

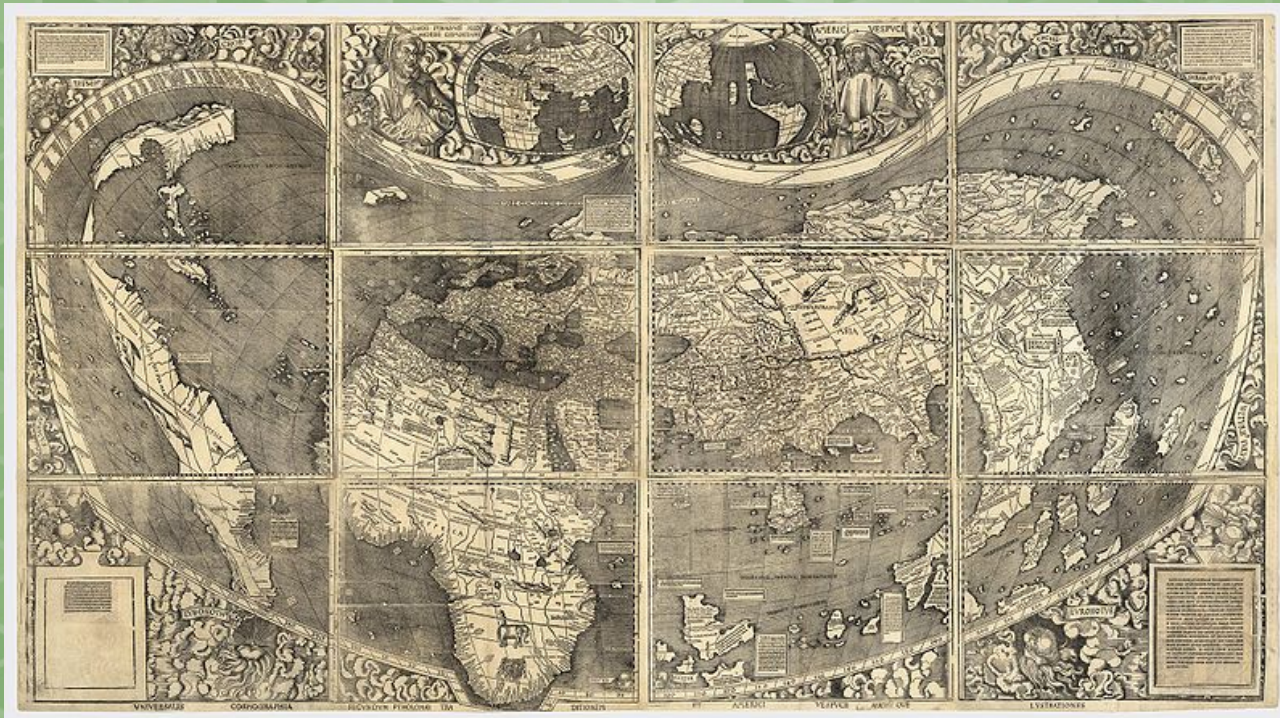
# Digital Mapping of Resource Boundaries

## Global Positioning System (GPS) Limitations and Solutions

Kristen Currens, Mason, Bruce & Girard, Inc.

# GPS Accuracy

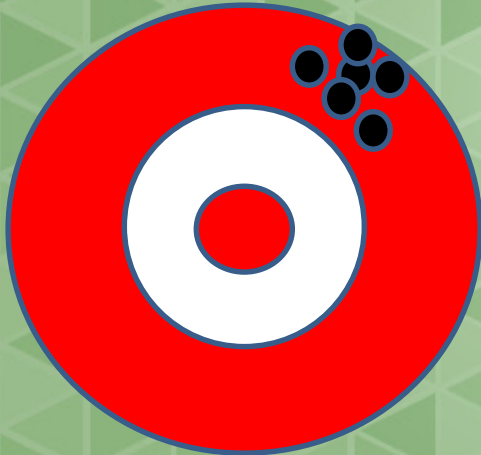
Accuracy is the twin brother of honesty; inaccuracy, of dishonesty. -Nathaniel Hawthorne



