CONNECTICUT CLIMATE ADAPTATION ACADEMY

May 3, 2014

UCONN
COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

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Vegetation Management

Damage Prediction Model

STORMWISE
Resilient Trees. Resilient Power.

UCONN DAMAGE PREMO
DAMAGE PREDICTION MODEL

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May 3, 2014

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Damage Prediction Model

UCONN DAMAGE PREMO

DAMAGE PREDICTION MODEL

Power Line Damage Modeling and Forecasting

***Goal**: Support decisions on utility resource allocation in response to weather-related outages and risk mitigation strategies through vulnerability analysis of past extreme events and potential severe weather scenarios*

Vulnerability analysis: Damage modeling can be used by utilities to assess the impact of vegetation management (e.g. tree trimming) and infrastructure hardening options on vulnerability reduction from different storm types.

Aspects of DPM Research

- Weather Modeling and Forecasting
- **Damage Prediction Modeling Research**
- Uncertainty characterization for risk analysis

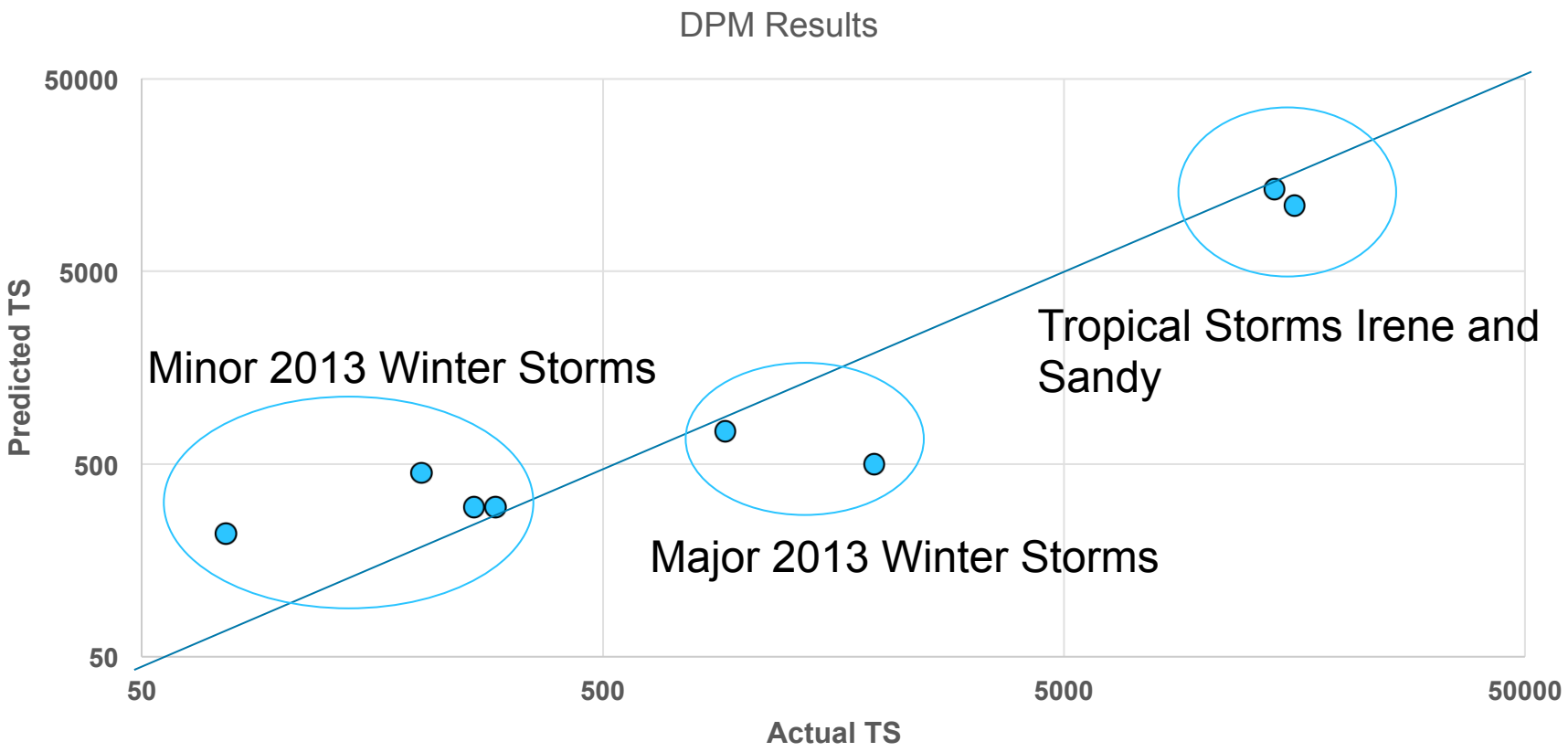
Status of DPM Development

- **Historical storm cases** (~120 storm events in the period 2005-2014):
  - Hurricanes (Irene, Sandy)
  - Major and minor summer T-storms and organized convective systems
  - Frontal systems and Coastal storms
  - Winter storms (Blizzards, Nor'easter storms and Ice storms)

- **Current damage models**
  - Weather parameters (2 km grid): Sustained winds and wind gusts, precipitation, soil moisture, snow water content;
  - Vegetation management: Percent of power lines trimmed in the past 4 years (SMT and ETT); vegetation height and density from LiDAR
  - Infrastructure: miles of power lines (backbone and lateral); number of poles and isolating devices
  - Land cover (% developed or forested), canopy density and type based on 30-m GIS

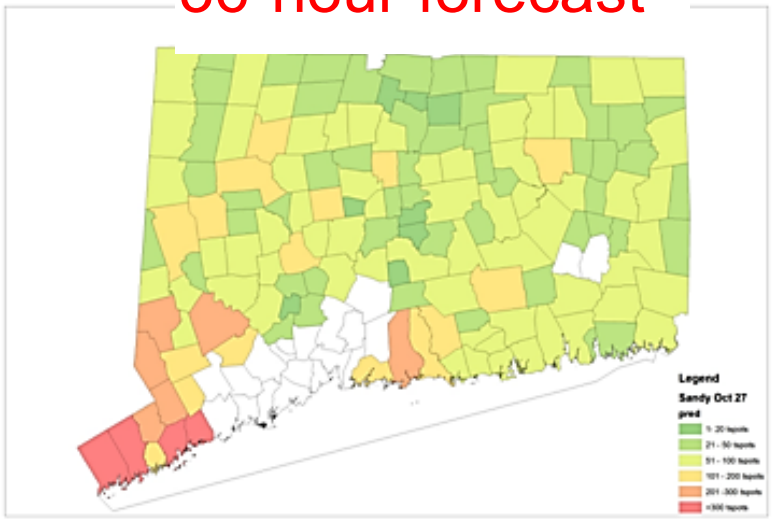
- **Weather Simulations**: WRF with advanced land surface parameterization

