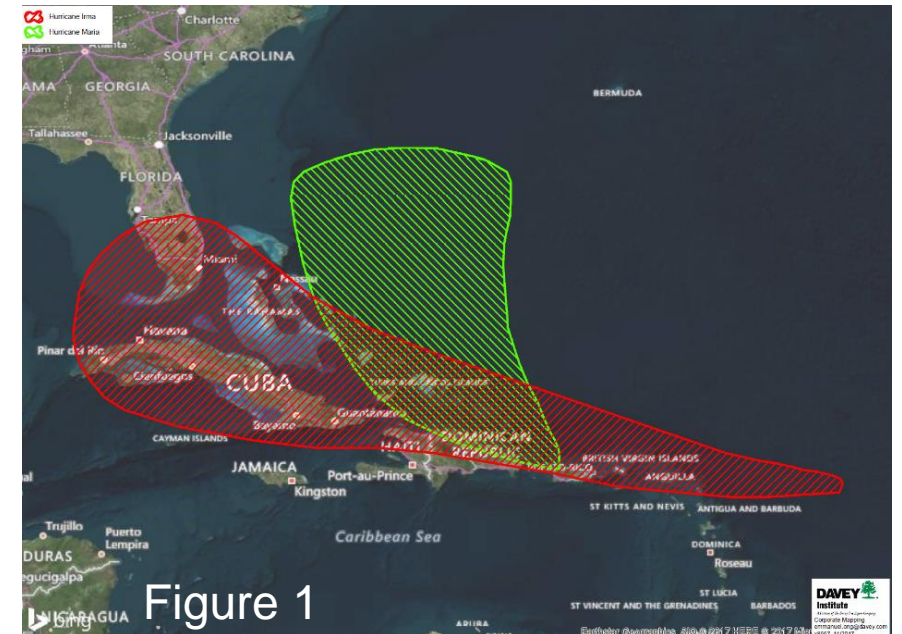


When Trees Fail: Biomechanical Analyses of Tree Failure After Storms in the Caribbean and North America

Anand Persad, PhD; BCE
Manager Arboriculture and
Plant Sciences / Entomologist
The Davey Institute