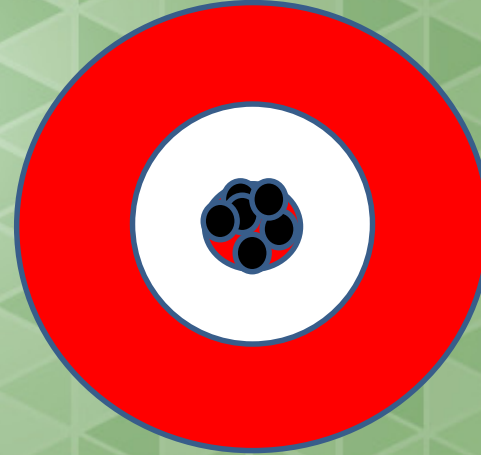
*Universalis Cosmographia*, Waldseemüller's 1507 world map



# Accuracy vs. Precision

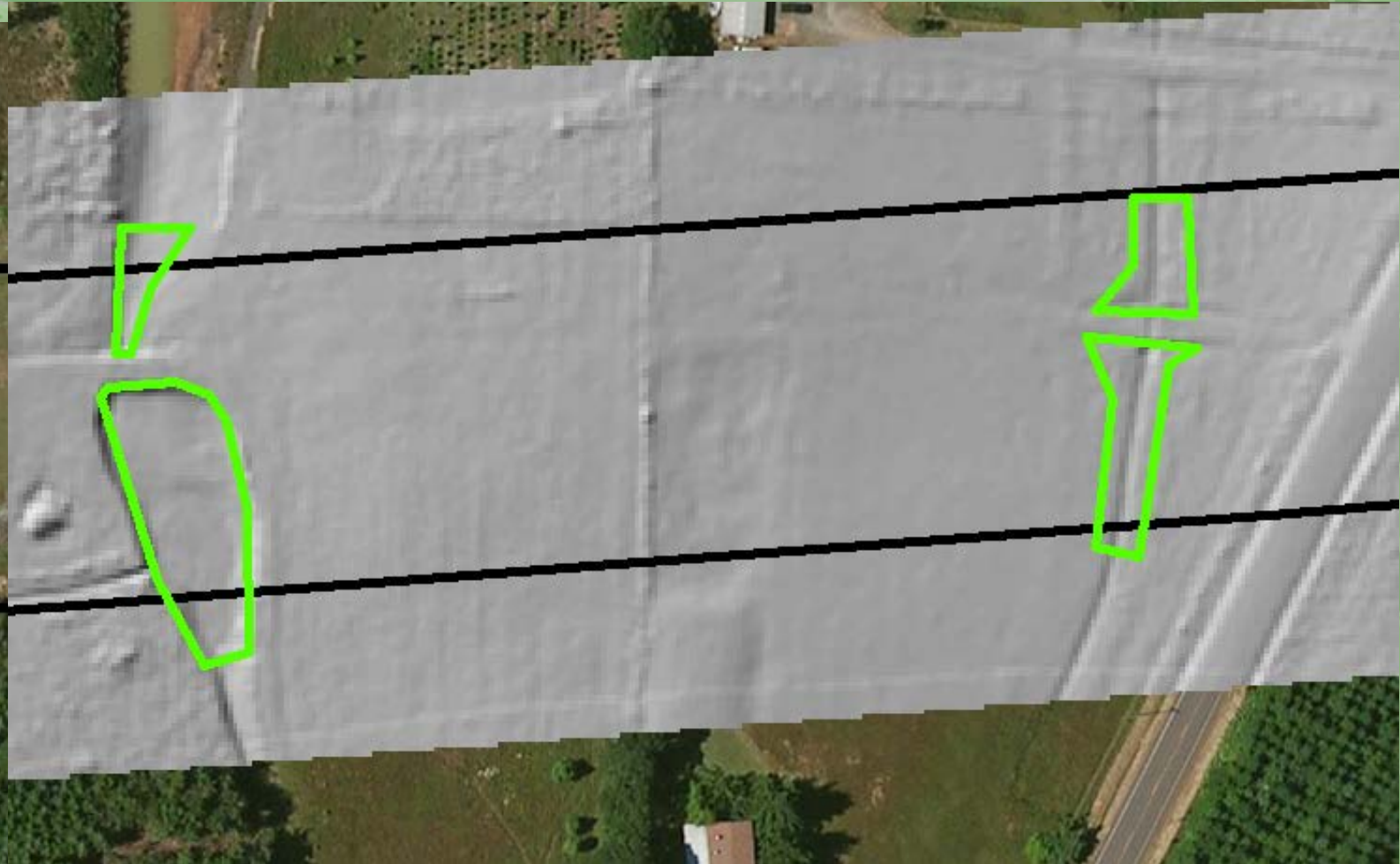


Precise but not accurate

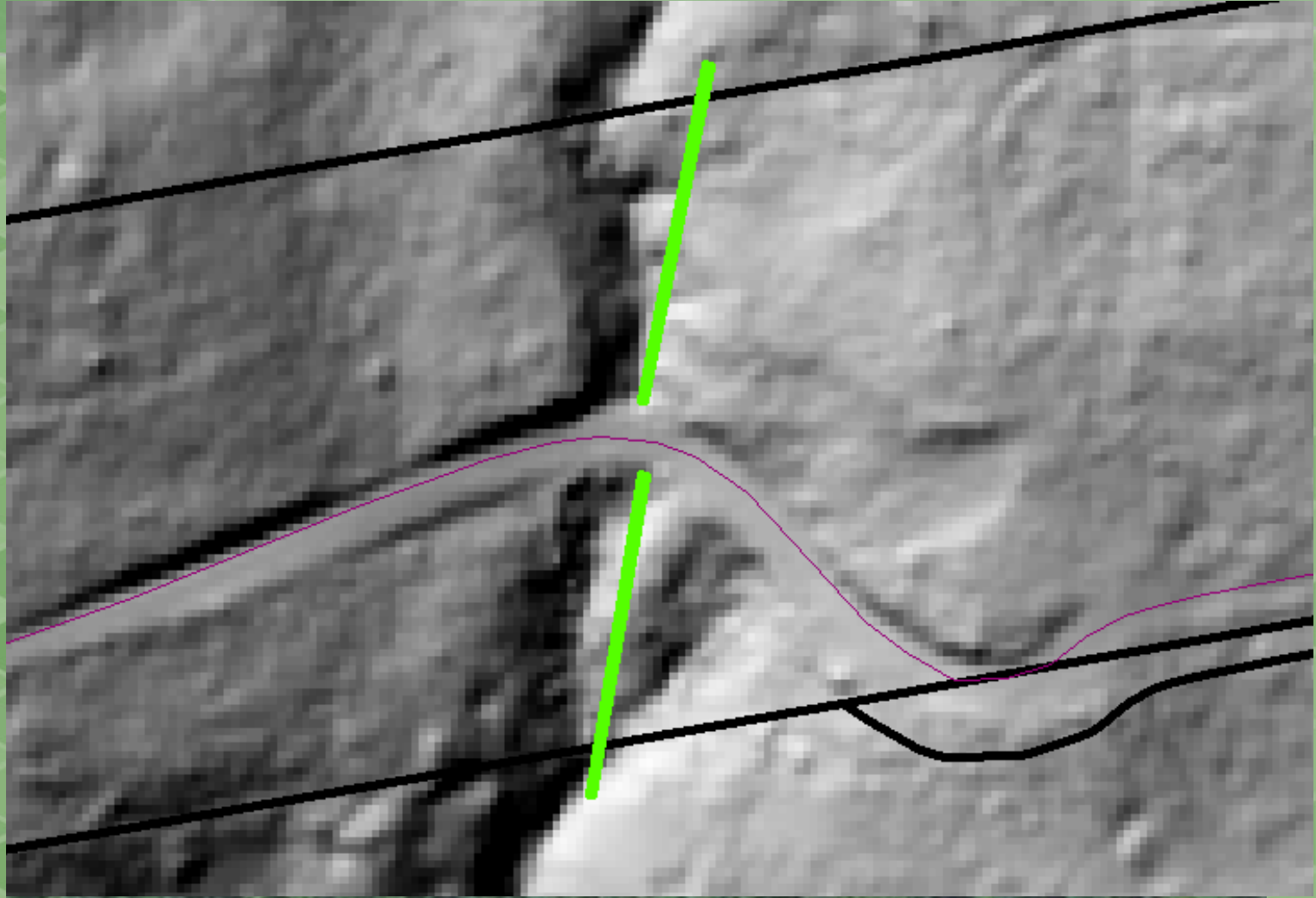


Precise and accurate

# The Problem

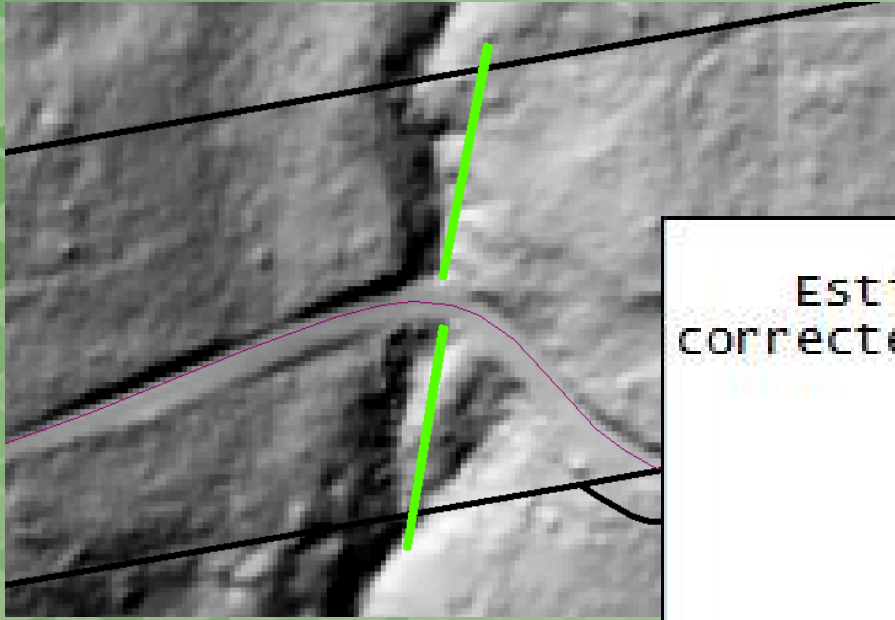


# The Problem





# The Problem



Estimated accuracies for 270 corrected positions are as follows:

Range	Percentage
-------	------------

0-5cm	-
5-15cm	44.44%
15-30cm	-
30-50cm	12.59%
0.5-1m	18.89%
1-2m	18.52%
2-5m	5.56%
>5m	-

Differential correction complete.

# The Problem

0.14m

0.45m

GeoXT 6000 Post Corrected

Monument

0.14 m

0.45 m

GeoXT 2005 Post Corrected

Estimated accuracies for 270 corrected positions are as follows:

Range	Percentage
0-5cm	-
5-15cm	44.44%
15-30cm	-
30-50cm	12.59%
0.5-1m	18.89%
1-2m	18.52%
2-5m	5.56%
>5m	-

Differential correction complete.

75% better than 1 meter

Estimated accuracies for 210 corrected positions are as follows:

Range	Percentage
0-5cm	-
5-15cm	-
15-30cm	-
30-50cm	83.33%
0.5-1m	11.90%
1-2m	2.38%
2-5m	2.38%
>5m	-

Differential correction complete.