Sample Events Predicted with DPM

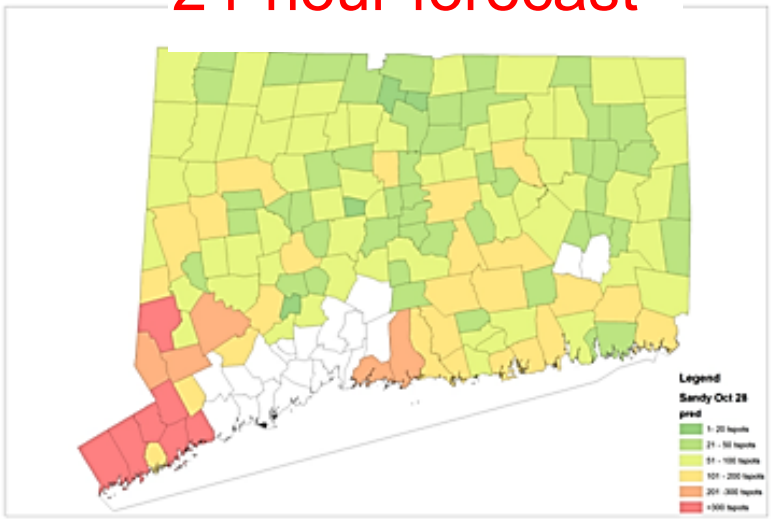


Town-by-Town TS Sandy Predictions

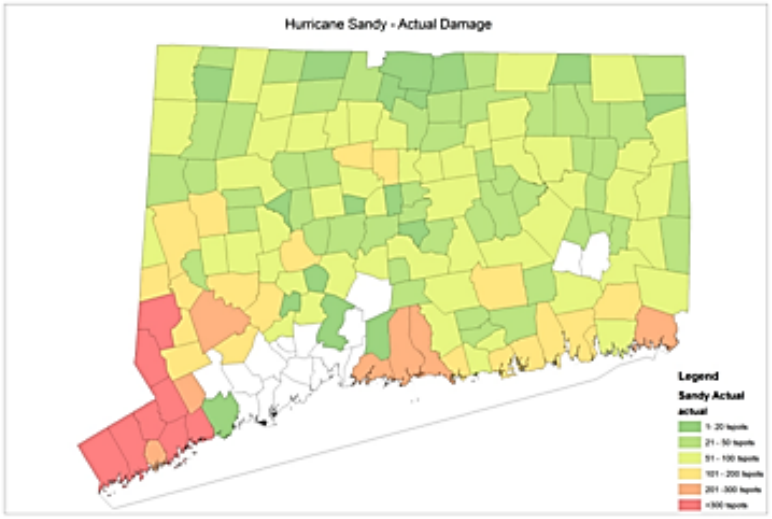
36-hour forecast



24-hour forecast



Actual Damages reported by CL&P



Mark Rudnicki, Thomas Worthley and John Volin

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NATURAL RESOURCES AND THE ENVIRONMENT

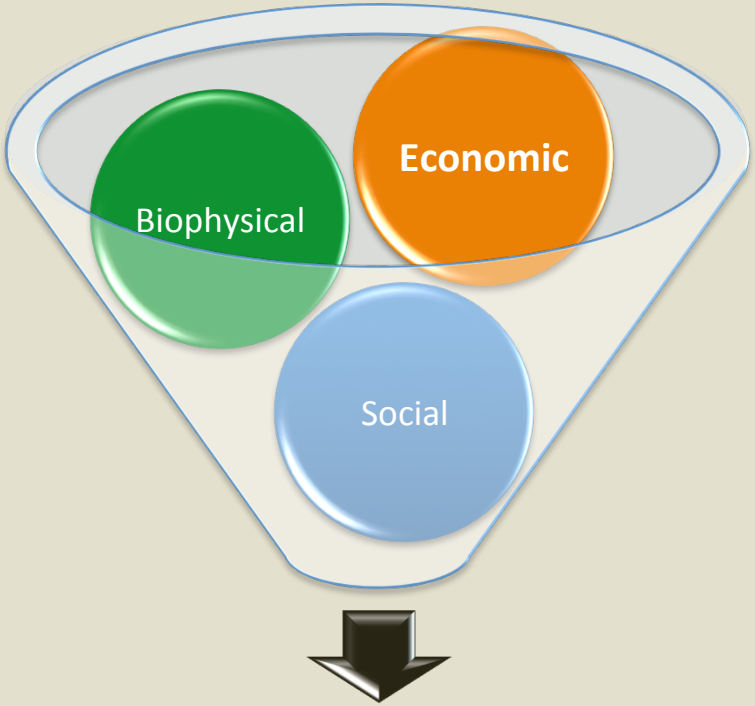
EXTENSION



90% of power outages due to trees

weak trees. unreliable power.

How do we *achieve* storm resilient trees and power?



Integrate the Biophysical, Economic and Social **dimensions of the task**

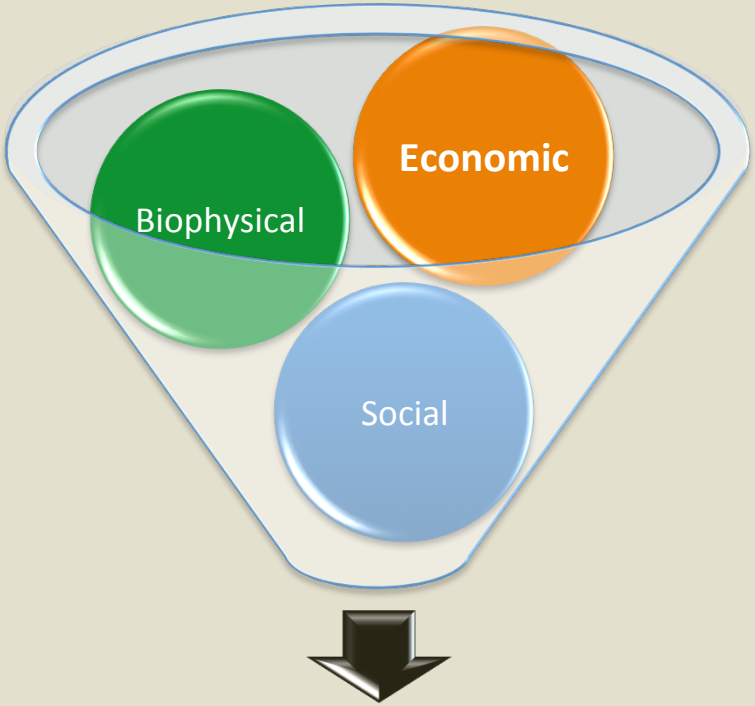
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How do we *achieve* storm resilient trees and power?



- **Biophysical -** How can we create tree storm resilience and long will it take?
- **Economic -** What will it cost and how do we pay for creation of tree/forest resilience?
- **Social -** How will we gain public acceptance and adoption of managing for resilience?

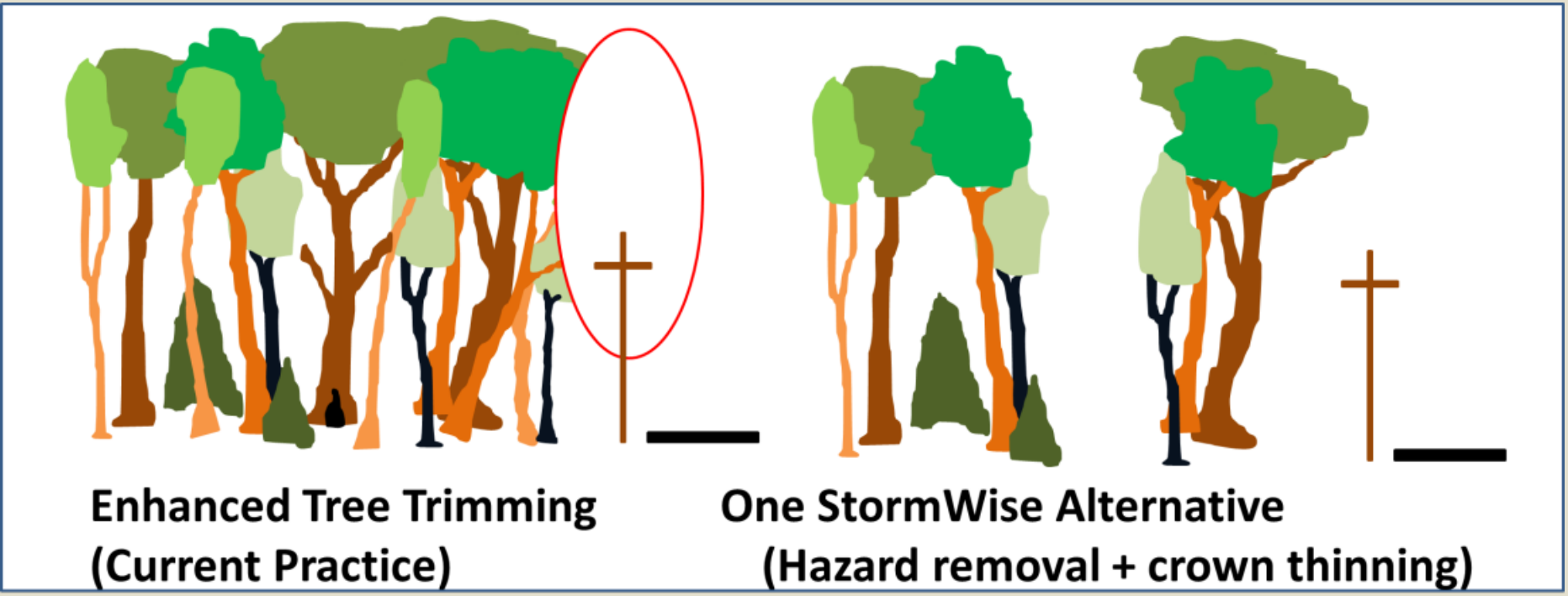
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Biophysical - How can we create tree storm resilience and long will it take?