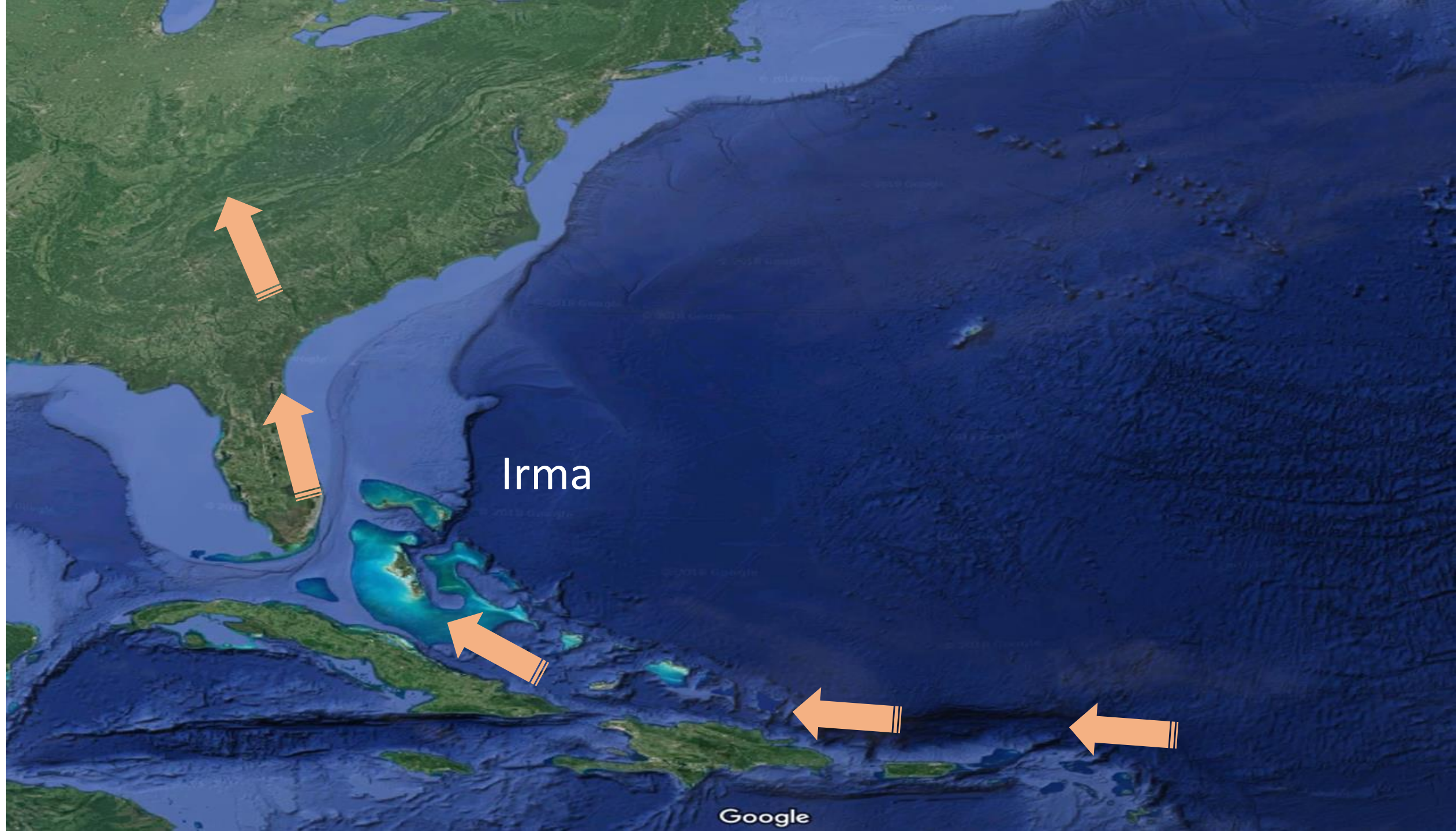
Tropical Storm Effects on Trees

Hurricane paths of Irma (red) and Maria (green) through the Caribbean region in 2017