95% better than 1 meter

# Accuracy Outputs

= Precision

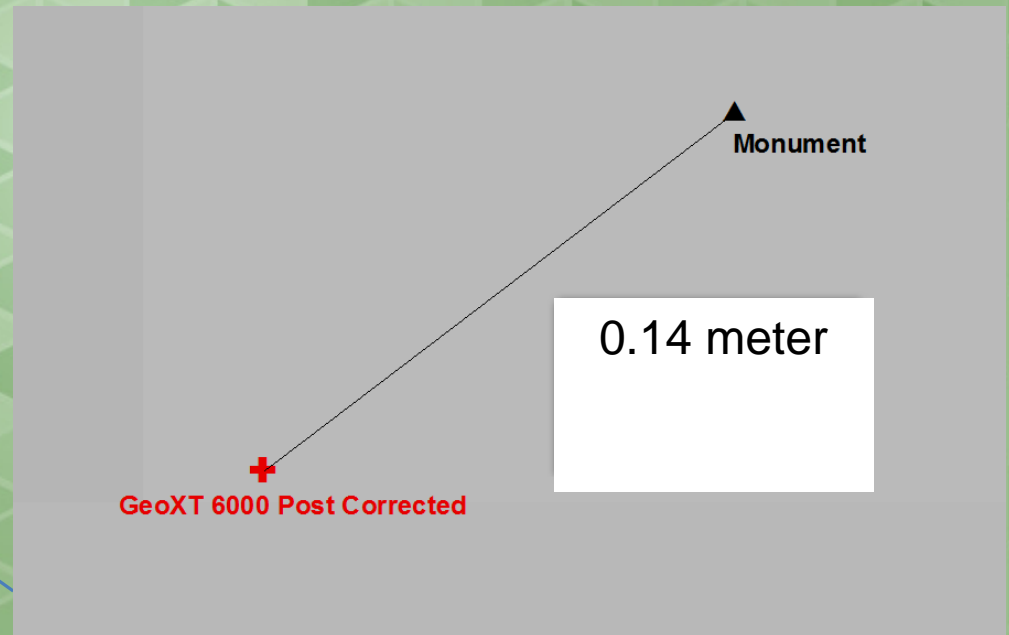
Estimated accuracies for 270 corrected positions are as follows:

Range	Percentage
0-5cm	-
5-15cm	44.44%
15-30cm	-
30-50cm	12.59%
0.5-1m	18.89%
1-2m	18.52%
2-5m	5.56%
>5m	-

Differential correction complete.



# Measured Accuracy



# GPS Accuracy

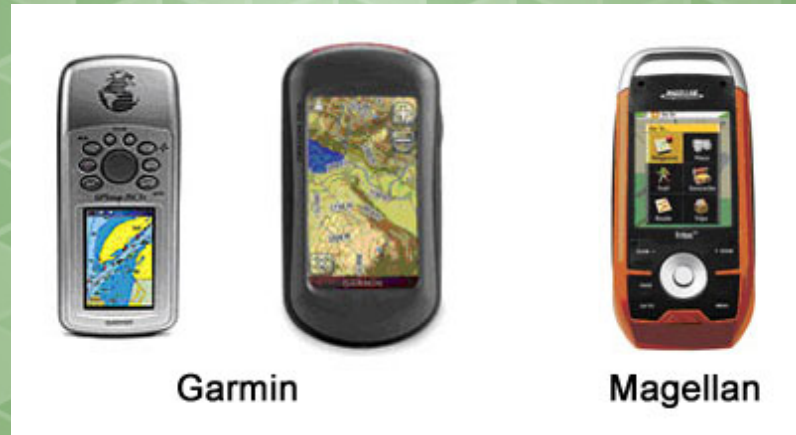
Accuracy is limited by:

- Equipment
- Site and satellite constraints
- Pre-field, field, and post-processing methods

# GPS Accuracy Equipment

3 grades:

- Consumer >3 meters
- Mapping 1-3 meters





# GPS Accuracy Equipment

3 grades:

- Professional (sub-meter) < 1 meter



# GPS Accuracy

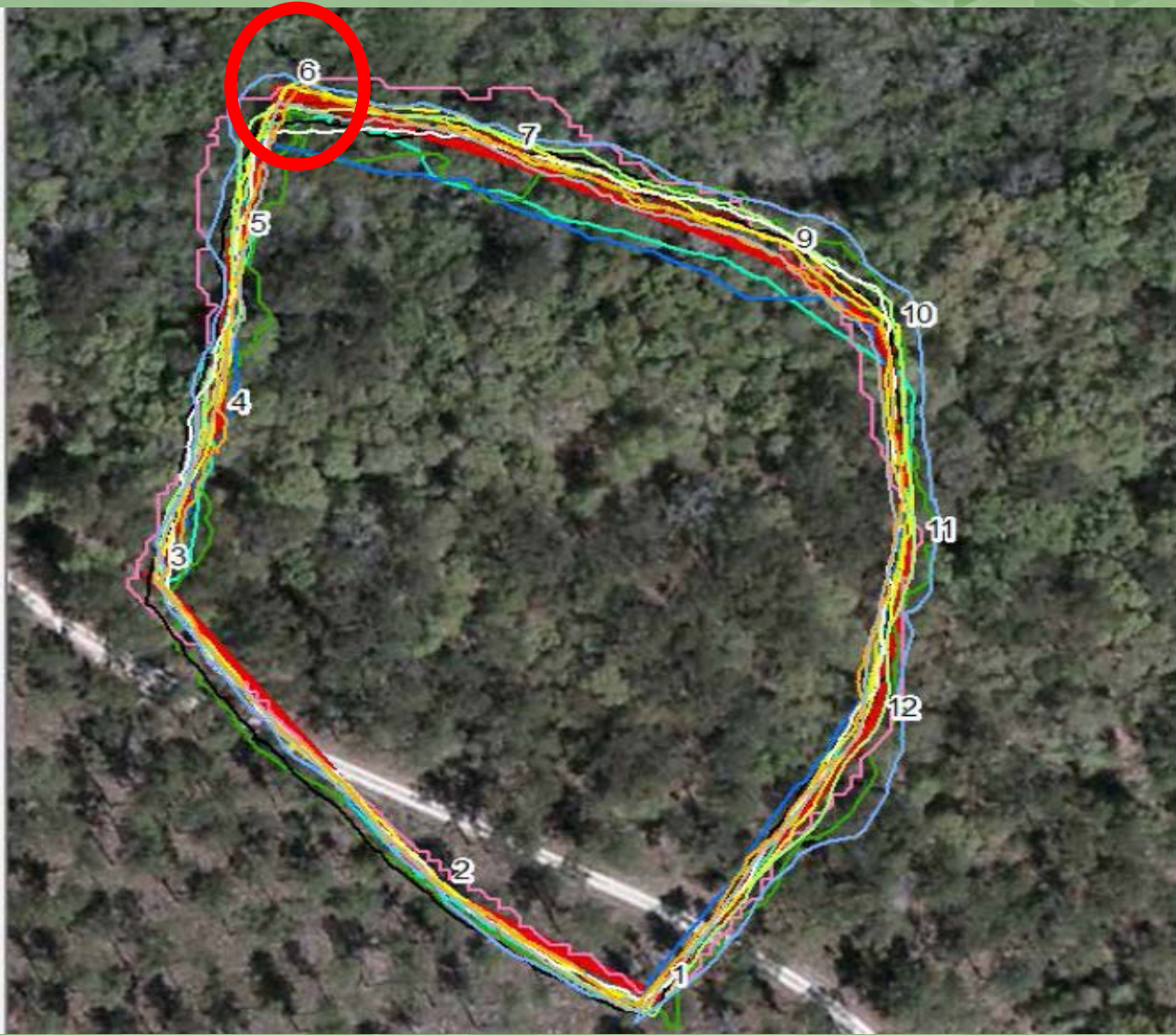
## Site and Satellite Constraints

- **Site Constraints:**
  - Steep topography
  - Buildings
  - Dense vegetation cover
- **Satellite Constraints:**
  - Satellite geometry
  - Multipath