Tree & Forest Edge Management: to enhance acclimative growth



Stormwise management:

1. Insures more wind exposure for strengthening growth

2. Light on all sides of crown for balanced growth



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Biophysical - How can we create tree storm resilience and long will it take?

Tree Biomechanics Research – rate of acclimation

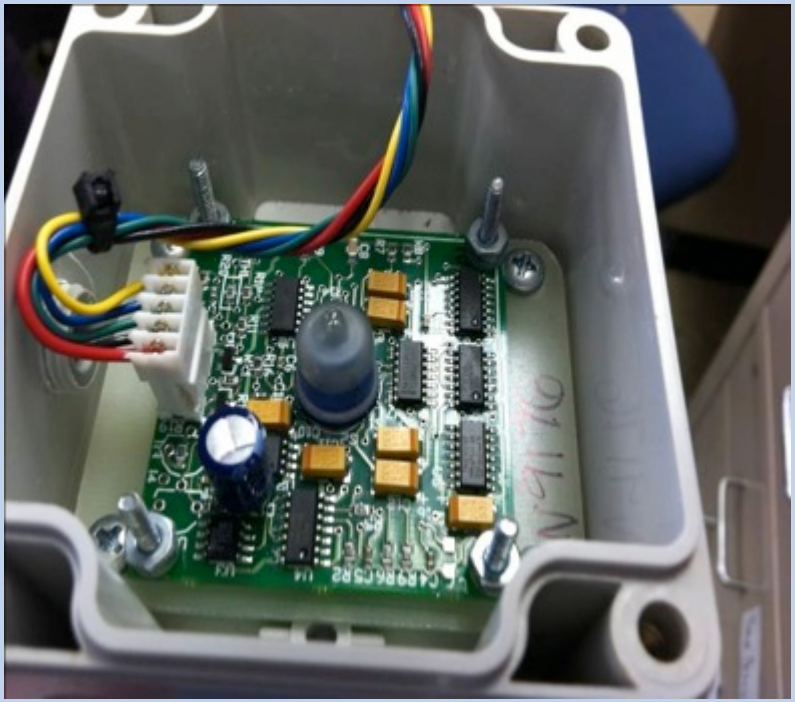
Sway dynamics – frequencies and sway patterns quantify increasing resilience.

As trees acclimate and increase storm resilience, their sway frequencies will increase.

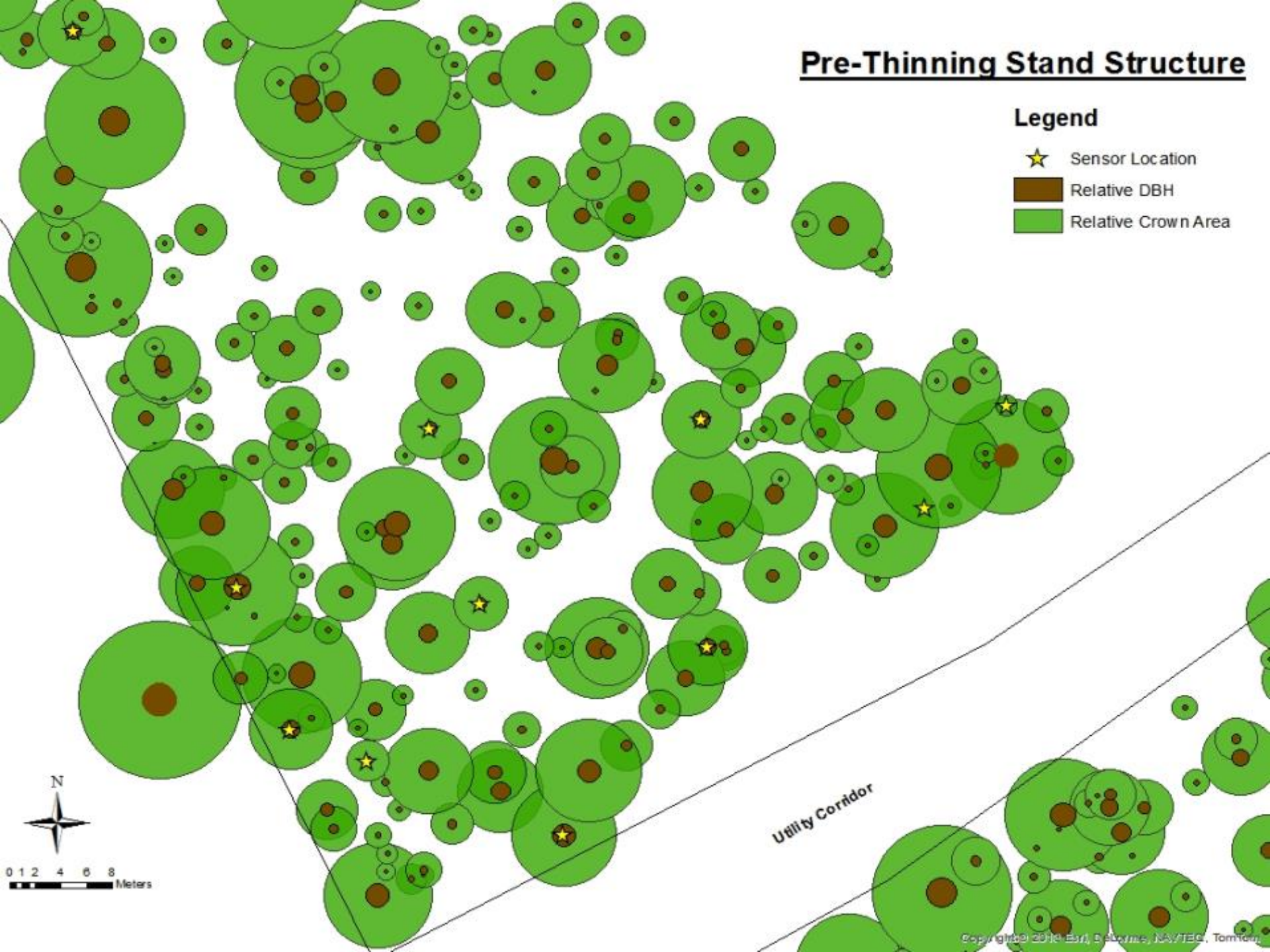
Methods

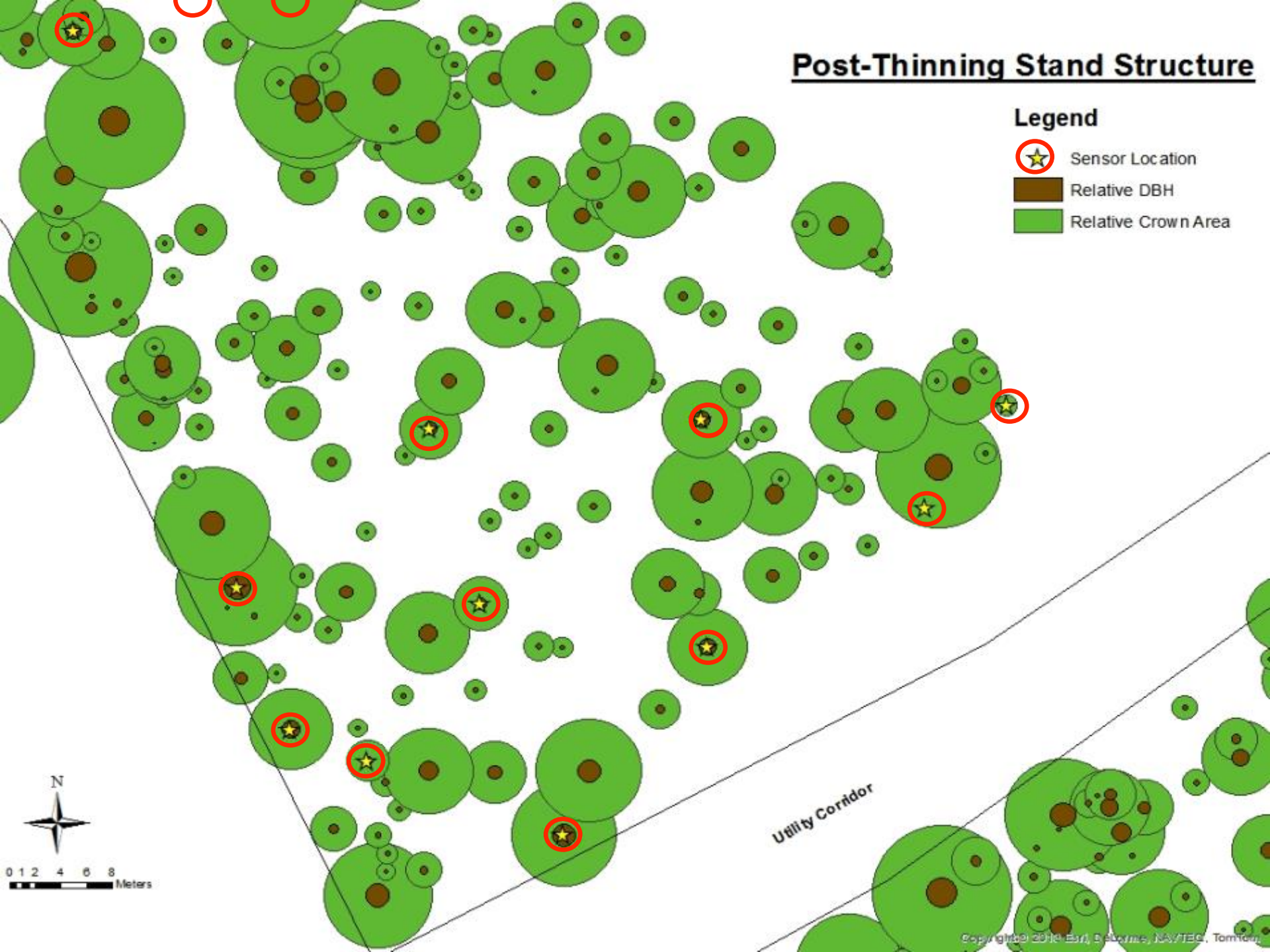
Biaxial Clinometers measure tree sway ten times per second







