

White Paper:

Using Bluetooth GPS Receivers with Tree Plotter®

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Purpose

This white paper provides information on available GPS technologies to integrate Bluetooth GPS receivers into online mapping applications for use on smartphones and tablets.



Audience

This document is oriented towards current and potential [Tree Plotter software](#) customers who are interested in using GPS receivers to collect the location of individual trees or other important assets. It can also be applied to users of other GIS-based browser applications with feature collection. Users of these applications include cities, state agencies, non-governmental organizations (NGO), and private companies.

Overview

At [Plan-It Geo](#), we develop and use Tree Plotter, a full-featured, supported, secure, web-based GIS tree inventory software application designed for inventorying, managing, and informing decisions about trees. It is built with the following technologies: OpenLayers, Leaflet, PostgreSQL, PostGIS, Amazon Web Services, and JavaScript. The software application does not require any proprietary hardware; it runs on any device with a web browser. Most users already own or have access to mobile phones and tablets which come with web browsers pre-installed.

Tree Plotter allows users to import an existing inventory or create a new one to manage public or private trees in an online map. Users can make use of the GPS location from their smart device to see where they are on a map and then place a point on the location of a tree onto an aerial imagery basemap to include it in their inventory. In most cases, this workflow works well and meets the needs of our clients where GIS is used to create the X/Y coordinates of a tree, not GPS. Many clients also collect other location data such as park amenities and assets.

Over the years, some users have requested a more conventional GPS data collection workflow for two main reasons: 1) difficulty inventorying dense stands of trees and 2) when the best available aerial imagery does not reflect the current landscape, e.g. new development in the area. The conventional GPS-based workflow includes using a high-accuracy location from a dedicated GPS unit to collect the tree's location. Many modern smart devices include GPS functionality and with a surprisingly high level of horizontal accuracy. However, they are typically not as accurate as a dedicated GPS unit, and using the GPS function on a smart device can drain the battery quicker than with normal use.

Enter the Bluetooth GPS, which connects to smart devices via Bluetooth technology and overrides the internal GPS. This market is still relatively new, and there are several manufacturers with prices ranging from \$99 to \$599. There are three main tiers of GPS receivers that offer differing levels of horizontal accuracy: survey grade (1 meter or under), map grade (1-5 meters), and recreational grade (5-10 meters). Using a current model of Bluetooth GPS receiver will allow our users to inventory their assets at the map grade accuracy level which is typically sufficient for their purposes.

Methodology

To meet our user's needs, Tree Plotter now allows a user to inventory a tree using the GPS location provided by Bluetooth GPS receivers. You simply click on the GPS-based option when adding a tree to employ this function. As part of this implementation, we performed some hands-on testing of two receivers from manufacturers who were kind enough to provide us with a loaner. We also evaluated the specifications of six receivers from manufacturers Bad Elf, Dual, and Garmin. Plan-It Geo has no affiliation with any of these manufacturers mentioned. [View the specifications](#) of all receivers that were evaluated.

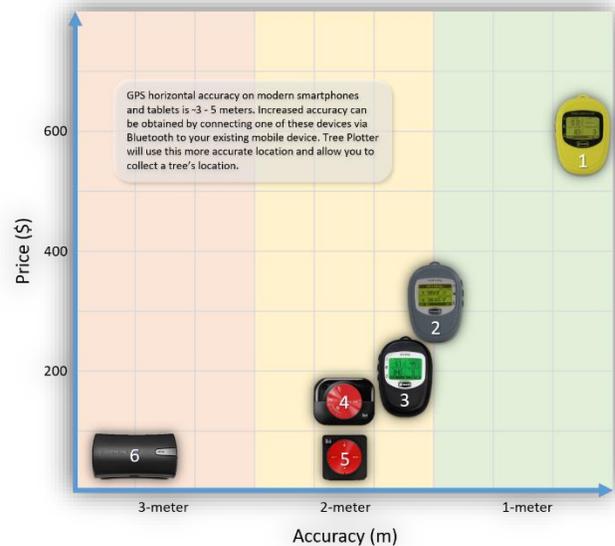


Figure 1 - GPS receivers with higher accuracy typically come with a higher price tag.

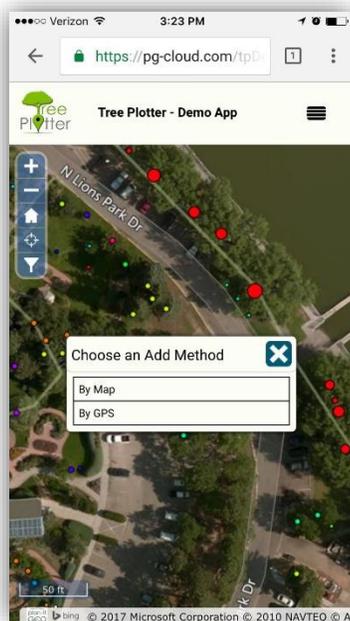


Figure 2 - A new way to add a tree or other asset to Tree Plotter. This functionality uses your device's GPS location to place a point on the map.