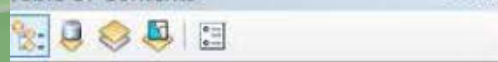
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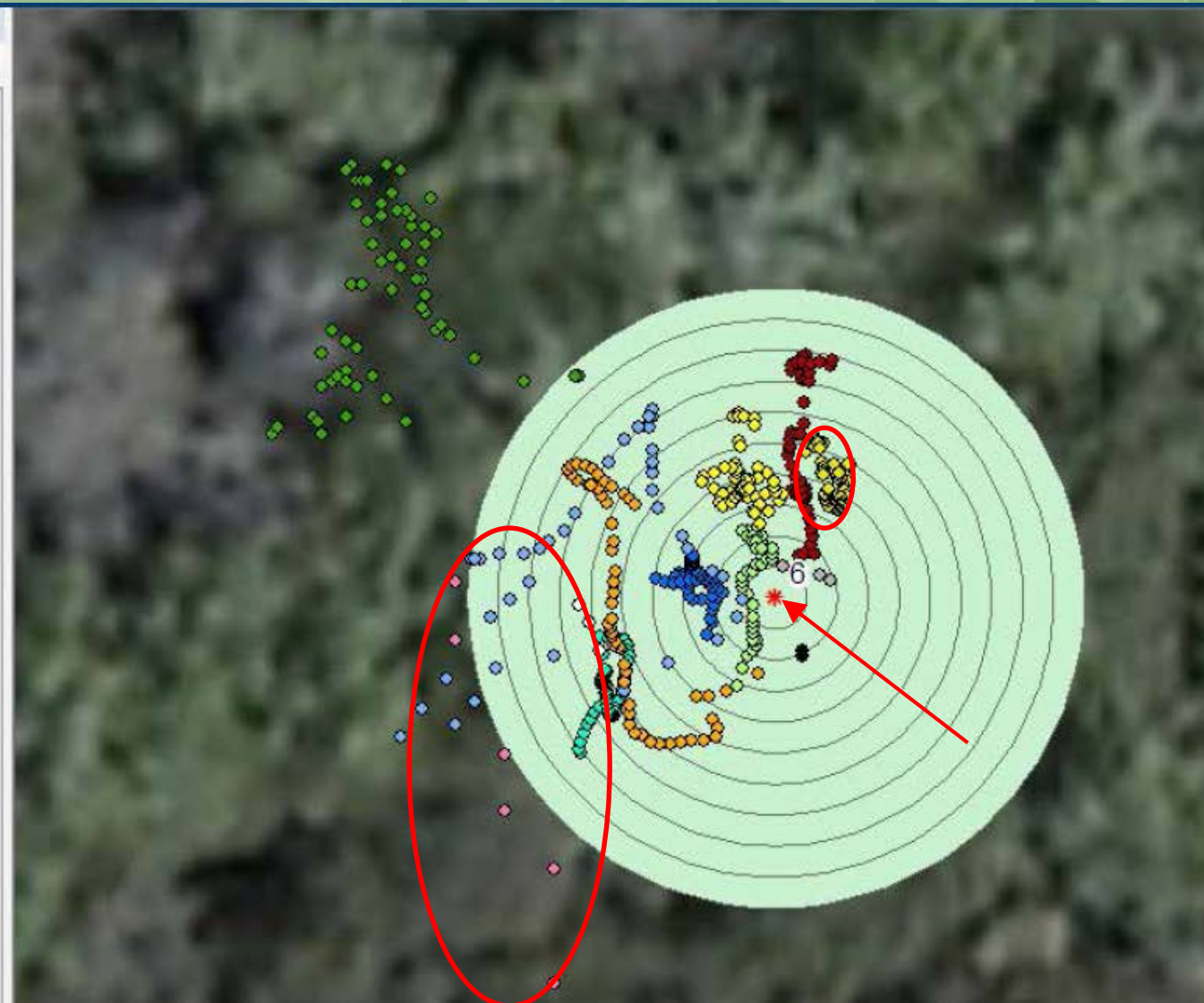


From John Thompson, GPS Accuracy: What Really Works Under the Canopy  
2013





- Layers
  - 3-14-13
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From John Thompson, GPS Accuracy: What Really Works Under the Canopy 2013