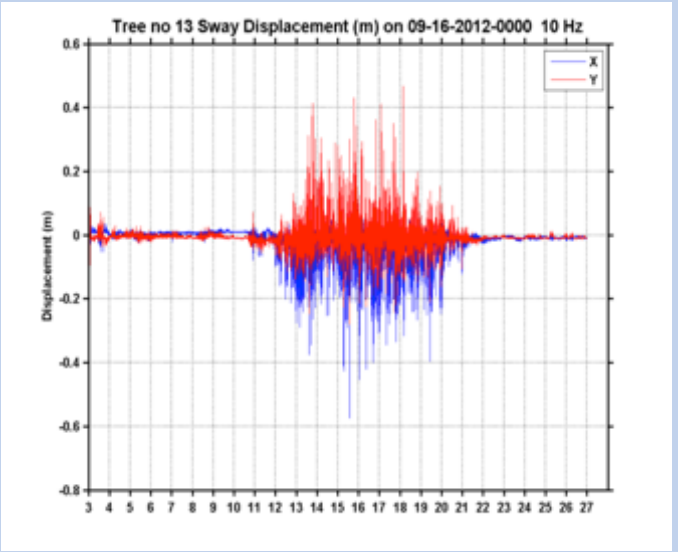

Pre-Thinning Stand Structure
Legend
Sensor Location
Relative DBH
Relative Crown Area
N
0 1 2 4 6 8
Meters
Utility Corridor


Post-Thinning Stand Structure
Legend
Sensor Location
Relative DBH
Relative Crown Area
Utility Corridor
N
0 1 2 4 6 8
Meters

Results – Quantifying Tree Sway

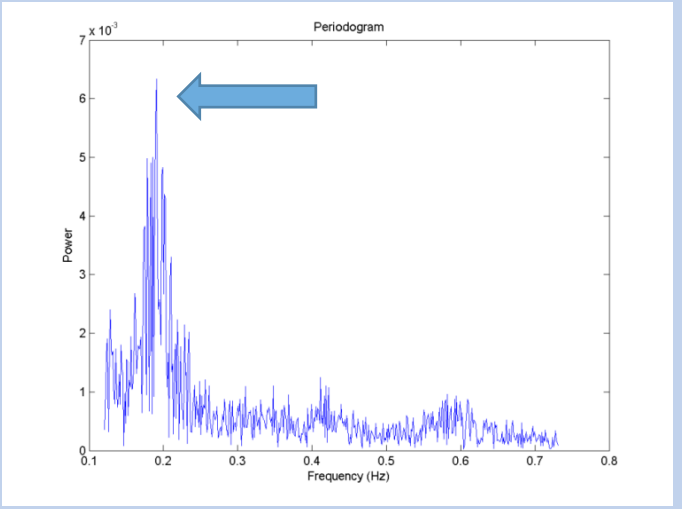
Displacement

- Distance from tree resting position
- Also provides shape of sway patterns

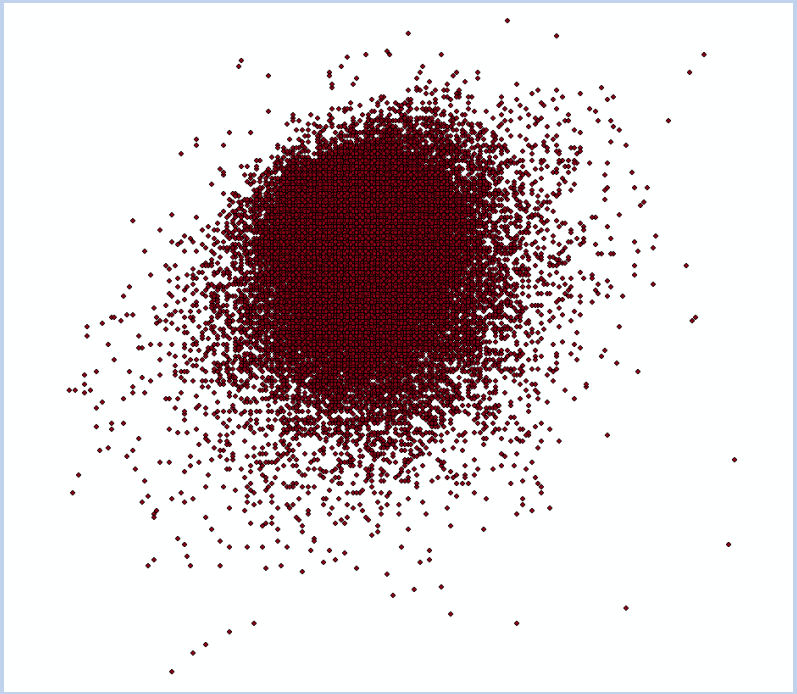


Frequency

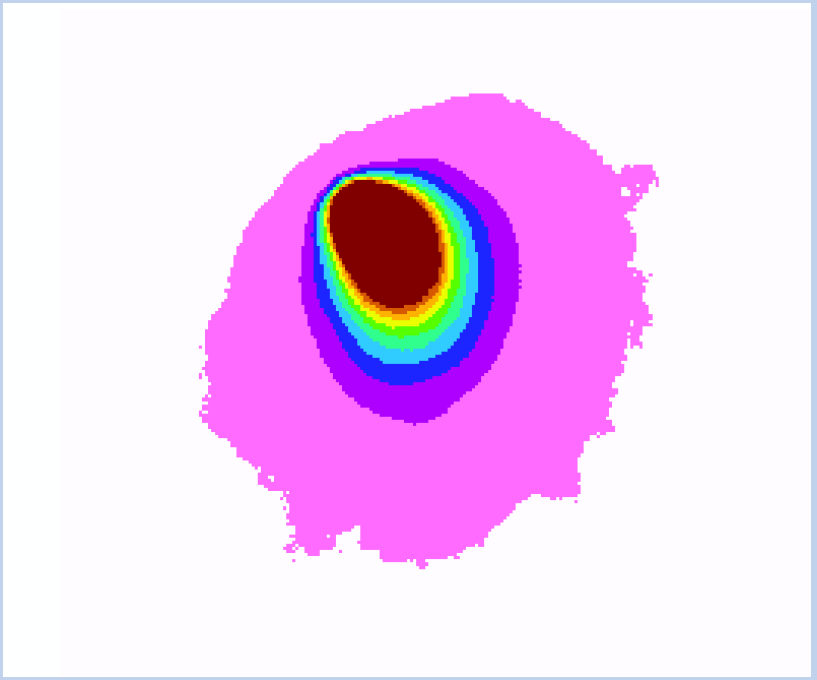
- Frequency is an indicator of tree stability
- By monitoring frequency, we can track rate of acclimation