Testing

We tested two different models of Bluetooth GPS receivers from the manufacturer Bad Elf. The Pro+ model has 2-meter accuracy, 35-hour battery life, and costs \$299. The GNSS Surveyor boasts 1-meter accuracy, 35-hour battery life, and costs \$599. Initial setup of both receivers was straightforward, connecting easily to the iPhone, iPad, iPad Mini, as well as Android phones and tablets. Testing with Windows-powered devices was not performed, but these devices are supported according to [Bad Elf's website](#).

For Apple devices, a mobile app was developed by the manufacturer that can be used to configure and calibrate the GPS receiver. Bad Elf does claim that their receiver requires "no complicated setup," but the app is available to Apple users who are more proficient with GPS specifications. A Bad Elf configuration app was not available for Android users.

After initial connection to the GPS receiver, experiences between Apple devices and Android devices diverged. Accuracy testing was performed in an urban environment with a mix of roads, parking lots, buildings, neighborhood parks, and low-density stands of trees. One tester stated that the GNSS Surveyor model had a "nearly flawless interface" with the Apple iPad Mini. While plotting points for individual trees on Apple devices, readings from the GPS receiver indicated accuracies ranging from 4.3 to 3.8 feet (1.1 to 1.3

meters). The Pro+ had a similar experience but with slightly less accuracy. Points plotted using the GPS location showed equivalent accuracies to what a user would be able to plot manually. Testing indicated, however, that in order to obtain the advertised horizontal accuracy specifications, the unit had to remain stationary for a few minutes, typical for dedicated GPS receivers.

Testing on Android devices was somewhat less straightforward, but horizontal accuracy was comparable, if not slightly higher, than with Apple devices. We performed testing using a Samsung Galaxy tablet and a couple different models of Android phones. Users are required to install a third-party app from the Google Play Store. We used Bluetooth GPS from GG MobLab. This app allows Android devices to use the “mock” location of the Bluetooth GPS receiver in replacement of the Android device’s GPS location. We found a small glitch where a mobile hotspot connection caused the Bluetooth connection between the Android device and the GPS receiver to fail. Mobile hotspots can provide internet connections through a cellular phone company to a device that is not web-enabled, e.g. tablets, allowing the use of Tree Plotter software on devices that do not have a data plan. For devices that have a data plan, this was not an issue. For Android devices that do not have a data plan, we have a few different solutions.

Alternative Solutions

At Plan-It Geo, we have developed an offline version of Tree Plotter called the Offline Collector. Without an installation and using only a web browser, the app allows a user to store previously inventoried trees and imagery tiles on their device. This must be done from a location where there is an internet connection, so planning ahead is required. Subsequent data collection is then performed while offline, and any new or edited data are then synced when an internet connection is established. Using the Offline Collector is one way to avoid the mobile hotspot issue with Android devices that is described above.

Another alternative is to collect data using your own dedicated GPS receivers and import or upload the data into Tree Plotter for use in dashboards, reports, data management tools, and work orders. As previously mentioned, there is a large selection of these receivers available, and many of them offer greater horizontal accuracy than most Bluetooth GPS receivers currently available.

Finally, Tree Plotter also has a Move tool that allows a user to select points and move them in the map if the GPS location needs further refinement. This can be done on a smart device or desktop computer and allows a user to reference current aerial imagery while moving a point.

Discussion

After contacting Bad Elf’s support team about the length of time it took to obtain an accurate location, they did offer some new functionality that uses Differential GPS (DGPS). DGPS “uses a network of fixed, ground-based reference stations to broadcast the difference between the positions indicated by the GPS satellite systems and



Figure 3 - Inventorying trees with a tablet and Bluetooth GPS receiver.

the known fixed positions.” Testing indicated that accuracy was about .3 meters less accurate, but the time required to obtain this location was significantly reduced. As a user, the tradeoff comes down to your mapping accuracy requirements.

We also reached out to Bad Elf’s support team about the mobile hotspot issue. They indicated that such issues could be avoided by using alternate technology such as the Lefebure NTRIP Client for Android. We were not able to test this configuration.

Compared to just five to seven years ago, there are significant cost savings and technological advantages to using GIS, browser-based apps. GPS hardware and post-processing software cost \$6-7,000 and provided approximately one meter horizontal accuracy. With a tablet, data plan, and Bluetooth GPS receiver, a similar accuracy can now be achieved for a tenth of the cost. From a data management perspective, there are now easier tools for non-technical users to manage data sets (data fields and lists of domain values) instead of creating costly or cumbersome data dictionaries. Finally, the increased screen size of tablets and even some smartphones compared to traditional GPS receivers makes it much easier evaluate and locate inventoried trees and other assets.

Summary

Overall, we recommend both Bluetooth GPS receivers that we tested for use with Apple and Android devices in Tree Plotter if you are looking to improve horizontal accuracy of your tree inventories using traditional GPS methods. The specific model of receiver that you use depends on your accuracy requirements. Generally speaking, the higher level of accuracy that is required, the higher the cost of the receiver. Tree Plotter is compatible with any receiver that can send a GPS location to a website.

We hope this information was useful for anyone using GPS, GIS, smart devices, apps, and web browser mapping technologies for their data collection.



Figure 4 - Tree Plotter software works on any device with a web browser.