



The Effect of Pruning on Crown Motion:

An in situ investigation of the effects of two pruning methods on sway properties of silver maple

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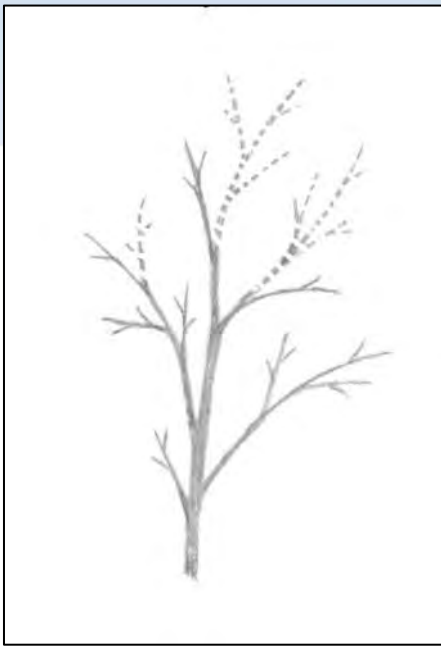


Background for Project:

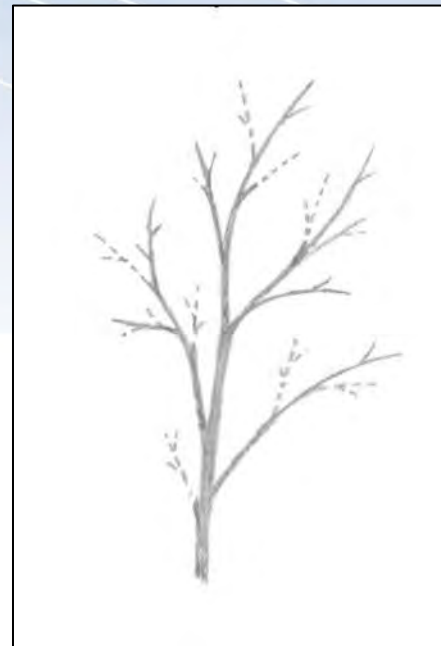
- Urban foresters and arborists prescribe procedures for development and maintenance of the urban forest.
- Risk mitigation of limb or tree failure is most often accomplished through some form of pruning regime
- Typically that involves the removal of branch and leaf matter to reduce wind loading

Background for Project:

- Thinning and reduction pruning are the two most frequently prescribed methods for failure mitigation



Reduction Pruning
(reducing length of parent stem)



Thinning Pruning
(removing interior limbs)

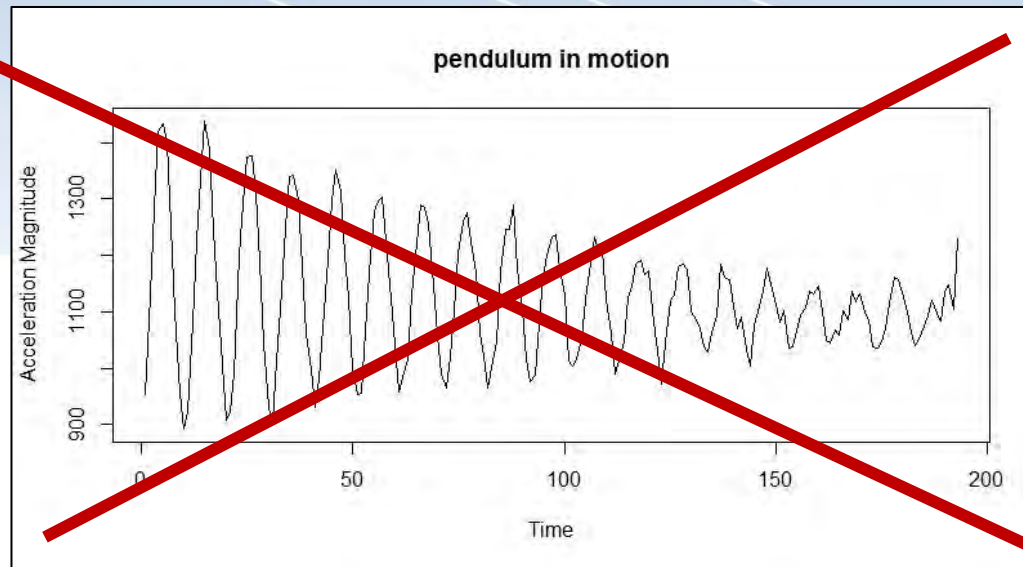


Background for Project:

