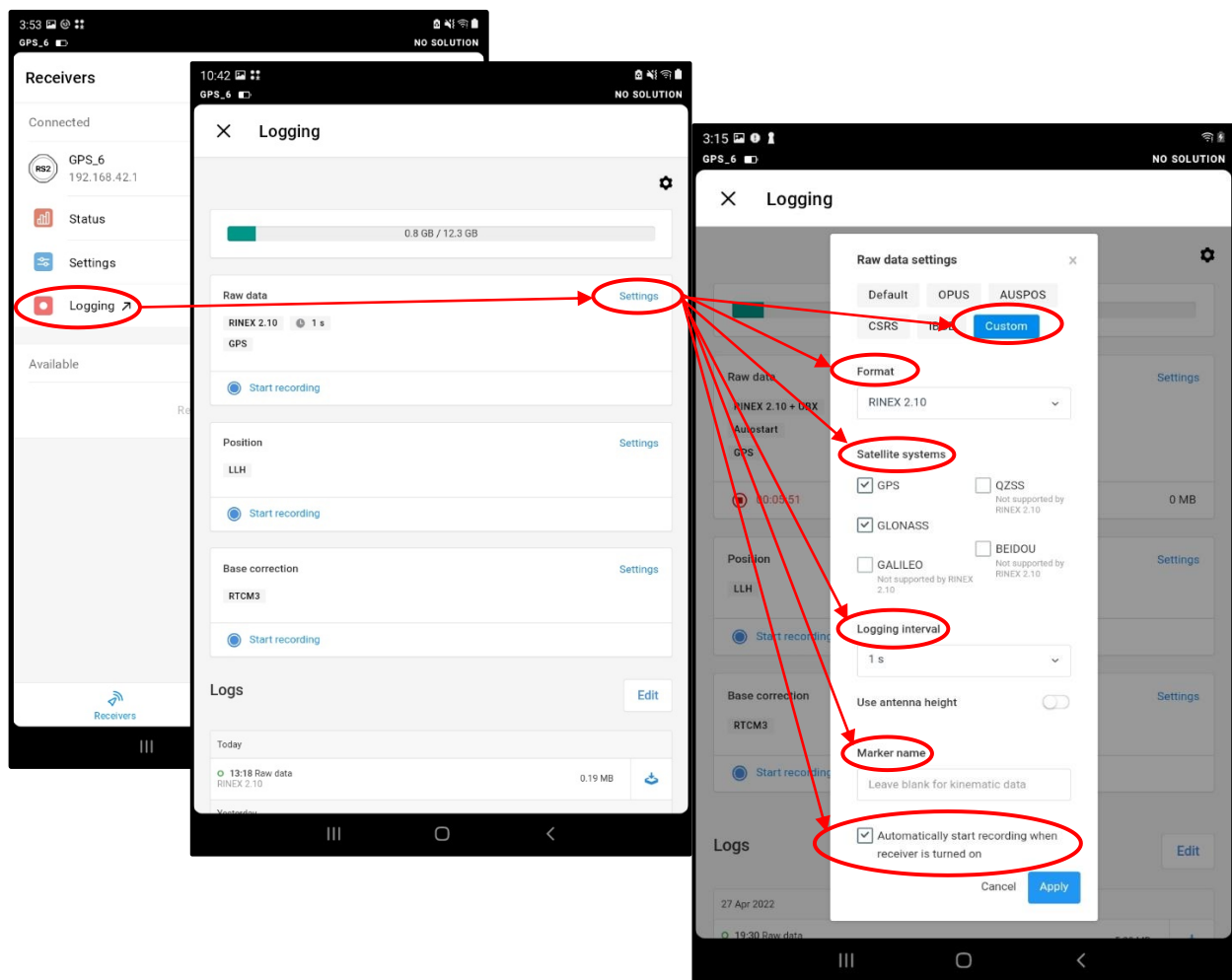


Figure 24. Figure showing the workflow for updating Logging Settings in the ReachView App with red circles and arrows showing the workflow.

7. At this point, your GPS is ready for the field. Charge the GPS prior to taking into the field
8. Check Settings routinely and after updates to the Mobile Device or GPS to assure proper collections

Trimble R2 GPS SET-UP

This section will cover instructions for connecting to and adjusting the settings for your Trimble R2 Receiver. All covered devices will follow the same instruction set for this setup.



Figure 25. Image showing Trimble R2 receiver with Power Button and Battery labeled

The R2 uses a specialized rechargeable battery. A charger should be provided to you. To charge, the battery is removed from the R2 and placed in the charger. The battery can be removed by pinching together the two tabs on either side of the battery tray, then pulling outward. To install a battery, insert the battery into the tray such that the metal contacts of the battery touch the metal contacts in the tray. Then press the battery bay into the R2 unit until you hear a “click”.

The battery is not “Hot-Swappable”. Removing the battery will power down the device.

You will notice the power button has two colors, green and yellow:

- A **solid green** indicates the unit is on and the battery is charged.
- A **blinking green** indicates the unit is receiving position corrections.
- A **blinking yellow** indicates the battery is low and needs to be charged.

1. To turn on your Trimble R2 receiver, press and hold the **Power Button** for around four seconds until it turns **Green**
 - a. *Do not press for more than 15 seconds – this resets the unit to factory settings.*
2. When the receiver Power Button light turns green you can connect a device to the GPS:
 - a. Power on your mobile device
 - b. Navigate to your Wi-Fi Settings and connect to the GPS
 - i. For Resource Assessment managed GPS receivers
 1. Tap **Trimble GNSS XXXX** - (GPS sequence will vary)
 2. Password (if prompted): **0000**
 - ii. For **NON**-Resource Assessment managed GPS receivers
 1. locate your named device and enter credentials if prompted
3. Open the URL using **Google Chrome** to access the GPS on your mobile device ([Figure 26](#))
 - a. Open a web browser on your device and enter the following URL: **192.168.142.1**
 - i. *Your mobile device must be connected to the Trimble Wi-Fi for URL to load*
 - b. At the top of the screen, you may see a banner to “Show Classic Web GUI”
 - i. Tap the banner on the and the page will reload a full display
 - ii. Depending on device and browser, this step may not be needed
 - c. Log in to the URL to access the GPS receiver
 - i. User: **admin**
 - ii. Password: **password**

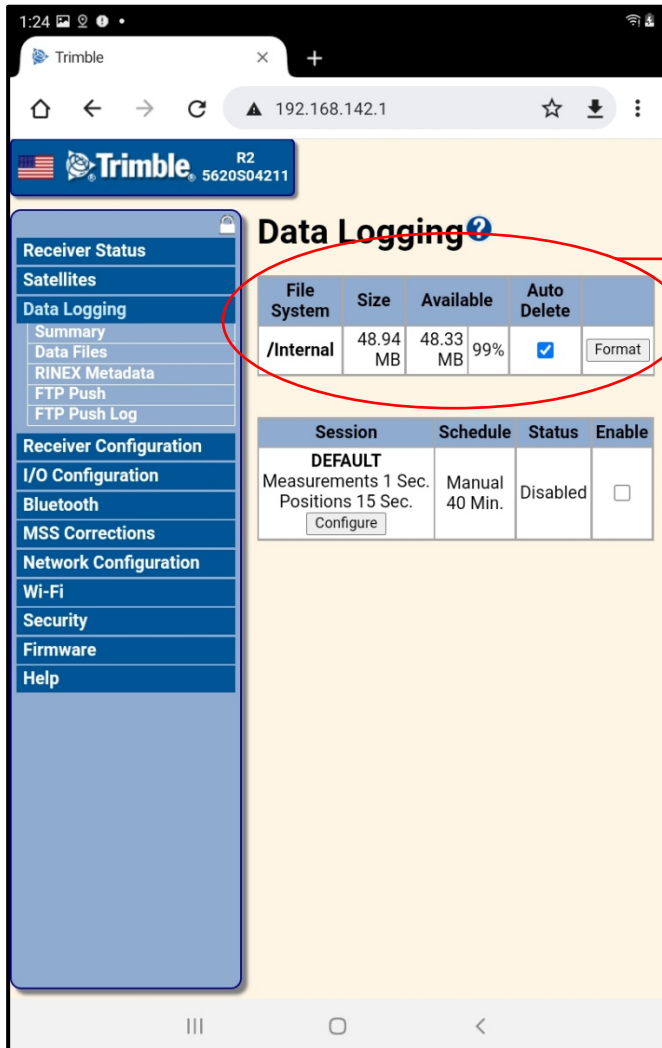


Figure 26. Trimble R2 “Show Classic Web GUI” Banner and Trimble R2 Login Page

4. Manage Settings ([Figure 27](#))

a. Review File System Settings

- i. Click on **Data Logging** on the left menu
- ii. Click on **Summary** (it should default to Summary when you click Data Logging)
- iii. Review file system fields to determine available Receiver space
 1. File System: Where memory is located
 2. Size: Total space in memory
 3. Available: Current available memory
 4. Auto Delete: Auto deletes the oldest file when it runs out of space if checked
 5. Format: *Do not Change this*
- iv. Check the box for **Auto Delete** (this auto deletes the oldest file when it runs out of space)



File System	Size	Available	Auto Delete	
/Internal	48.94 MB	48.33 MB	99%	<input checked="" type="checkbox"/> Format

File System	Size	Available	Auto Delete	
/Internal	48.94 MB	48.33 MB	99%	<input checked="" type="checkbox"/> Format

Figure 27. Figure showing Trimble R2 Data Logging Summary Page including File System Information and Auto Delete function with red circles and arrows showing the information.

b. Configure Session Settings ([Figure 28](#))

- i. Under **Session** on the Data Logging page select **Configure** and confirm the status of the following fields and change if necessary
 1. Schedule: Manual
 2. Duration: 40 minutes
 3. File Format: T02
 4. Measurement Interval: 1 sec
 5. Smooth Pseudo range: check
 6. Smooth Phase: check
 7. Position Interval: 15 sec
 8. Log Received Corrections: not checked
 9. Log raw nav data: not checked
 10. Log SBAS Data: not checked
 11. File System: /Internal
 12. Path Style: Flat
 13. Name Style: #####YYMMDDhhmm
 14. FTP Push: not checked
 15. Email push: not checked
- ii. Press OK to save the changes to the session settings

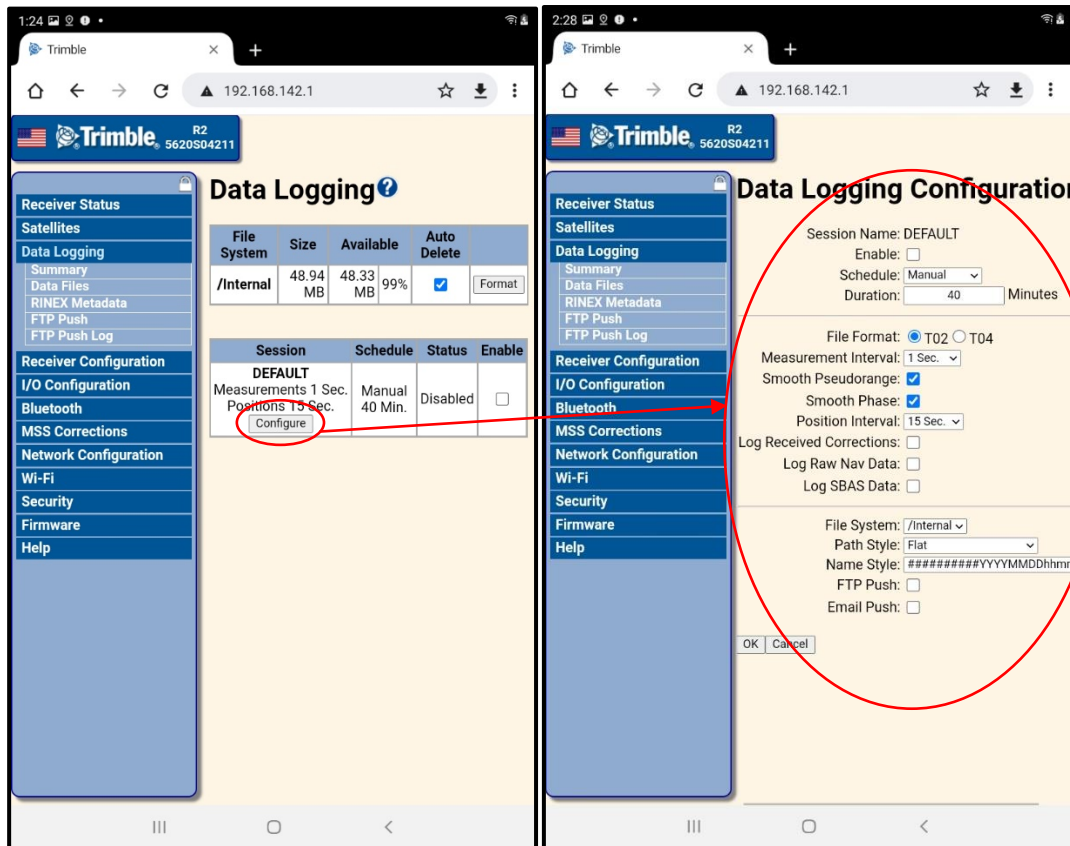


Figure 28. Figure showing Trimble R2 Data Logging Session Configuration workflow with red circles and arrows showing the workflow.

- c. Save the URL to your Device for Quick Access ([Figure 29](#))
 - i. The process will vary depending on the mobile device and web browser you are using. You may save a shortcut, bookmark or favorite depending on your configuration. There are two common workflows represented here. Contact RA for assistance with other methods of saving URL
 1. Samsung Tab A (Using Google Chrome Web Browser)
 - a. Select the Three dots in the upper right
 - b. Select option for “Add to Home Screen”
 - c. Rename if you like and select add to create shortcut
 - d. You should now see a shortcut for the URL on your home screen

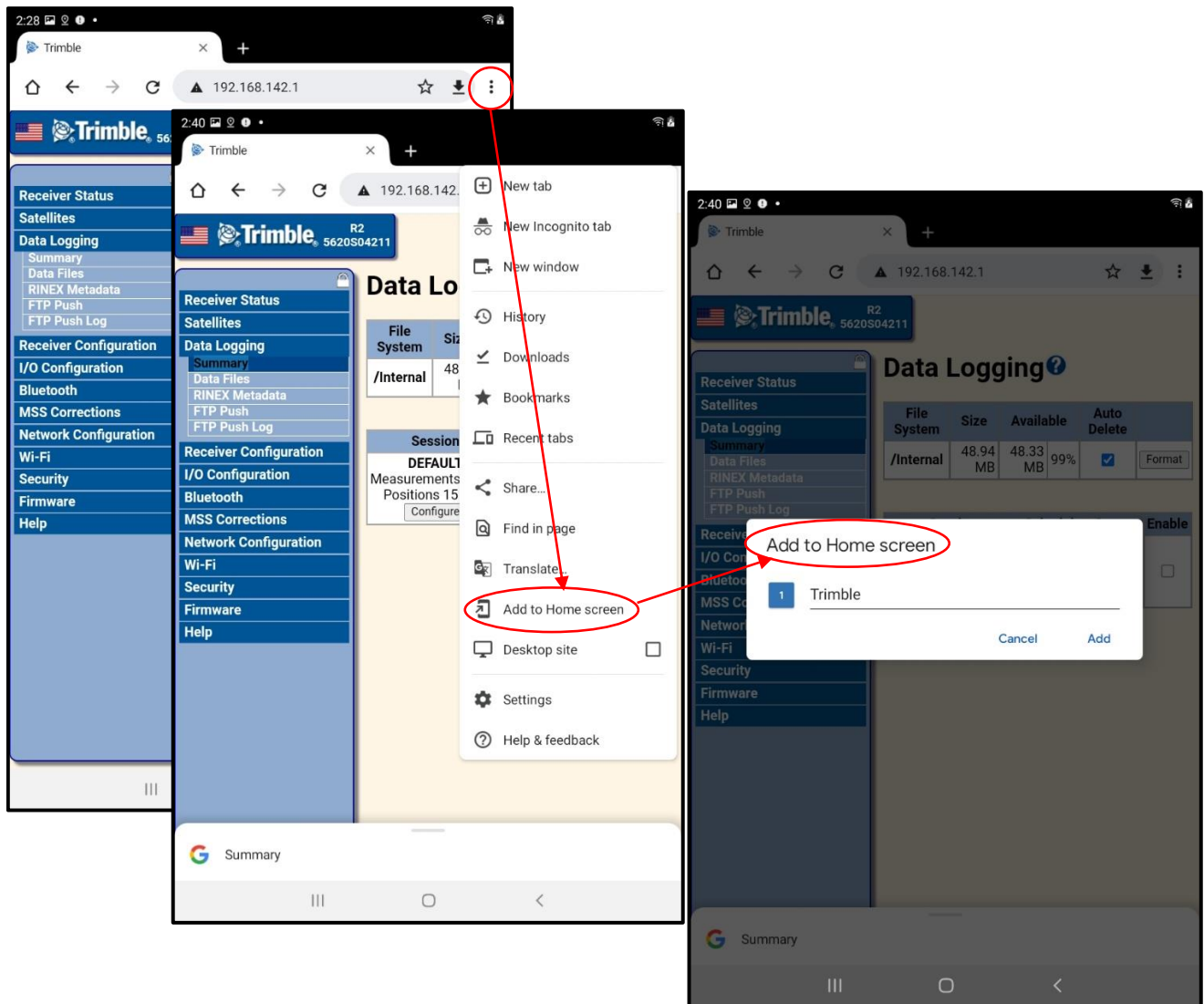


Figure 29. Figure showing Trimble R2 Samsung Galaxy Tab A Home Screen Shortcut workflow with red circles and arrows showing the workflow.

2. iOS devices (Using Google Chrome Web Browser) ([Figure 30](#))
 - a. Select the Three dots in the upper right
 - b. Scroll down, select “Bookmark” star icon with a + inside of it
 - c. Add the Bookmark by selecting Done in the upper right
 - i. Find Bookmark for later use by selecting three dots as above, selecting bookmarks, and selecting Trimble URL

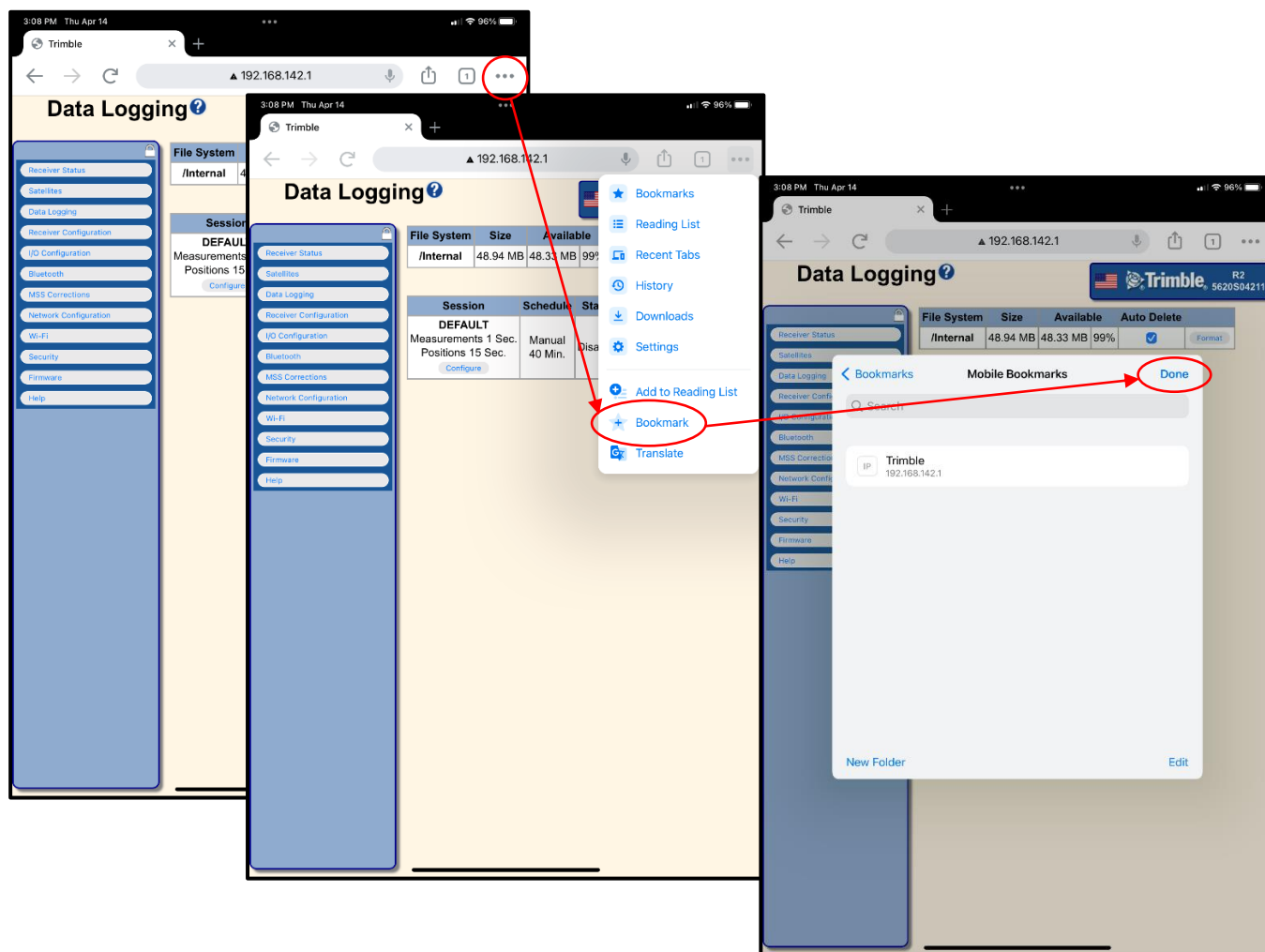


Figure 30. Figure showing Trimble R2 iPad Mini bookmark workflow displayed with red circles and arrows showing the workflow.

