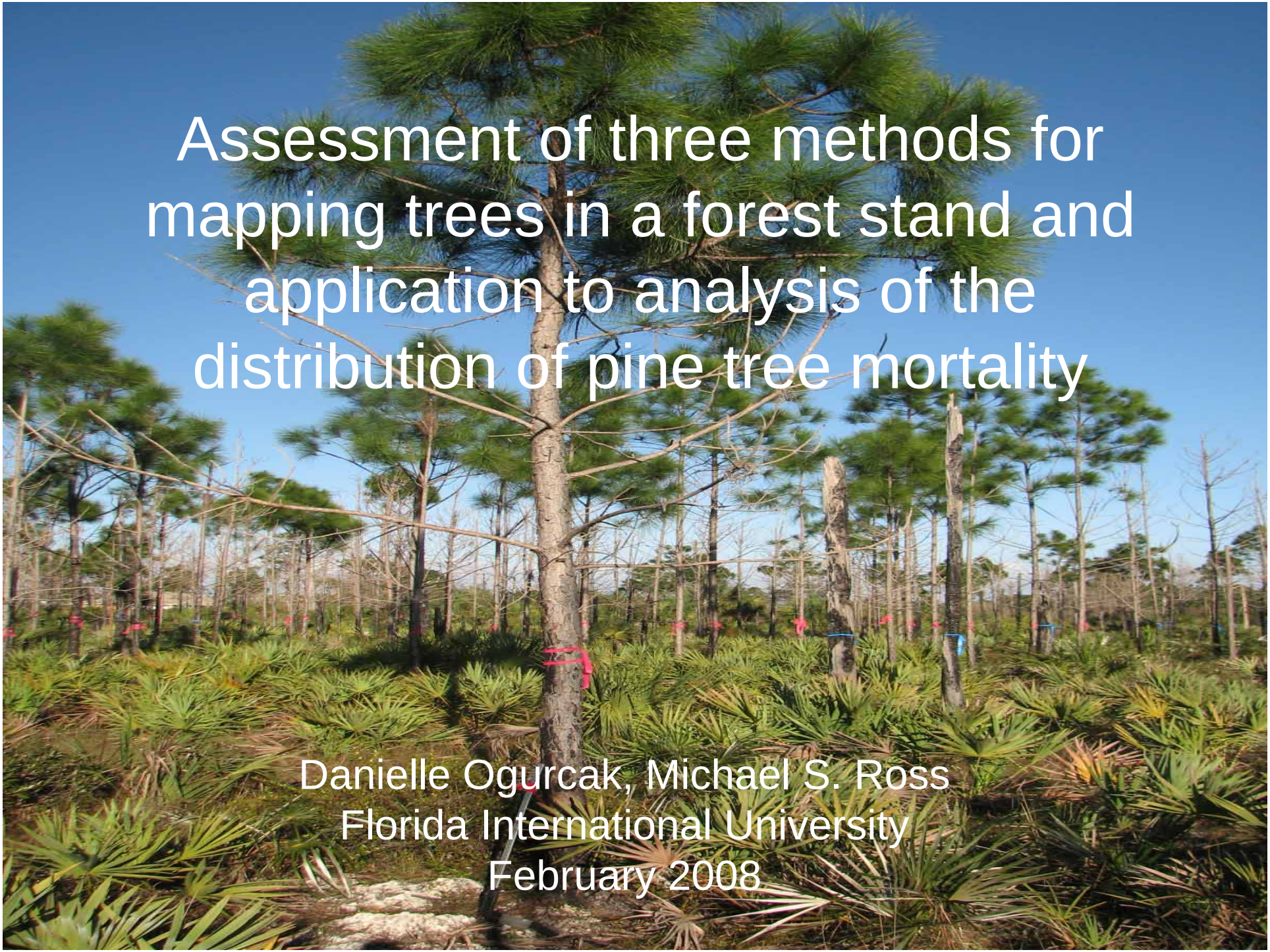

Assessment of three methods for mapping trees in a forest stand and application to analysis of the distribution of pine tree mortality

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Purpose

- Assessment of three methods for mapping trees in a forest stand
  - Explanation of methods
  - Accuracy Assessment
  - Efficiency (time, equipment, personnel considerations)
- Implications – Why does high accuracy matter?
  - Comparison with remotely sensed variables and in situ measurements
  - Ability to do fine-scale analyses (e.g., within-stand variation)
  - Before we can do analyses, we must have an accurate tree map!

Goulds Pineland, Goulds, Fl

- Pine rockland managed by Miami-Dade County
- Approximately 15 ha
- Hurricane Andrew (1992)
- Replanted with 2007 seedlings (1996)
  - 1240 (w. side of 120th Ave)
  - 767 (e. side of 120th Ave)
- Arson fire – March 16, 2006
- 0.25 ha plot established in late January 2008
- 49 Live trees tagged
- Diverse herb layer - at least 66 species present in understory