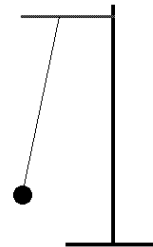
- How do these changes to the structure alter its behaviour and safety?

Theory overview:

- Complex tree crowns do not tend to exhibit single harmonic motion (James 2003, 2006; Moore & Maguire, 2006; Niklas, 1992; Spatz et al 2007)



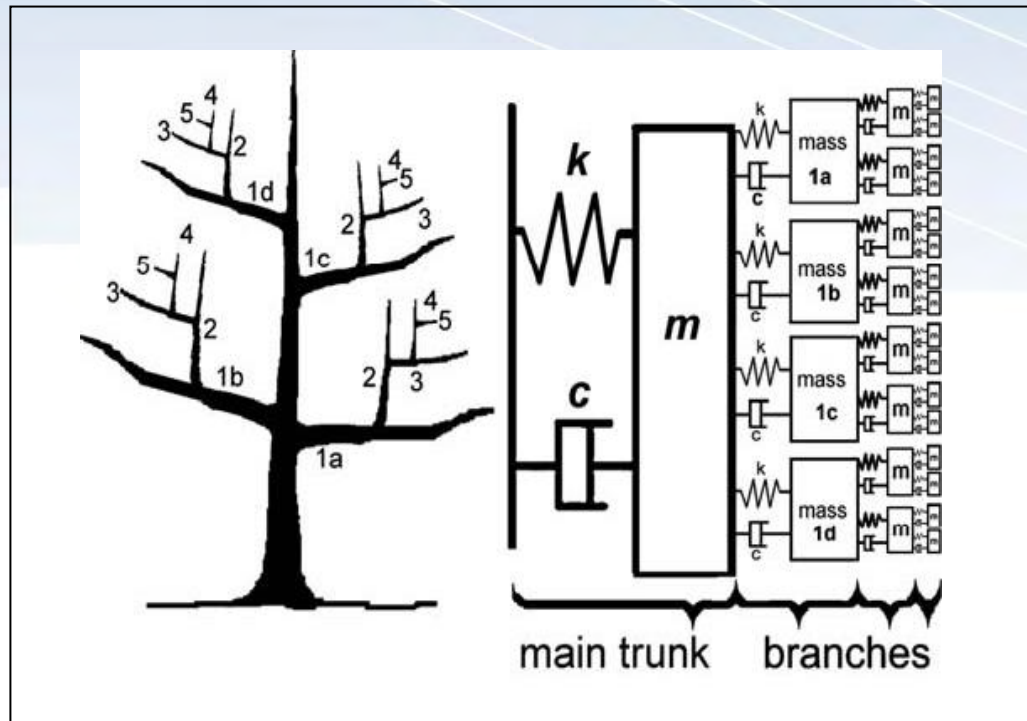
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Theory overview:

- But rather rely on damping systems (mass and aerodynamic) to alter sway properties