5. At this point, your GPS is ready for the field. Charge the GPS prior to taking into the field
6. Check Settings routinely and after updates to the Mobile Device or GPS to assure proper collections

Emlid Reach RS2 – GPS FIELD OPERATION

1. Establish GPS location from plot center
 - a. Find the largest canopy gap in the plot and mark the chosen GPS location with a pin flag
 - b. From the center of the plot, measure the distance, (to the tenths of feet) and azimuth, (to whole degrees) to the GPS location
 - c. At the GPS location, set-up. If using extendable pole, extend to 2m and secure
 - d. Take GPS out of carrying case
 - e. Attach GPS to range pole/bipod
 - f. Ensure range pole and GPS are stable and level
2. Connect to the GPS and begin collecting GPS data (See [Emlid Reach RS2 – GPS Set-Up](#)).
 - a. Power on the GPS and Connect the mobile device to the GPS Wi-Fi signal
 - b. Open the **ReachView 3** Application on your mobile device
 - c. Select “Logging” on the main page to view logging page ([Figure 31](#))
 - i. The GPS should automatically be logging the raw data
 1. The recording timer should start automatically. If not, refer to the [Emlid Reach RS2 – GPS Set-Up](#) instructions to set up automatic recording.
 2. You can manually begin collecting data by selecting “Start Recording” in the raw data section if data is not being automatically collected already

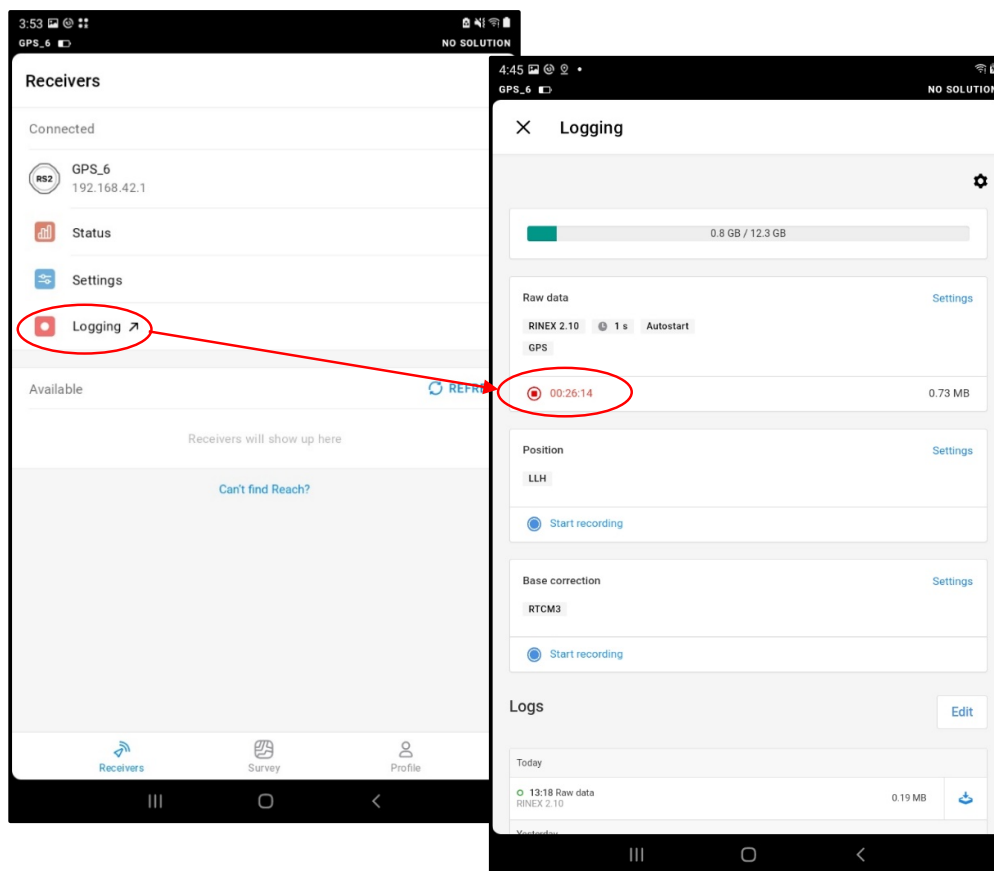


Figure 31. Figure showing Emlid Reach RS2 workflow for confirming data is logging displayed with red circles and arrows showing the workflow.

3. Once you have set up the GPS and the recording has begun, minimize or close the application without disconnecting the Wi-Fi connection and begin PBI plot measurements
4. Following completion of Plot measurements, you will download the GPS File to your device. Instructions for Downloading your Emlid GPS files will be different when using a Samsung Tab A device compared to an iOS device (iPad, iPhone). This section will cover both device downloads when working with the Emlid receiver. Refer to sections below for your device

[Samsung Galaxy Tab A Download Instructions](#)

[iPad Mini Download Instructions](#)

[iPhone Download Instructions](#)

Samsung Galaxy Tab A Download Instructions

- a. Open **ReachView 3** Application and return to the Logging page ([Figure 32](#))
- b. Ensure that the recording time is showing at least **30 minutes (best if >2.5 hours)**.
 - i. Let GPS collect for at least 30 minutes (wait if necessary)
- c. Stop recording raw data by selecting the icon to stop recording
 - i. This will trigger the raw data download files to appear near the bottom of the screen under Logs. The file you created should be located at the top.
- d. Close out the “Logging” page by selecting the **X** in the upper left corner of the page.

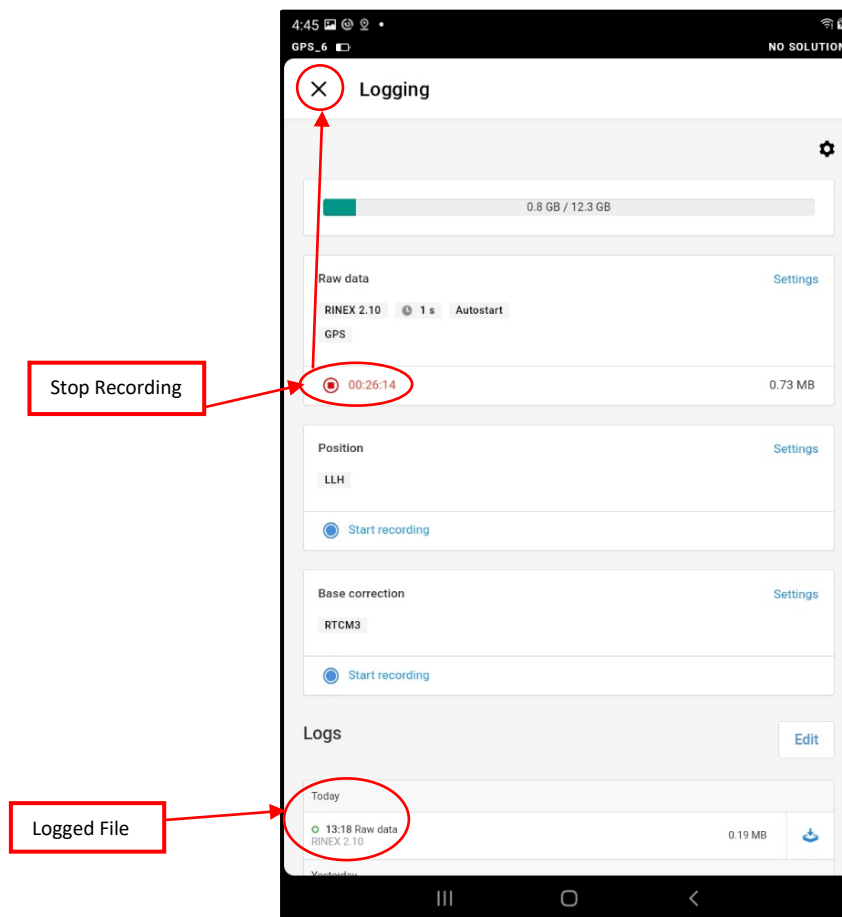


Figure 32. Figure showing Emlid Reach RS2 workflow for confirming data logs with red circles and arrows showing the workflow

- e. In the Receivers page, select the **GPS name (i.e. GPS_6)** with **URL 192.168.42.1**
- f. Select “Reach Panel” at the bottom of the screen ([Figure 33](#))
- g. This will open the URL for the Receiver.
 - i. Alternatively, you can type the URL into a web browser to access the page
- h. In the upper right corner, select the four horizontal bars
- i. Select Logging and navigate to Logs on the bottom of the screen
- j. Click the download file icon next to the **rinex file** to download the GPS data
 - i. Do not delete download files from logging once you have downloaded
 - ii. If storage becomes an issue on the unit, delete oldest files first, only after assuring file is no longer needed and has been submitted and corrected

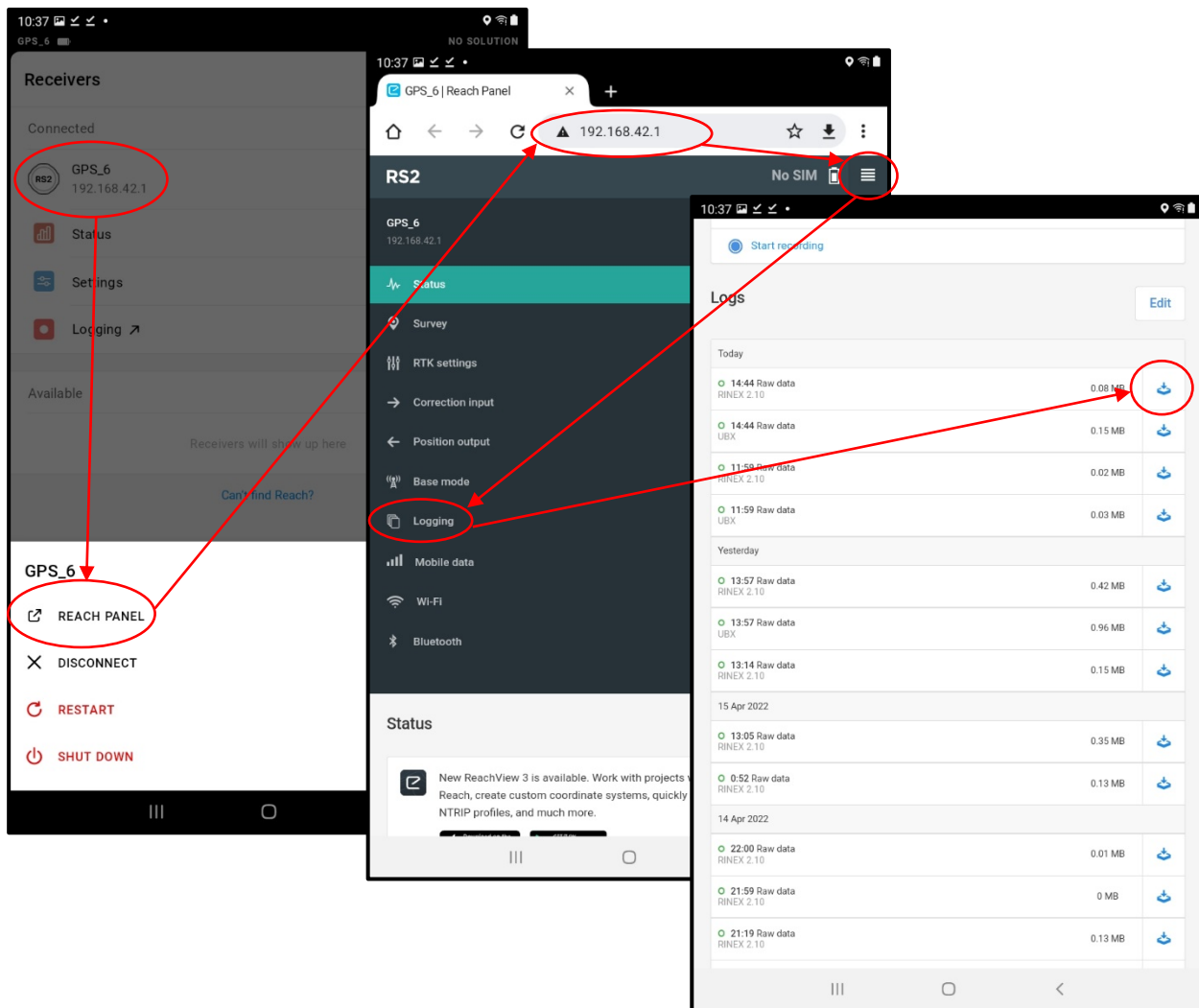


Figure 33. Figure showing Emlid Reach RS2 workflow for beginning a download with red circles and arrows showing the workflow

- k. When download completes Select the popup that say “Open” in Chrome
 - i. If using another browser other than Chrome, navigate to File Manager
 - ii. Refer to the [Getting Started with Your Mobile Devices](#) section of the guide

- I. Select Open File to open File Manager ([Figure 34](#))
 - i. Select “Download” and locate your downloaded file (should be first by date)
 - ii. Select radio button to the right of the file (selection will show in blue)
 - iii. On bottom of screen select “More”, then “Copy”
 - iv. Select “Internal Storage”
 - v. Select the **PBI_GPS** folder (scroll down if necessary) created in the
 - vi. Select “Paste” at bottom of screen
 - vii. You now have your GPS file saved to the device for attaching to Survey123
 - viii. Once location is confirmed, you will attach the GPS file to your Survey123 form using the steps outlined in [Attaching downloaded GPS files to Survey123](#)

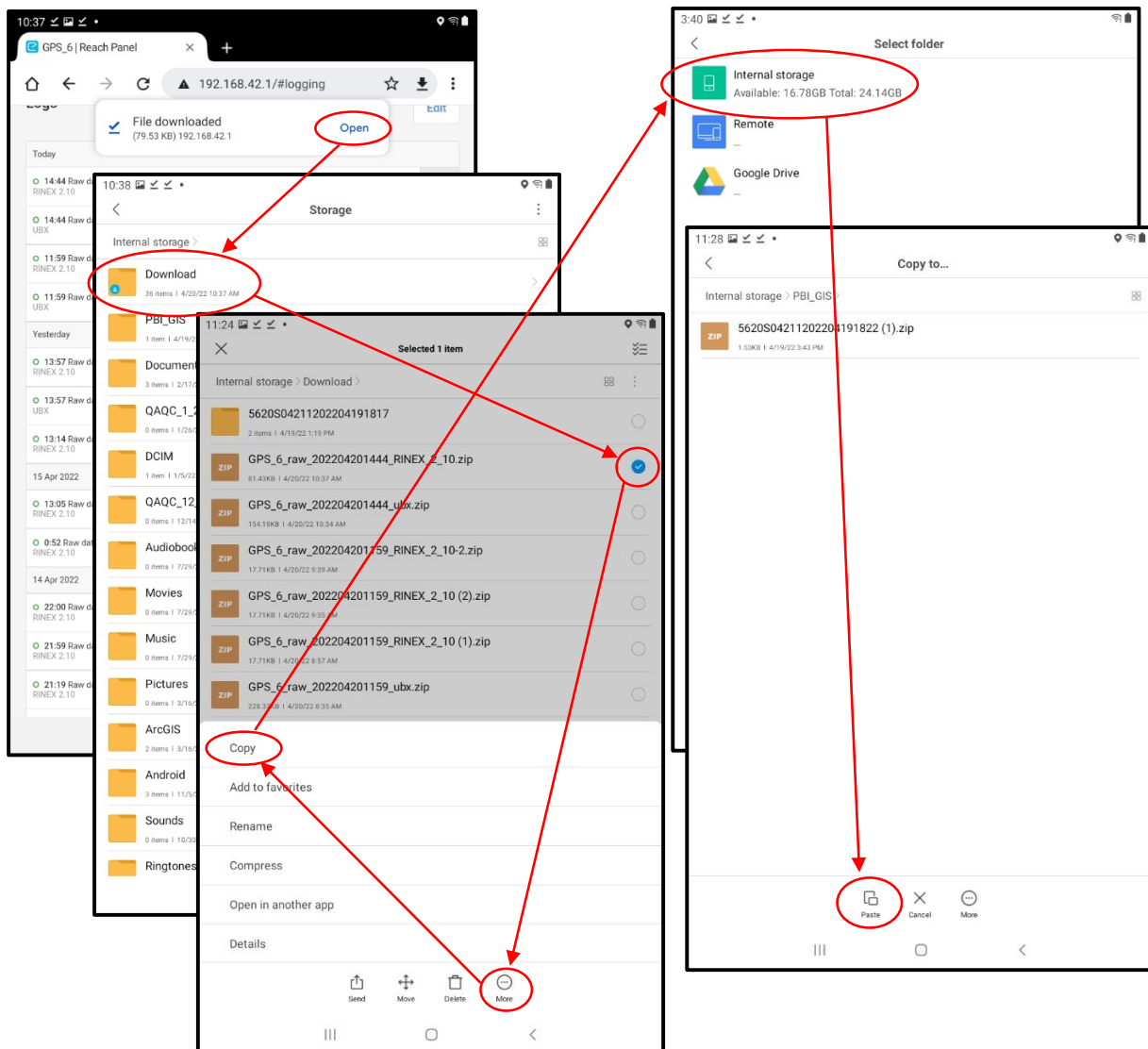


Figure 34. Figure showing Emlid Reach RS2 workflow for moving GPS File to PBI_GPS folder with red circles and arrows showing the workflow

iPad Mini Download Instructions ([Figure 35](#))

- a. Open **ReachView 3** Application
- b. Return to “Logging” page
- c. Ensure that the recording time is showing at least **30 minutes (best if >2.5 hours)**.
 - i. Let GPS collect for at least 30 minutes (wait if necessary)
- d. Stop recording raw data by selecting the icon to stop recording with the recording time adjacent
 - i. This will trigger the raw data download files to appear near the bottom of the screen under Logs. The file you created should be located at the top of the section under “Today”
 1. You can also access previously collected files by collection date
- e. Click the download file icon next to the **rinex** file to download the GPS data
 - i. Do not delete download files from logging once you have downloaded
 - ii. If storage becomes an issue on the unit, delete oldest files first, only after assuring file is no longer needed and has been submitted and corrected

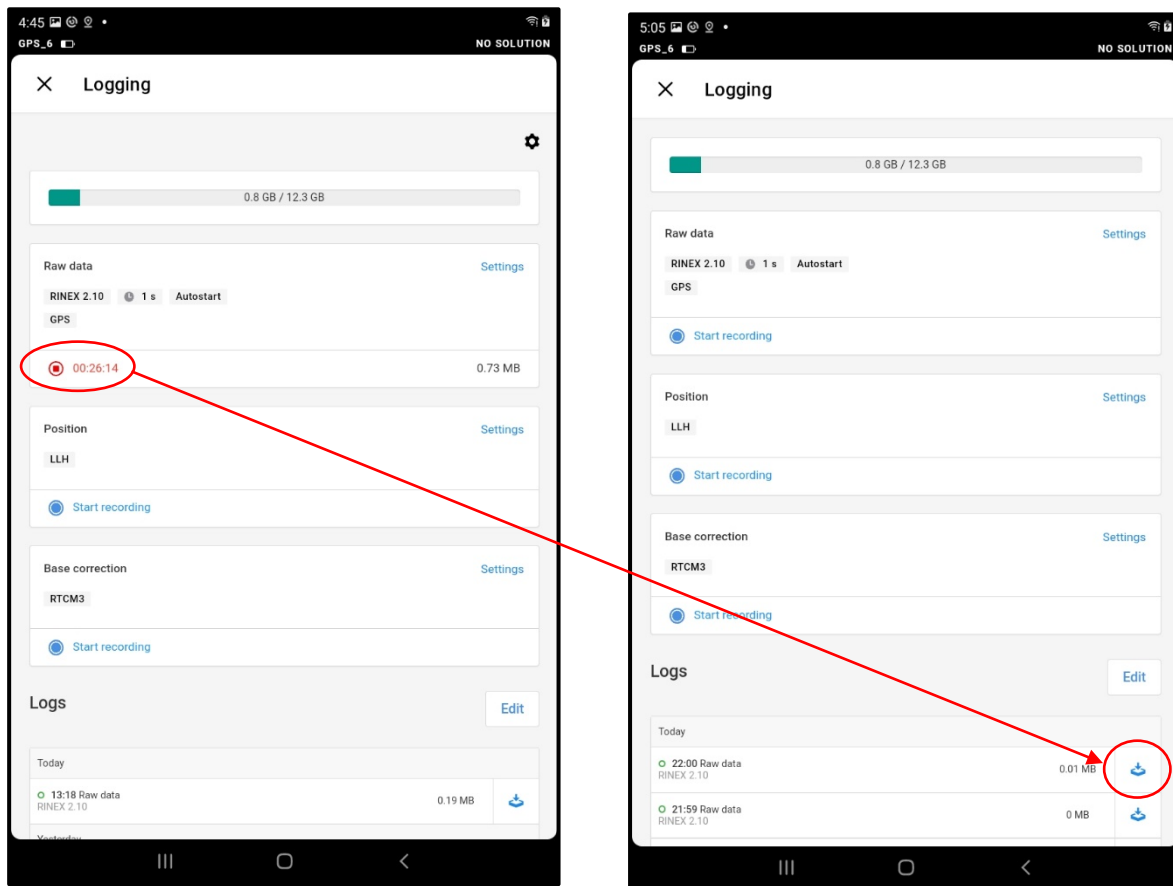


Figure 35. Figure showing Emlid Reach RS2 workflow on iPad Mini for downloading data with red circles and arrows showing the workflow

- f. Following selection of the download icon, an options display will come up ([Figure 36](#))
 - i. Select “Save to Files”
 - ii. Navigate to “On my iPad”
 - iii. Select the **PBI_GPS** folder (scroll down if necessary) created in the [Getting Started with Your Mobile Devices](#) section of the guide
 1. You can also create a folder anytime and move files around following download if the download file path was not set up prior to download.
 - iv. Return to home screen and navigate to “files”
 - v. Find “On my iPad” and locate the file you downloaded to confirm location for adding to Survey123.
 - vi. You now have your GPS file saved to the device for attaching to Survey123
 - vii. Once location is confirmed, you will attach the GPS file to your Survey123 form using the steps outlined in [Attaching downloaded GPS files to Survey123](#)

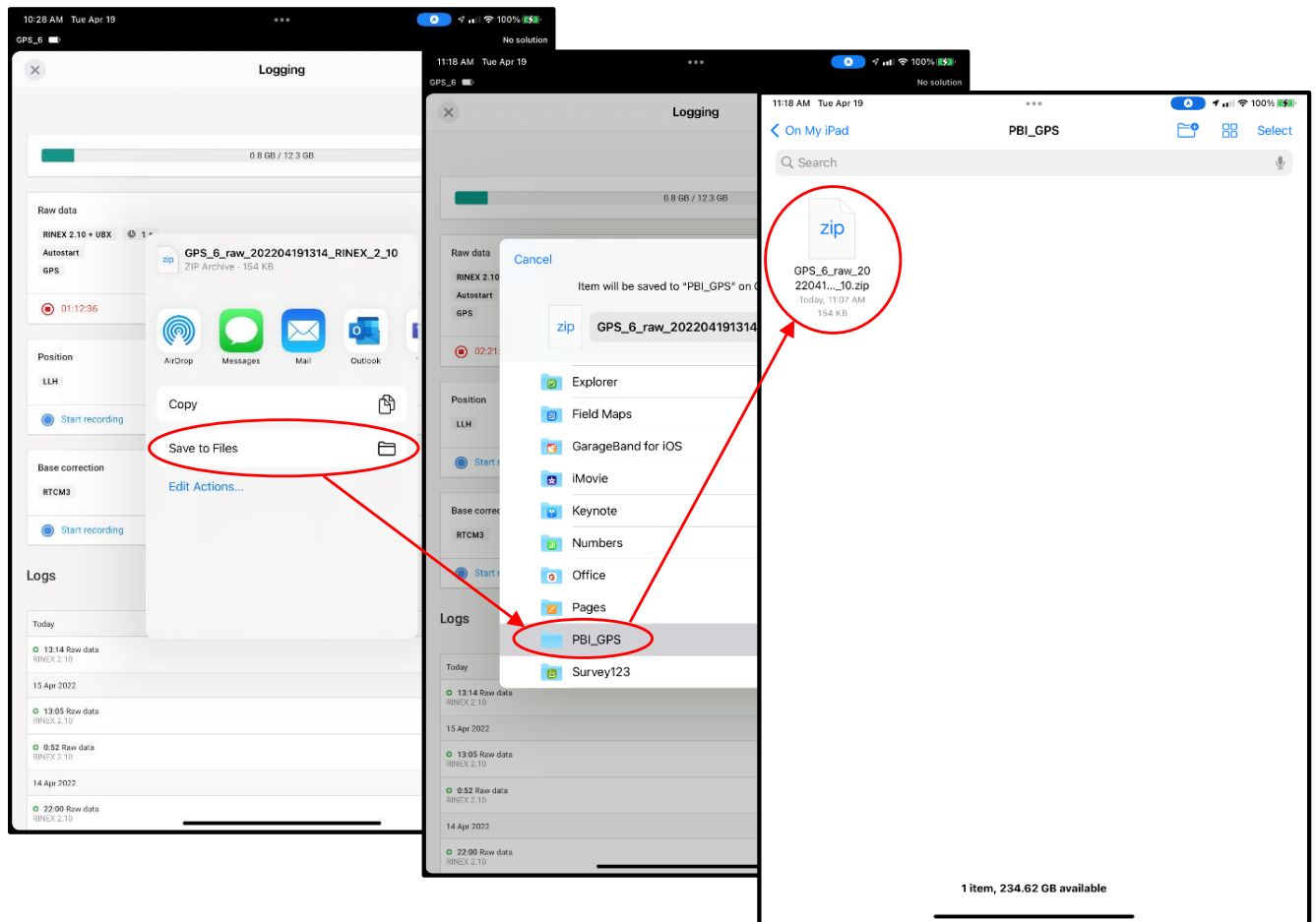


Figure 36. Figure showing Emlid Reach RS2 workflow on iPad mini for saving GPS file to PBI_GPS folder with red circles and arrows showing the workflow

iPhone Download Instructions

- a. Refer to instructions highlighted in the iPad mini 5/6 section for guidance
 - i. iPhone and iPad devices both use the iOS operating system and workflows should largely mirror each other. If significant deviation from the workflow is identified, an update to the section will be considered. Contact Resource Assessment for questions.
5. Once you are confident that you have collected and downloaded your GPS location, you can pack up your GPS and move on to [Attaching downloaded GPS files to Survey123](#)
 - a. Turn off the GPS by pressing and holding the power button for 3 seconds until all the lights turn off.
 - b. Disconnect the GPS from the range pole.
 - c. Put the GPS back in the carrying case.
 - d. Take down range pole/Bipod.
 - e. Mark the GPS pole location with a pin flag.