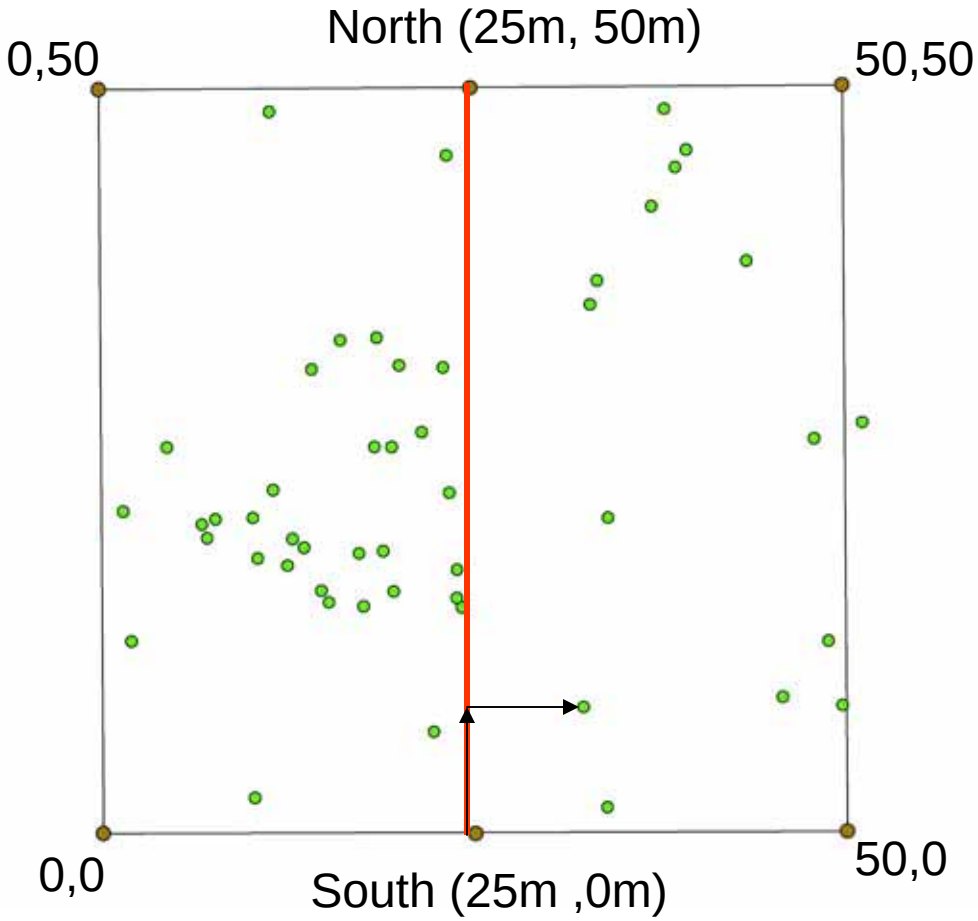
Methods

Method	Needed Equipment	# of Personnel	Average Error	Citation
Right Angle Prism (RAP)	Meter tapes, dbh tape, right angle prism	2 -3	23 cm	Reed et al., 1989
Interpoint	Meter tapes, dbh tape, laptop	2-3	5.5 cm	Boose et al., 1998
GPS with differential correction	GPS units, dbh, tripods, tape, compass	1	0.5 cm	Magellan manual

- RAP and Interpoint require the establishment or use of a specific number of known benchmarks
- All trees must be tagged and DBH recorded

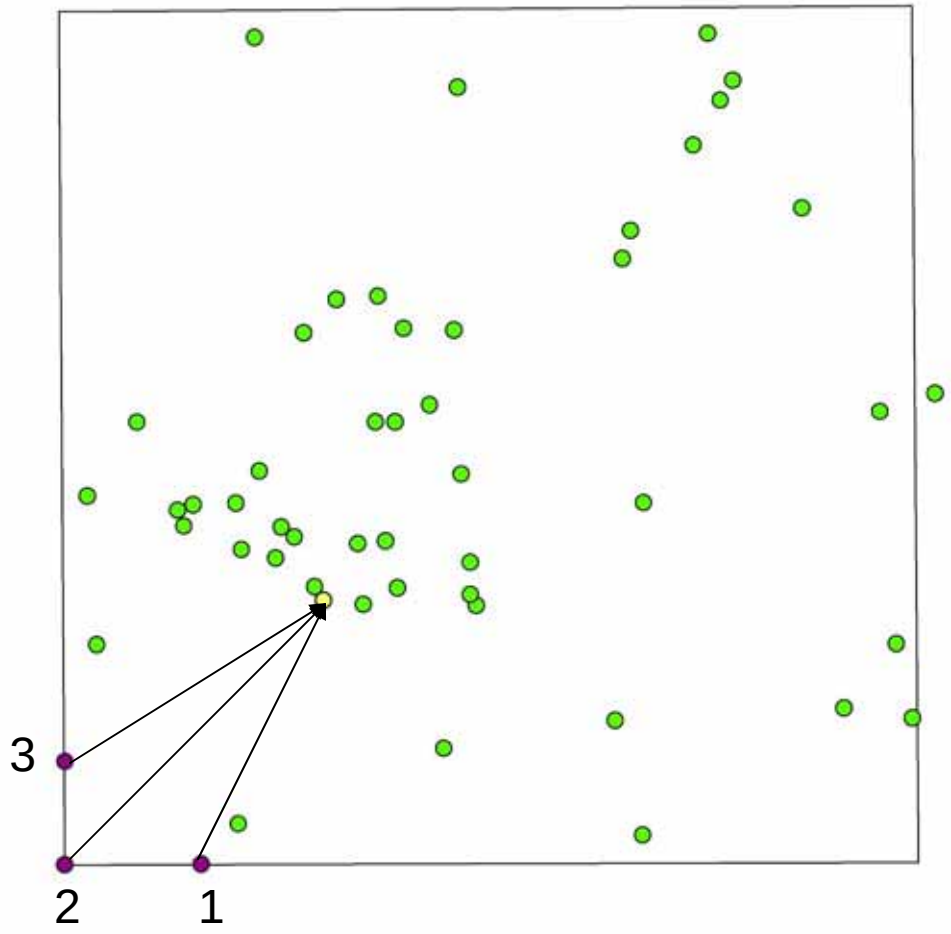
Right Angle Prism (RAP) Method

- Establish baseline from known location in due N-S or E-W direction
- Use right angle prism to create 90 degree angle from baseline to target tree
- Record distance along baseline
- Measure distance to target tree from baseline



Interpoint Method

- Measure to 3 known locations (not closer than 1 meter to target)
- Clockwise direction
- No angles <20 or >160 degrees (to avoid magnifying errors in measurements)
- Run Interpoint program
- Possible errors identified
  - Open triangles
  - Error > set thresholds