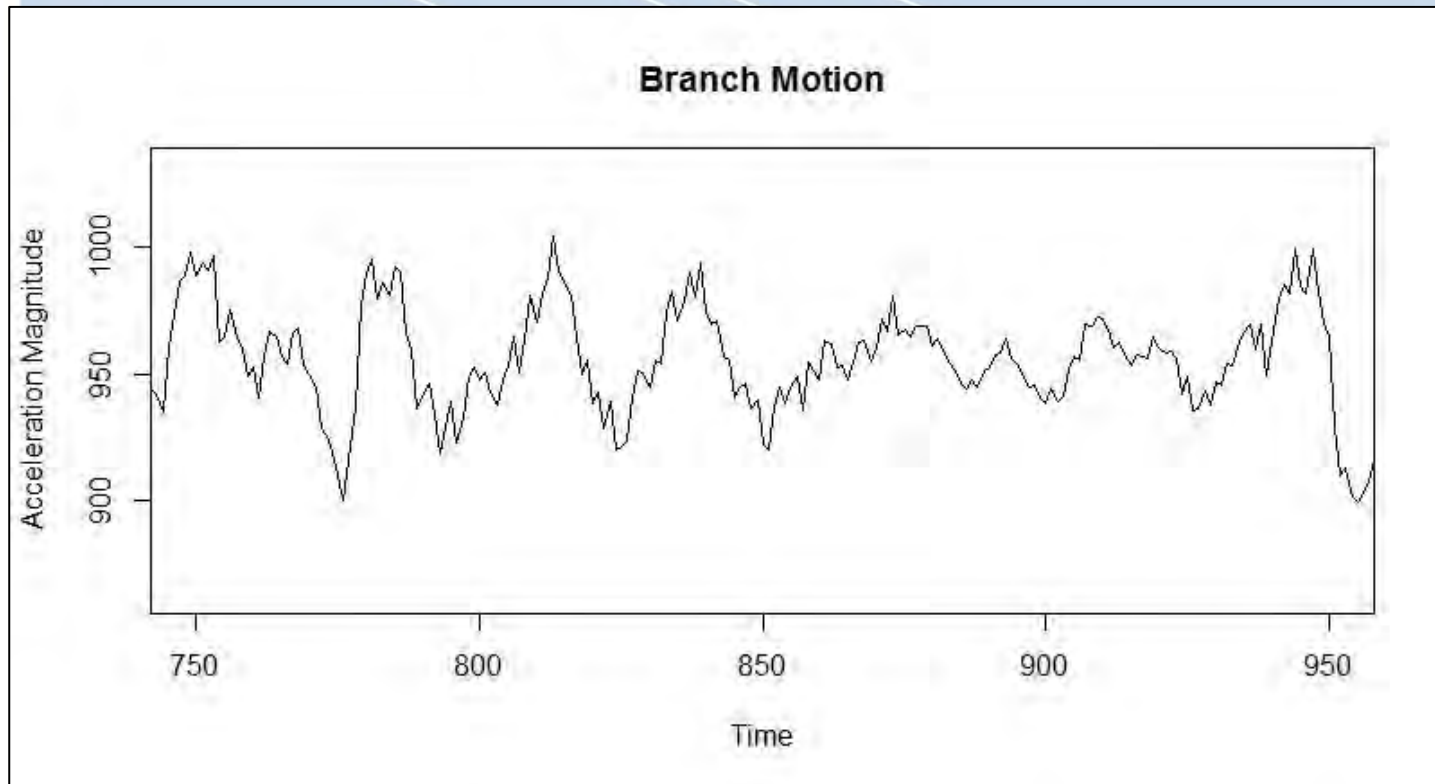


(James 2006)



Theory overview:

- And therefore display more complex sway properties





Theory overview:

- Theoretical models are well developed (James 2003, 2006; Moore & Maguire, 2006; Niklas, 1992; Spatz et al 2007)
- Testing of sway properties from “pull and release tests” (Haritos & James, 2008; Campiformio, 2012)
- Wind experiments and pruning (Smiley & Kane 2006; Gilman, Masters & Grabosky 2008)
- However, limited applied studies of pruning in natural wind conditions
- And, how does thinning compare to reduction pruning with regard to sway properties?????



Project overview:

Hypothesis 1:

Pruning affects branch oscillation frequency and amplitude as well as damping properties.

Hypothesis 2:

Crown thinning increases branch oscillation frequency and reduces damping ratio more than crown reduction.