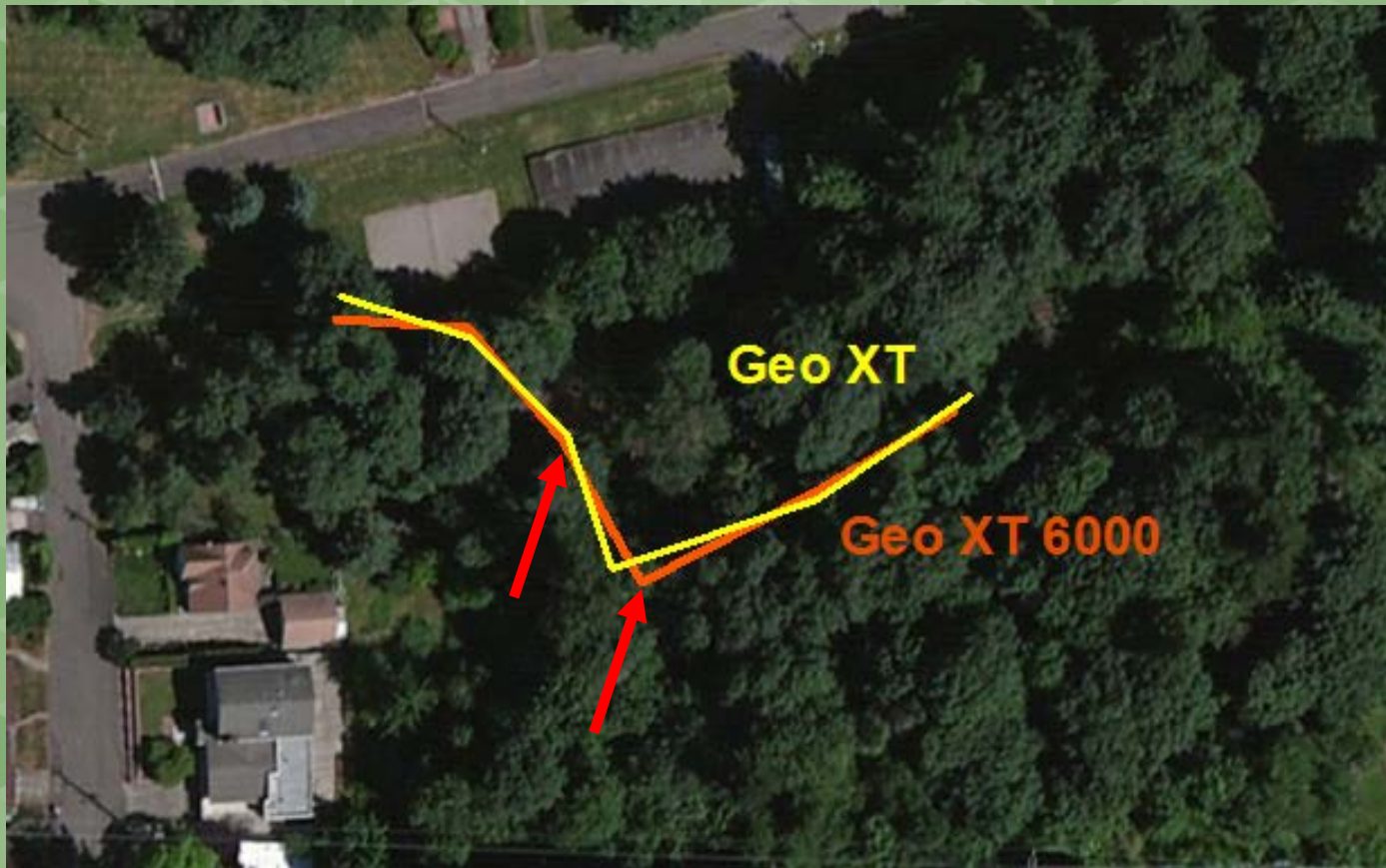
GPS	Avg Error (m)	Rank
Post Processed GeoXH 6000 GLONASS	0.75	1
Garmin_19X	1.63	2
Flint_Internal	1.85	3
Post Processed GeoXT 6000 WAAS	1.87	4
Holux_M1000C	1.99	5
Hemisphere_A100	2.66	6
GeoXH 6000 GLONASS	3.97	7
Trimble T41	4.02	8
GeoXT 6000 WAAS	4.36	9
Forge_Internal	5.73	10
SX_Blue II	6.18	11
iPhone5	10.57	12
GalaxyTab	15.60	13
Nomad_800_Internal	16.08	14

From John Thompson, GPS Accuracy: What Really Works Under the Canopy 2013



# GPS Accuracy Equipment

Differences between two professional-grade units





# GPS Accuracy Methodology

## Pre-field Methodology

- GPS settings (“Smart Settings”)
- Pathfinder trip planning

# GPS Accuracy Methodology

## Field Methodology

- Back to the north
- Hold unit with receiver pointing directly up
- Hold still with unit at the same vertical and horizontal position
- Collect at least one surveyed monument/day

# GPS Accuracy Methodology

## Post-processing Methodology

- Office processing ensures best results
- Compares monument locations to select the best base-station



# Project Management Implications

**Fast is fine, but accuracy is everything.**  
**-Wyatt Earp**

Quality of other project data collected by:

- Other entities
- Different equipment
- High standards and protocols necessary

**Get help from your product vendors**

# Mason, Bruce & Girard, Inc.

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