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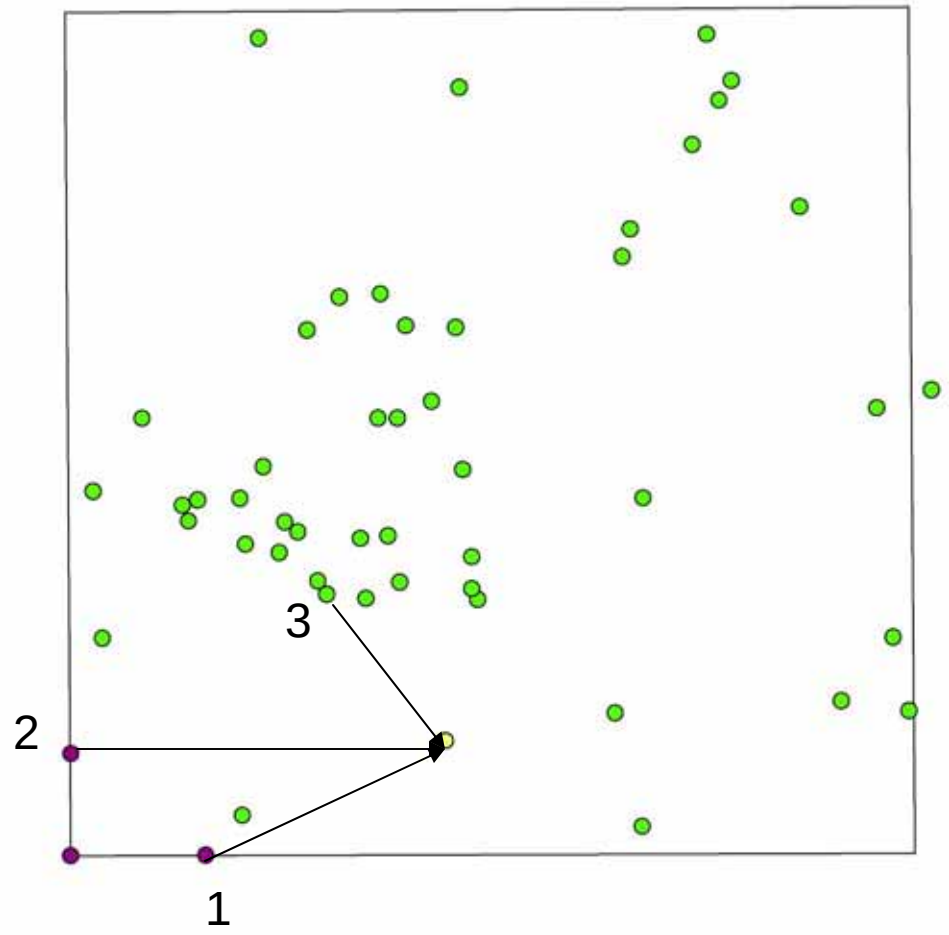
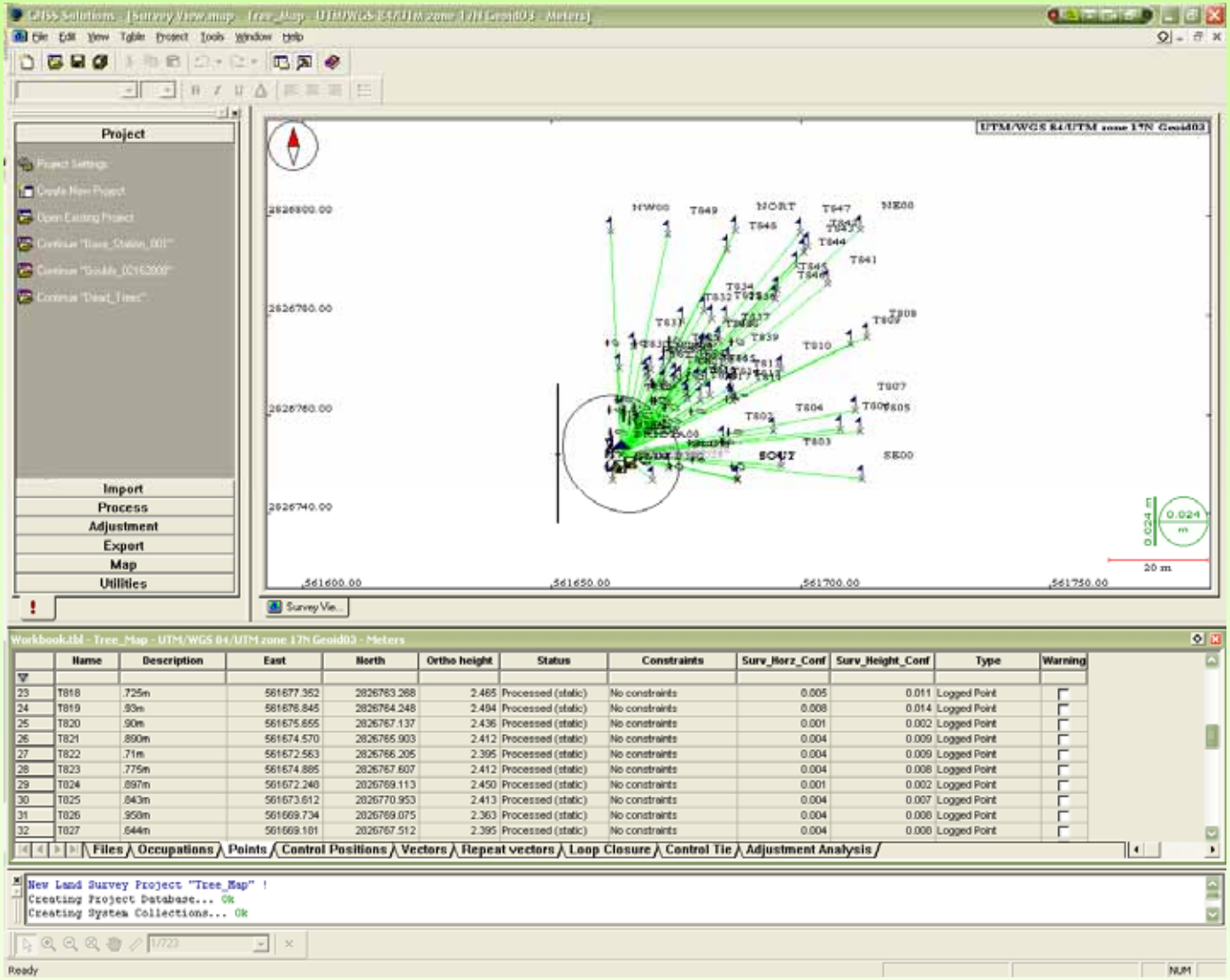


Interpoint Method

ProMark 3 GPS

- Establish base-station
  - Records location during entire time of survey
- Take waypoint at each tree with rover
- Note direction of offset
- Measure distance from GPS tripod to tree
- Good satellite coverage and signal important
- Post-process data with established beacons and base-station data

Post-processing rover GPS data with base-station



Accuracy Assessment 1

Comparing all three methods to measured distances between 30 randomly selected pairs of trees (distance = 30m or less)

Mapping Method	Mean Error	Median Error	Std. Dev.	RMS Error	95% CI	Error normally distributed?
ProMark 3 GPS	0.0	-0.01	0.08	0.08	+/- .15	yes
RAP	0.01	0.01	0.13	0.13	+/- .26	yes
Interpoint	-0.06	-0.02	0.15	0.16	NA	no

Error = Observed (measured) distance between trees – calculated distance between trees

