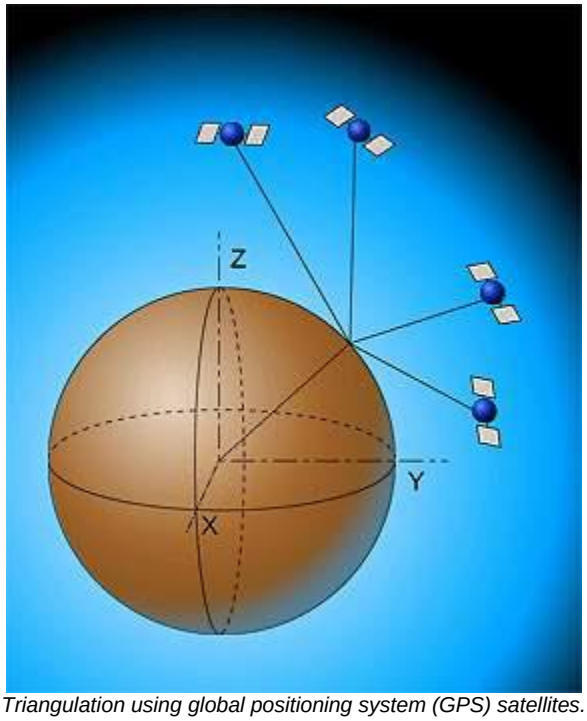
FOR 2542 - Forest Inventory
Global Positioning Systems
David Larsen

Global Positioning Systems (GPS) have increased in popularity in the forestry community in recent years. The system works by have a number of orbiting satellites circling the globe. The satellites maintain information about the distance to all other satellites. This system was designed and implemented by the US military for location and guidance of troops and equipment in the field.



Triangulation using global positioning system (GPS) satellites.
Image credit: TELSAT Guide telsat.belspo.be

The GPS device you carry is a radio receiver that operates on specific frequencies from 390 MHz to 1550 MHz. The GPS carrier frequencies (1227.6 Mhz and 1575.42 MHz) are in the L band. The system works using basic trigonometry. The distance between satellites is known and maintained by the satellite system. Each satellite maintains a list of other satellites that are on in its general area of space. The person on the surface of the earth receives a signal and calculates a distance to a satellite using the time difference needed for the signal to reach you. If you have three or more your receiver can get distances to three or more satellites a location for your receiver can be calculated.

The accuracy depends on many things. First you must operate the receiver equipment correctly; you can add considerable error by using the equipment incorrectly. Second, the number of satellites received affects the accuracy. Three satellites can estimate one position, four satellites can estimate three positions, and five satellites can estimate 9 positions and so on. Thirdly is selective availability, this means the US military added a random component to the time signal to reduce the accuracy of your location. The US military use receivers that filter out this random component. In the early years of GPS, this was turned on all the time. On May 1, 2000 the US military decided to turn selective availability. They reserve the right to turn it back on if necessary but have not to date. Fourth, you will note that the radio frequencies used are rater short wave

length. This means they operate line-of-sight. These receivers experience difficulty with foliage and tree branches as interference. Also hills can block the access to some of the satellites. This interference will cause the signal to “drop-out” as you move through the landscape. Fifth, these signals can be influenced to some small extent by atmospheric ionic variation, which added variation to the times of the signal. This interference can cause several feet of variation at the worst case.

Several methods have be generated to deal with these problems. First the variation is the same for all points on the earth at the same moment. So it you place a receiver at a known point on the earth the difference between the known location and the GPS location is the correction factor for all other points. This is called differential correction. There are several GPS receiver set over known point that log data and make it available on the Internet. The important key to this data is the exact time of each signal.

Some of these receivers have transmitters that GPS receivers can access to provide real time correction. This approach is called WAAS (Wide Area Augmentation System) set up by the FAA to increase precision for aircraft. Some receivers systems come as paired receivers one you place on a known benchmark and the other is used to collect point data, they communication with each other to differently correct your collected locations.

http://www.navcen.uscg.gov/gps/default.htm

http://www.swpc.noaa.gov/

Magnetic storms

Halloween Storm, October 28-30, 2003