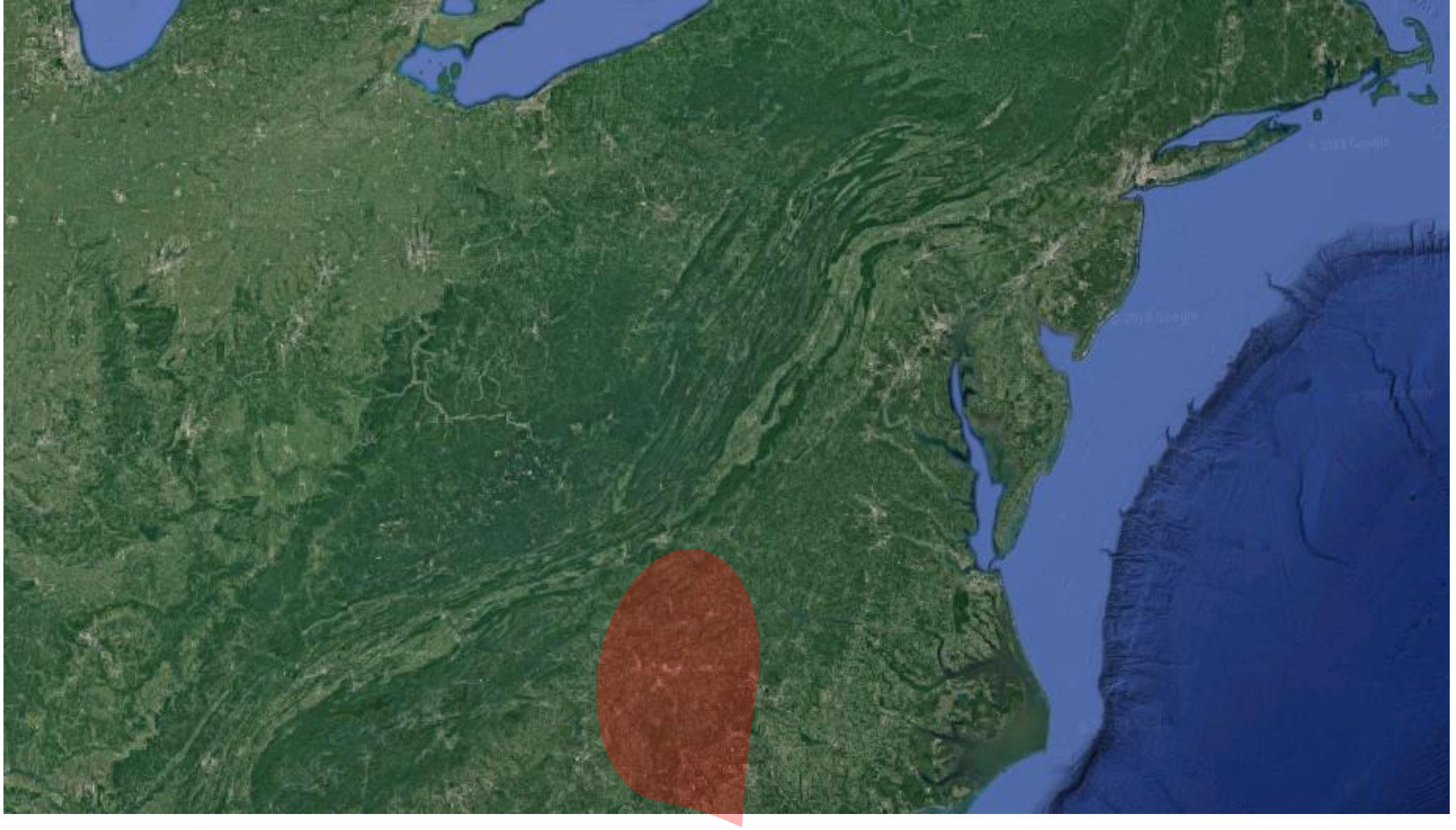
Maria







Irma



Natural Dismantling in Trees

Biomechanics of Natural Loading

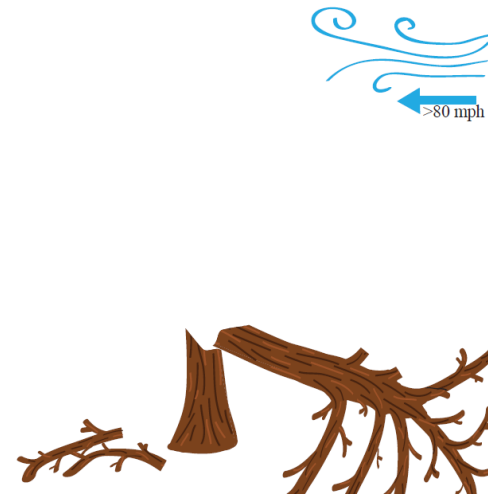
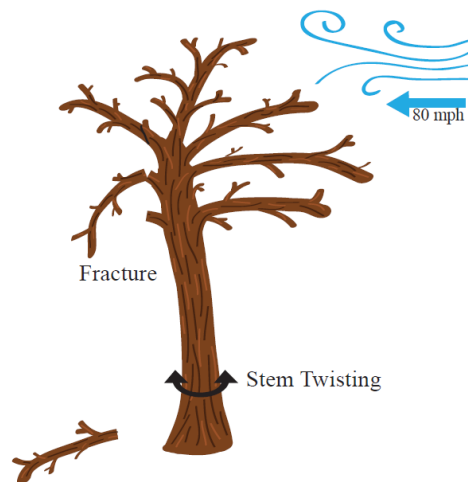
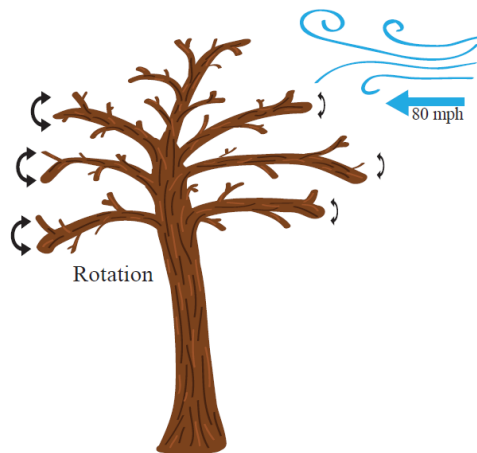