Sample size: 30 pairs out of a possible 1176 unique combinations

This analysis enabled us to take into consideration the directionality of error

Accuracy Assessment 2

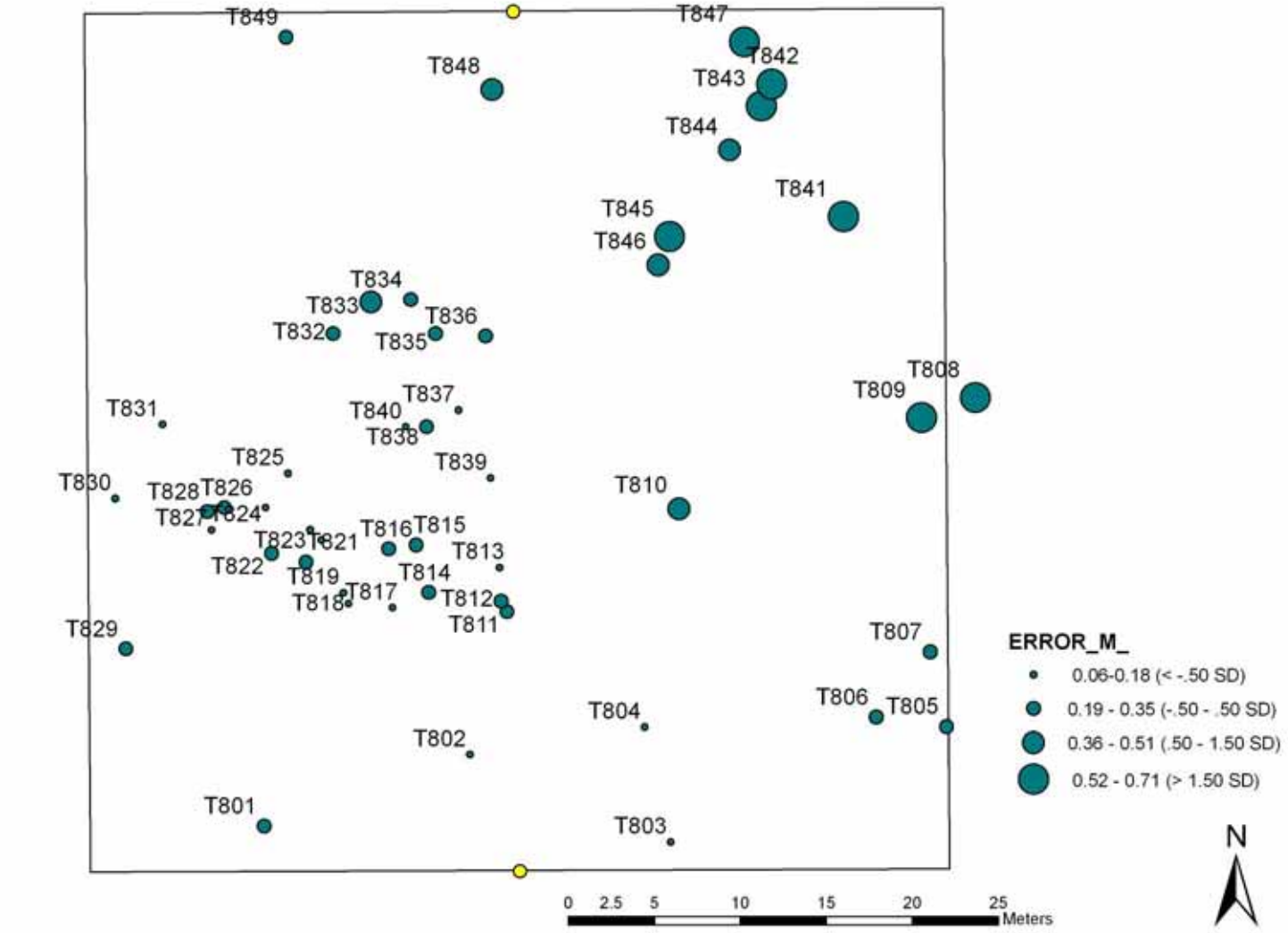
Comparison with Locations determined by ProMark

Mapping Method	Mean Error	Median Error	Std. Dev.	RMS Error	# of trees with error > +1 SD of mean	Error normally distributed?
RAP	.27	.21	.17	.31	8 trees (error > .44cm)	no
Interpoint	.18	.14	.16	.24	5 trees (error >.34cm)	no

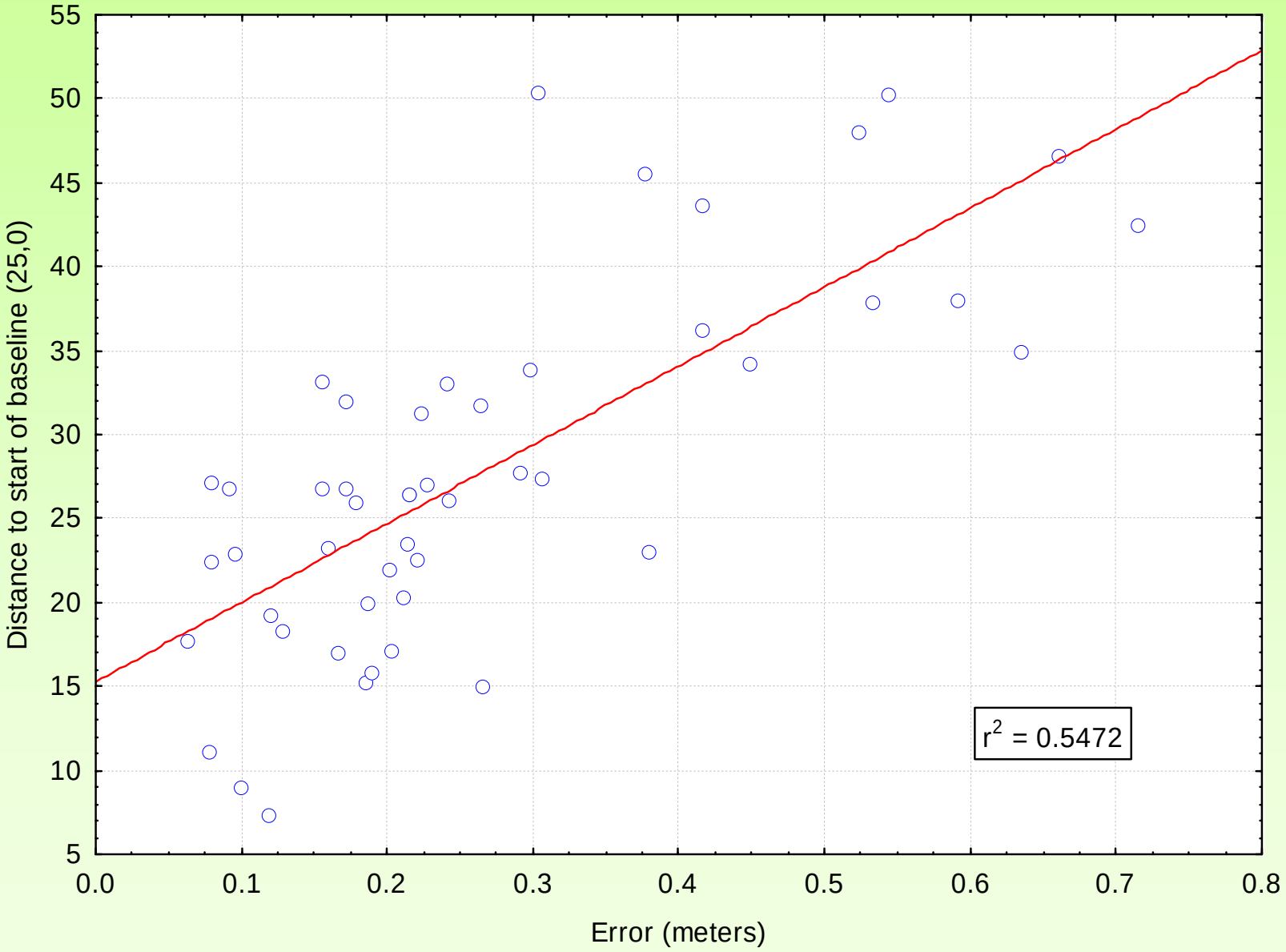
Questions:

- What is causing the high error for a subset of the trees with both methods?
- Is there a spatial pattern to the distribution of error?

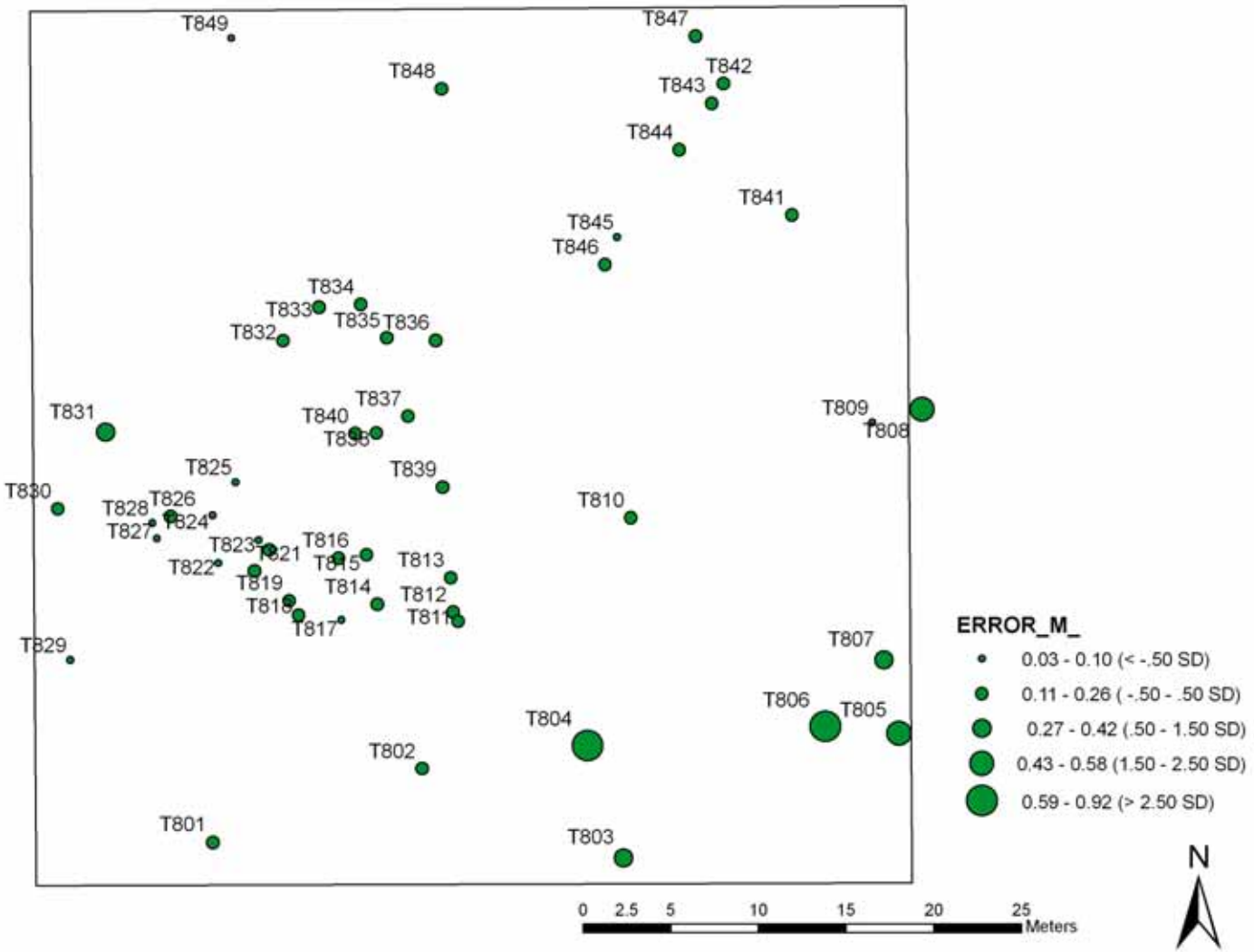
Spatial Distribution of Error – RAP



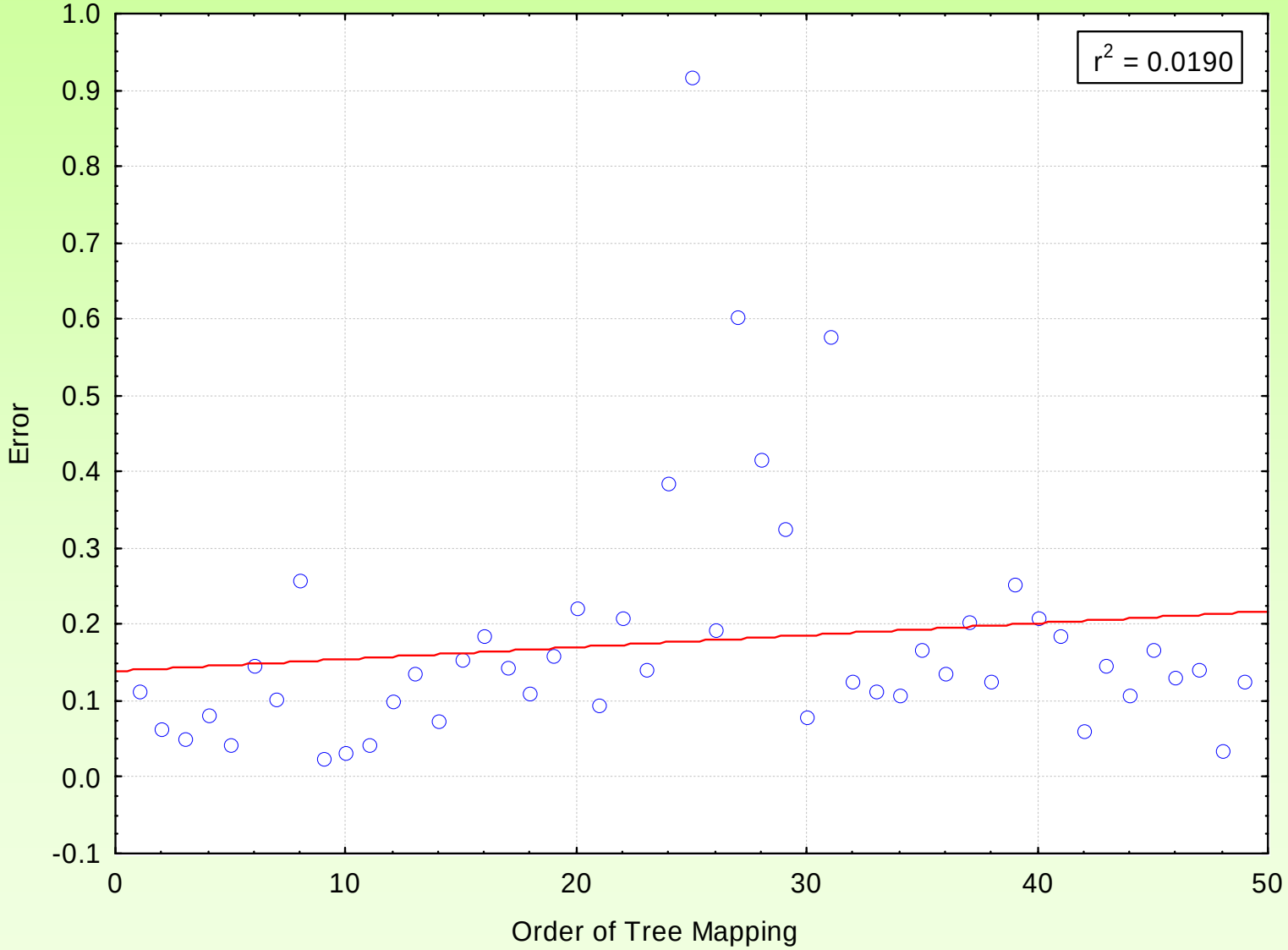
