The Use of Global Positioning Systems to Perform Wetland Delineations

by

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Abstract

Global Positioning Systems (GPS) are enabling trained wetland professionals to reduce the time and cost associated with wetland delineations far beyond any other available tool or technique. This is extremely important as current conditions of understaffing and future policy changes are destined to add to agency response time for the completion of wetland verifications and permit submissions. The use of GPS systems to locate wetland boundaries and other important features is the only option available which is capable of reducing time and costs for wetland projects by approximately 50%.

Introduction

Every development project, from the construction of a single building to the development of large tracts, should *begin* with the accurate location of wetland boundaries. Implementing a project without this knowledge is destined to create problems and delays. Prior to the advent of GPS usage, this has been accomplished in two phases.

1. A wetland scientist physically delineates wetland boundaries as defined by the U.S. Army Corps of Engineers *1987 Wetland Delineation Manual*. Flagging tape is placed along the boundary.
2. A survey crew is contracted to locate the flagging around the wetland perimeter using conventional survey equipment (line of sight). The survey data is then used to create a wetland exhibit, authenticated with the signature of a professional land surveyor (PLS).

Mapping grade GPS systems consist of an antenna and receiver which is connected to a Windows-based hand-held computer (PC). The antenna receives AM radio signals from orbiting satellites which contain the time the signal was transmitted in Greenwich Mean Time and the satellite's elevation and bearing. The GPS receiver translates this signal and relays it to the PC, which defines the distance from the satellite to the antenna by using the time calculated for the signal to travel to the GPS antenna and the known speed of the AM radio signal. When multiple distances are determined (most GPS systems require a minimum of 4 satellites to produce mapping grade accuracy) the PC uses a series of calculations known as trilateration to determine the GPS system's location. Trilateration is 3-D and should not be confused with triangulation, which is commonly used by conventional survey systems, and is 2-D.

AM radio signals are easily deflected and may be affected by trees, underbrush, and atmospheric conditions; which can effect accuracy when the GPS is not properly setup and operated. Trained professionals are necessary to obtain accuracy with the GPS.

The development of GPS systems capable of mapping grade accuracy has provided a tool allowing a wetland scientist to locate the wetland boundary *simultaneously* with the physical delineation; therefore eliminating the need for a survey crew in the field. The office time required to produce the signed and sealed wetland exhibit remains the same.

Historical Wetland Boundary Location by a Professional Land Surveyor (PLS)

The historical method of locating wetland boundaries is complicated by several factors.

- Survey instruments commonly used require a clear line of sight from each wetland point surveyed to the next.
- Survey crews commonly consist of two personnel.
- Wetlands commonly involve increased shrub level vegetation; therefore, a survey crew must physically cut and clear paths from surveyed point to surveyed point.
- It is common for survey crews to encounter problems finding wetland flagging in thick vegetation. When this occurs, the wetland scientist is often called to guide the survey crew to the wetland flags, which further increases expense.

Some surveyors are utilizing mapping grade GPS systems to locate wetland boundaries placed by a wetland scientist. This method requires only one survey professional. However, problems in the location of wetland flagging by the survey professional may still be encountered and the delineation and location of the wetland boundary involves two professionals (survey professional and wetland scientist) along with associated expenses.

Wetland Boundary Location by a Wetland Scientist and GPS System

A wetland scientist using a GPS system is able to maneuver through thick vegetation, delineate and mark the wetland boundary with flagging tape, and survey the flagging in one step. It is not necessary to cut paths from flag to flag as required by conventional survey equipment. The problems listed for the historically used method of wetland boundary location are eliminated with this technique. However, it is highly important to

note that the GPS location must be performed under the supervision of a PLS.

If a wetland scientist is trained in GPS operation and possesses substantial field experience with the GPS, the typical time require to place and locate a wetland flag is approximately 15 seconds, even in thick overstory and midstory vegetation. When the satellites providing the signals used by the GPS are not arrayed evenly overhead, the GPS is incapable of accurately locating a position. Average downtime due to incorrect satellite array is approximately 20 minutes each day.

Cost Savings

Since the fees charged for wetland delineations and survey location of wetland boundaries vary, cost savings are expressed as time savings in this discussion. Three savings scenarios are outlined below based on the assumption that a wetland scientist is capable of delineating approximately one mile of wetland boundary during each 8 hour day and the assumption that a two man survey crew using conventional survey equipment is capable of surveying approximately 0.32-mile of wetland boundary during each 8 hour day. These time estimates are based on average conditions and substantial field experience.