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Trimble R2 – GPS FIELD OPERATION

1. Establish GPS location from plot center
 - a. Find the largest canopy gap in the plot and mark the chosen GPS location with a pin flag
 - b. From the center of the plot, measure the distance, (to the tenths of feet) and azimuth, (to whole degrees) to the GPS location
 - c. At the GPS location, set-up. If using extendable pole, extend to 2m and secure
 - d. Take GPS out of carrying case
 - e. Attach GPS to range pole/bipod
 - f. Ensure range pole and GPS are stable and level
 2. Connect to the GPS Wi-Fi, check settings, and navigate to data logging tab ([Figure 37](#))
 - a. Power on the GPS and Connect the mobile device to the GPS Wi-Fi signal
 - i. Refer to [Getting Started with Your Mobile Devices](#)
 - b. Check settings and navigate to the Data Logging tab on the Trimble R2 URL
 - i. Refer to [Trimble R2 – GPS Set-Up](#)
 - c. Select “Data Logging” on the main page to view logging page
 - d. Under “Session”, check the box under “Enable”
 - i. The Status will change from “Disabled” to “Pending” to “Logging”
 - ii. The GPS will collect for 40 minutes
- **Note: When using the data logging URL on mobile devices, you may need to scroll the page to the right to see all the information.**

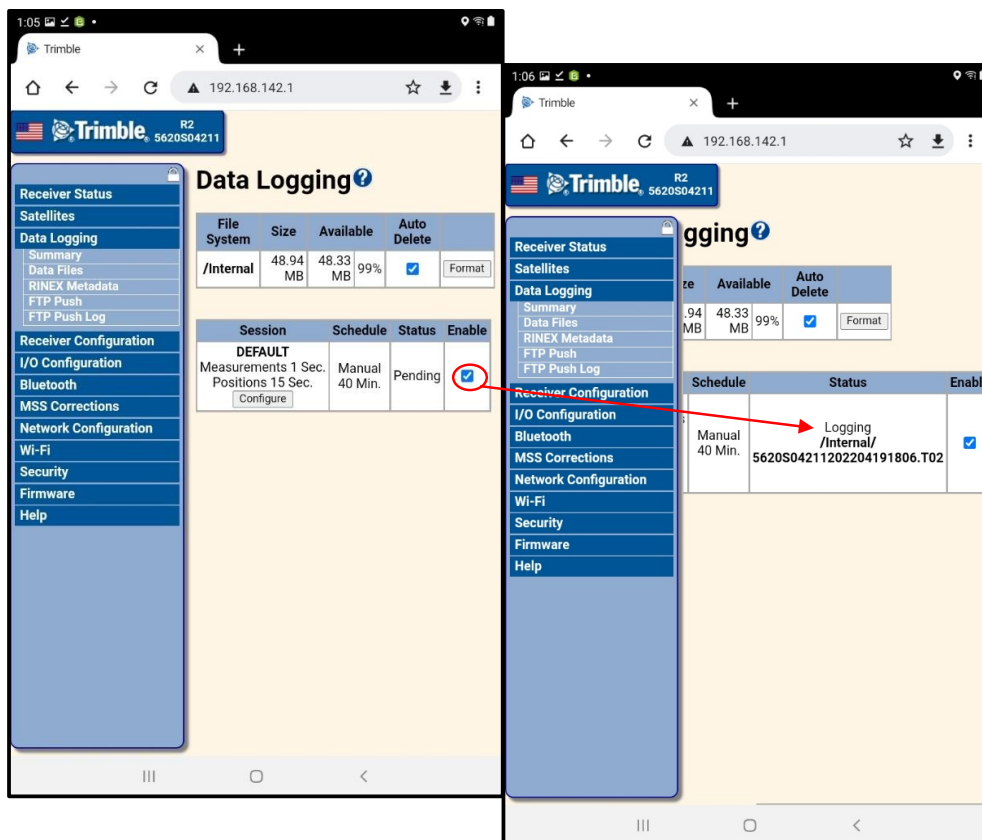


Figure 37. Figure showing Trimble R2 workflow for confirming data is logging with red circles and arrows showing the workflow

3. Once you have set up the GPS and the recording has begun, minimize or close the application without disconnecting the Wi-Fi connection and begin PBI plot measurements
 - a. Data will continue to collect in the background as you collect your plot data
4. Following Plot Measurements download the GPS file ([Figure 38](#))
 - a. Minimize survey and bring up Trimble R2 URL
 - b. Navigate back to the “Data Logging” tab
 - c. Logging Status should now say “Done” if the logging time of **40 minutes** has elapsed
 - d. Once the Status of the Logging Page reads “Done” you can download the GPS file
 - e. Uncheck the “Enable” box and proceed to downloading your GPS file

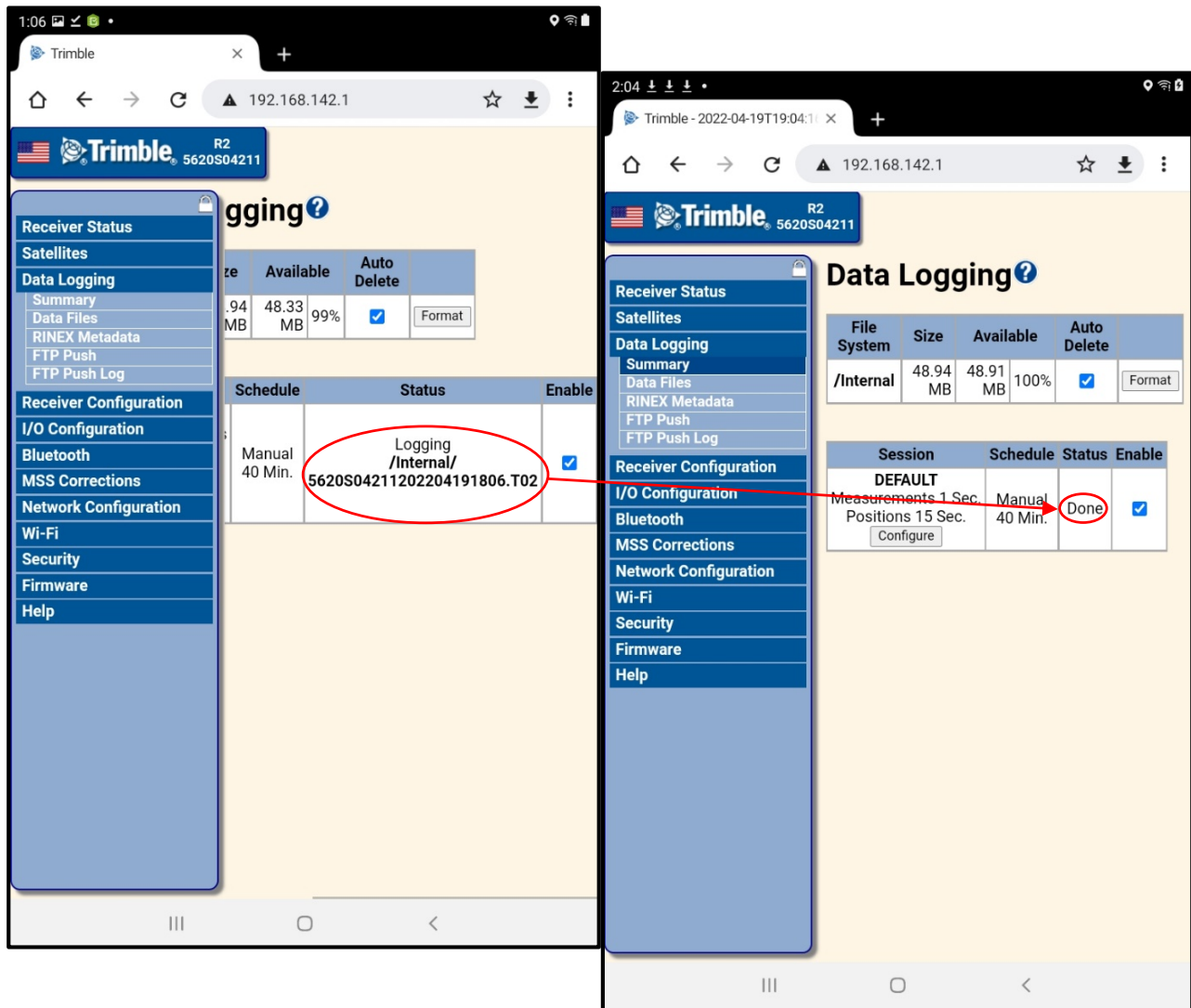


Figure 38. Figure showing Trimble R2 workflow for confirming data has finished logging with red circles and arrows showing the workflow

5. Download Data files from Trimble URL ([Figure 39](#))
 - a. Select “Data Files” under the “Data Logging” tab
 - b. Choose “Internal” and scroll to the far right to see the download options (if necessary)
 - c. Check the box for the file you wish to download. The most current file should be the top file with the most recent time stamp indicated in the record
 - d. Select the option to “Convert and Download Selected Files”
 - e. Set left side to “Rinex 2.11” and right side to “Observables and Ephemeris”
 - f. Select “Convert and Download” to begin downloading GPS file
 - i. Ok the download if prompted and follow any pop-up instructions

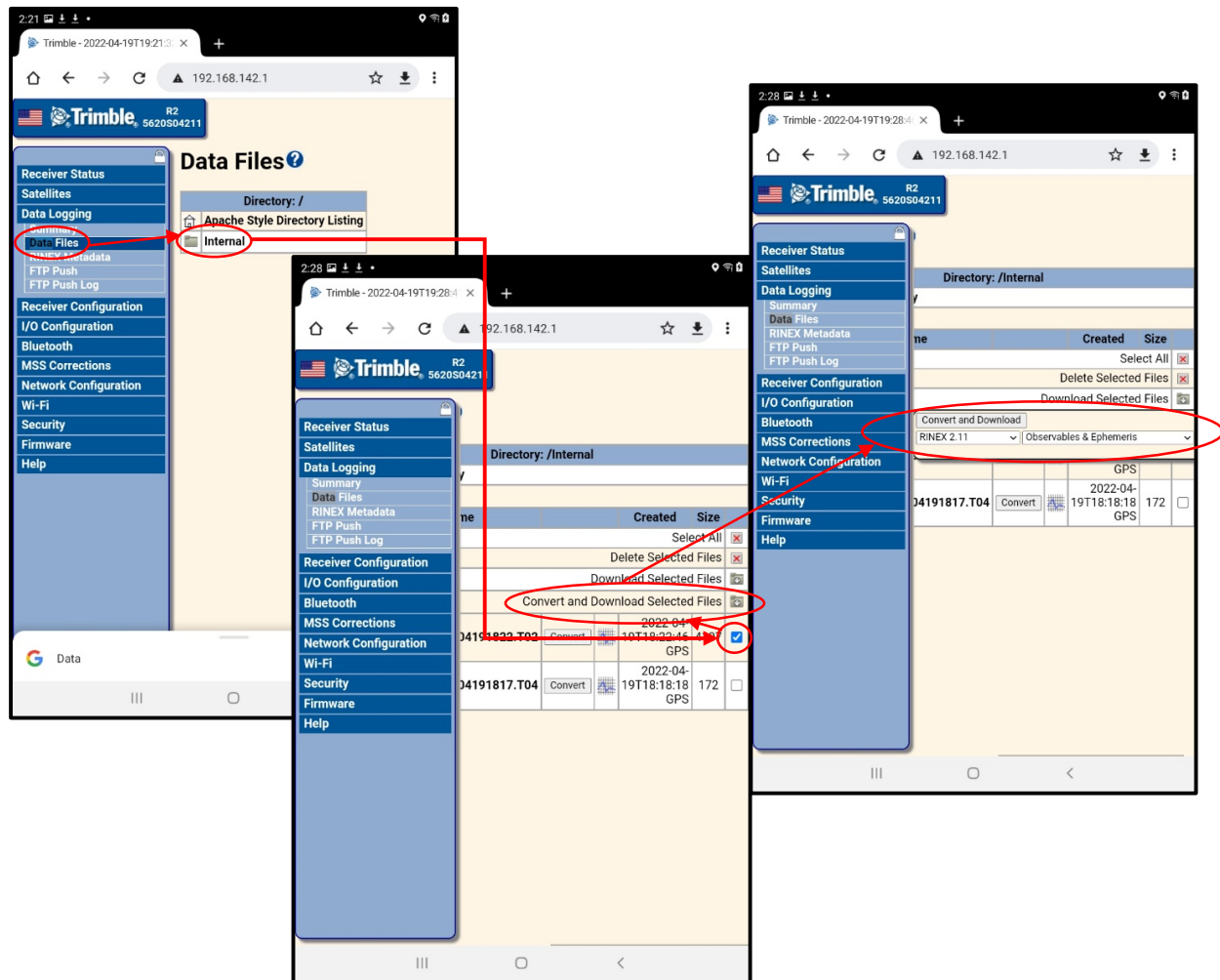


Figure 39. Figure showing Trimble R2 workflow for downloading data with red circles and arrows showing the workflow

6. Instructions for Downloading your Trimble GPS files will be different when using a Samsung Tab A device compared to an iOS device (iPad, iPhone). This section will cover both device downloads when working with the Trimble receiver.

[Samsung Galaxy Tab A Download Instructions](#)

[iPad Mini Download Instructions](#)

[iPhone Download Instructions](#)

Samsung Galaxy Tab A Download Instructions ([Figure 40](#))

- a. When download completes, find and store download to device
- b. Following download completion, Open **File Manager: free and easily**
 - i. Refer to [Getting Started with Your Mobile Devices](#) section of the guide
- c. Select “Downloads” and locate your downloaded file (should be first by date)
- d. Select radio button to the right of the file (selection will show in blue)
- e. On bottom of screen select “More”, then “Copy”
- f. Select “Internal Storage”
- g. Select the **PBI_GPS** folder (scroll down if necessary) created in the
- h. Select “Paste” at bottom of screen
- i. You now have your GPS file saved to the device for attaching to Survey123

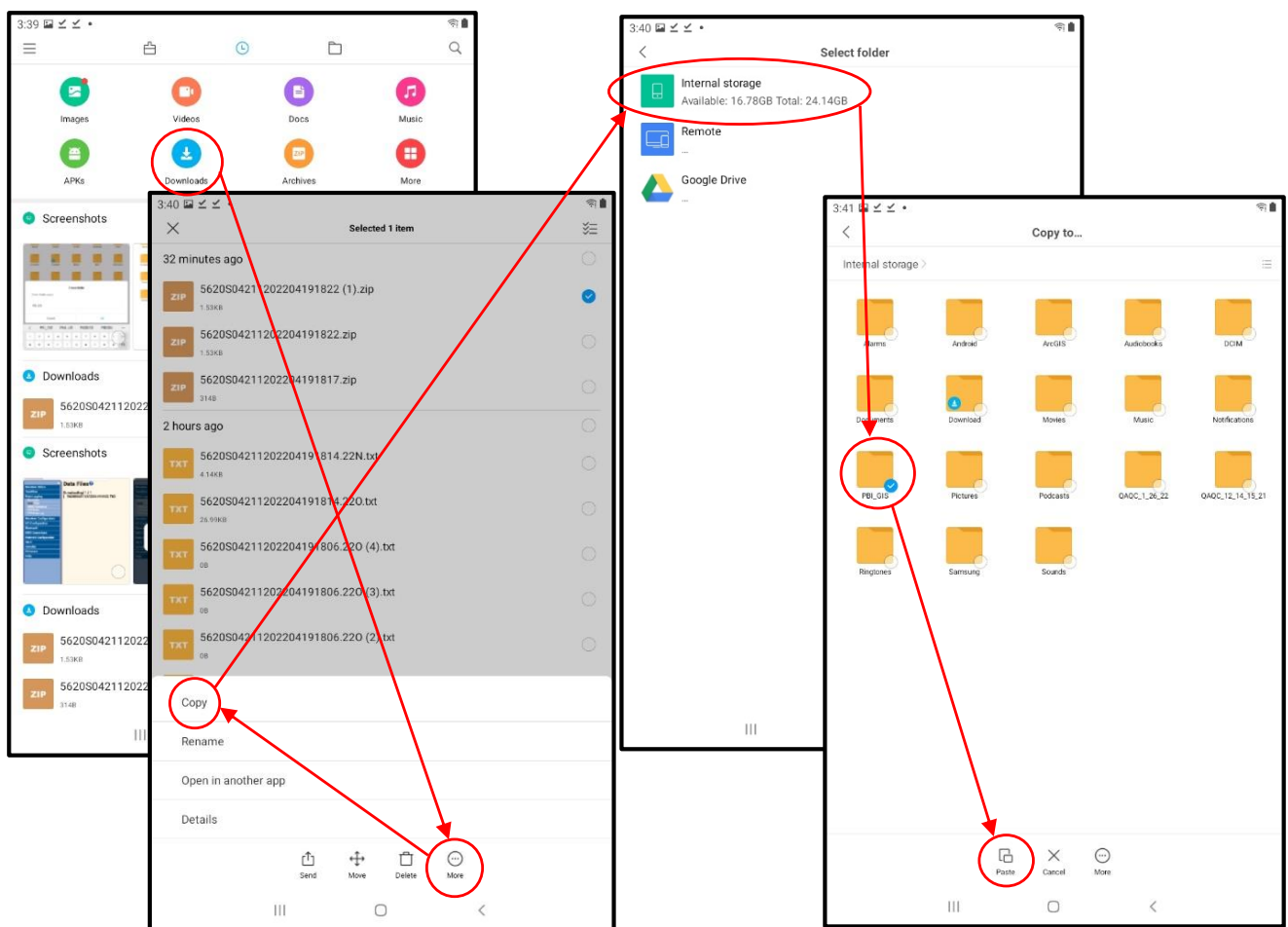


Figure 40. Figure showing Trimble R2 workflow on Samsung Galaxy Tab A for moving GPS file to PBI_GIS folder with red circles and arrows showing the workflow

iPad Mini Download Instructions ([Figure 41](#))

- f. To complete the download, you will need to initiate from the Trimble URL
 - i. On bottom of screen select “Download”
 - ii. Following Download, select “Open in....”
 - iii. Select “Save to Files”
 - iv. Navigate to previously created **PBI_GPS** folder
 - v. Select “Save” to save the file to your folder
- g. Navigate to file location to assure your file was downloaded correctly
- h. You now have your GPS file saved to the device for attaching to Survey123

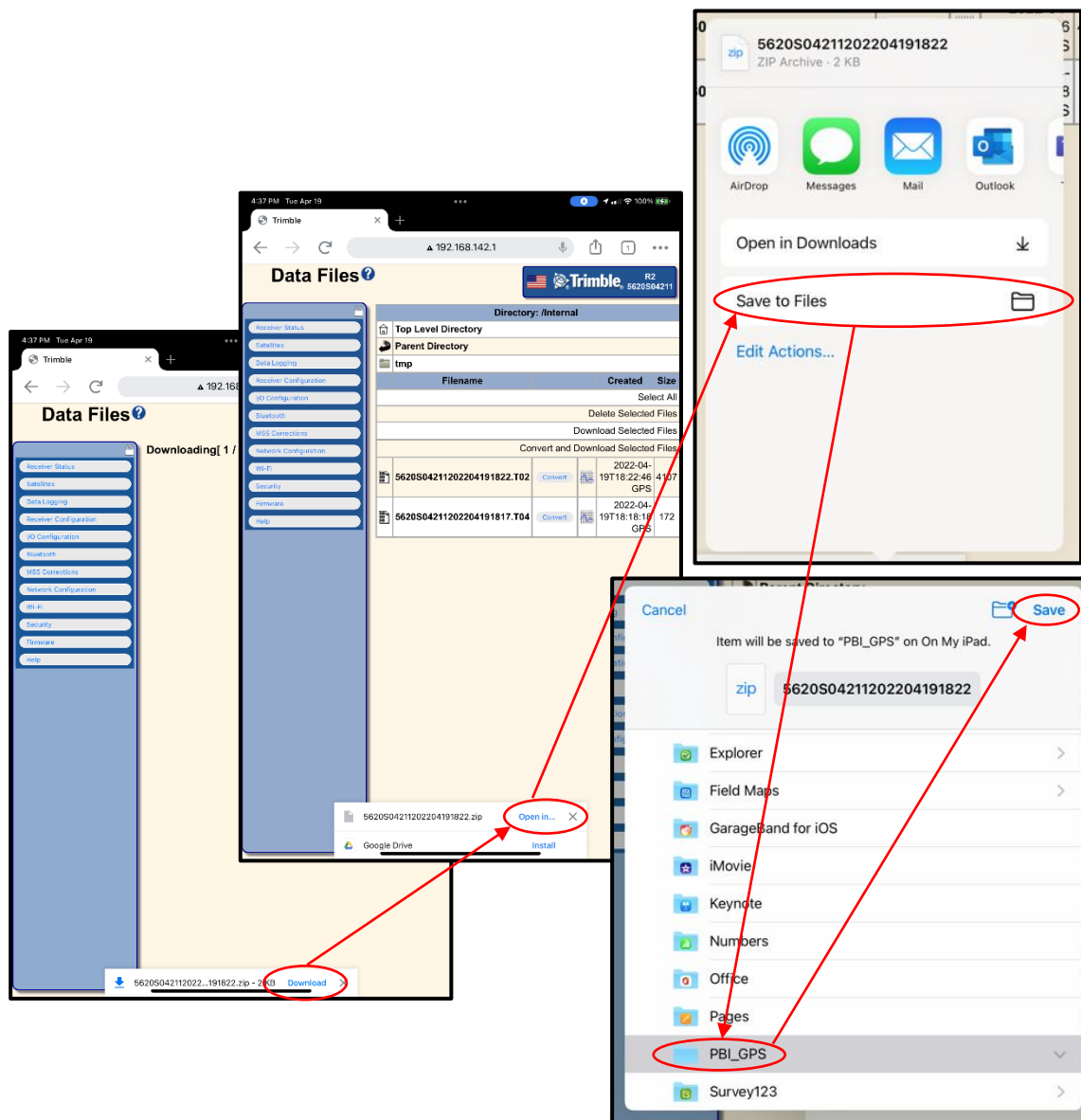


Figure 41. Figure showing Trimble R2 workflow on iPad Mini for moving GPS file to PBI_GIS folder with red circles and arrows showing the workflow

iPhone Download Instructions

- a. Refer to instructions highlighted in the iPad mini 5/6 section for guidance
 - ii. iPhone and iPad devices both use the iOS operating system and workflows should largely mirror each other. If significant deviation from the workflow is identified, an update to the section will be considered. Contact Resource Assessment for questions.
6. Once you are confident that you have collected and downloaded your GPS location, you can pack up your GPS and move on to [*Attaching downloaded GPS files to Survey123*](#)
 - j. Turn off the GPS by pressing and holding the power button for 3 seconds until all the lights turn off.
 - k. Disconnect the GPS from the range pole.
 - l. Put the GPS back in the carrying case.
 - m. Take down range pole/Bipod.
 - n. Mark the GPS pole location with a pin flag.