Sway Density Contours



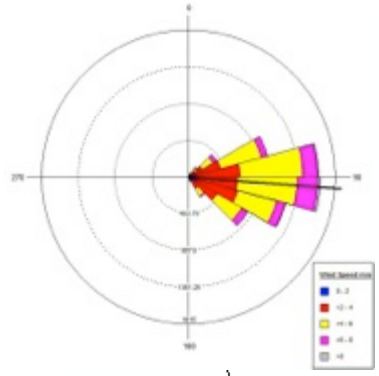


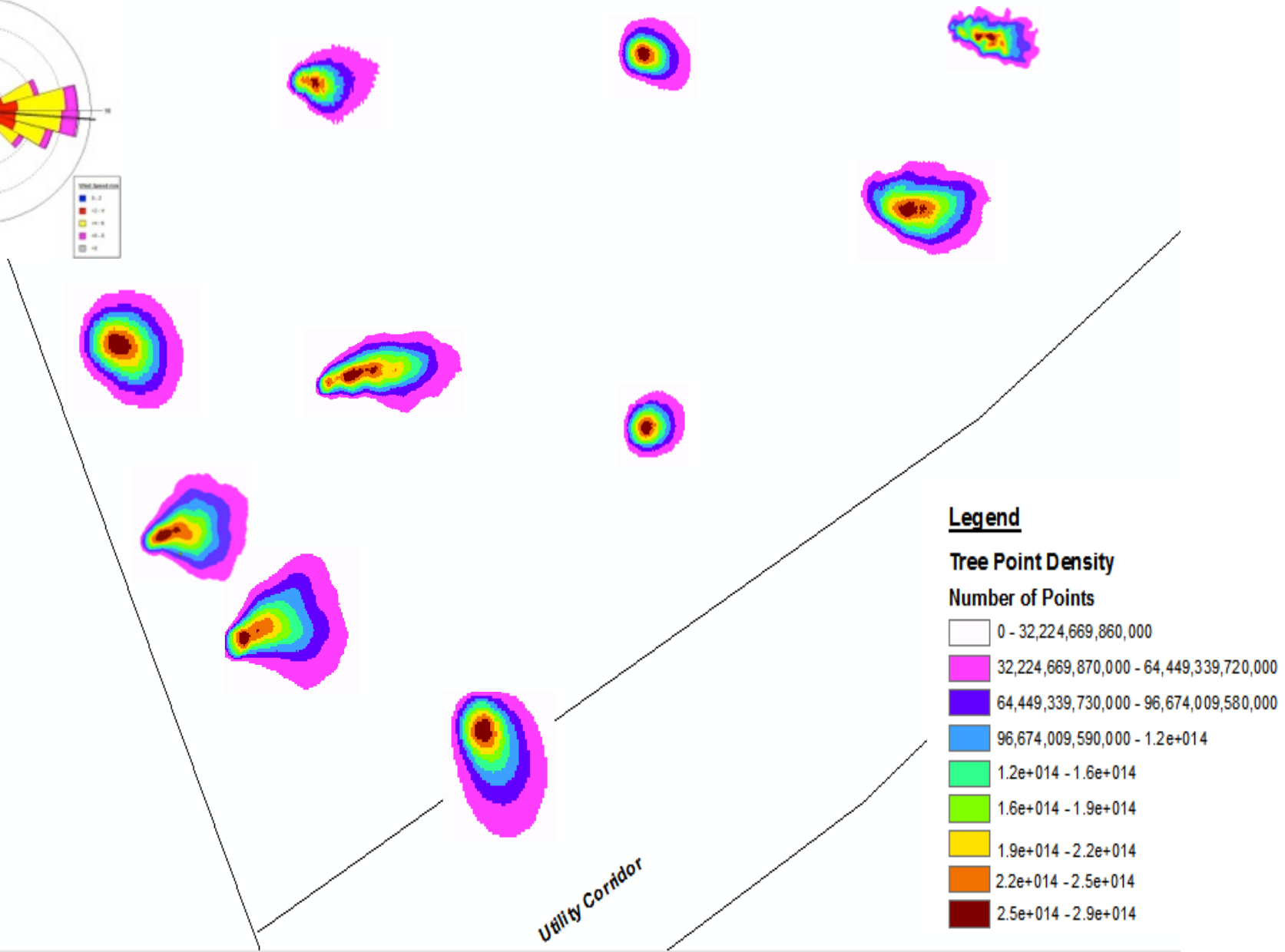


Sway Density Contours

June 8, 2013 11:00 A.M to 2:00 P.M. Average Wind Speed 3.0 – 4.0 m/s (6.7 – 8.9 mph)

NOTE: Images were enlarged for illustration.







Economic - What will it cost and how do we pay for creation of tree/forest resilience?

Economics Study: Scale-appropriate harvesting scenarios, treatment costs and value recovery.



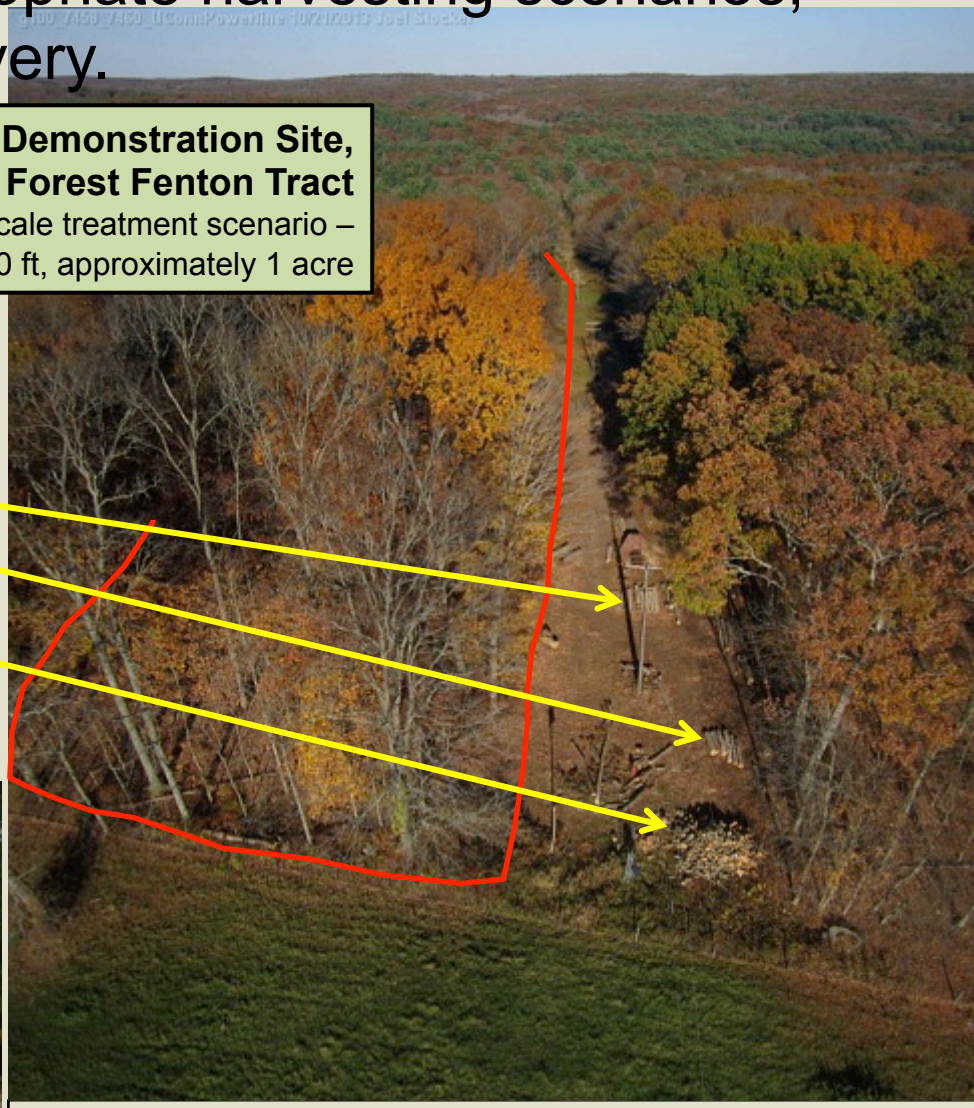
Economic - What will it cost and how do we pay for creation of tree/forest resilience?

Economics Study: Scale-appropriate harvesting scenarios, treatment costs and value recovery.