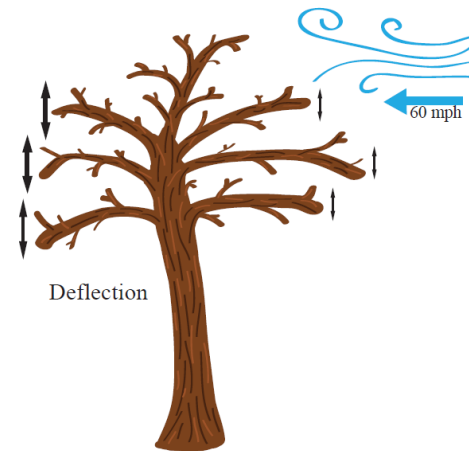
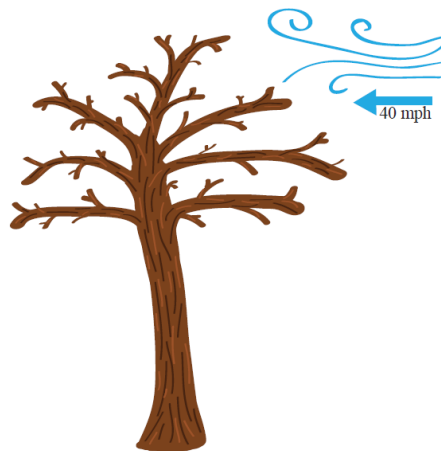
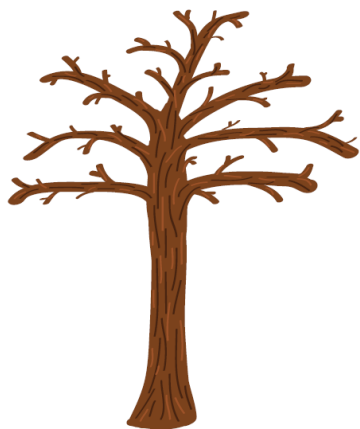
- Wind
- Water
- Snow
- Ice
- Abiotic- causes
- Biotic –causes
- Tree Defects-
- Destabilizing factors