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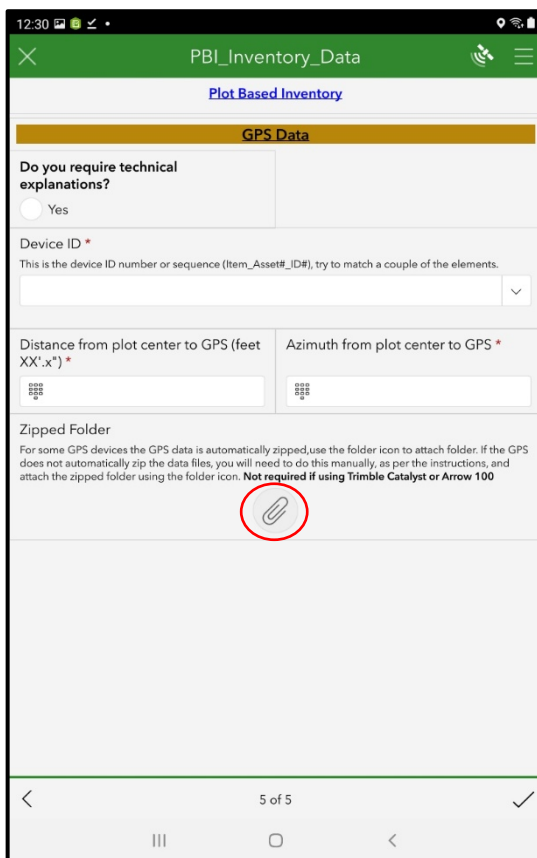
Attaching downloaded GPS files to Survey123

Attaching the file requires the file to be downloaded and saved locally to your mobile device. If you are unable to download or save your GPS files to your mobile device, please contact Resource Assessment for assistance. Application versions, updates and other changes within the current process may occur and require adjustments to your workflow.

If you have collected and cannot download your GPS file:

- The GPS itself will store your files, making them accessible later.
- Record the GPS file name
- Record the Plot Number
- Contact RA for assistance

1. Open the Survey and navigate to Page 5 of the survey (**GPS_Data**) ([Figure 42](#))
 - a. If you require a refresher on Survey123 field data collection, refer to the [Plot Based Inventory \(PBI\) Survey123 Guide](#) section for instruction. This guide will only cover attaching GPS files to the survey and will not cover other aspects of Survey123 data collection
2. Fill out other relevant information on the page (*Technical Explanations, Device ID, Distance, Azimuth*) according to instruction detailed in the PBI Manual
3. Select the “Paper Clip” Icon under the “Zipped Folder” section
4. Choose to Attach a “File” if prompted



12:30

PBI_Inventory_Data

[Plot Based Inventory](#)

GPS Data

Do you require technical explanations?

☐ Yes

Device ID *

This is the device ID number or sequence (Item_Asset#_ID#), try to match a couple of the elements.

Distance from plot center to GPS (feet XX'.x") *

Azimuth from plot center to GPS *

Zipped Folder

For some GPS devices the GPS data is automatically zipped, use the folder icon to attach folder. If the GPS does not automatically zip the data files, you will need to do this manually, as per the instructions, and attach the zipped folder using the folder icon. **Not required if using Trimble Catalyst or Arrow 100**

5 of 5

Figure 42. Figure showing Page 5 of Survey 123 form for attaching GPS files with Red Circle highlighting attachment link

5. Follow the file path to the location you saved your downloaded files
 - a. This path will be dependent upon your mobile device
 - i. **Samsung Galaxy Tab A** ([Figure 43](#))
 1. When attachment folder opens select the four horizontal bars in the upper left to navigate to the correct location
 2. Choose the option beginning with “Galaxy Tab A” beneath Downloads
 3. Select the downloaded file from the folder titled **PBI_GIS**

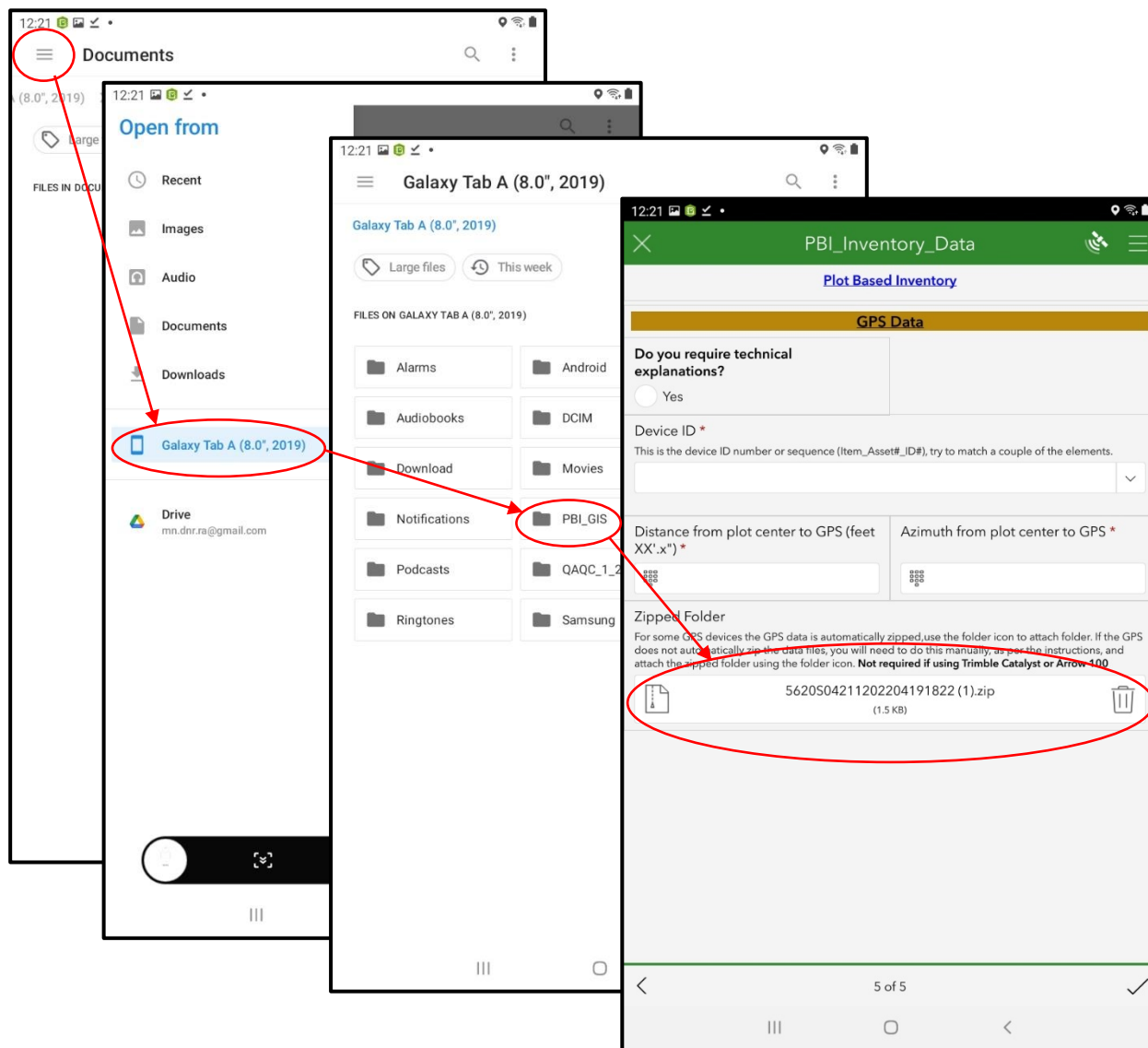


Figure 43. Figure showing Samsung Galaxy Tab A workflow for Attaching GPS File to Survey 123 with red circles and arrows showing the workflow

ii. iPad Mini (*Figure 44*)

1. When attachment folder opens select “On my iPad” in the upper left
2. Select the folder titled **PBI_GIS**
3. Select the Downloaded file

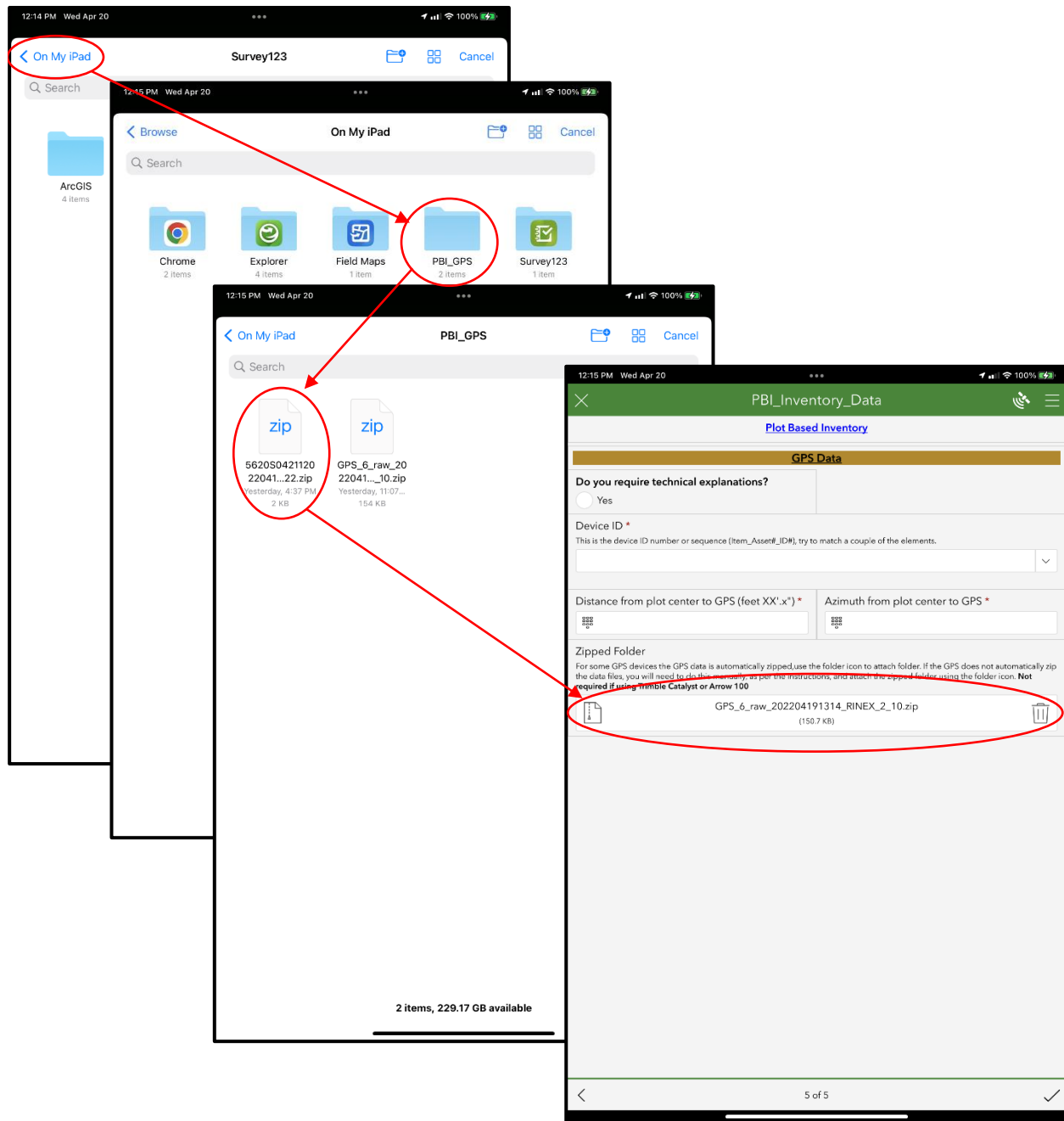


Figure 44. Figure showing iPad Mini workflow for Attaching GPS File to Survey 123 with red circles and arrows showing the workflow

iii. iPhone

1. Refer to instructions highlighted in the iPad mini 5/6 section for guidance
 - iPhone and iPad devices both use the iOS operating system and workflows should largely mirror each other. If significant deviation from the workflow is identified, an update to the section will be considered. Contact Resource Assessment for questions.
6. After attaching the file to the survey check to make sure the correct file was attached and continue with any other checks and measurements needed for completion of the Survey form
7. Submit the Survey when all collections are completed, and attachments are correctly assigned to the plot.

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SECTION 3: PLOT BASED INVENTORY (PBI) SURVEY 123 GUIDE

Downloading Survey123 Application

Before conducting PBI field measurements you will need to first download the Survey123 Application and connect to the MN DNR Portal. Downloading the Survey123 Application is a one-time action, but areas within this section will be helpful for logging into the portal, new device usage and updates to devices that may cause a need to re-establish connections.

Prior to downloading the Survey123 Application, assure that you are operating under the following conditions...

- Connected to a reliable Wi-Fi network
- Have performed all necessary device setup prior to installation
 - For 4Trees devices this assumes your device is fully set up (Contact DNR MNIT for assistance with 4Trees device general setup)
- Have proper permissions to download Applications
- Have an application “Store” to download and install Applications

This Manual will cover general instructions on downloading Survey123 to your device, but instructions may vary across devices. In general, the act of downloading and working within an application is relatively consistent across devices. If you have trouble downloading and configuring the application, please contact Resource Assessment for assistance.

1. Navigate to your device application “store”
 - a. App Store (Apple/iOS)
 - b. Play Store (Android)
 - c. Microsoft Store (Windows)
 - d. Etc.
2. From your application store, search for “Survey123”
3. Initiate the download of the application
4. Once downloaded, move to accessible location on your device for ease of use

You have now successfully downloaded the Survey123 application. The next steps in using the application for PBI data collection are to setup the MN DNR Portal connection, review some settings and download the survey form needed for plot collection.

MN DNR Portal Access

You will now need to establish a connection with the MN DNR Portal for collection and submission of data to the Resource Assessment managed Database

Survey data is collected and sent to a database when completed, making data transmission seamless and allowing Resource Assessment to track data collections in “real time”. For the system to work we first need to connect to the Portal and setup the application. You will need to maintain your connection to a Wi-Fi connection to complete these steps.

Connecting to the MN DNR Portal ([Figure 45](#))

1. Open the application
2. Select “OK” if prompted to allow Survey123 to use your Camera
 - a. This will be needed for capturing plot images within the survey form
3. Select Manage ArcGIS connections box
4. Choose “Add connection” in the bottom left of the screen
5. Enter **arcgis.dnr.state.mn.us/portal** into the ArcGIS connection URL box and select “Add”
 - a. Include **https://** if not already populated
6. You should now see your Portal connection displayed in the Connections window
7. Select the “back arrow” in the upper left of the screen to return to the login page

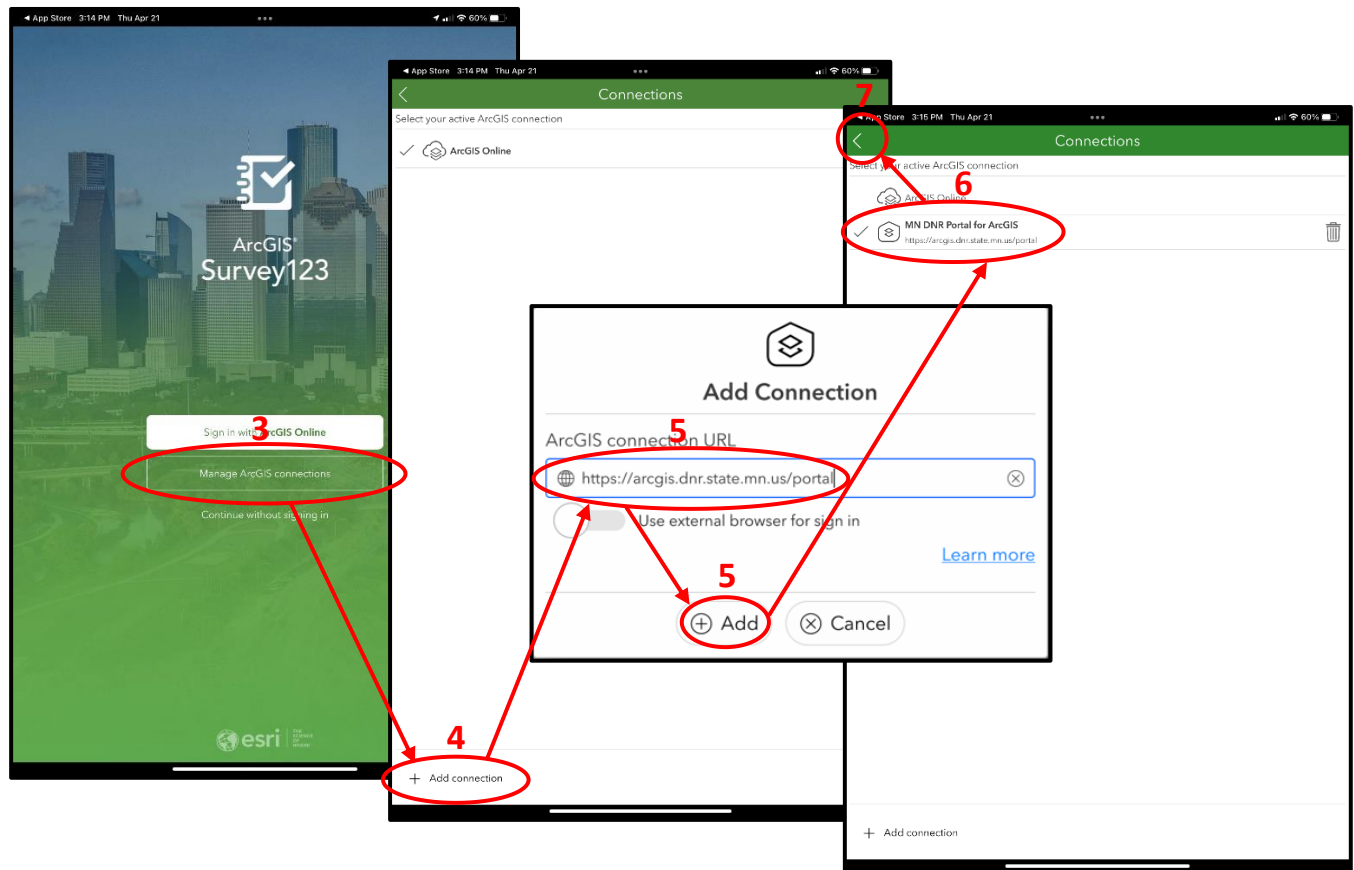


Figure 45. Figure showing multi-step workflow for setting up portal connection with red lines, boxes and numbers highlighting steps of the workflow

Signing into the MN DNR Portal ([Figure 46](#))

8. Select “Sign in with **MN DNR Portal for ArcGIS**”
9. Enter your sign in Credentials and choose “Sign In”
 - a. For DNR Staff enter the information below (*F=First Name Letter, L=Last Name Letter*)
 - i. **Username:** FFLLLLL@MNDNR
 - ii. **Password:** Password used for access to DNR Computer
 - b. For NON-DNR Staff
 - i. Refer to information supplied in agreement or supplied by RA Staff
 1. Contact RA for assistance
10. Select “Allow While Using App” when prompted by Survey 123 to use your location

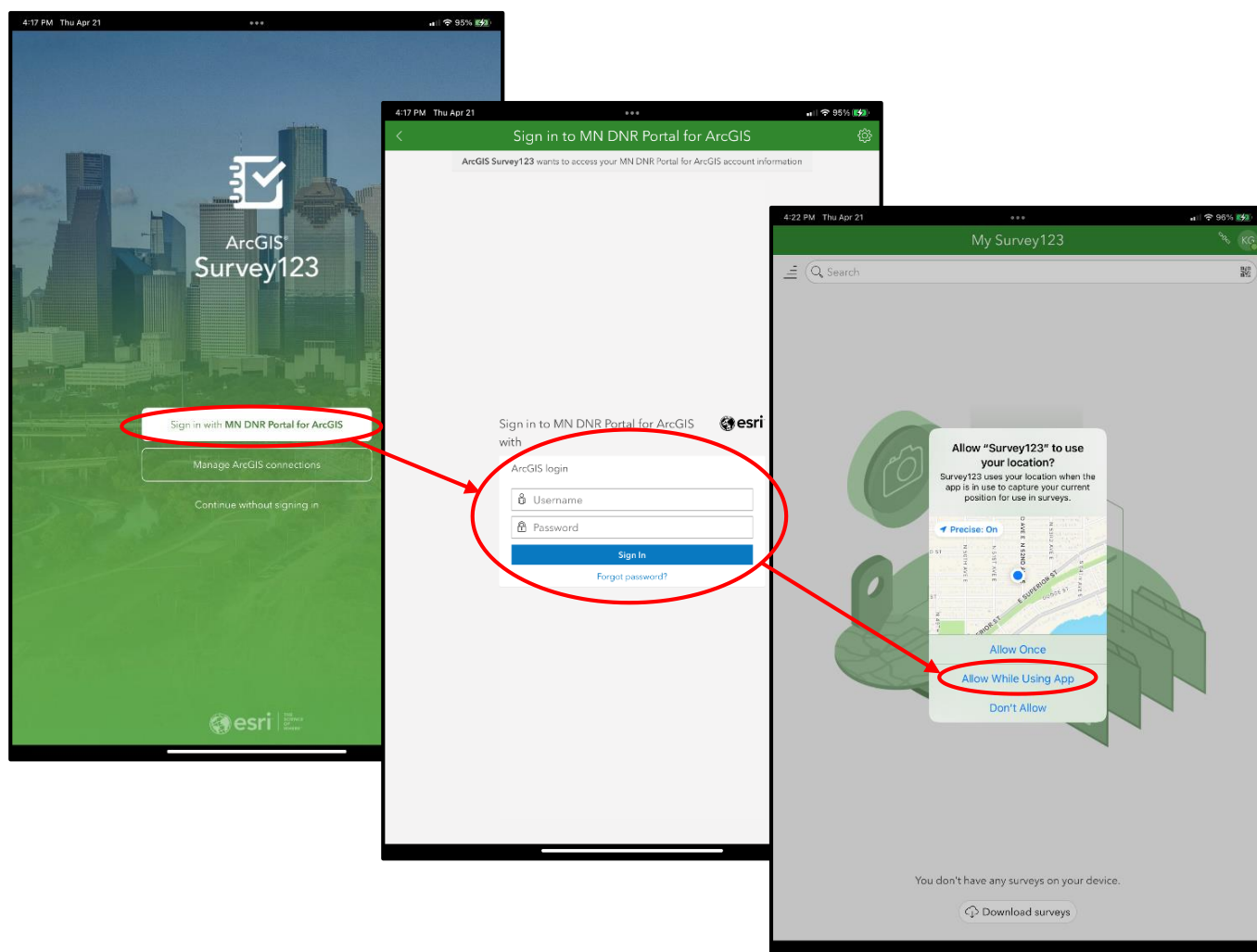


Figure 46. Figure showing workflow for signing into MN DNR Portal and allowing location use with red lines and circles showing the workflow

Downloading and Updating Surveys

Now that you have connected to and signed into the MN DNR Portal you can download survey forms.