- Micro-scale harvesting
- Interior trees felled first
- Edge trees felled by arborist crew
- Logs marketed roadside
- **One-acre cost approx. $6600.00**

- Approximate yield:
  3600 bd ft of high grade logs, value: $2400.
  3200 bd ft of low grade logs, value: $900.
  8 cord fuelwood, value: $1200.
  1500 bd ft miscellaneous sawn material (portable band sawmill), value: $1800.
- **Total estimated product value: $6300.00**





Demonstration Site,
UConn Forest Fenton Tract
Small-scale treatment scenario –
100 ft x 440 ft, approximately 1 acre

Other value-added activity scenarios are also under investigation for product and value recovery.

Social - How will we gain public acceptance and adoption of managing for resilience?



Public Engagement, Extension Education and Social Science Research to Develop and Implement STORMWISE

Social - How will we gain public acceptance and adoption of managing for resilience?

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Concept of APP for:

1. Mobile tree failure data collection and

2. Tree risk assessment

Engage and educate communities and individuals about how they can prepare for the next storm.

- Development of local Stormwise treatments jointly with stakeholders and arborists and foresters.
- Social Science research to assess knowledge, & beliefs to develop programs that can change attitudes.
  - For instance one strategy is to: Promote self-assessment of trees to increase awareness of tree risk and mitigation strategies.
  - Another strategy to affect attitudes is to engage in **"Conspicuous Production" –** demonstrate creation of value added wood products at a farmers market. Likely receptive audience already familiar with CT GROWN and societal and environment benefits of "keeping it local".

Coventry Regional farmers' market

CONNECTICUT GROWN THE LOCAL FLAVOR.



STORMWISE

Resilient Trees, Resilient Power

Acknowledgment of support:

Storrs Agricultural Experiment Station (SAES)
McIntire-Stennis Forestry Grants

US Forest Service - State and Private Forestry 2013

The United Illuminating Company

Connecticut Light and Power, a Northeast Utilities Company

STORMWISE

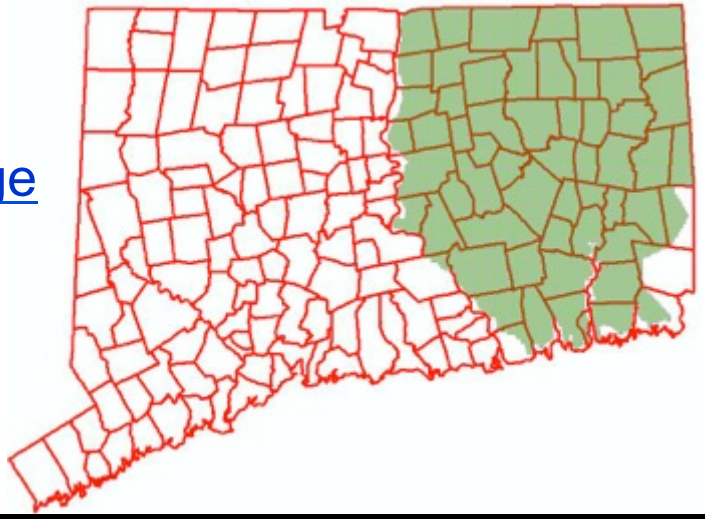
Resilient Trees, Resilient Power

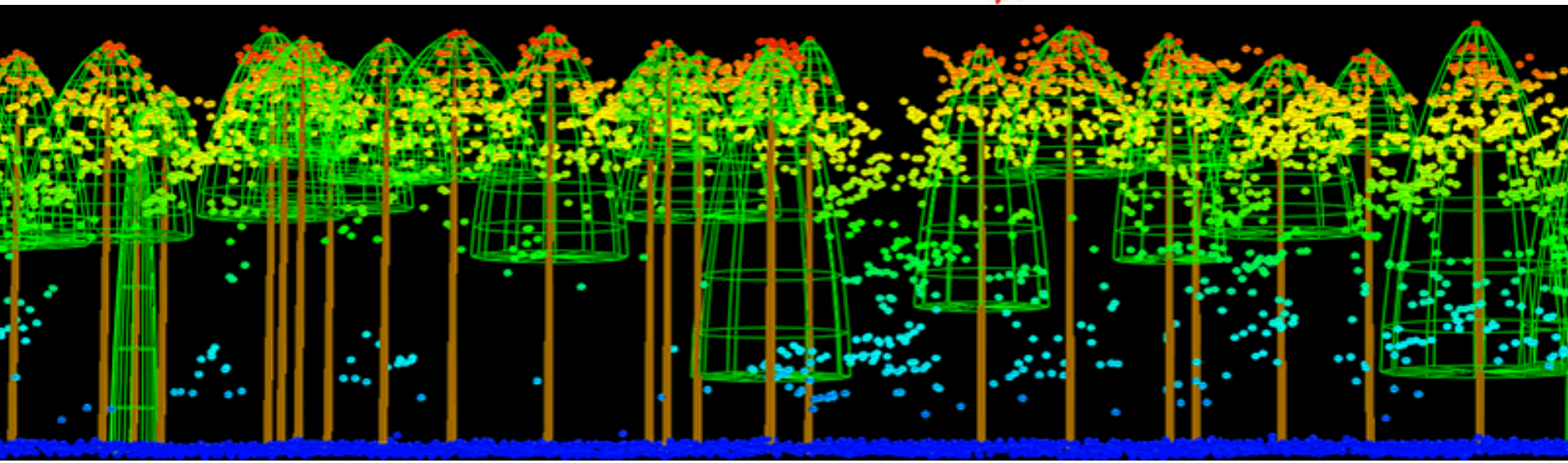
Questions?

Light Detection and Ranging (LiDAR)

- Airborne laser scanner determines location and elevation of objects on ground surface.