Distance to start point of N-S baseline (25,0)



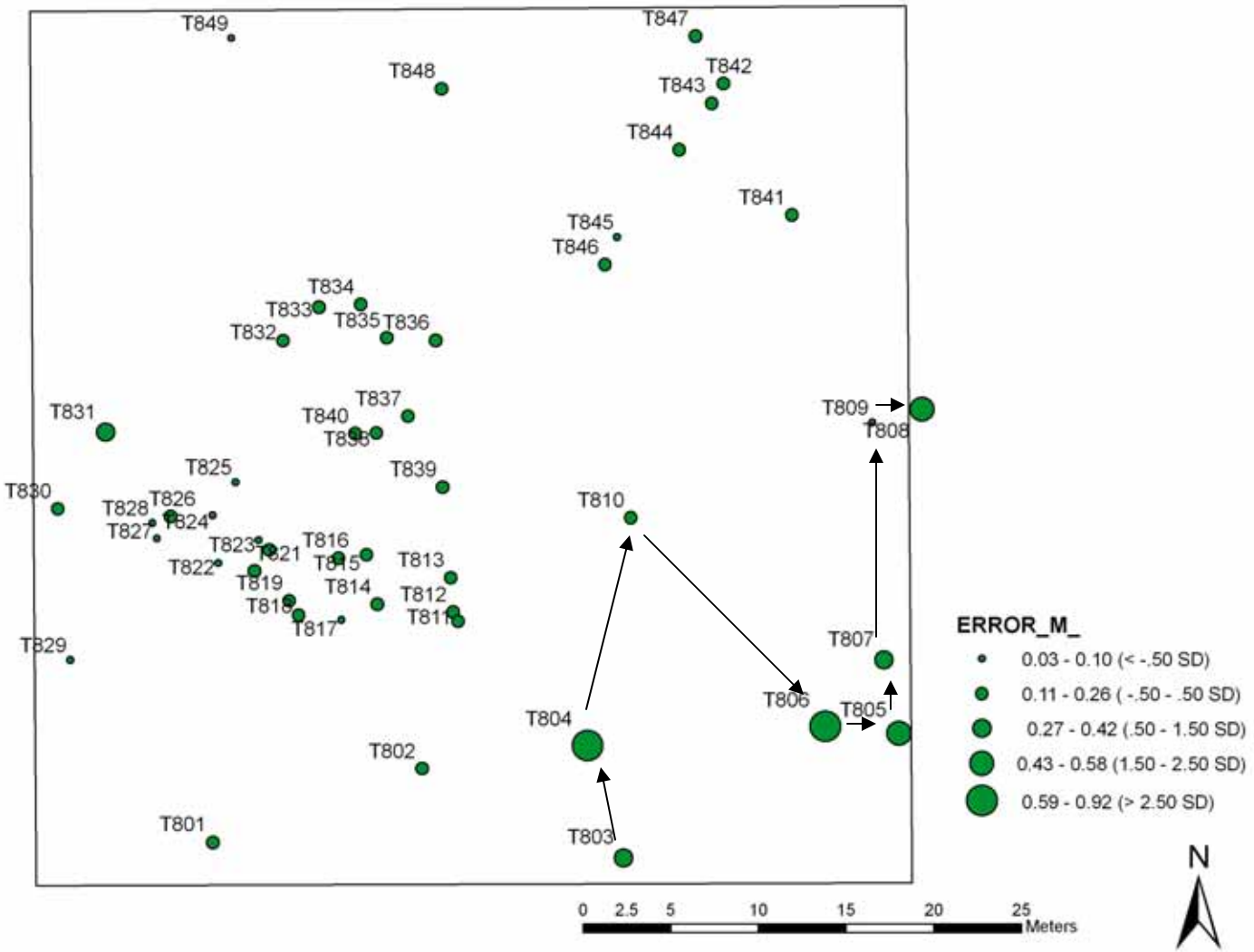
Spatial distribution of error - Interpoint



Distribution of error (Interpoint method) by order in which trees were measured in the plot