Storm Damage

The Story of Freddy the Tree





Restricted Root Space



Wind Throw



Improper Pruning, Mechanical Damage & Biotic Effects Lead to Defects



Visible Defects: Branch Cracks, Wounds

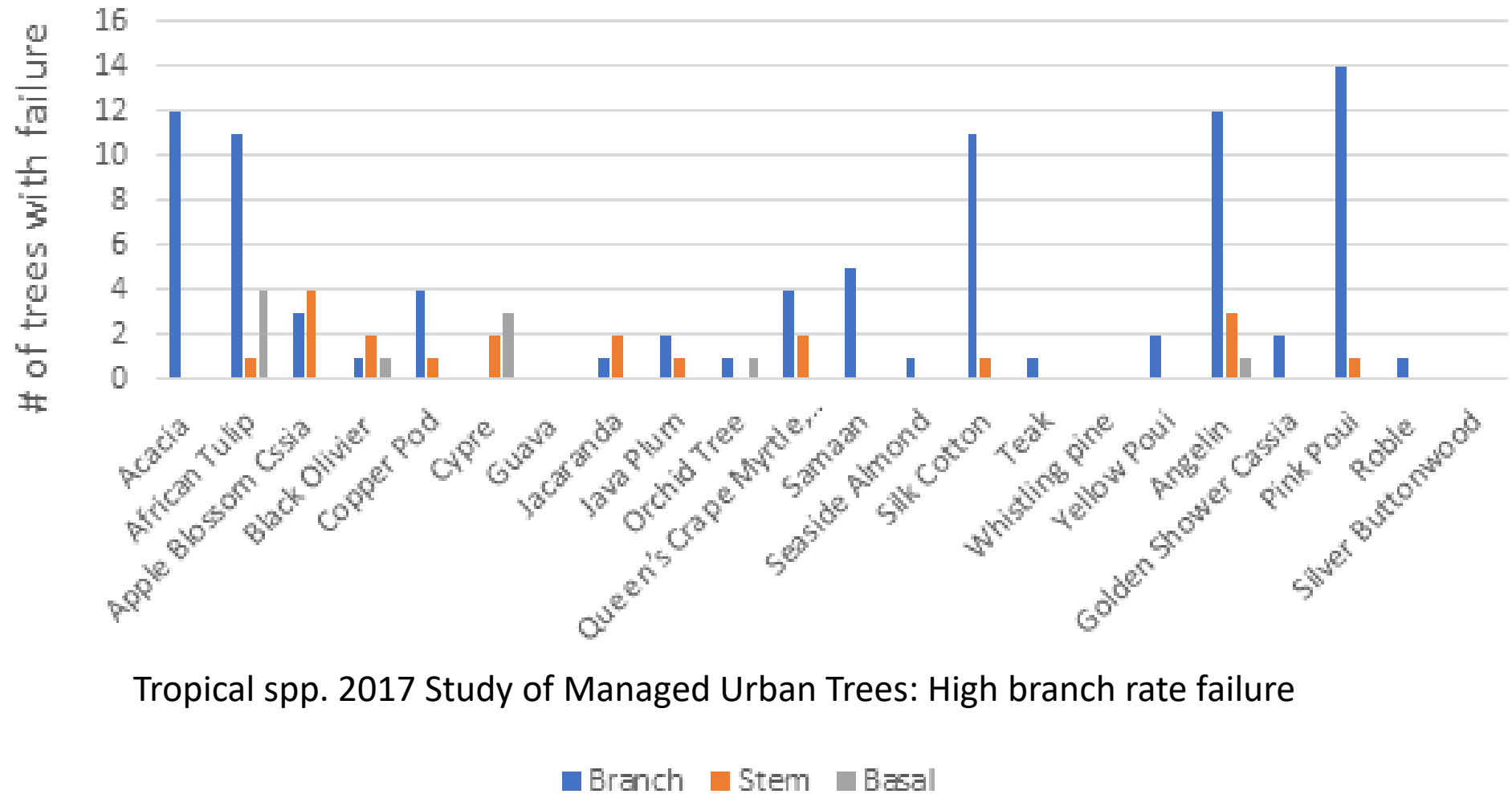
Water &
wind and no
visual
defects





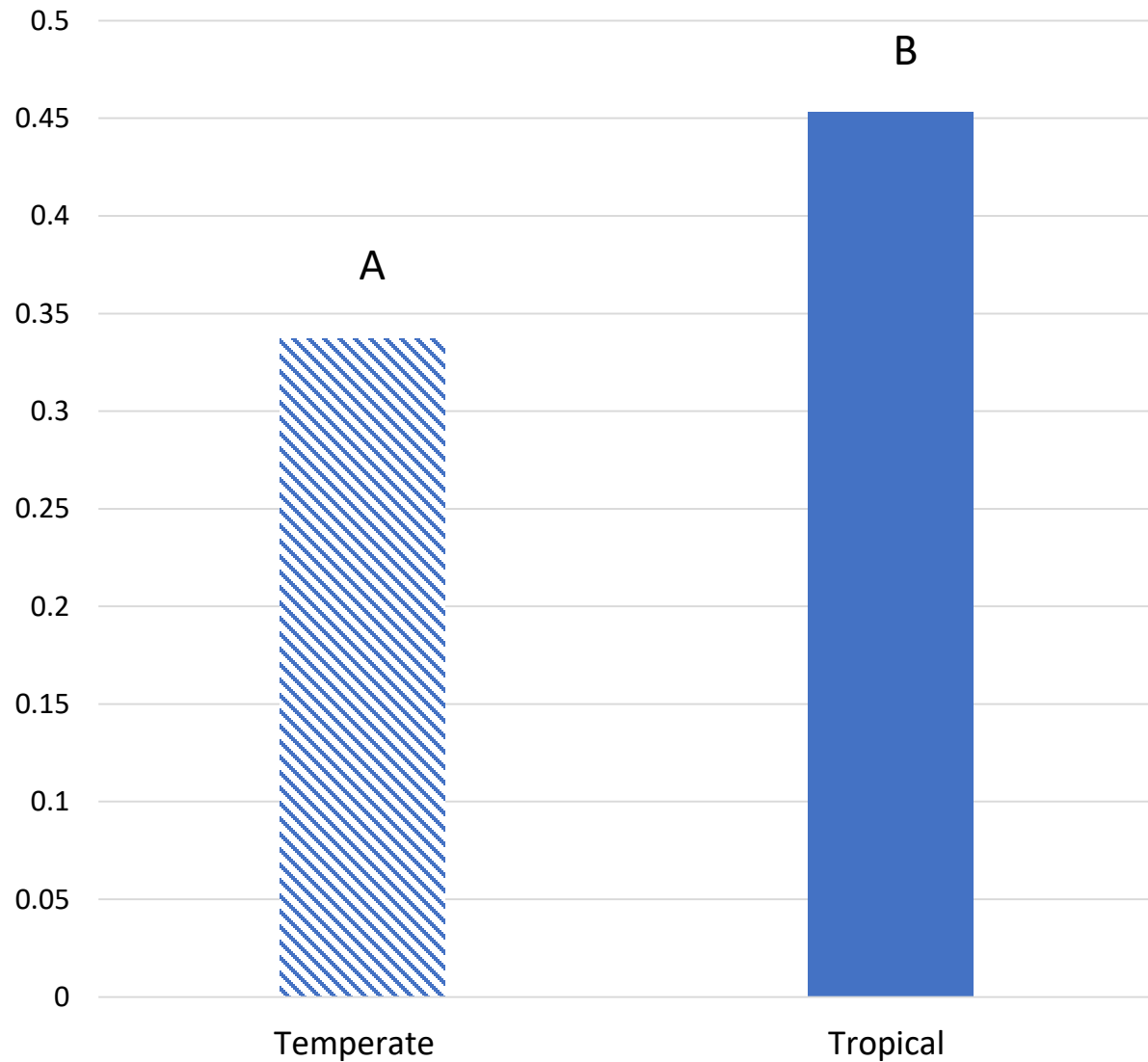
Risk Assessments and Does Management
Lead to Stability?