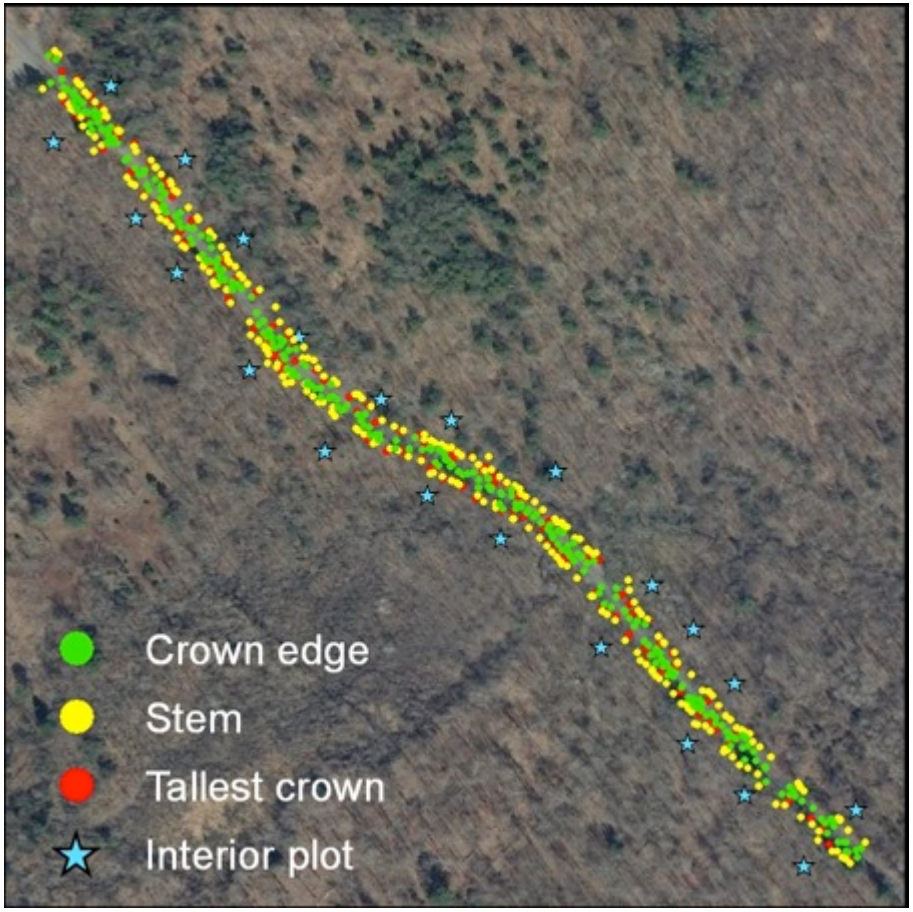
Eastern CT LiDAR coverage





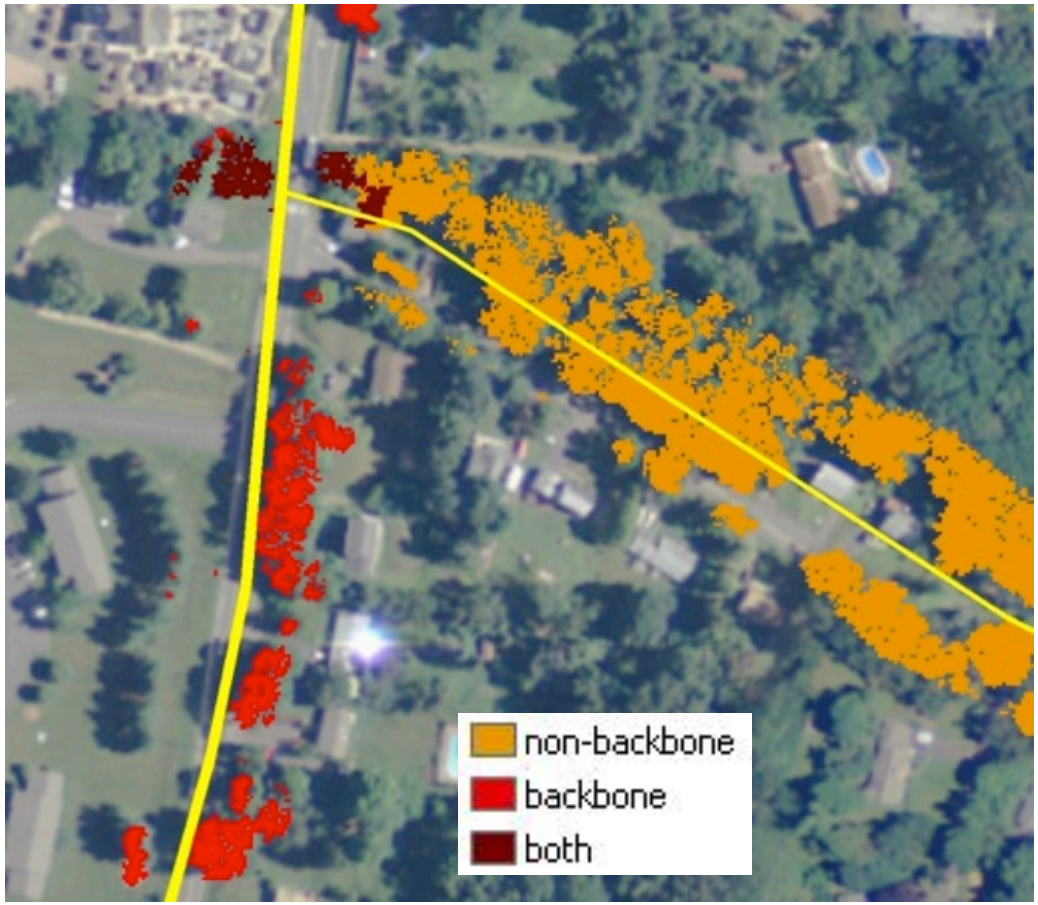
LiDAR based improvements to Damage Model -

- Tree inventory and hazards to characterize roadside forests. (1650 roadside trees)
- Coupled to LiDAR imagery
- Create hazard pixels



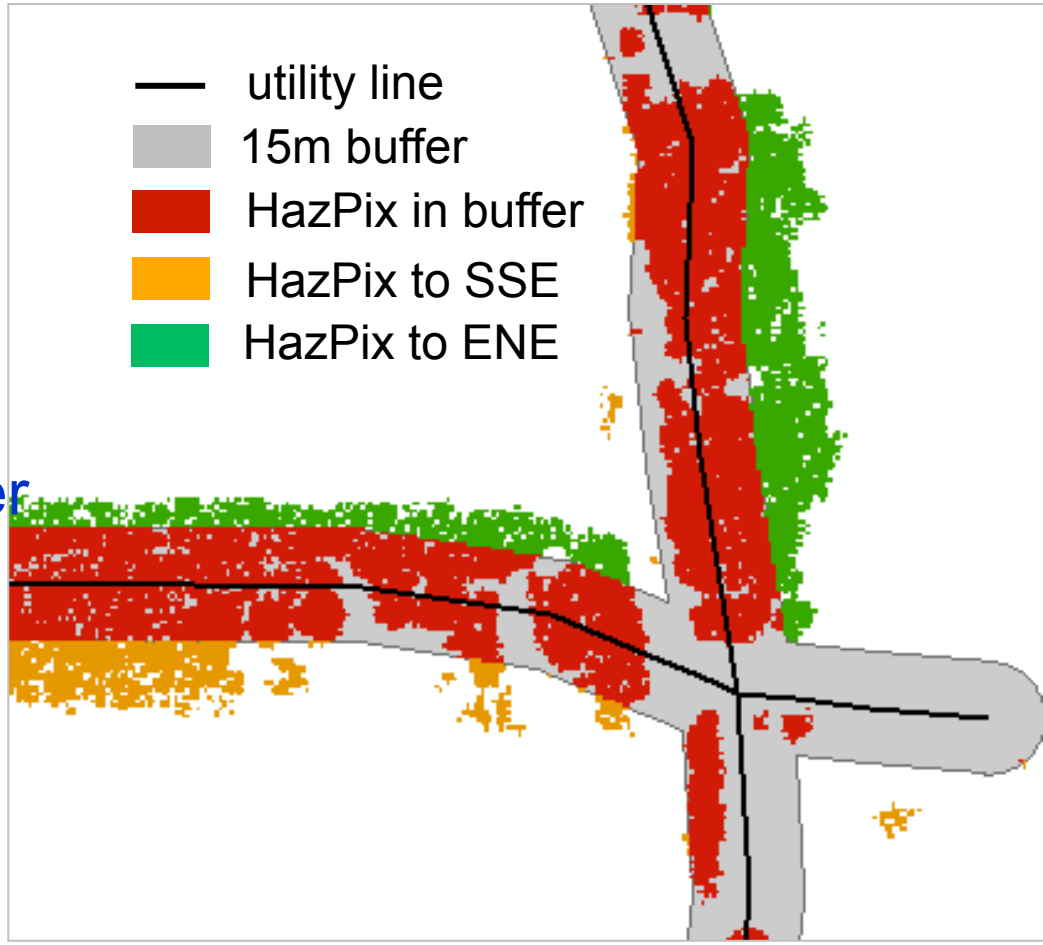
Hazard pixels

- Pixels tall enough and close enough to strike lines in event of a tree failure.
  - pixels are a proxy for trees
- Classified based on type of lines they can reach…
  - backbone or non-backbone.



Position of hazard pixels

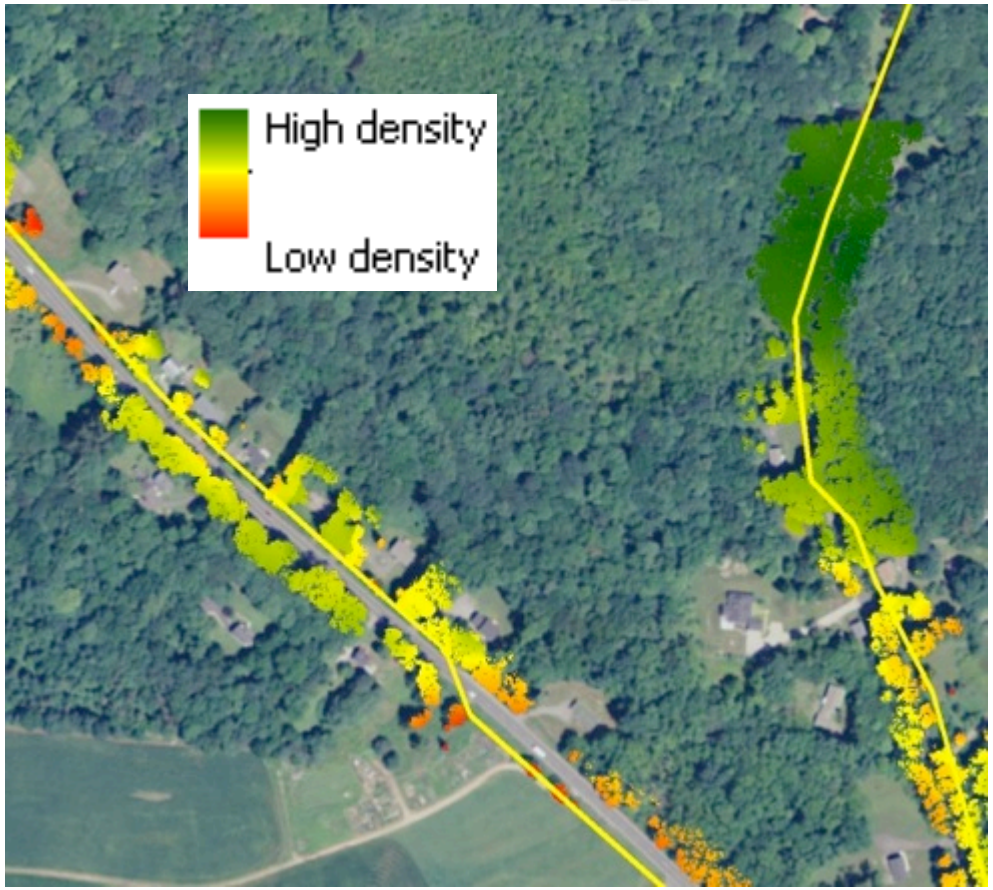
- Pixels classified by position relative to lines
  - within 15 meters
  - direction to lines (i.e. NNE, ENE, etc.)
- Upwind hazard pixels likely to be of greater risk to power lines.