Delineation by Wetland Scientist with a GPS Unit

Personnel Required	**Distance Covered**	**Time Required**
1 Wetland Scientist	1 mile	8.0 hours
	Total	8.0 hours

Delineation by Wetland Scientist and Survey by PLS with Conventional Equipment

Personnel Required	**Distance Covered**	**Time Required**
1 Wetland Scientist	1 mile	8.0 hours
2 Survey Professionals	1 mile	49.7 hours
	Total	57.7 hours

Delineation by a Wetland Scientist and Survey by PLS with GPS

Personnel Required	**Distance Covered**	**Time Required**
1 Wetland Scientist	1 mile	8.0 hours
1 Survey Professional	1 mile	10.0 hours
(Survey professionals must search for flags, which adds time)	**Total**	18.0 hours

The time savings estimated for a wetland delineation and boundary location by a wetland scientist using a GPS system is approximately 55% when compared to a wetland delineation and boundary location by a wetland scientist and a PLS using a GPS system and approximately 86% when compared to a wetland delineation and boundary location by a wetland scientist and a survey crew consisting of two professionals.

No elaboration is required to demonstrate the advantage of utilizing a wetland scientist under the supervision of a PLS to delineate wetlands and locate the flagging with a GPS unit.

Additional Benefits

There are many benefits associated with the use of a GPS unit to locate wetland boundaries.

- When a project must meet a strict deadline, a wetland scientist and associated PLS can provide up to date wetland locations daily to aid in preliminary project design and planning.
- On large tracts of land, the wetland scientist can use the GPS to navigate to and from wetland locations by utilizing the shortest route.
- The wetland location data gathered during the wetland delineation can be used to navigate to the original flag location even if time or fire has destroyed the flags.
- A sub-meter GPS unit can be used to assign coordinate systems to tract and wetland boundaries, which allows other planning data, such as U.S. Geological Survey topographical lines, soils maps, and aerial photography, to overlay the project using the proper software.

Cautions

Since this is a relatively new technique, evolving within the last 5 years, beware of wetland scientists who are using GPS units for wetland boundary location during delineations without PLS supervision. Various models of GPS units are available with various capabilities and accuracy levels and accuracy. In addition, accuracy can be decreased when the settings in the GPS system are not configured properly. It is important to insure that GPS systems capable of sub-meter accuracy are used and that the data is post processed with the proper software and techniques. In order to meet the requirements of state agencies that oversee professional land surveyors, GPS data must be checked by a PLS for accuracy before the wetland exhibit can be validated with a PLS signature and seal. Any wetland scientist performing wetland boundary location with a GPS during wetland delineations should be under the direct supervision of a properly registered PLS who is willing to validate and defend the data if necessary. Wetland boundaries are not final until verified by the U.S. Army Corps of Engineers; therefore, any preliminary project planning and design can also be subject to change.

The Future

Conventional survey methods rarely assign coordinate systems to the data collected. Without a properly assigned coordinate system, a survey drawing can exist anywhere in the world as long as the measurements match the physical location of the boundary markers. When a coordinate system is assigned, the survey data is tied to the specific location where the data was collected. The use of GPS systems with the proper capabilities allows the drawings produced by a PLS to be associated with the exact location the data was collected through the use of Geographic Information Systems (GIS). GIS also allows attribute data, collected for each feature recorded by the GPS, to be associated with the location of the collected data. This capability allows important data collected in the field to be recorded, analyzed, and associated with a specific location. The incorporation of GIS in surveying is in the initial stages at this time; however, current trends indicate that GIS and surveying will rapidly merge in the future.

In addition, several agencies involved in the regulation of wetlands are currently attempting to finalize requirements for detailed information to be recorded for each wetland. The use of GPS units capable of recording database information at specific

locations and GIS systems to associate the data with maps and other information will be the most efficient method of meeting these future requirements. The use of GPS units to map wetland boundaries and record location data is sure to increase in the future.

Summary

The development of GPS systems capable of sub-meter accuracy offers major cost reductions when proper equipment is used by experienced personnel and verified by a PLS. In addition, accurate location data can be provided for preliminary planning, which speeds the overall completion of a project.

About the Author

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Mr. Gentry develops and leads natural resource investigations specific to wetlands and water quality issues, produces wetland delineations, endangered species surveys, wetlands mitigation design, and other work related to natural resources. He has completed 7 years of practical experience in the use of sub-meter GPS systems and has completed training by Trimble, Inc. a major producer of GPS equipment. Mr. Gentry has delineated wetlands for 10 years and is knowledgeable in the proper use of GPS units to record location data. Mr. Gentry conducts and coordinates environmental studies, participates in regulatory negotiations for clients, and conduct Phase 1 environmental assessments. Mr. Gentry has conducted endangered species investigations and wetland verifications in Georgia and South Carolina. In addition, Mr. Gentry has completed two courses in Geographic Information Systems (GIS) and provides photographic interpretations and data analysis through the use of GIS. He serves as a project scientist for the Natural Resource Department at Ward Edwards and resides in Bluffton, South Carolina.

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