Point of Failure in 22 spp. of Trees Surveyed After Irma & Maria



Tropical spp. 2017 Study of Managed Urban Trees: High branch rate failure

Aspect Ratio and Origin: Failure in Temperate and Tropical Trees

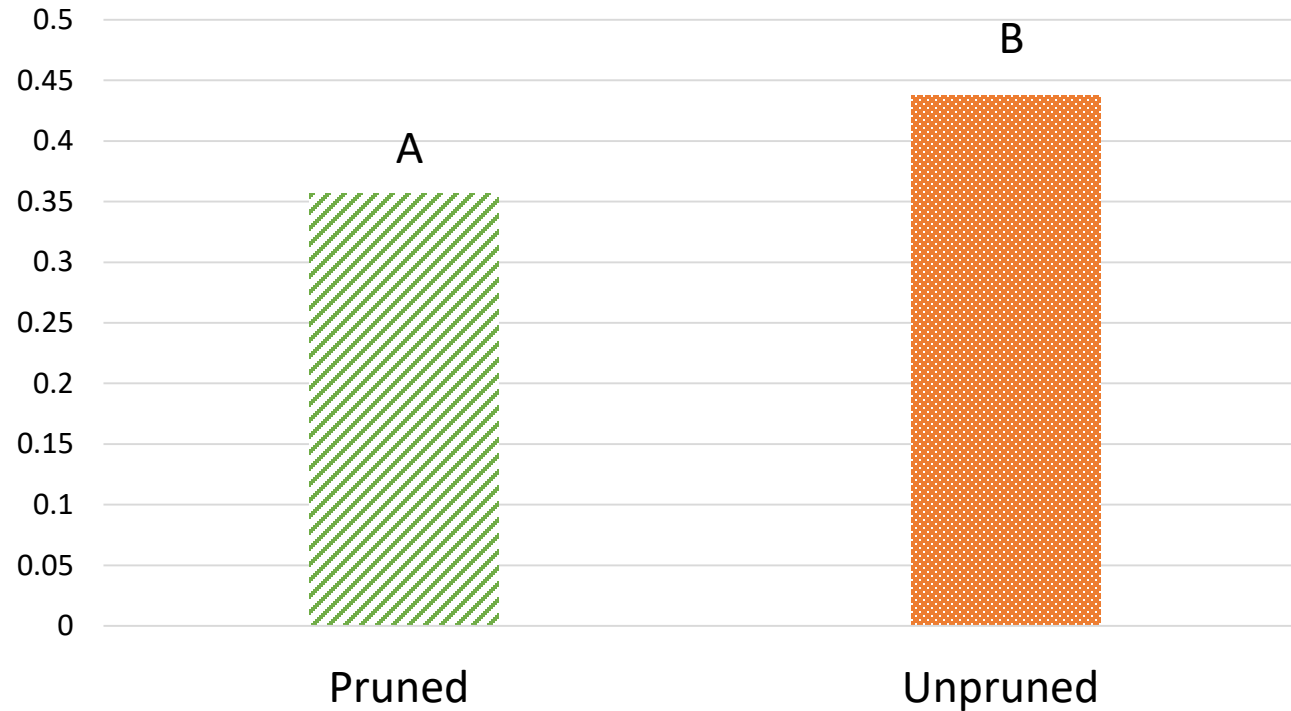


P- 0.036, F- 3.890, EDF- 193, SAS System, Scheffe's Test for ratio

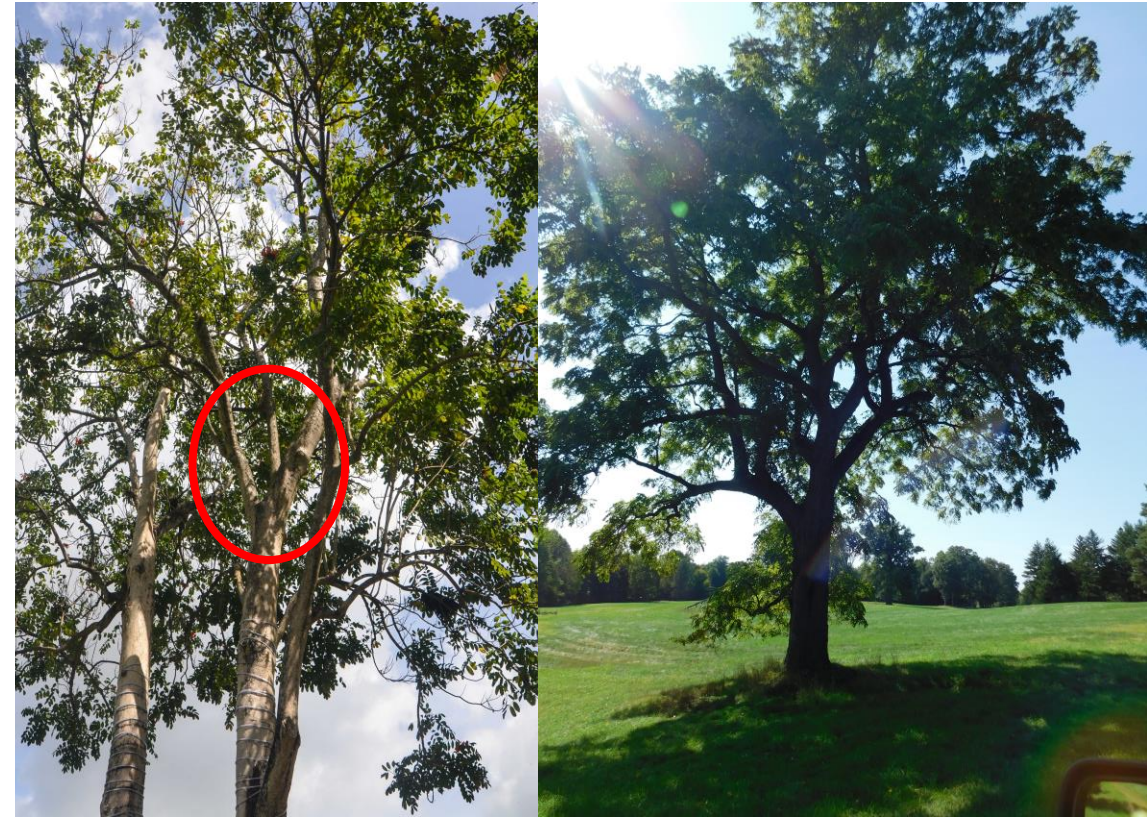


Brazil nut (*Bertholletia excelsa*)