Survey forms are updated and change over time. Additional survey forms are added to the application by other users and depending on the settings that the user has defined for sharing, you may see forms that are not related to your work or may be useful additions to your work as well as the work of others.

Download the Plot_Based_Inventory Survey – Option 1 ([Figure 47](#))

1. After connecting and signing in you will be on the home screen of Survey123. You will see on this page that you do not currently have any surveys on your device
 - a. Select *“Download Surveys”* on the bottom of the screen
2. This will bring you into a menu of available surveys within the MN DNR Portal that have been shared with your user account
 - a. Find the survey for **Plot_Based_Inventory** and select the *“Download Icon”*
 - i. Once the download is complete the icon will change to a *“Refresh Icon”*
 1. The refresh icon can be selected to update the survey to current version
3. Select the *“Back Arrow Icon”* in the upper left corner of the download page to view the **Plot_Based_Inventory** Survey
4. You have now downloaded the PBI survey form and are ready to collect data

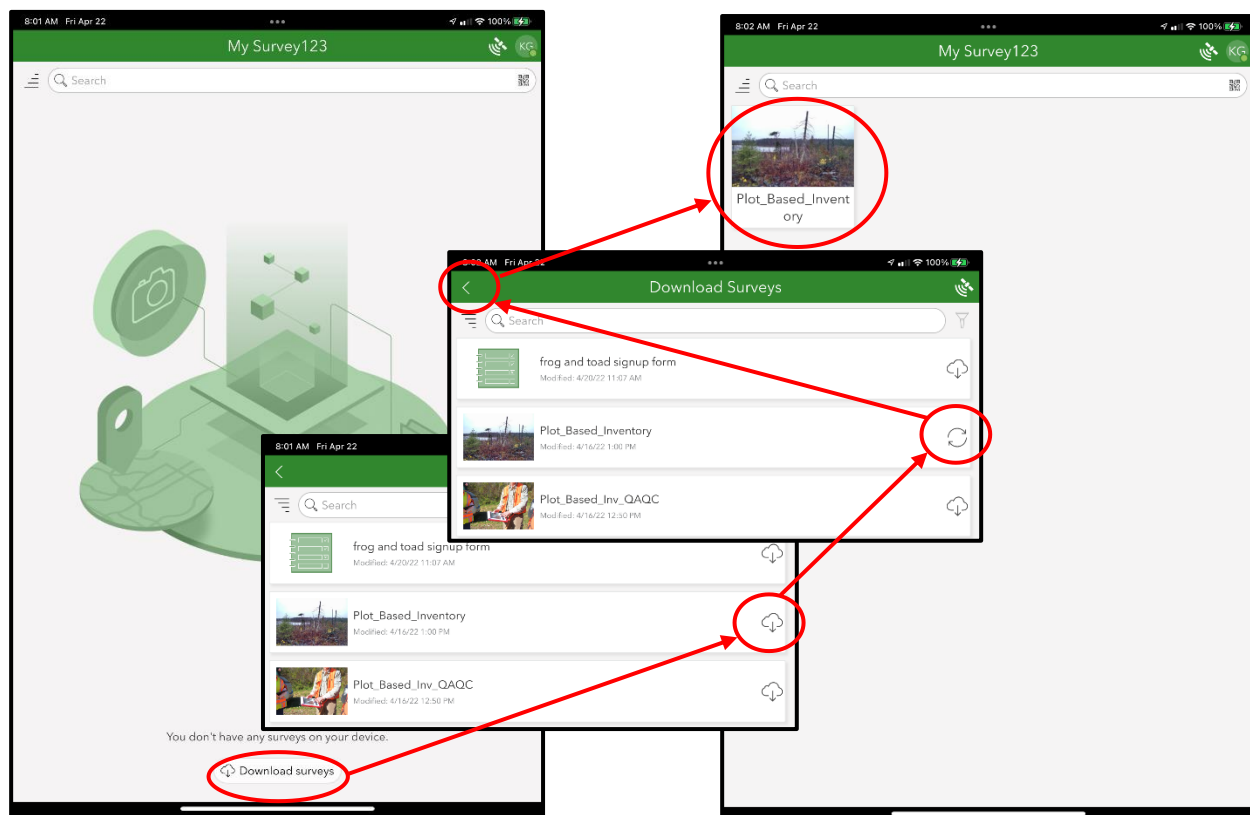


Figure 47. Figure showing workflow for downloading survey following application installation with red lines and circles showing the workflow

Download the Plot_Based_Inventory Survey – Option 2 [\(Figure 48\)](#)

5. In the upper right-hand corner of the My Survey 123 page or My Surveys Page you will see a bubble with initials within it (Your initials or RA account initials)
 - a. Select the bubble and you will see a menu of options in the dropdown
6. There are options for downloading surveys, settings, application information, signing out and account information
 - a. Select the option for “Download Surveys”
7. Follow the instructions above starting with **STEP 2** to complete the download

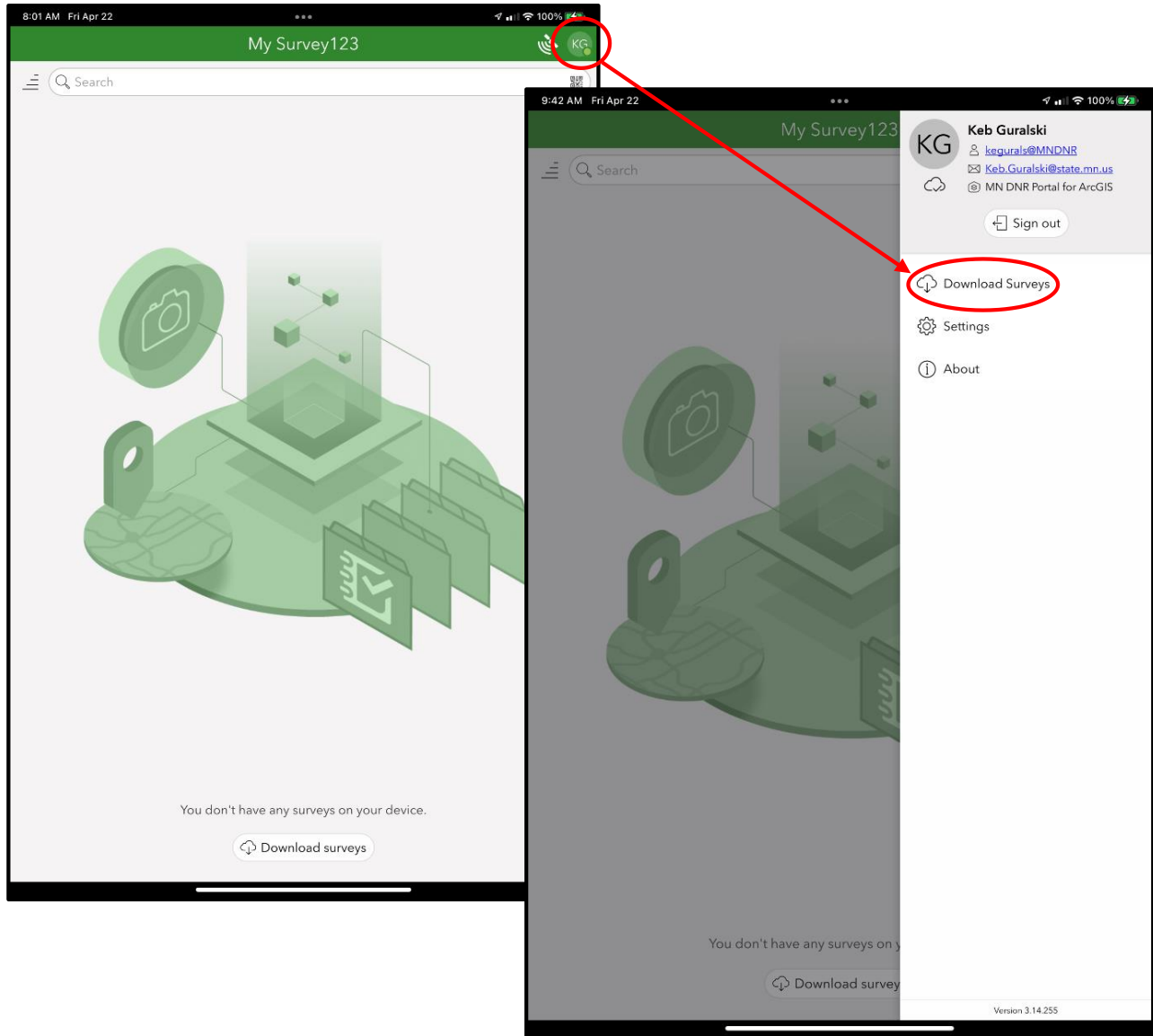


Figure 48. Figure showing alternative workflow for downloading survey following application installation with red lines and circles showing the workflow

8. Following survey download your device should be ready for Survey123 data collection. Checking for survey updates is an important part of the process and will be outlined in the next section

Checking for Updates and Updating Survey Form ([Figure 49](#))

The **Plot_Based_Inventory** survey will periodically be changed to update lists, add fields, or change the appearance of some pages for a more user-friendly display. The survey form will not automatically update, and the user will need to check for updates while connected to a Wi-Fi network to obtain the newest version of the survey form.

Check for updates on days that you are going to measure a plot prior to heading to the field. Form updates can have variable impacts and may cause a failure in submission. Typically this can be mitigated by updating the form and then editing the saved draft and submitting. The best practice is to keep the form up to date, and send data once it is complete, as soon as an internet connection can be found. To lower the risks when updating the form, RAP staff typically update forms over weekends, and send out notifications when an update is implemented.

1. You can update the application by navigating to the download survey location highlighted in the download section and select the “Refresh Icon”
 - a. This can be done periodically to assure you are staying up to date
2. From that page, you can also select the “Download Updates Icon” on the bottom of the screen
 - a. This will only display if an update is available. Check this frequently

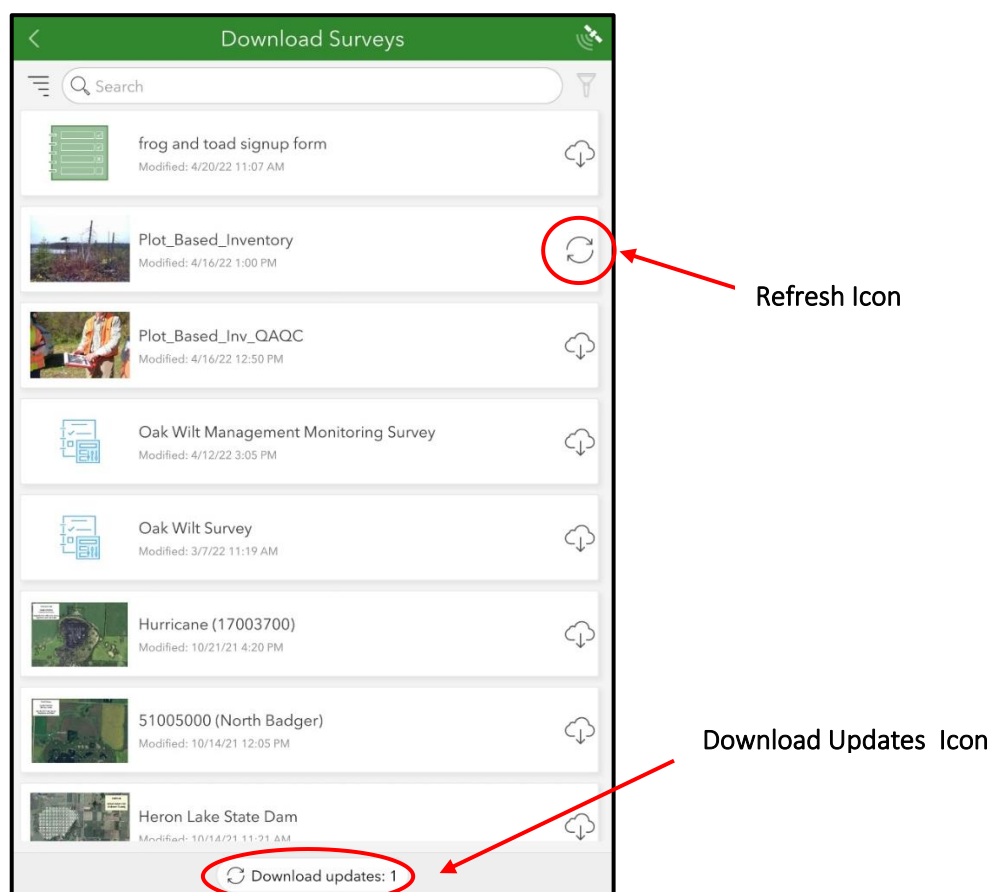


Figure 49. Figure showing multiple labeled options for updating Plot Based Inventory survey form with red circles showing the selection

3. You can also watch for prompts on your Survey Screen for updates. When you open the application and are connected to Wi-Fi, you will see a banner along the top of the screen that states that Updates are Available ([Figure 50](#))
 - a. Select the Banner to view available updates
 - b. Select the “Refresh Icon” or the “Download Updates Icon”
 - i. This will initiate download of the selected update

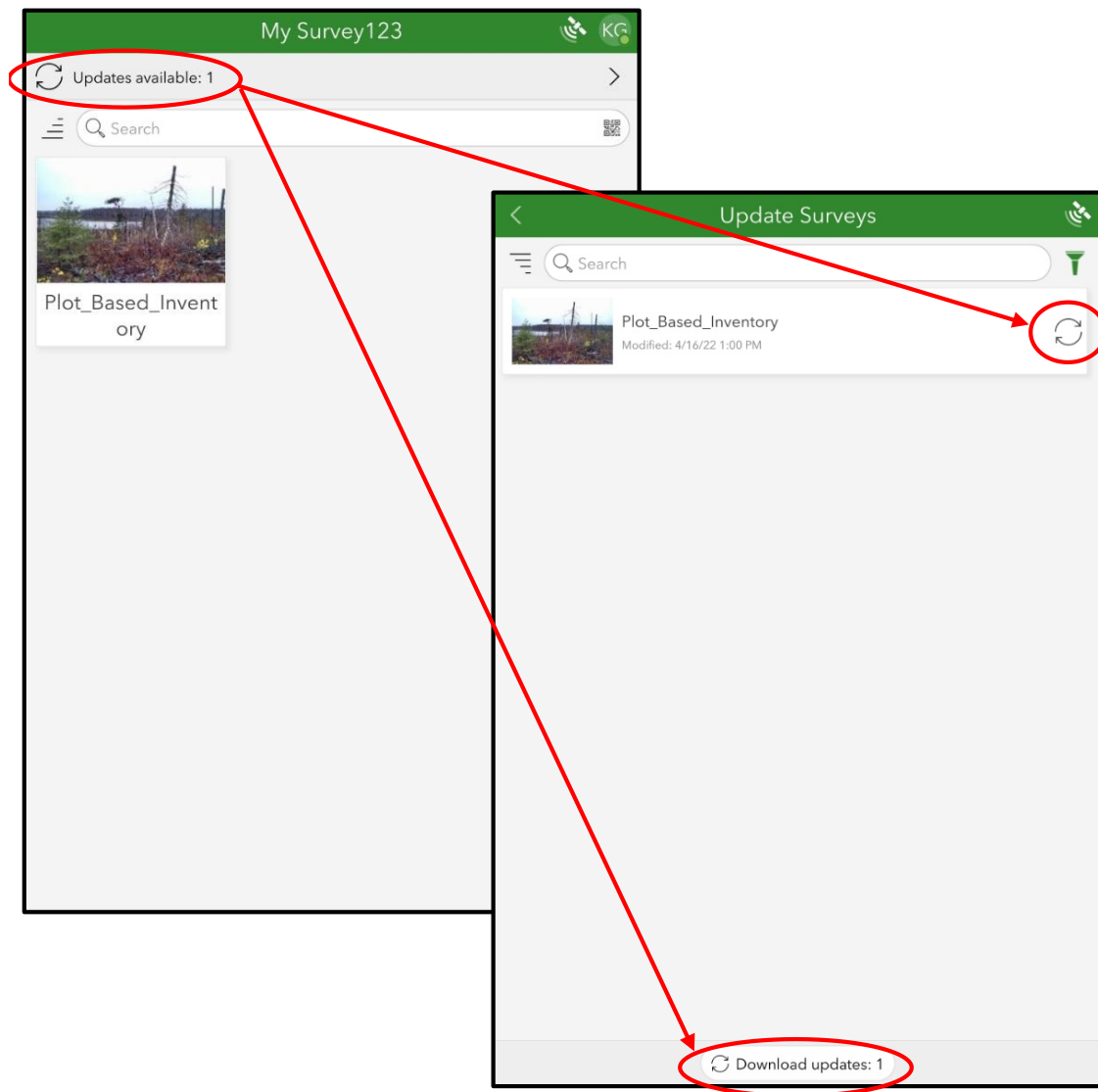


Figure 50. Figure showing workflow for updating Plot Based Inventory Survey123 form when prompted with red lines and circles showing the workflow

4. After the Survey is updated, the notification should no longer be on the screen and no updates should be available
 - a. Keep in mind that other survey forms you download are on different update schedules based on the author and you may see updates for other forms when the PBI survey is up to date
5. Now that the survey is downloaded and updated, you can take your device to the field

Complete a Survey

Completing a survey using the application does not require a connection to a Wi-Fi or data network. Once the survey is downloaded and updated it is ready for offline use.

Refer to the [Plot Based Inventory \(PBI\) Field Technology Guide](#) section for GPS collection instruction.

This section will cover all instructions relating to using the Survey123 application to collect data outlined in the [PBI Survey](#) pages of the [Plot Based Inventory \(PBI\) Field Procedures Guide](#) section.

Upon completion of Plot Establishment, you will need to open the Survey 123 application and begin a new survey.

Open the Survey123 Application

1. Open the Survey123 Application
 - a. Since you are offline, you may see a warning that you are offline. There will be an option for continuing without signing in. You can collect and save your data to your device while offline. You cannot perform updates, download new surveys, or submit results
 - b. If you are on a data plan or have an available network, you can either sign in or continue without signing in
 - c. See below ([Figure 51](#)) for messages you may receive when working offline