Project overview:

- In situ experiment using park grown mature silver maple
- 2 pruning strategies: Reduction pruning and Thinning
- 6 trees
- 10 limbs
- 20 data-logging 3 axis accelerometers (2 per limb, sample rate of 12 hz)
- 10 anemometers (one per limb; data captured at 1hz)
- 8 day control period (pre pruning condition)
- Several weeks post pruning period

Project overview:



Anemometer provides linear voltage signal (above)



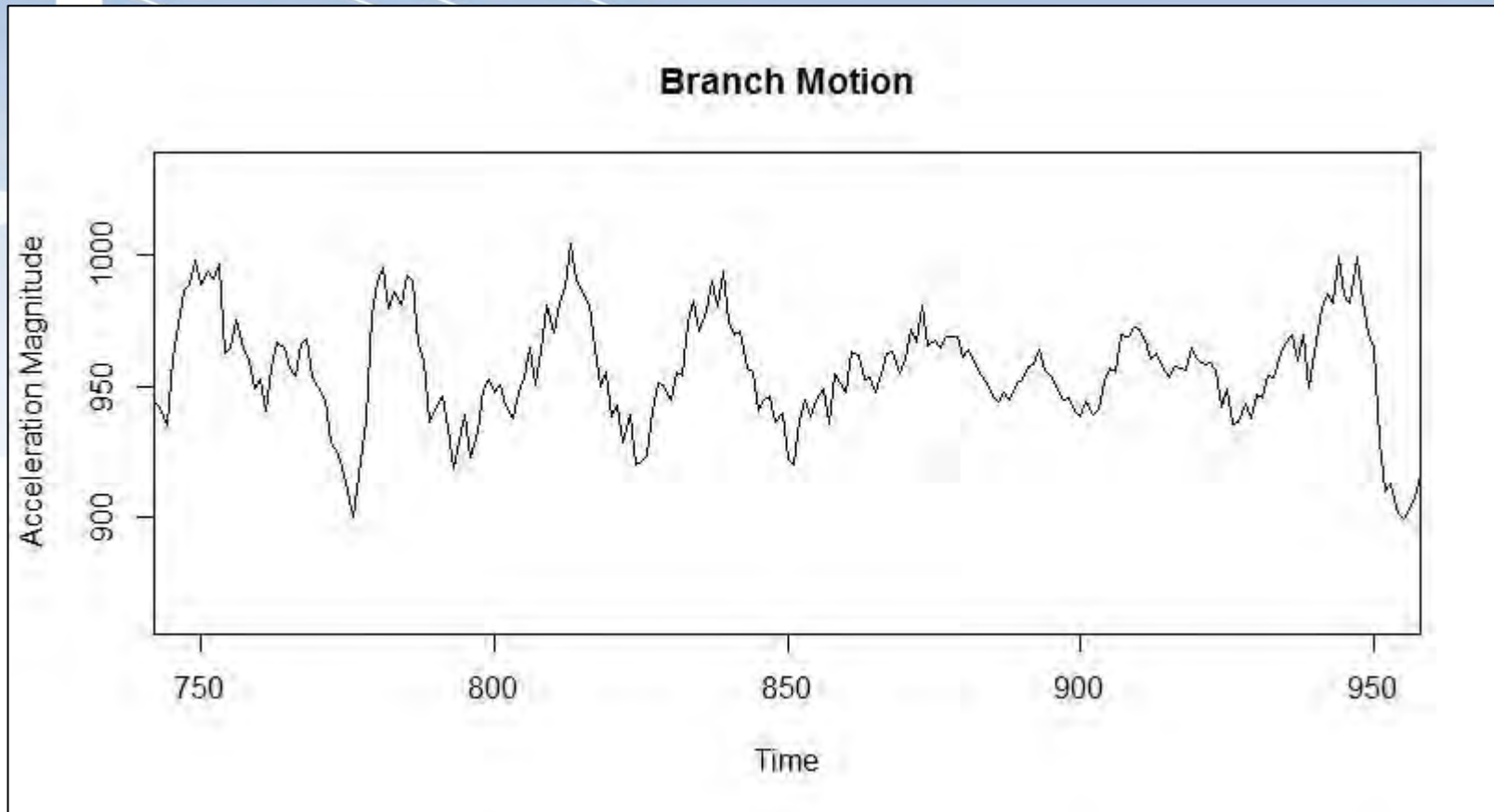
Accelerometer collects motion data (right)