Pruned and Unpruned Tropical and Temperate Trees



P- 0.053, F- 3.890, EDF- 193, SAS System, Scheffe's Test for ratio



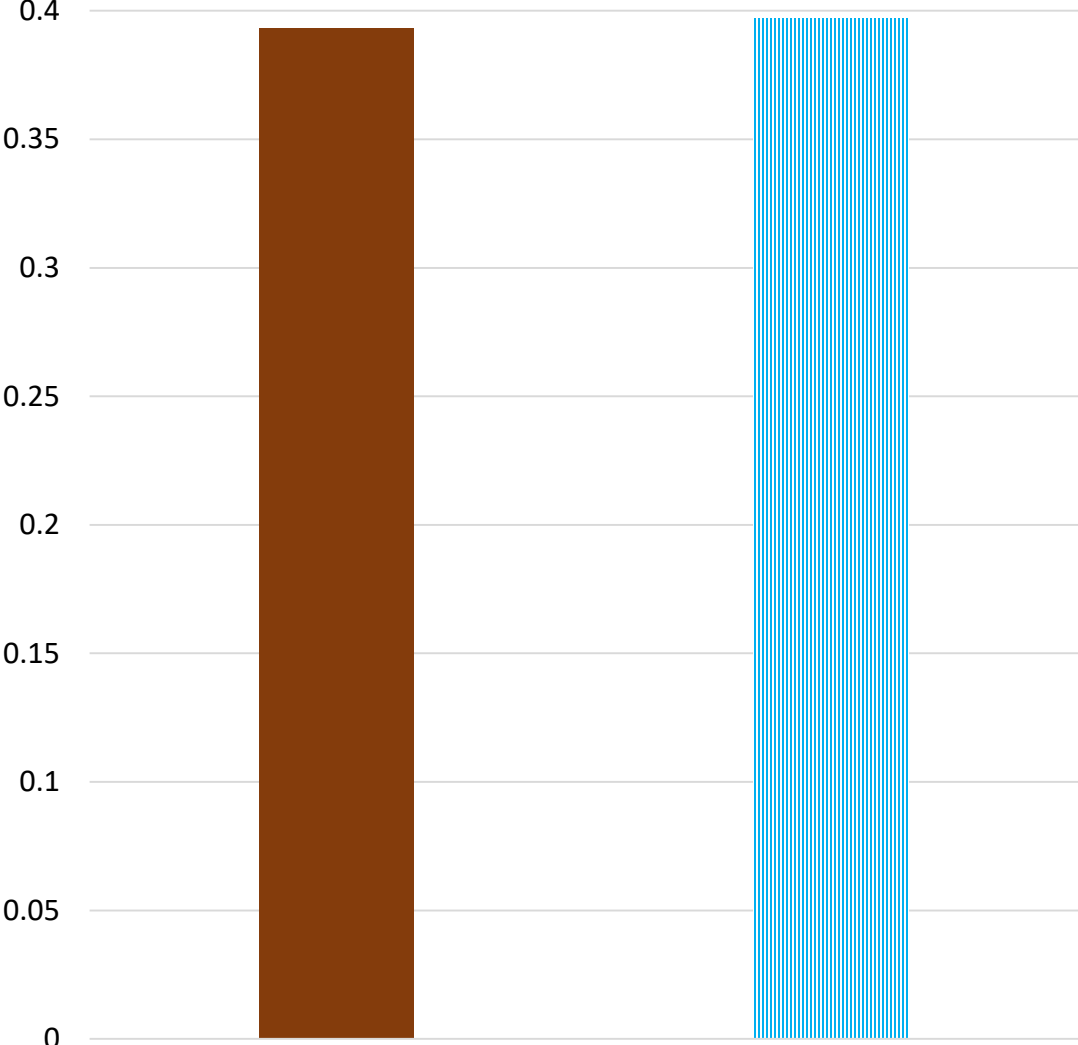
Unpruned African tulip tree (*Spathodea campanulata*)

Aspect ratio is better managed in trees pruned for structure compared to unpruned trees in trees that failed at both origins. In unpruned trees aspect ratio is more of an issue (higher aspect ratio) that is not desirable in urban spaces.