Spatial distribution of error - Interpoint



Comparison of Methods

	ProMark 3 GPS	Interpoint	Right Angle Prism
Advantages	• Highest accuracy • Requires only 1 person • Doesn't require location or establishment of benchmarks	• Good accuracy • Only 3 benchmarks required • Error checking built in	• Minimum amount of equipment • Easily employed in the field
Disadvantages	• Requires relatively open canopy to keep satellite signal • Cost of equipment • Amount of equipment	• More labor and time intensive than other methods • Location of error in measurements is not always clear	• Lowest accuracy of 3 • Requires establishment of plot and benchmarks • Requires measurements to be due N-S and E-W directions • No way to check measurement error
Time required	4hrs * 1 pers. = 4hrs	6hrs * 2 pers = 12hrs	3hrs * 2 pers. = 6hrs

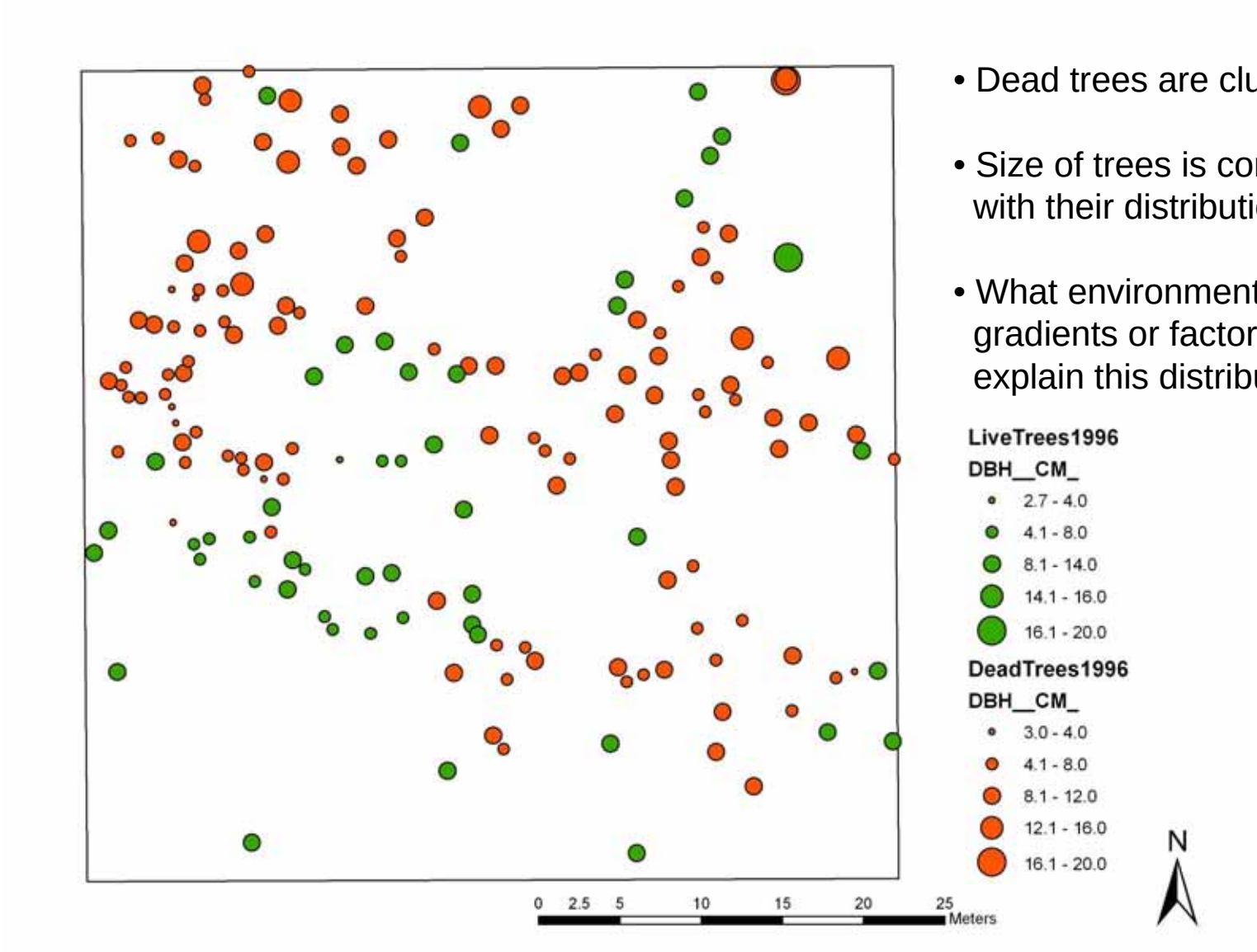
Implications and Applications

- Accurate locations of any study subject are needed not only if we are endeavoring to understand their distribution on the landscape, but especially if we are trying to relate the distribution or observed measured characteristics of the study subjects to remotely sensed spatial data or other *in situ* field measurements describing environmental gradients

- This becomes extremely important when one considers the spatial resolution of the remotely sensed or measured environmental variables (e.g. 5 foot resolution LiDAR data)