Project overview:

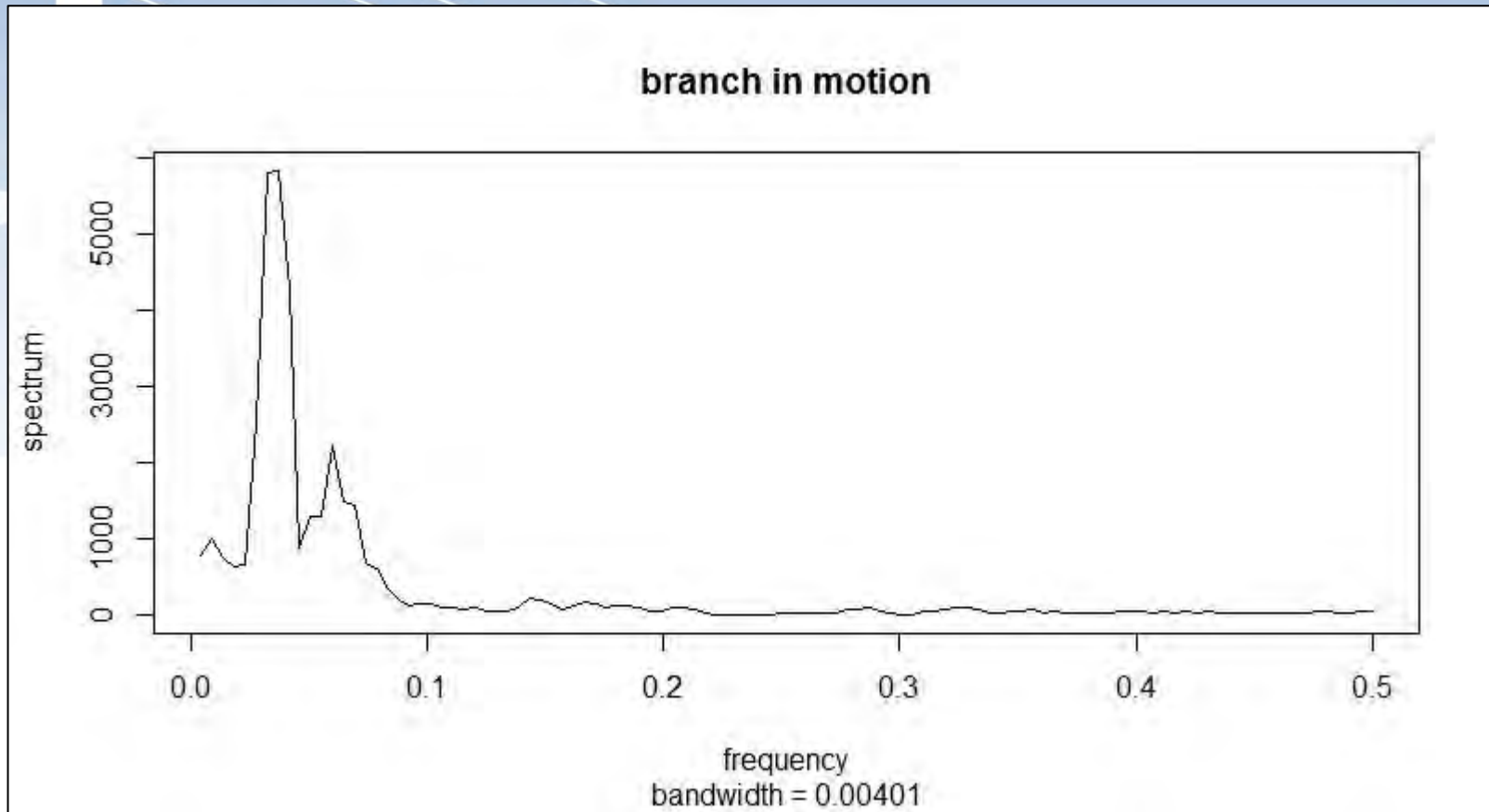


Arborist from Borough of NDG

Results: Data explanation