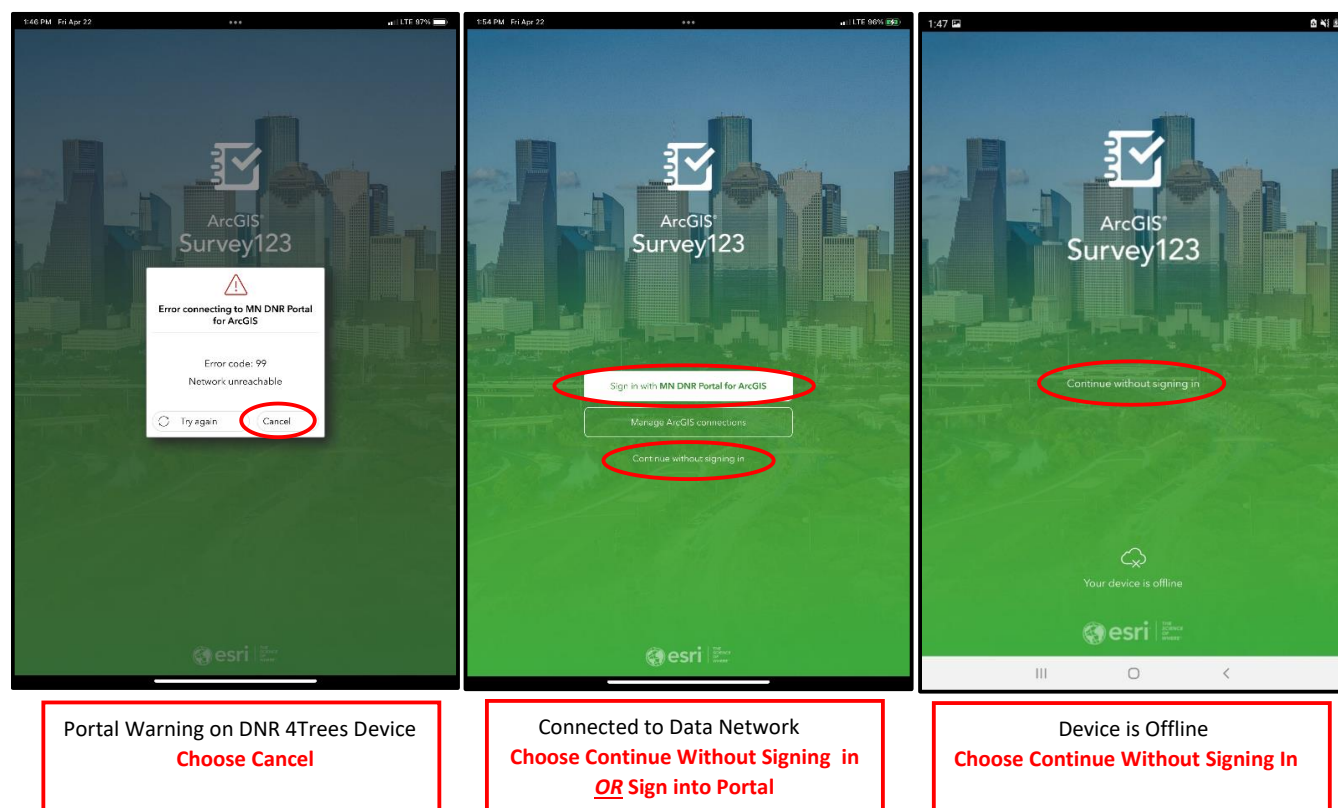
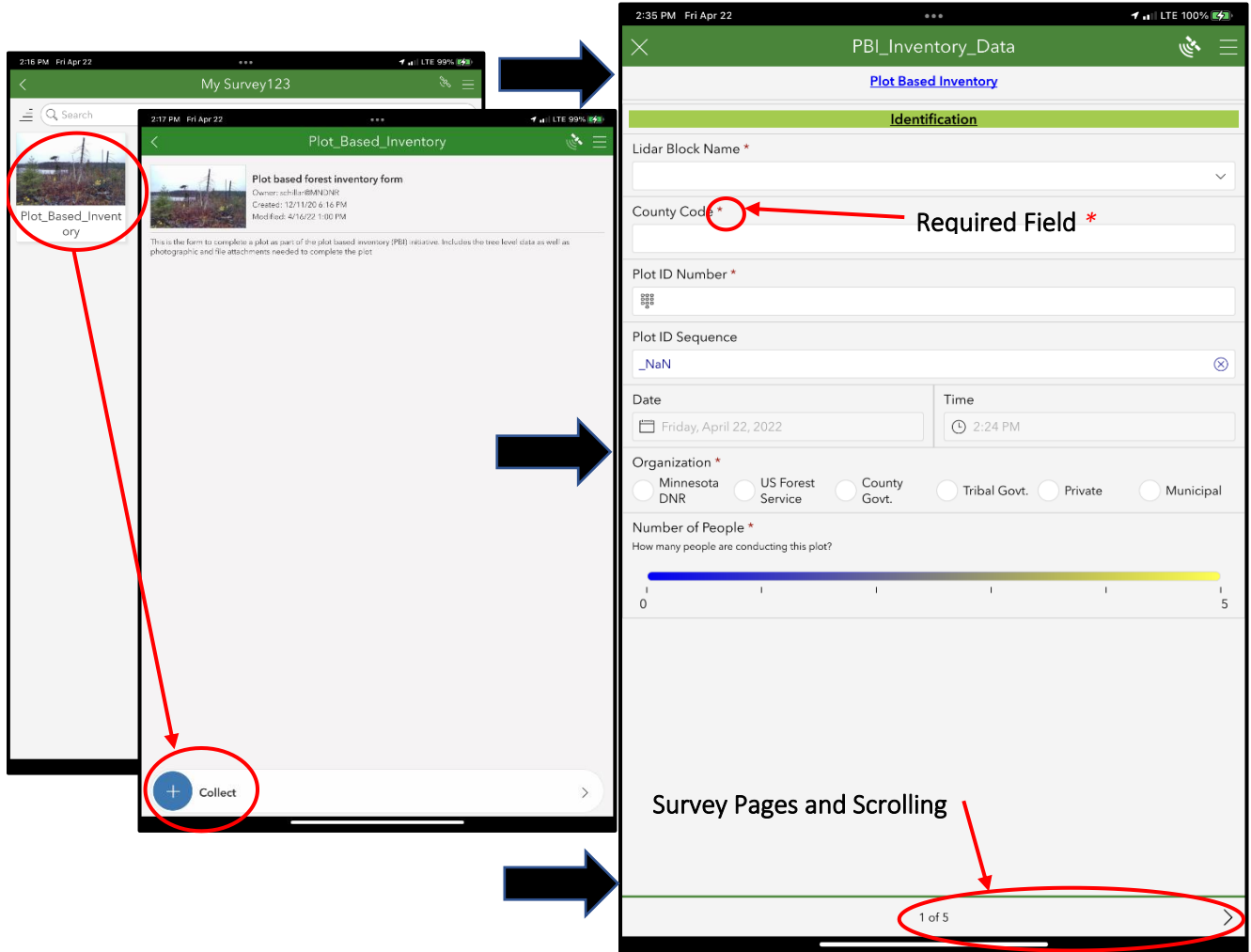


Figure 51. Figure showing Survey123 Offline screen results with red circles showing options

Opening Plot Based Inventory Survey Form (*Figure 52*)

1. From the Survey 123 Home Screen, locate and select **Plot_Based_Inventory**
 - a. This will open the survey's home page
2. From the survey home page select the option for "Collect" on the bottom of the screen
3. This will open your survey



The figure illustrates the workflow for opening the Plot Based Inventory Survey form. It consists of three screenshots of the Survey 123 app interface, connected by arrows indicating the sequence of steps.

Step 1: The first screenshot shows the 'My Survey123' home screen. The 'Plot_Based_Inventory' option is circled in red, indicating it should be selected.

Step 2: The second screenshot shows the 'Plot_Based_Inventory' survey home page. The 'Collect' button at the bottom is circled in red, indicating it should be selected.

Step 3: The third screenshot shows the 'PBI_Inventory_Data' form. The 'County Code' field is circled in red and labeled 'Required Field *'. The '1 of 5' page indicator at the bottom is also circled in red.

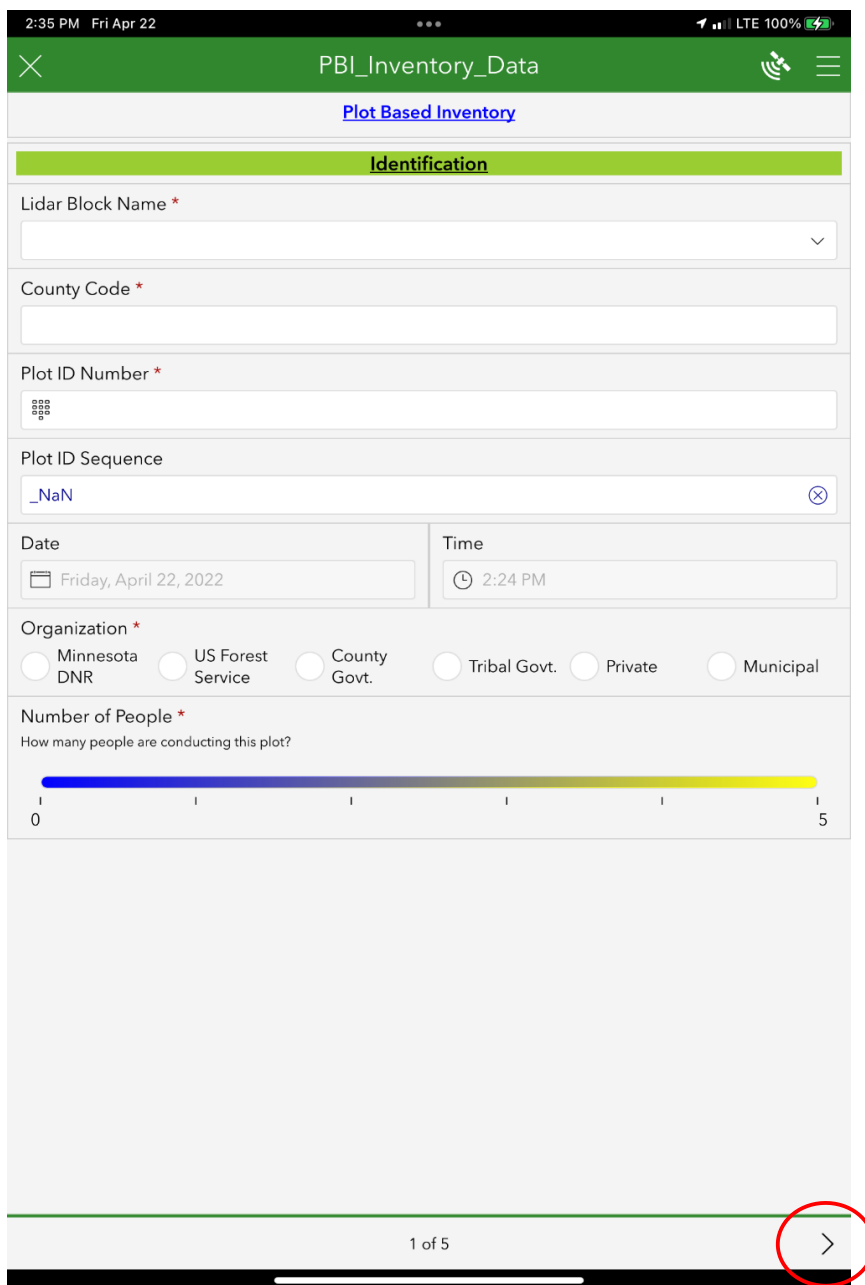
Figure 52. Figure showing workflow for opening Plot Based Inventory Survey form with red lines and circles showing the workflow and labels showing locations of page scrolling and required fields

4. At the bottom of the screen, you will notice that you are on page 1 of 5.
 - a. The survey is set up as pages. You may toggle back and forth between them using arrows in the lower left and right corners of the screen as you page through the survey
5. Items that have a red Asterisk * are required fields. You will need to fill these out to submit a survey
 - a. When submitting or saving your survey to an outbox later, these fields will need to have been completed. If required fields are not complete, you will be prompted to complete them. The survey will take you to the first such field and highlight it, prompting you to complete the field.

Survey Page 1 – Identification ([Figure 53](#))

Complete Page 1 under guidance found on the [Identification](#) pages of the [Plot Based Inventory \(PBI\) Field Procedures Guide](#) section.

Page 1 of the survey is focused on Plot and Plot Collector Identification. Check County Code and Plot Number carefully to assure data correlation when analysis is being conducted.



2:35 PM Fri Apr 22 LTE 100%

PBI_Inventory_Data

[Plot Based Inventory](#)

Identification

Lidar Block Name *

County Code *

Plot ID Number *

Plot ID Sequence

_NaN

Date: Friday, April 22, 2022

Time: 2:24 PM

Organization *

☐ Minnesota DNR
 ☐ US Forest Service
 ☐ County Govt.
 ☐ Tribal Govt.
 ☐ Private
 ☐ Municipal

Number of People *

How many people are conducting this plot?

0 1 2 3 4 5

1 of 5

>

Figure 53. Figure of Survey123 form Showing Page 1 - Identification

- Following completion of page 1, continue to Page 2 by selecting the Arrow on the Bottom corner of the screen circled in red above ([Figure 53](#))

Survey Page 2 – Plot Images and Geospatial Information ([Figure 54](#))

Complete Page 2 under guidance found on the [Plot Images and Geospatial Information](#) pages of the [Plot Based Inventory \(PBI\) Procedures Guide](#) section.

Page 2 of the survey is focused on collecting a geospatial point and photographs of the plot in each of the Cardinal directions. Please note that the geospatial point collected here is *NOT* the official plot center, which must be taken using a sub-meter GPS device. The geospatial point collected using this form is for data integrity and progress tracking.

1. Fill in all fields
2. Following completion of page 2, continue to Page 3 by selecting the Arrow in the bottom right corner of screen ([Figure 54](#))

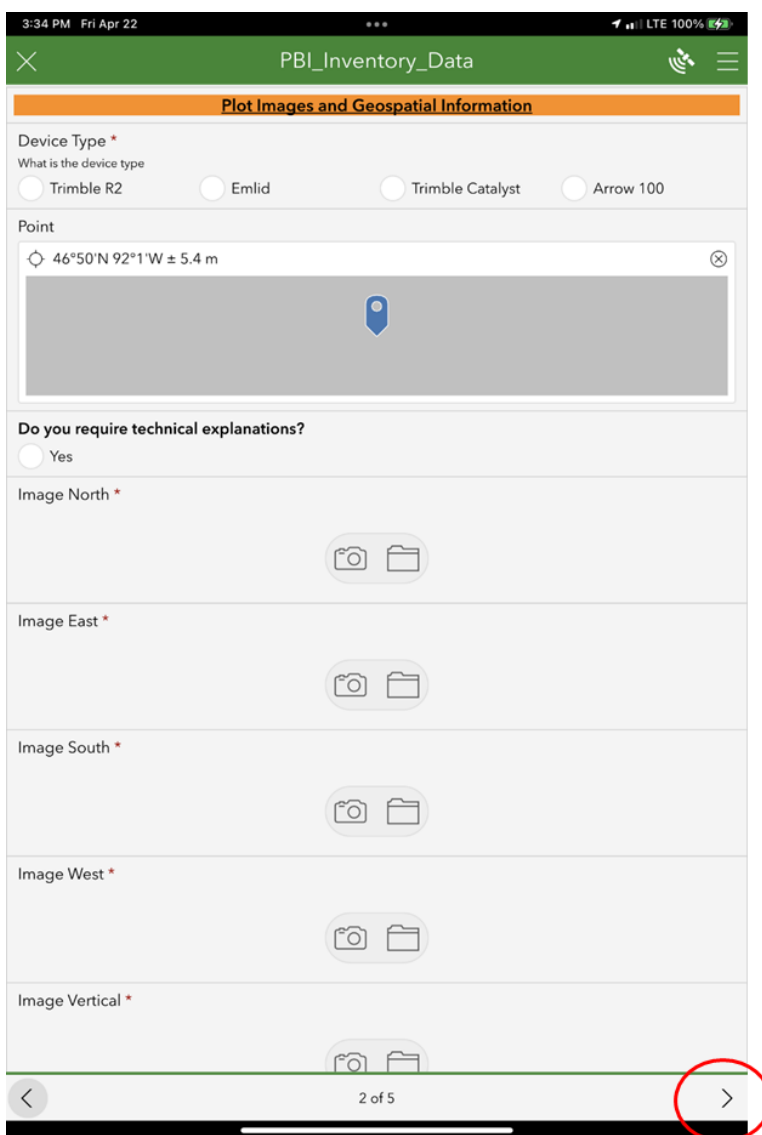


Figure 54. Figure of Survey123 form Showing Page 2 – Plot Images and Geospatial Information

Survey Page 3 – Tree Level Data ([Figure 55](#))

Complete Page 3 under guidance found on the [Tree Level Data](#) pages of the [Plot Based Inventory \(PBI\) Field Procedures Guide](#) section.

Page 3 of the Survey is for collecting Tree Data. The page will load additional features dependent upon other selections. If trees are present, you will add trees to the form as you record them.

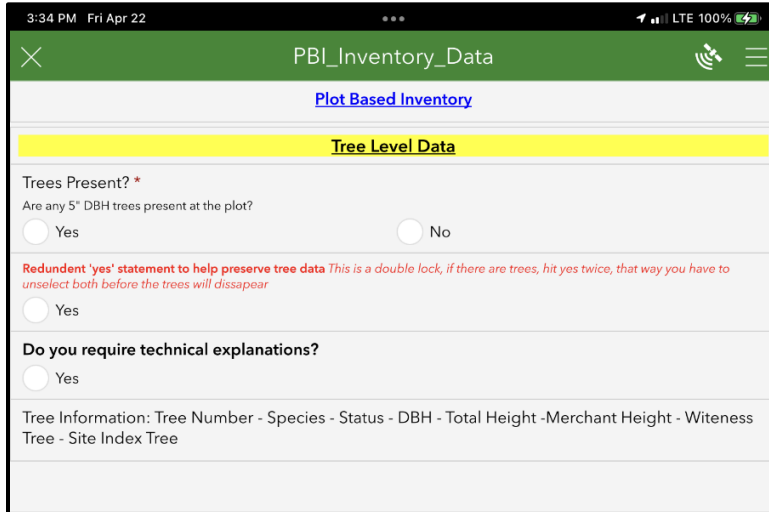


Figure 55. Figure of Survey123 form Showing Page 3 – Tree Level Data

1. Determine if there are trees on the plot and add records ([Figure 56](#))
 - a. If there are **NOT** measurable trees on the plot (>5.0" DBH) select "No"
 - b. If there are measurable trees on the plot (>5.0" DBH) select "Yes"
 - i. An "Add Icon" will appear, and you can add a tree by selecting the Icon
2. Toggle on the "Redundant Yes Statement" button to protect you from data loss.
3. You will now be able to add Tree Information to the survey

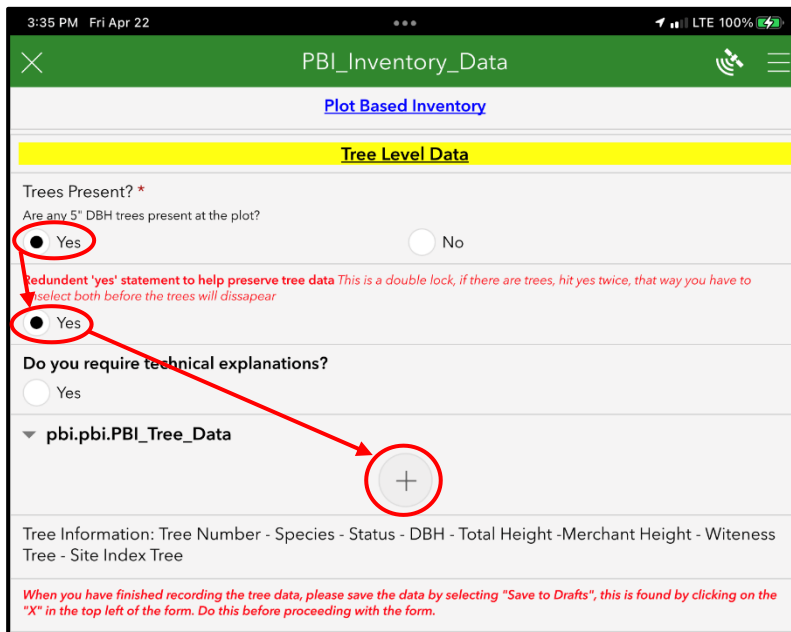
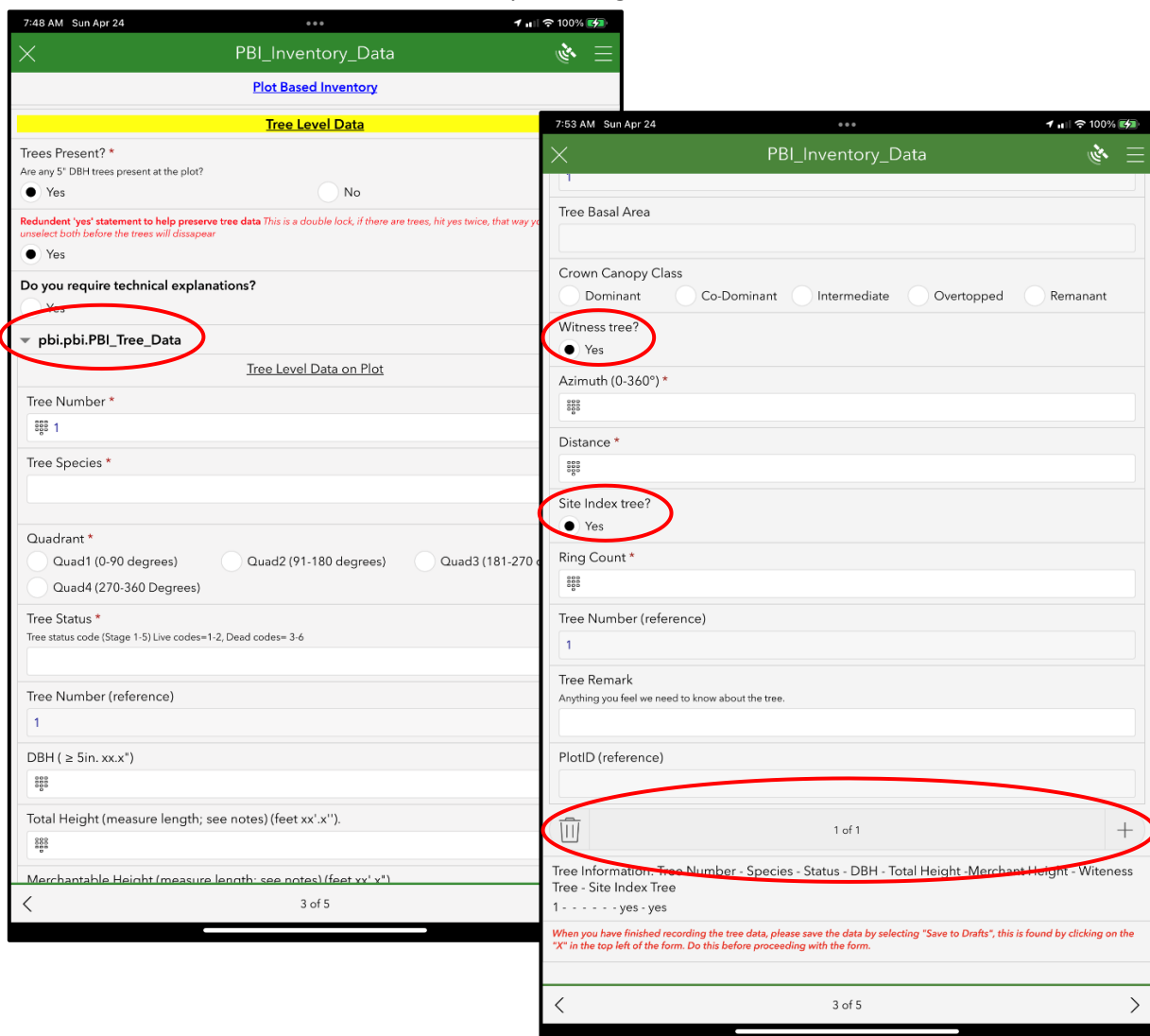


Figure 56. Figure showing workflow adding a Tree record to Page 3 with red lines and circles showing the workflow

4. A tree record form will populate below **pbi.pbi.PBI_Tree_Data** ([Figure 57](#))
 - a. The tree Number will be auto populated, but can be edited if needed
5. Enter all needed information for Tree 1
 - a. Refer to the [Tree Level Data](#) pages of the [Plot Based Inventory \(PBI\) Field Procedures Guide](#) section for information on measurements
 - b. Species lists are populated based on Lidar Block indicated on Page 1 of the survey
 - i. If a species is missing from the list, choose “Unknown” and enter in Tree Species in the Tree Remark field. ([Figure 57](#))
6. If the tree record is a Witness or Site Index Tree, select “Yes” for those questions and fill in the additional information (*Witness – Azimuth, Distance*)(*Site Index – Ring Count*) ([Figure 57](#))
7. When measurements are complete for Tree 1, you can add additional records to your survey by selecting the “Add Icon” under Plot Reference to add a new record
 - a. You can also delete a record by selecting the “Trash Can Icon”



Tree Level Data

Trees Present? *

Are any 5" DBH trees present at the plot?

☒ Yes ☐ No

Redundant 'yes' statement to help preserve tree data This is a double lock, if there are trees, hit yes twice, that way you can unselect both before the trees will disappear

☒ Yes

Do you require technical explanations?

☒ Yes

▼ **pbi.pbi.PBI_Tree_Data** [Tree Level Data on Plot](#)

Tree Number *

1

Tree Species *

Quadrant *

☐ Quad1 (0-90 degrees) ☐ Quad2 (91-180 degrees) ☐ Quad3 (181-270 degrees) ☐ Quad4 (270-360 Degrees)

Tree Status *

Tree status code (Stage 1-5) Live codes=1-2, Dead codes= 3-6

Tree Number (reference)

1

DBH (≥ 5in. xx.x")

Total Height (measure length; see notes) (feet xx'.x").

Merchantable Height (measure length; see notes) (feet xx'.x").