Forest canopy density

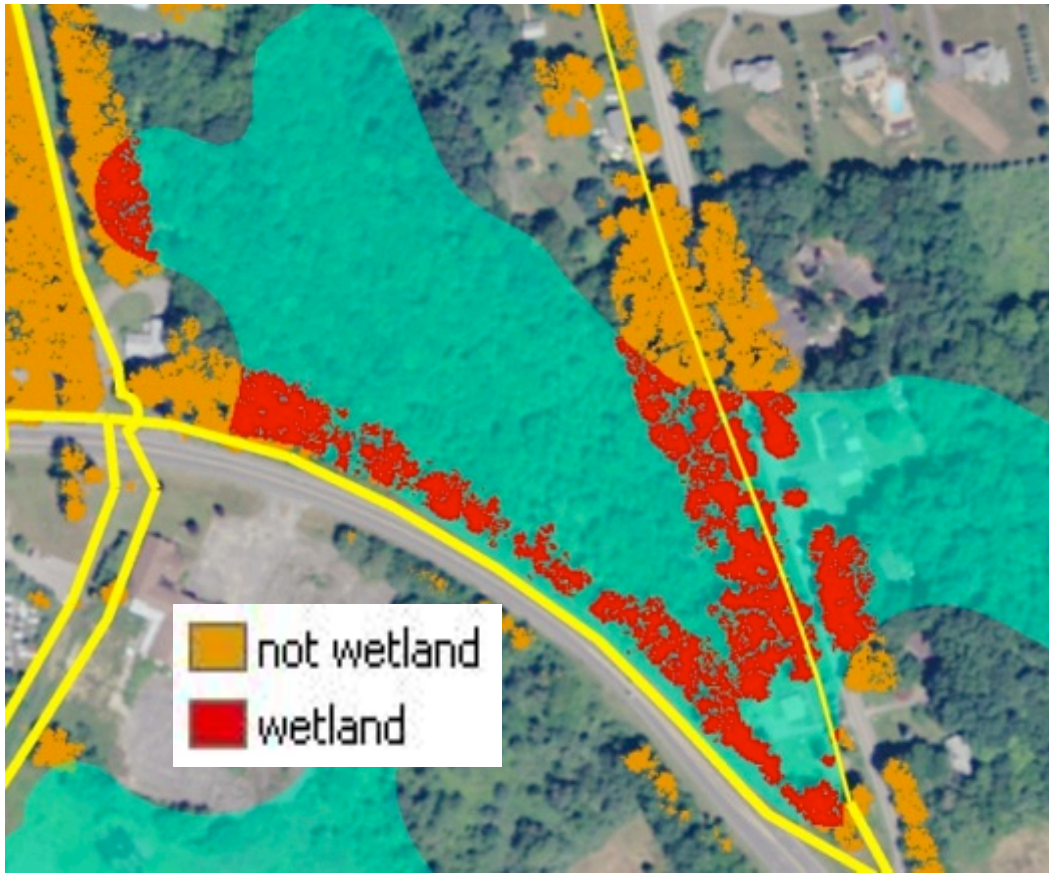


- Canopy density influences tree wind exposure and thus wind adaptation.
- Canopy density calculated for hazard pixels



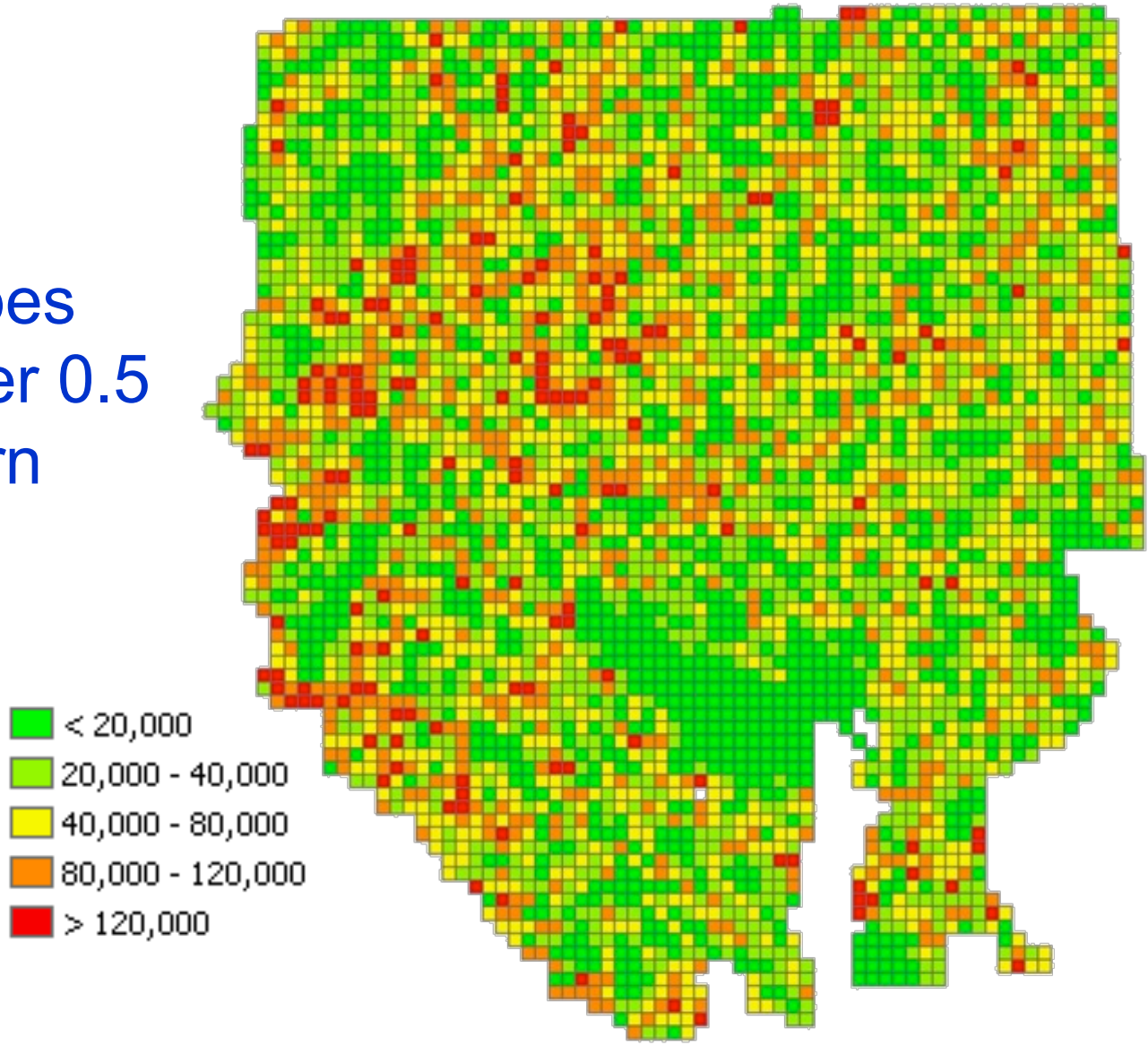
Soil conditions

- Wet soils increase potential for windthrow.
- Hazard pixels classified by presence of wetland soils (DEEP GIS data).



Pixel summary

- Hazard pixel types summarized over 0.5 km tiles. (Eastern Connecticut)



Count of hazard pixels