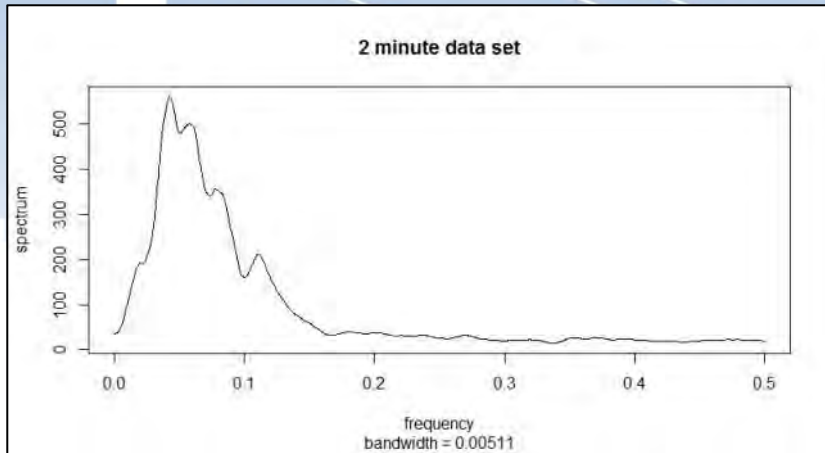


Results: Data explanation

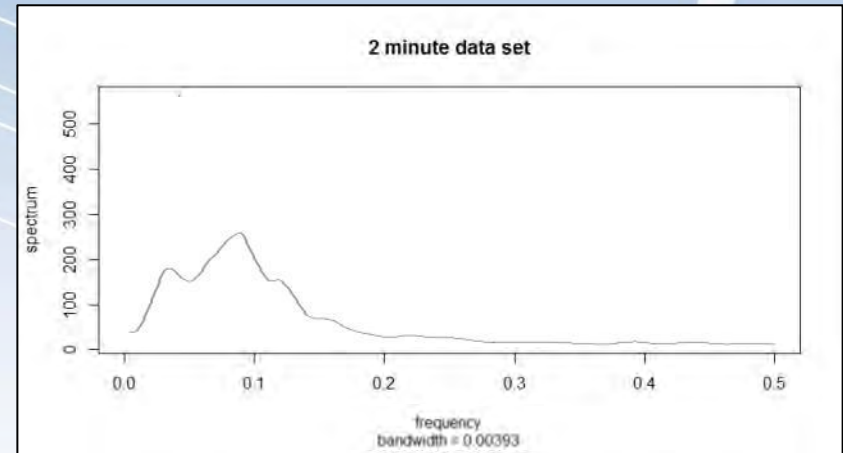


Results:

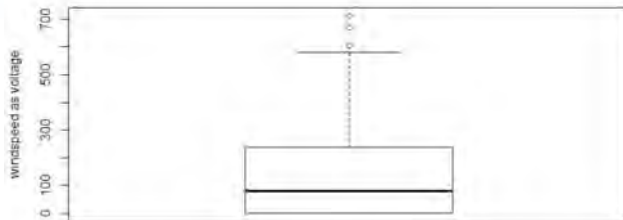
Pre-Thin



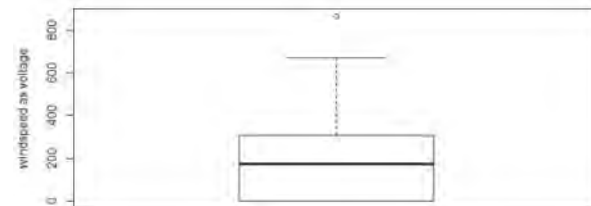
Post-Thin



Windspeed

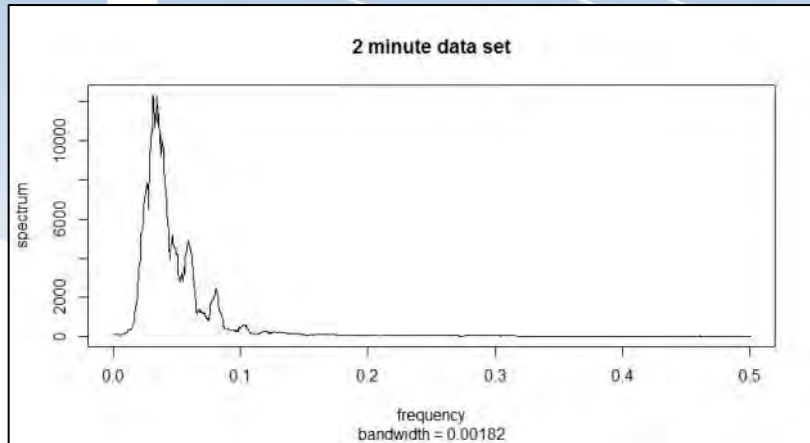


Windspeed

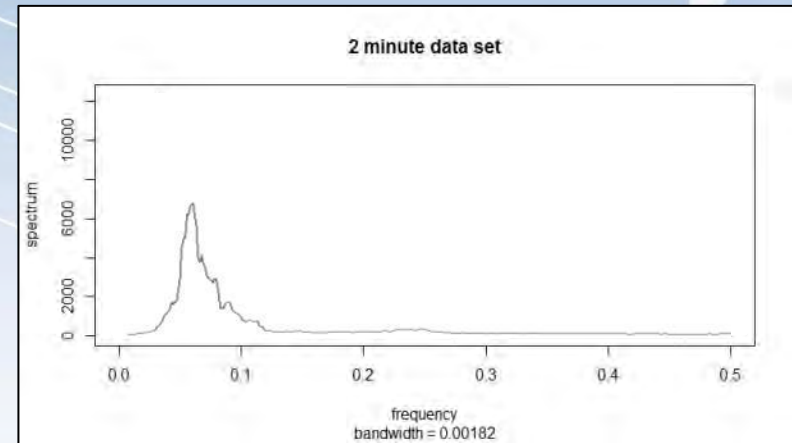


Results:

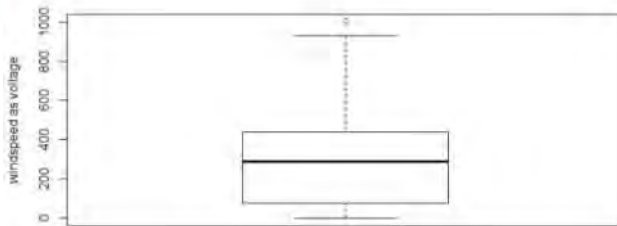
Pre-Reduce



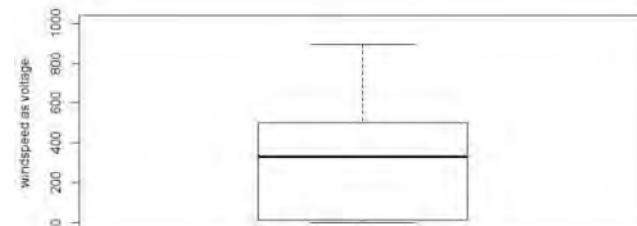
Post-Reduce



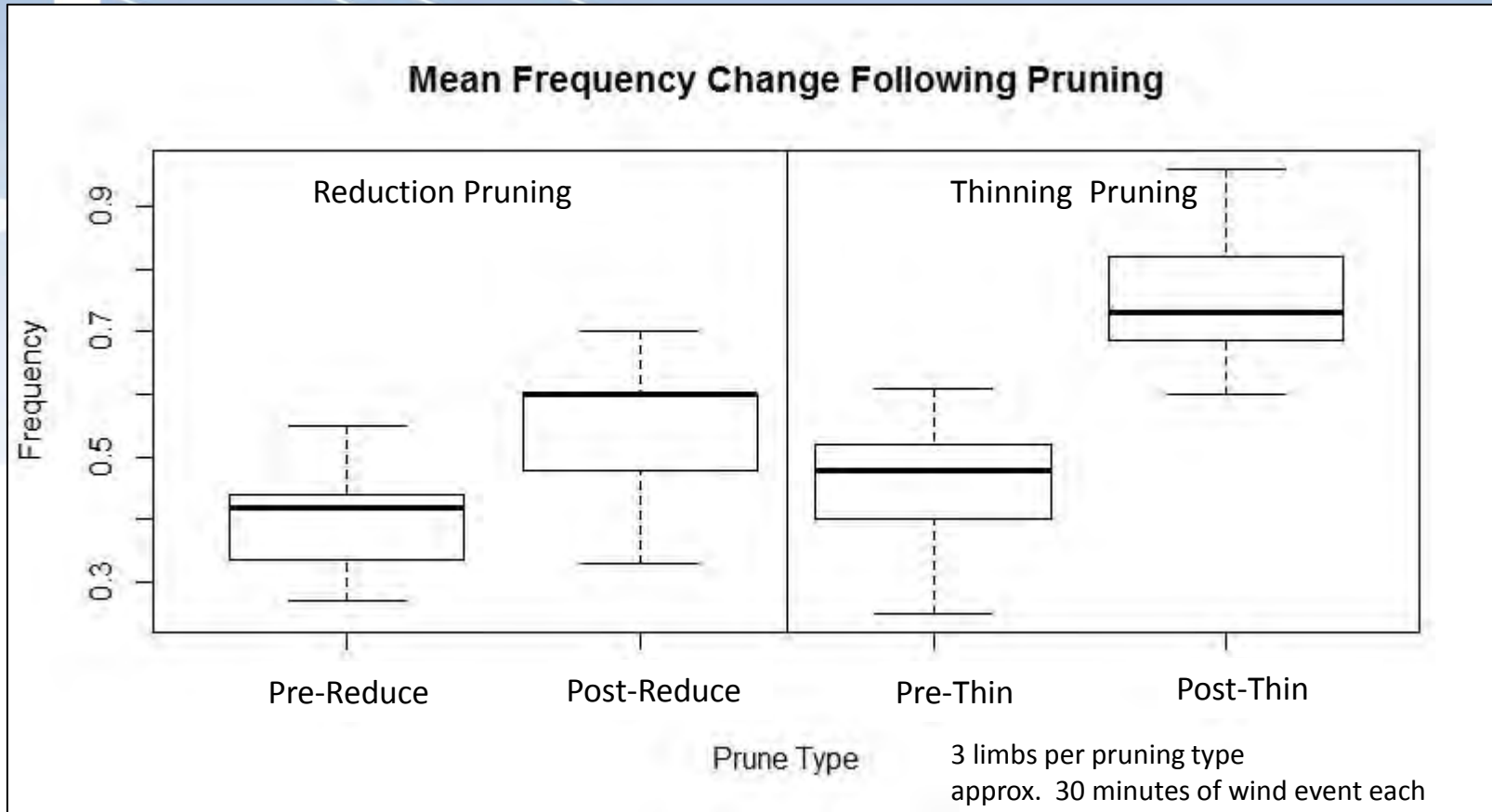
Windspeed



Windspeed



Results:





Conclusions:

Pruning does affect sway properties

Reduction pruning seems have less affect on the damping properties, allowing the tree to return to steady state sooner. This is perhaps a better strategy to reduce limb or tree failure potential

More work to understand wind affect (gusting, and corresponding transfer functions)

More work to examine reduction in applied load (that's the amplitude discussed at the beginning)