3 of 5

PBI_Inventory_Data

Tree Basal Area

Crown Canopy Class

☐ Dominant ☐ Co-Dominant ☐ Intermediate ☐ Overtopped ☐ Remnant

Witness tree?

☒ Yes

Azimuth (0-360°) *

Distance *

Site Index tree?

☒ Yes

Ring Count *

Tree Number (reference)

1

Tree Remark

Anything you feel we need to know about the tree.

PlotID (reference)

1 of 1

Tree Information: Tree Number - Species - Status - DBH - Total Height - Merchant Height - Witness Tree - Site Index Tree

1 - - - - yes - yes

When you have finished recording the tree data, please save the data by selecting "Save to Drafts", this is found by clicking on the "X" in the top left of the form. Do this before proceeding with the form.

3 of 5

Figure 57. Figure showing adding tree record (left), and witness trees and site index trees (right) to with workflow shown in Red Circles

8. Upon completion of tree measurements, it is recommended that you save your survey to prevent data loss. Follow the instructions on the next page to save the survey as a Draft
9. Save the Survey as a Draft by selecting the X in the upper left corner of the screen ([Figure 58](#))
 - a. **Survey 123 has limited auto save and recovery capabilities** but will save the data from the most recent survey you are working on if the application crashes. Your survey will appear when you reopen the form, **but only once**. This is subject to a page having been completed. If you have finished page 3, and are on page 4 and it crashes, all data up to page 3 will be recovered. Please save a Draft after collecting tree data to prevent loss.
10. Choose the option to “Save in Drafts”
 - a. **DO NOT CHOOSE CLOSE AND LOSE CHANGES**. This will result in losing your survey data
11. This will take you to the main survey page and you will see an area for Drafts on the bottom of the screen. Select “Drafts”
12. Find your draft plot and open to continue editing

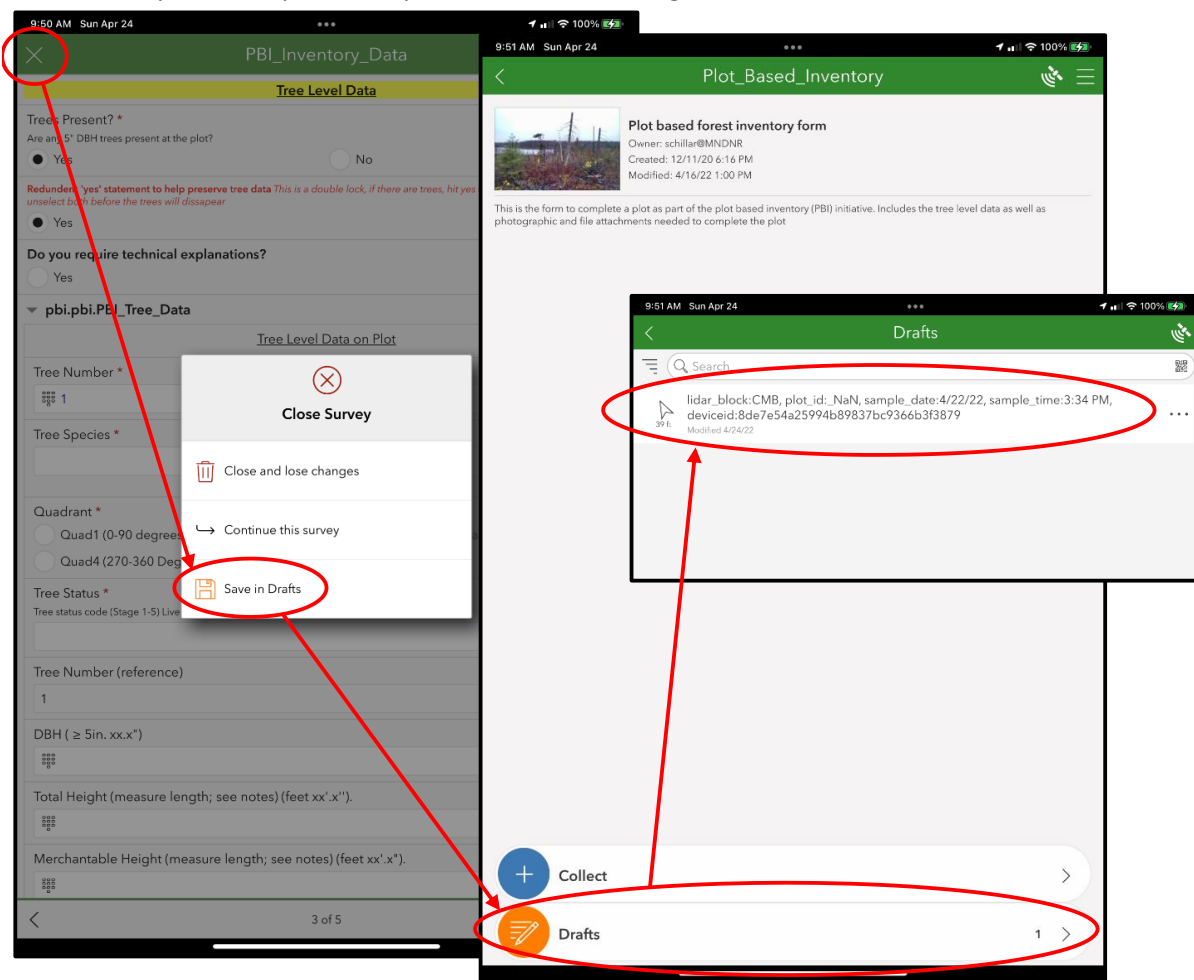


Figure 58. Workflow showing how to Save as a Draft in the survey and re-open for editing with Red Circles and Arrows showing the workflow

13. This will bring you back to your survey. You can now continue to Page 4 by selecting the Arrow in the bottom right corner of screen
 - a. You can save any survey as a draft at any time using this method. It is good practice to Save as a Draft after significant amounts of data are collected to prevent loss.

Survey Page 4 – Plot Level Data ([Figure 59](#))

Complete Page 4 under guidance found on the [Plot Level Data](#) pages of the [Plot Based Inventory \(PBI\) Procedures Guide](#) section.

Page 4 of the Survey is for collecting additional Plot Level Data. The page will load additional features dependent upon other selections.

1. Fill in the Plot Description and Cover type fields
2. Estimate and select the number of Regeneration Species there are on the plot. You can change the number as you go to add additional species ([Figure 59](#))
 - a. When you select the number of species, a drop down for additional Regeneration information will appear showing Species, Size, Density and Distribution
3. Enter any Remarks you have for the Plot on this page

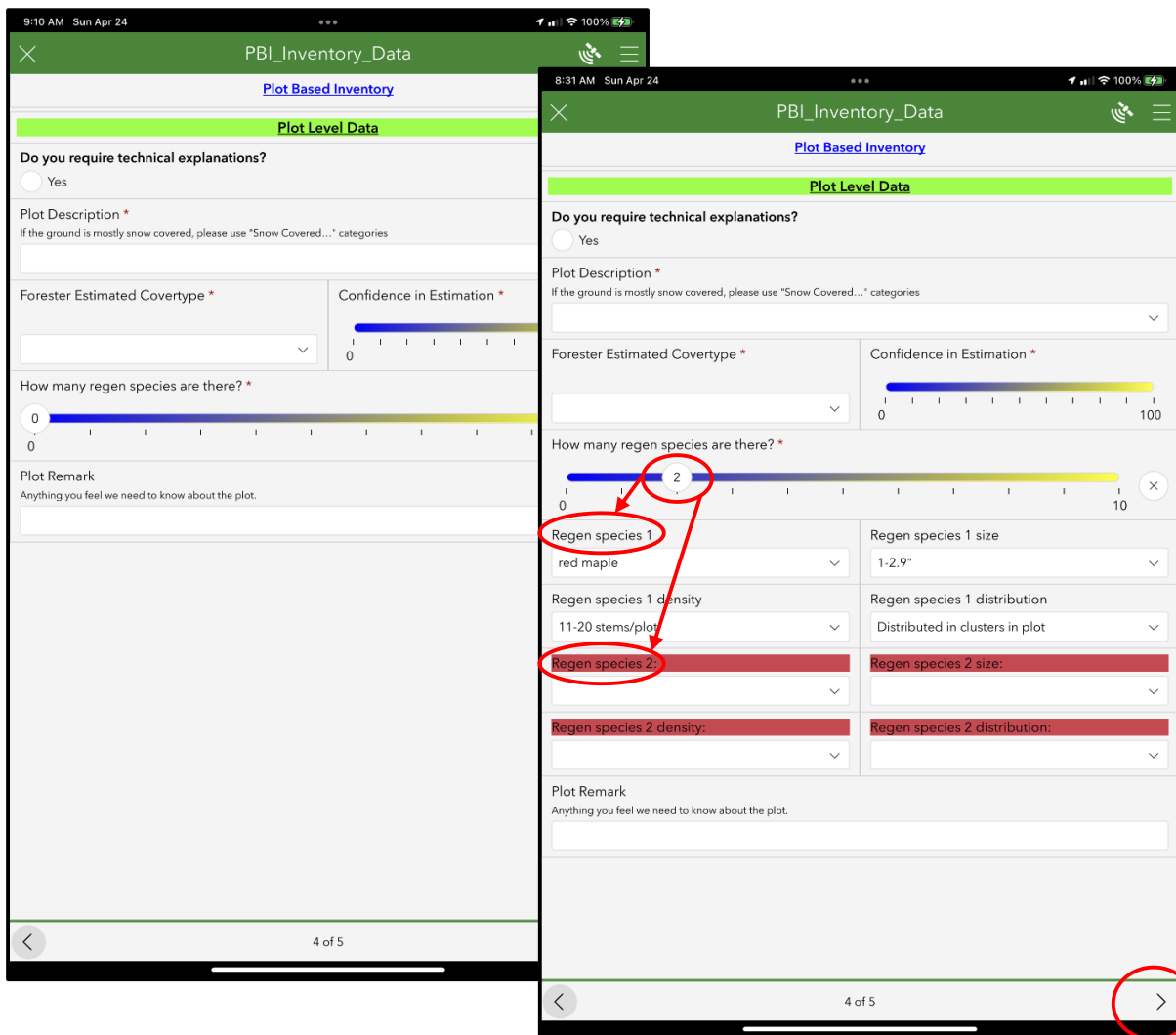


Figure 59. Figure showing Page 4 Fields and selection of regeneration species count and associated fields shown with Red Circles

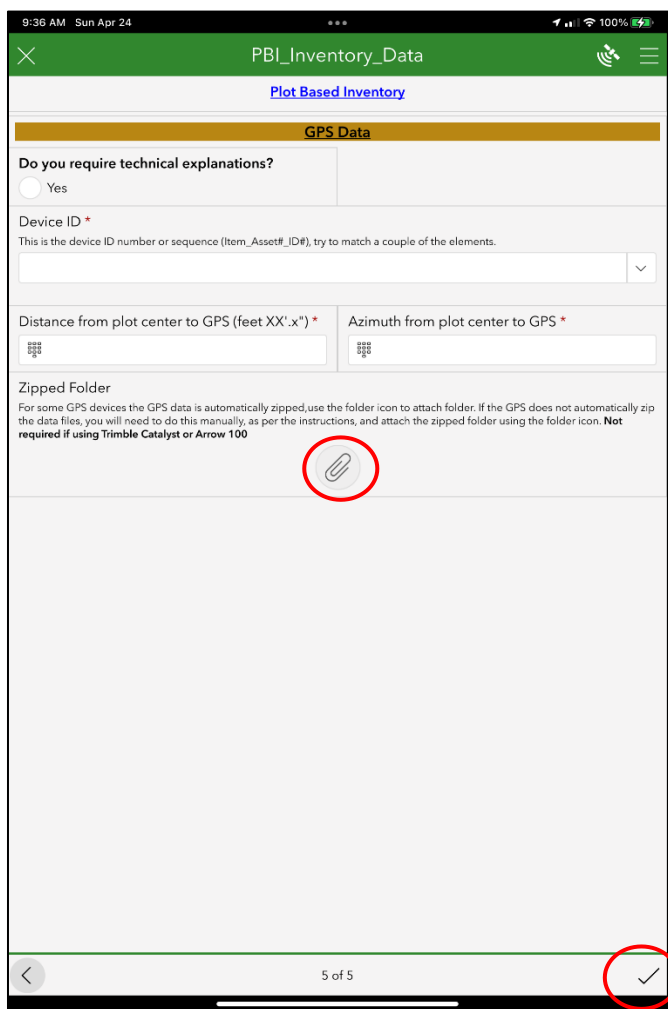
4. Following measurement of all trees on the plot recorded on Page 4, continue to Page 5 by selecting the Arrow in the bottom right corner of screen

Survey Page 5 – GPS Data ([Figure 60](#))

Complete Page 5 under guidance found on the [GPS Data](#) pages of the [Plot Based Inventory \(PBI\) Procedures Guide](#) section, as well as the [Attaching downloaded GPS files to Survey123](#) pages of the [Plot Based Inventory \(PBI\) Field Technology Guide](#) section.

Page 5 of the Survey is for collecting and attaching GPS data. The process of attaching the files is like the process of adding images to page 2. Once the GPS files are collected, downloaded, and saved correctly, you may attach them.

1. Fill out fields for identifying what GPS is used and where the GPS is relative to plot center.
2. Attach the Zipped folder created during GPS collection by selecting the “Paper Clip Icon”
 - a. Refer to [Plot Based Inventory \(PBI\) Field Technology Guide](#) section for instruction on collecting and downloading GPS files



9:36 AM Sun Apr 24

PBI_Inventory_Data

[Plot Based Inventory](#)

GPS Data

Do you require technical explanations?

☐ Yes

Device ID *

This is the device ID number or sequence (Item_Asset#_ID#), try to match a couple of the elements.

Distance from plot center to GPS (feet XX'.x") *

Azimuth from plot center to GPS *

Zipped Folder

For some GPS devices the GPS data is automatically zipped, use the folder icon to attach folder. If the GPS does not automatically zip the data files, you will need to do this manually, as per the instructions, and attach the zipped folder using the folder icon. **Not required if using Trimble Catalyst or Arrow 100**

5 of 5

Figure 60. Figure showing Page 5 of Survey with GPS file attachment icon and plot submission icon shown with a Red Circle

3. Now that you are on the final page of the survey, you will notice a Check Mark Icon in the bottom right corner of the screen. When you have reviewed your data and are ready to submit the plot you will select the Icon to submit your survey.

Submitting a PBI Survey

Once your data is complete there are several options for submitting the survey, depending on your connection to a network.

1. Select the “Check Mark Icon” and choose from the following options ([Figure 61](#))
 - a. If connected to a network or Wi-Fi connection, you can choose “Send Now”
 - i. You can also save in outbox for further review before submission
 - b. If you are not connected to a network, you will need to select “Save in Outbox”
 - c. You can also select “Continue this Survey” to go back and edit or review

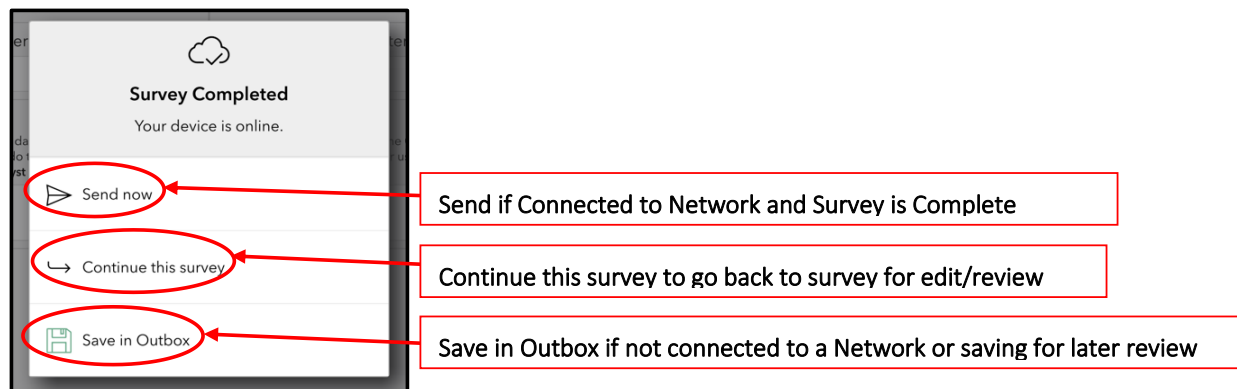


Figure 61. Image showing options for submitting survey shown in Red Circles and labeled

2. If you choose Send Now, your survey will be sent to the PBI Database
 - a. *If you have sent a survey and need to perform additional edits, Contact Resource Assessment to assure duplicate surveys are not in the database and the correct survey is used for data modeling. You can edit and resubmit surveys, though this is not recommended*
3. If you choose “Save in Outbox” you will be taken back to the main Survey screen. You will see an option for “Outbox” on the screen.
4. When you can connect to a network and are ready to submit your survey, navigate back to your **Plot_Based_Inventory** survey homepage
5. There are several options that may appear on the bottom of this screen depending on collection status ([Figure 62](#))
 - a. Collect, Drafts, Outbox and Sent are all options
 - i. You will not see the options on this screen that you do not have available



Figure 62. Plot Based Inventory options for Collect, Draft, Outbox and Sent

6. Select “Outbox” and follow the instructions below ([Figure 63](#))
 - a. Locate the survey that you wish to send
 - b. If multiple surveys are in the outbox, you will need to open your targeted survey and send from Page 5.
 - c. If only one survey is in the outbox, or you are ready to send all surveys from the outbox Select “Send” in the bottom right corner of the screen to send the surveys that are in your outbox
 - i. This will send **ALL** surveys

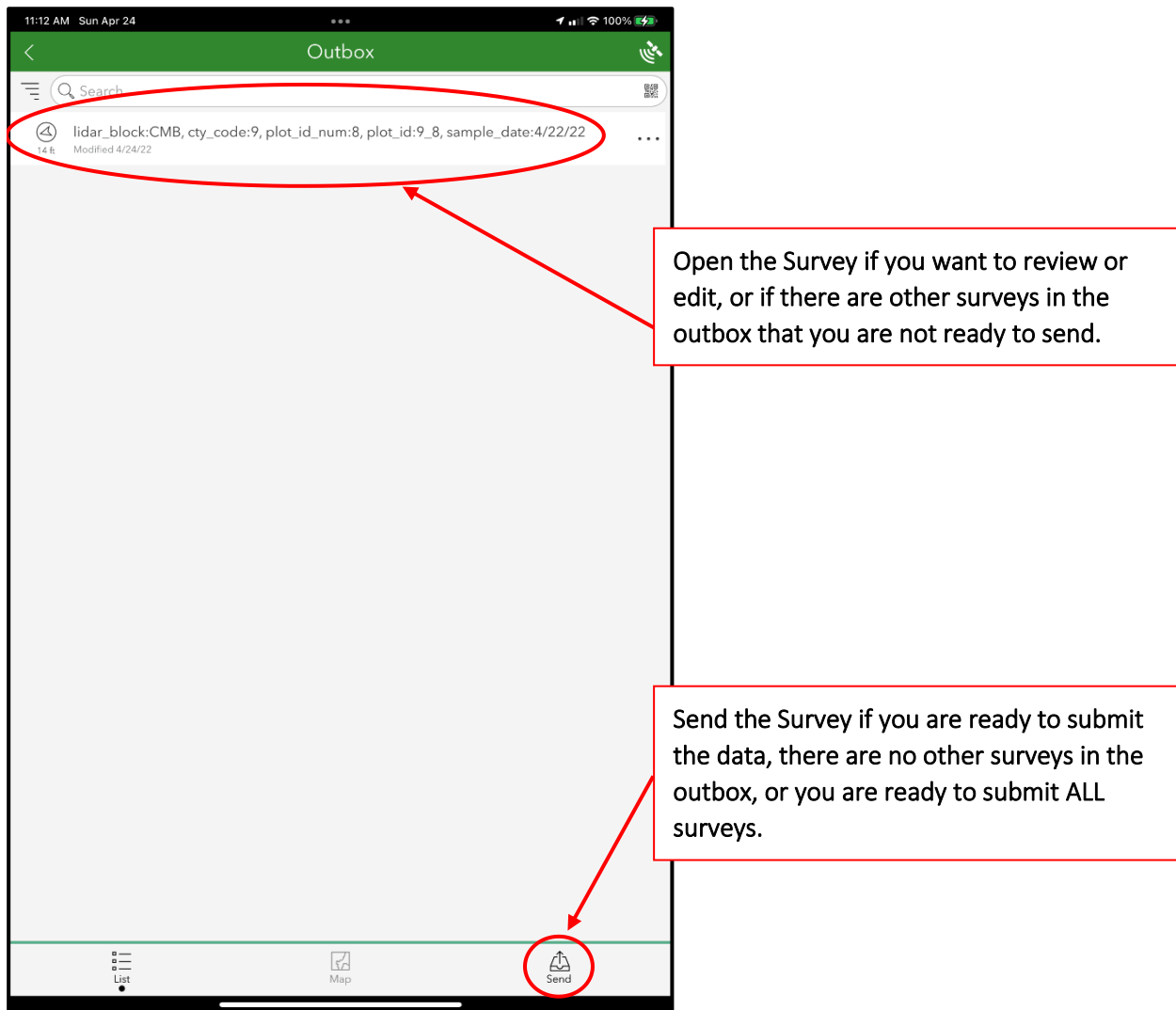


Figure 63. Figure showing sending survey from the Outbox options with Red Circles and Lines showing options with labels

7. Congratulations! You have now sent your survey.
8. Save your surveys on your device in case there are issues with submitting, or data needs to be reviewed after submission

APPENDIX A - PLOT DESIGN

Each plot is a circular, fixed-radius area covering 1/10 (0.1) acre ($r=37.2\text{ft}$) ([Figure 64](#)).