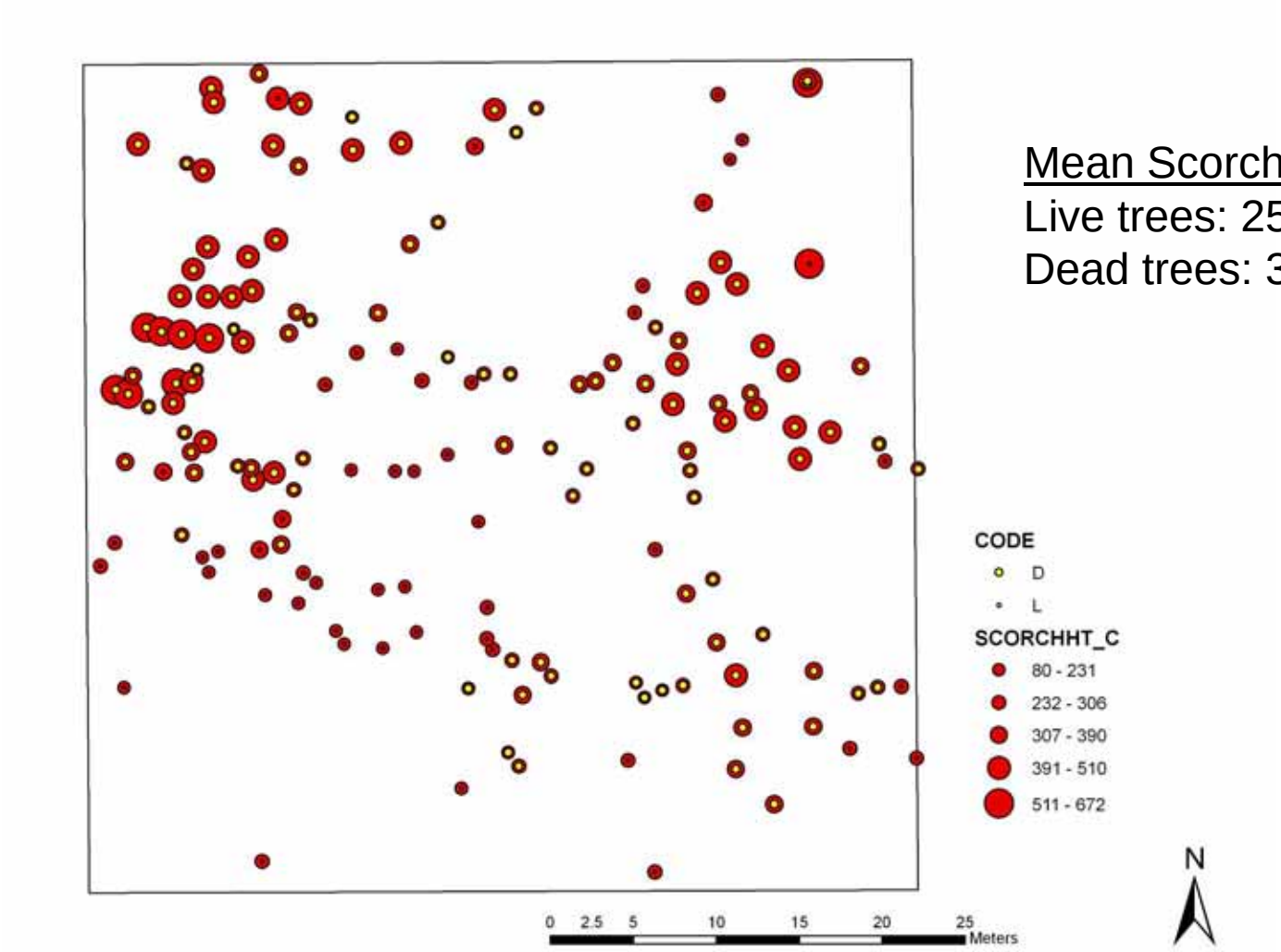
- High accuracy enables us to look at distribution at fine spatial scales and test hypotheses about within-stand variation

Spatial distribution of mortality resulting from 2006 arson fire classified by DBH

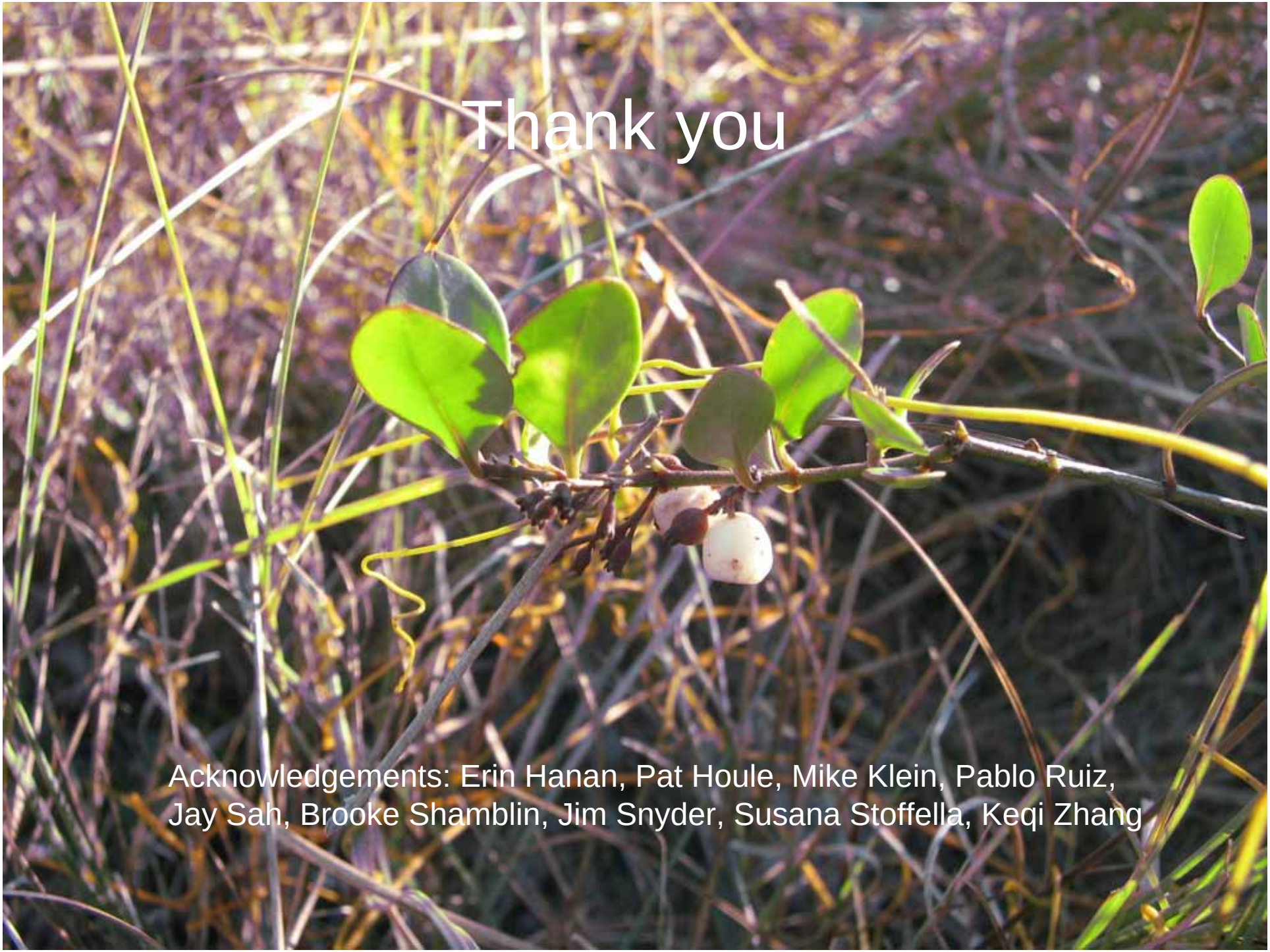


- Dead trees are clustered
- Size of trees is correlated with their distribution
- What environmental gradients or factors can explain this distribution?

Distribution of live and dead pine trees classified by scorch height (in cm)



Mean Scorch Height:
Live trees: 255cm
Dead trees: 361cm



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