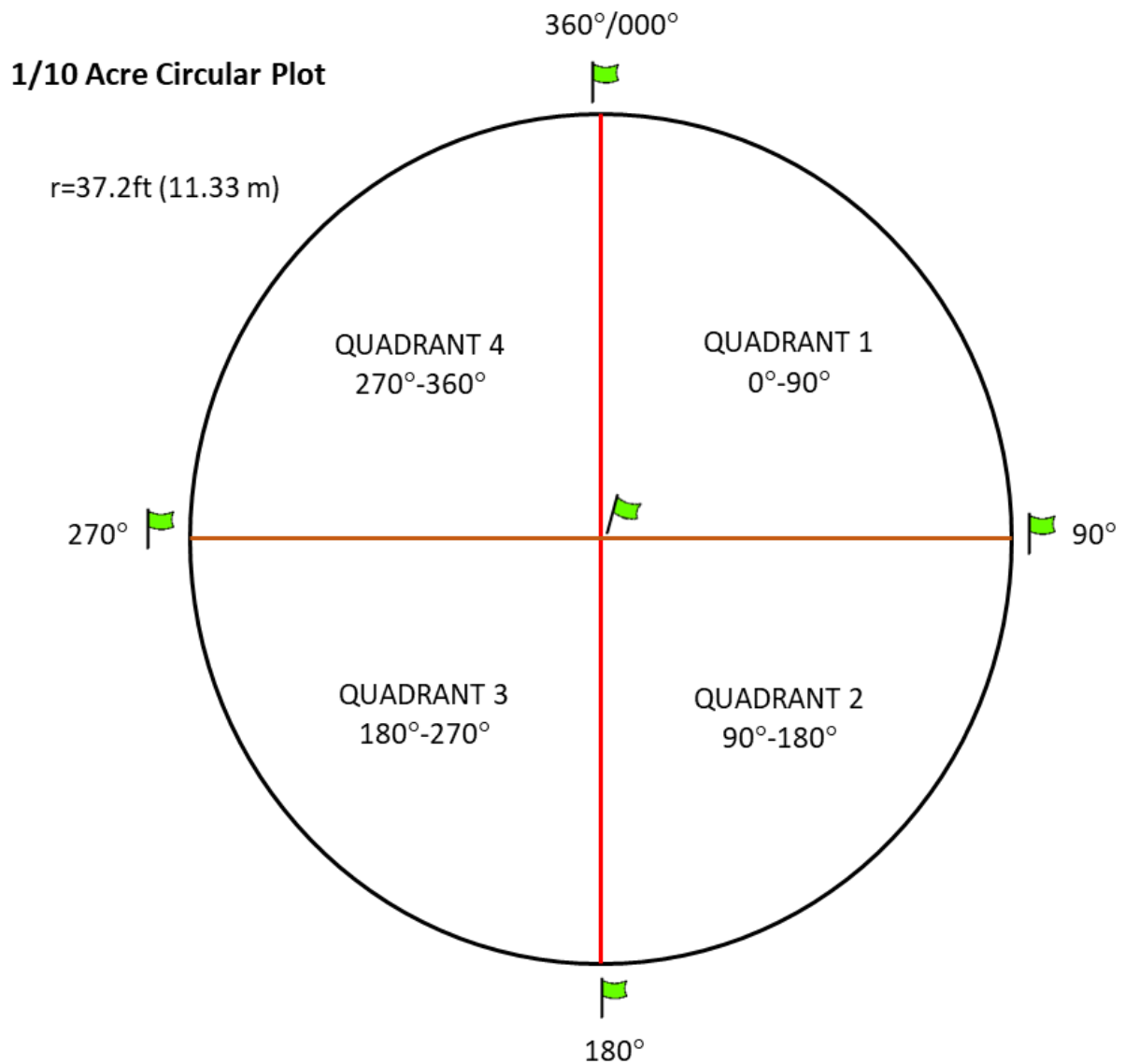


Figure 64. Visual depicting the circular fixed-radius 1/10-acre plot.

APPENDIX B - HORIZONTAL SLOPE CORRECTION

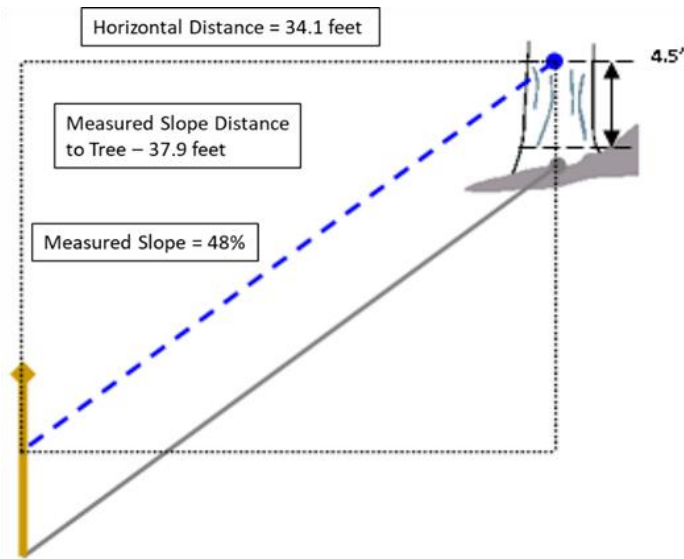


Figure 65. Horizontal Distance Calculation (source: FIA)

When direct horizontal distance cannot be accurately measured due to steep terrain, slope distance and percent slope should be used to calculate the horizontal distance ([Figure 65](#)). This requires an eye level measurement from the plot center to the same eye level at the target tree or pin location.

There are tables and potentially automated options for calculating the slope correction for determining if a tree is within the plot, or for adjusting pin flags to delineate the correct plot area when working on slopes.

Calculate the correction factor or refer to [Table 3](#) for calculated correction factors. Once your correction factor is calculated you can determine horizontal distance adjustment for your pin flag locations or calculate if a tree is in or not by measuring slope distance and calculating for horizontal distance.

$$\text{Slope Correction Factor} = \sqrt{1 + \left(\frac{\text{Slope Percent}}{100}\right)^2}$$

Example 1 (Calculating needed slope distance when slope and horizontal distance are known):

- You are setting out boundary pin flags and have measured a slope percentage of **48%** to one of your flags. To calculate the slope distance equivalent to the required 37.2' horizontal distance you need to apply a correction factor.

1) Calculate the Correction Factor (Refer to [Table 3](#) for calculated Correction Factors)

$$\sqrt{1 + \left(\frac{48}{100}\right)^2} = 1.109$$

2) Calculate the Corrected Slope Distance:

- Using 37.2 as your fixed horizontal distance from plot center to plot boundary pin

$$1.109 * 37.2 = \mathbf{41.3 \text{ Feet}}$$
 (This is the plot boundary distance when measured along a 48% slope)

Example 2 (Calculating needed horizontal distance when slope and slope distance are known):

You are determining if a tree on a slope is within your plot area. You know your slope is 48% and the tree measures 37.9 feet from the plot center to the pith of the tree. You can assume your tree is in because your slope distance is **41.3'** from plot center using Example 1.

Alternatively, you can calculate the horizontal distance from plot center to the tree by doing the inverse of the previous equation.

1) Calculate the Horizontal Distance:

- We know from **Example 1** our Slope Correction factor is **1.109**
- Distance to Tree pith from plot center: **37.9**

$\frac{37.9}{1.109} = \mathbf{34.2'} \text{ (Horizontal Distance from plot center to tree when measured along a 48\% slope)}$

Table 3. Slope Correction Factor Table used to calculate Horizontal and Slope Distance measurements on uneven ground.

Slope %	Correction Factor	Slope %	Correction Factor
0-10	1	68-69	1.21
10-17	1.01	70	1.22
18-22	1.02	71-72	1.23
23-26	1.03	73-74	1.24
27-30	1.04	75	1.25
31-33	1.05	76-7	1.26
34-36	1.06	78-79	1.27
37-39	1.07	80	1.28
40-42	1.08	81-82	1.29
43-44	1.09	83	1.3
45-47	1.1	84-85	1.31
48-49	1.11	86	1.32
50-51	1.12	87-88	1.33
52-53	1.13	89	1.34
54-55	1.14	90-91	1.35
56-57	1.15	92	1.36
58-59	1.16	93-94	1.37
60-61	1.17	95	1.38
62-63	1.18	96-97	1.39
64-65	1.19	98	1.4
66-67	1.2	99-100	1.41

APPENDIX C - SPECIES LIST

Table 4. Tree Species list represented in Survey123 PBI Plot Form

CONIFEROUS	DECIDUOUS		MISC.
Balsam fir	American elm	Ironwood	N/A
Black spruce	American Hornbeam	Kentucky coffee tree	Unknown
Eastern red cedar	Balsam poplar	Northern pin oak	Unknown Dead Hardwood
Jack pine	Basswood	Northern red oak	
Norway spruce	Big-toothed aspen	Paper birch	
Red pine	Bitternut hickory	Quaking aspen	
Scotch pine	Black ash	Red elm	
Tamarack	Black cherry	Red maple	
Norther white cedar	Black locust	Red Mulberry	
White pine	Black maple	River birch	
White spruce	Black oak	Rock elm	
	Black walnut	Shagbark hickory	
	Box elder	Siberian elm	
	Bur oak	Silver maple	
	Butternut	Sugar maple	
	Cherry spp.	Swamp white oak	
	Cottonwood	White ash	
	Green ash	White oak	
	Hackberry	Willow	
	Honey locust	Yellow birch	

APPENDIX D - CROWN CLASS DIAGRAMS

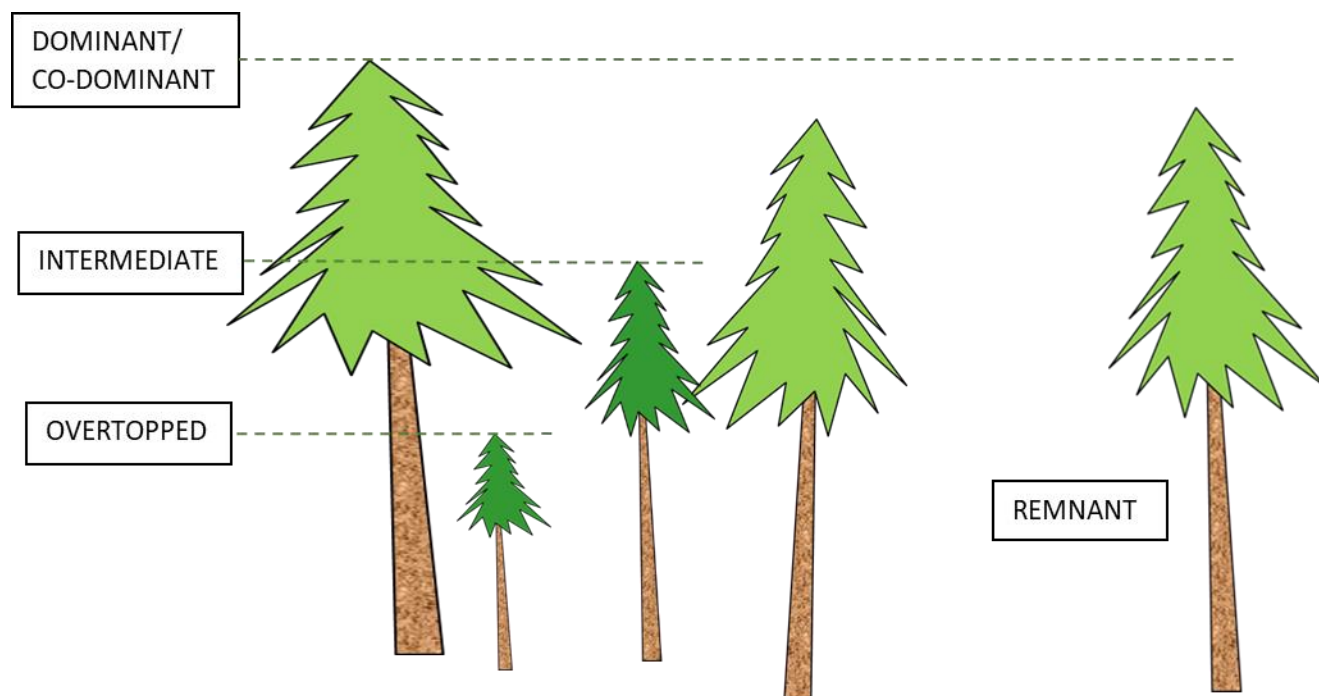


Figure 66. Crown Class Diagram with all Classes Represented

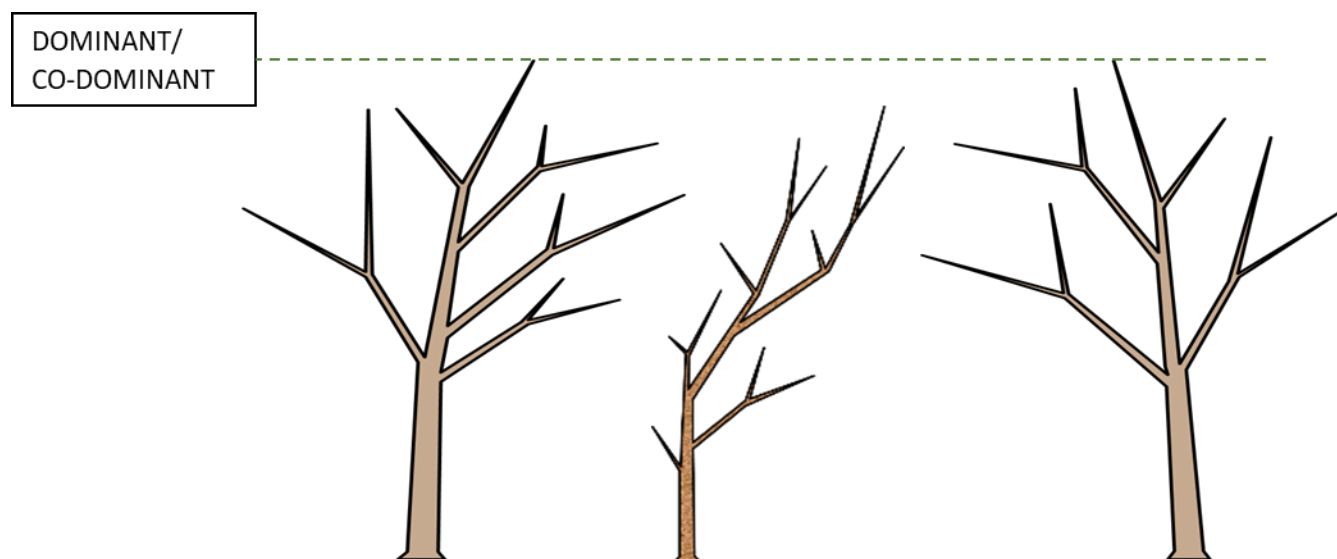


Figure 67. Crown Class Diagram Including Co-dominant and Dominant Classes

APPENDIX E - PBI FIELD TATUM GUIDE

Plot Establishment - Tasks to establish PC and materials needed		
REFER TO PBI MANUAL FOR DETAILED INSTRUCTION		
Item	#	Notes
Pin Flags	8 flags	Plot Center (3), Plot boundaries at Cardinal Directions, GPS
Flagging Roll	1 Roll	Hang flags above ground at all Pin Flag locations
Tube Paint	1 tube	Mark Witness and SI Trees
Aerosol Paint	1 can	Number trees facing PC for QAQC
Witness Trees	per Qua	Record Azimuth and Distance; Paint small X facing PC
Pictures	5	N, S, E, W, Facing North Vertical

GPS Field Operation Instructions	
REFER TO PBI FIELD TECHNOLOGY GUIDE FOR DETAILED INSTRUCTION	
1	Navigate to Plot Center Coordinates Provided
2	Establish Plot Center with 3 Pin Flags
3	Locate largest Canopy Break within the Plot Area
4	Establish GPS Location with 1 Pin Flag
5	Record Azimuth and Distance From Plot Center to GPS Pin F
6	Set up the Tripod and assure it is level
	Set the Range Pole at an Approximate Height of 2 Meters
7	Attach, Turn on and Connect to GPS Reciever
8	Turn on GPS Application or Navigate to URL
9	Begin Logging GPS Data
10	Begin PBI Plot Data Collection
11	Navigate back to GPS Application or URL
12	Turn off Logging and Download GPS File to Device
13	Attach GPS File to Survey123 Form
14	Complete Plot and Save or Send Survey 123 Form
15	Turn off and Pack Up GPS

Supplies Needed	
GPS - Navigation and Collection	
Tripod	
Tablet	
Pin Flags (x8)	
Flagging Roll (x1)	
Tube Paint (x1)	
Aerosol Paint (x1)	
Mensuration Equipment	

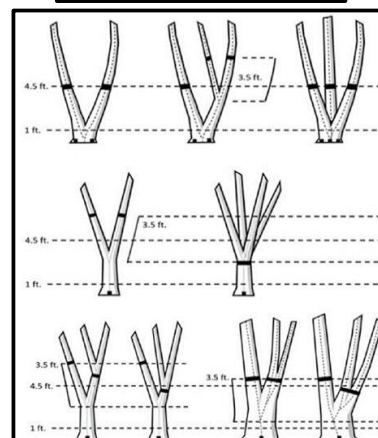
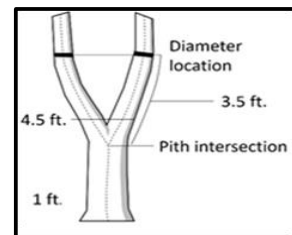
Plot Level Data			
REFER TO PBI MANUAL FOR DETAILED INSTRUCTION			
Description	Xeric - Dry, Nutrient Poor		
	Mesic - Well Drained, Nutrient Medium High		
	Hydric - Poorly Drained, Nutrient Poor		
	Snow Covered Xeric		
	Snow Covered Mesic		
	Snow Covered Hydric		
Cover Type	Within Plot Area ONLY		
Confidence	Represented as a Percentage		
Regn. Notes	Consider all stems <5.0" DBH		
	Use 1/4 plot for high density Regeneration		
	Use Most Abundant Species for Size Class Estimate Density and Distribution		

Slope %	Correction Factor	Slope %	Correction Factor
0-10	1	68-69	1.21
10-17	1.01	70	1.22
18-22	1.02	71-72	1.23
23-26	1.03	73-74	1.24
27-30	1.04	75	1.25
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56-57	1.15	92	1.36
58-59	1.16	93-94	1.37
60-61	1.17	95	1.38
62-63	1.18	96-97	1.39
64-65	1.19	98	1.4
66-67	1.2	99-100	1.41

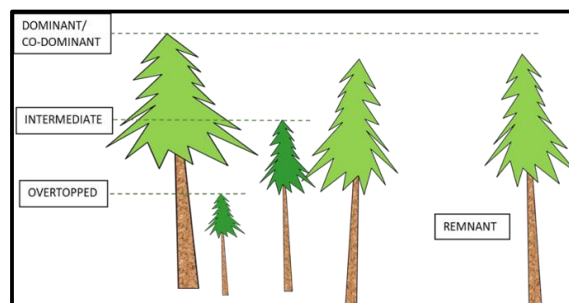
$$\text{Slope Correction Factor} = \sqrt{1 + \left(\frac{\text{Slope Percent}}{100}\right)^2}$$

Figure 68. PBI Tatum Guide Page 1 showing various Plot Level reference materials

Tree Level Data	
REFER TO PBI MANUAL FOR DETAILED INSTRUCTION	
Tree Order	Begin at North, Mark Tree # facing PC
Quadrant	Start plot in Quadrant 1 (0-90) and progress clockwise
Tree Status	Refer to Tree Status Table
DBH	Nearest 10th inch (Refer to Forked Tree Diagram)
Total Height	Highest LIVE foliage or branch measured along Bole
Merch Height	Height to 4" Top or highest point of merchantability
Crown Class	Refer to Crown Class Table
Witness Tree	Choose 1 long-lived Tree/Quadrant
SI Tree	Choose 1 long-lived Tree/Plot Choose Co-Dominant Tree Representative of Cover Type Count Rings Only, no added establishment years



CROWN CLASS (tree compared to general level of canopy)	
Top Below Midpoint	
Overtopped	no light received
Intermediate	some light, very crowded
Top Reaches Midpoint	
Overtopped	no light received
Intermediate	some light, very crowded
Co-Dominate	some light, somewhat crowded
Top Above general level	
Dominant	significant light, taller than average
Remnant	no neighbors (lone in open)



Tree Status Table						
Status	Status Description	Top	% Bark Remaining	Sapwood Presence and Condition	Heartwood Condition	Status 2 Description
1	1 - All Features Present	Pointed	100	Intact, Sound, No Decay, Hard, Original Color	Sound, Hard, Original Color	Live
2	2 - Dieback begins from Upper and Outer portions of the tree	May be Broken	Variable	May be Sloughing; Minor Decay, Firm to Soft, Light Brown	Sound at Base, Incipient Decay in outer edge of upper bole, Hard, Light to reddish brown	Live, but Declining
3	3 - All Present	Pointed	Variable	Intact; Sound, Incipient Decay, Hard, Original Color	Sound, Hard, Original Color	Dead
4	4 - Few limbs, No Fine Branches	Broken	Variable	Sloughing; Advanced Decay, Fibrous, Firm to Soft, Light Brown	Sound at Base, Incipient Decay in outer edge of upper bole, Hard, Light to reddish brown	Dead Loose Bark
5	5 - Limb Stubs, or None	Broken	Less Than 20%	Sloughing; Fibrous, Soft, Light to reddish brown or Gone	Incipient decay at base, Advanced decay in upper bole	Dead Broken

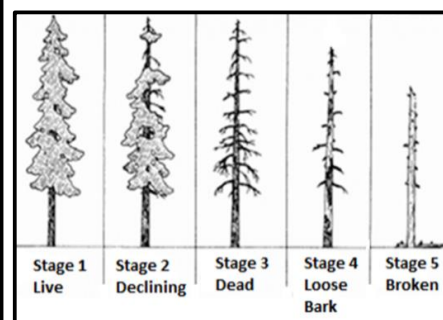


Figure 69. PBI Tatum Guide Page 2 showing various Tree Level reference materials

APPENDIX F - HELPFUL LINKS AND INFORMATION

Refer to the links and information below related to Plot Based Inventory data collection and general program information. Contact Resource Assessment at the email below for PBI related inquiries.

Resource Assessment Contact Information

The information below is the preferred contact information for PBI related content.

- **PBI questions and General Information:**
 - ForestInventory.dnr@state.mn.us
- **Contractor Invoicing:**
 - ForResourceAssessment.dnr@state.mn.us

PBI related Websites

There are a variety of Public and Internal (DNR) facing websites that can provide more information on PBI. Please contact Resource Assessment for specific questions you may have on PBI.

- **Resource Assessment Website (Public):**
 - [Resource Assessment | Minnesota DNR \(state.mn.us\)](https://state.mn.us/resource-assessment/)
- **Minnesota Lidar Hub (Public):**
 - [MNLidarHub \(arcgis.com\)](https://arcgis.com/mnlidarhub/)
 - Review Lidar Status Maps, Planning and Lidar related information
- **PBI Dashboard (Internal – Requires MNDNR Portal Account):**
 - [CSA PBI Dashboard - For DNR Foresters and Supervisors - Overview \(state.mn.us\)](#)
 - Above version for general overview of PBI collection data
 - [CSA PBI Dashboard - For DNR Foresters and Supervisors - Filters \(state.mn.us\)](#)
 - Above version for identifying specific data sets using filters

DNR PBI Equipment Microsoft Teams Group

A PBI Equipment Microsoft Teams Channel is managed by Resource Assessment to provide documentation, recordings, discussion, and general information of PBI to Minnesota DNR staff. Non-DNR Staff will not be able to access this information, but it can be provided by request.

- **DNR PBI Equipment Teams Group (Internal):**
 - Contact RA (ForestInventory.dnr@state.mn.us) to be added to the group
 - Open the Microsoft Teams Application and look for “Teams”
 - Search for DNR_PBI Equipment to locate the channel
 - If you are unable to access the channel, you may need to be added. Contact RA for access issues.
- **DNR PBI Equipment SharePoint Site (Internal):**
 - [DNR PBI Equipment - General - All Documents \(sharepoint.com\)](#)
 - This site provides a direct link to files managed in the Microsoft Teams Group

SOURCES

U.S. Department of Agriculture, Forest Service. October 2019. Forest Inventory and Analysis National Core Field Guide Volume 1: Field Data Collection Procedures for Phase 2 Plots. Version 9.0.

Thomas, J. W. 1979. Wildlife habitats in managed forests – the Blue Mountains of Oregon and Washington. Agriculture Handbook 553. U.S. Department of Agriculture, Washington, D.C., USA.