Defects of Tropical and Temperate Trees

A

A



Defects

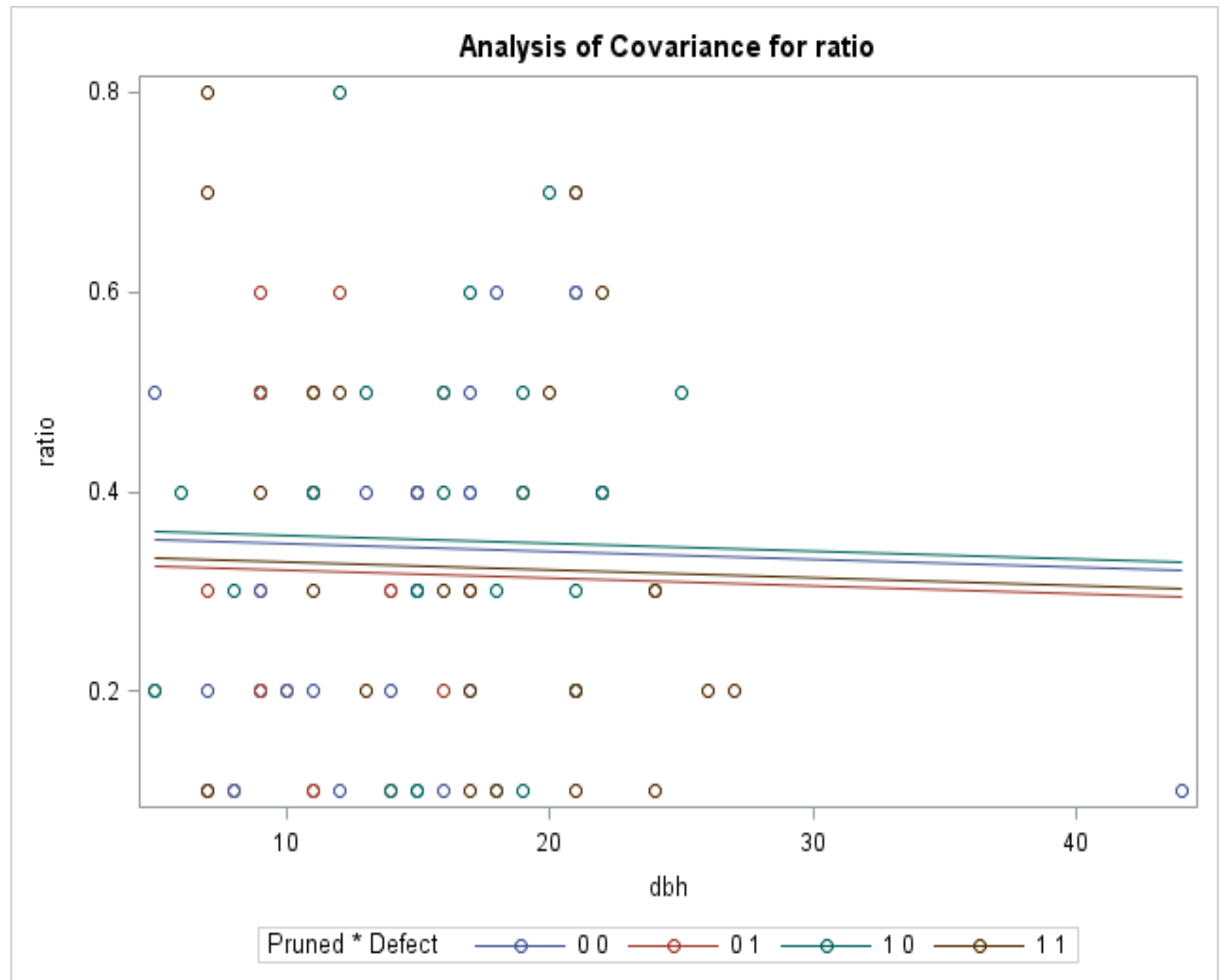
No Defects

P- 0.053, F- 3.890, EDF- 193, SAS System, Scheffe's Test for ratio

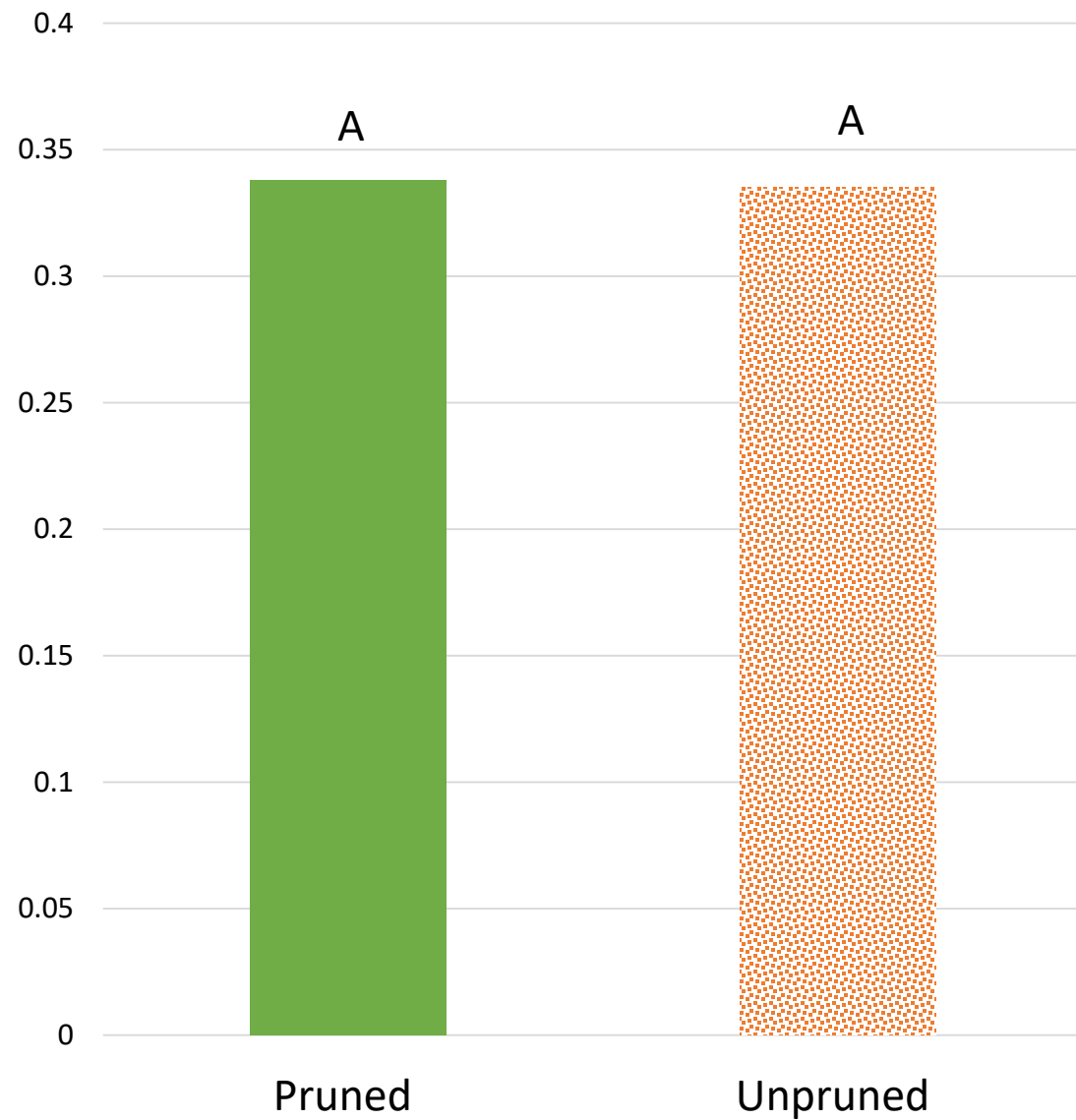


Norway maple (*Acer platanoides*)

Branch Failure in Temperate Trees

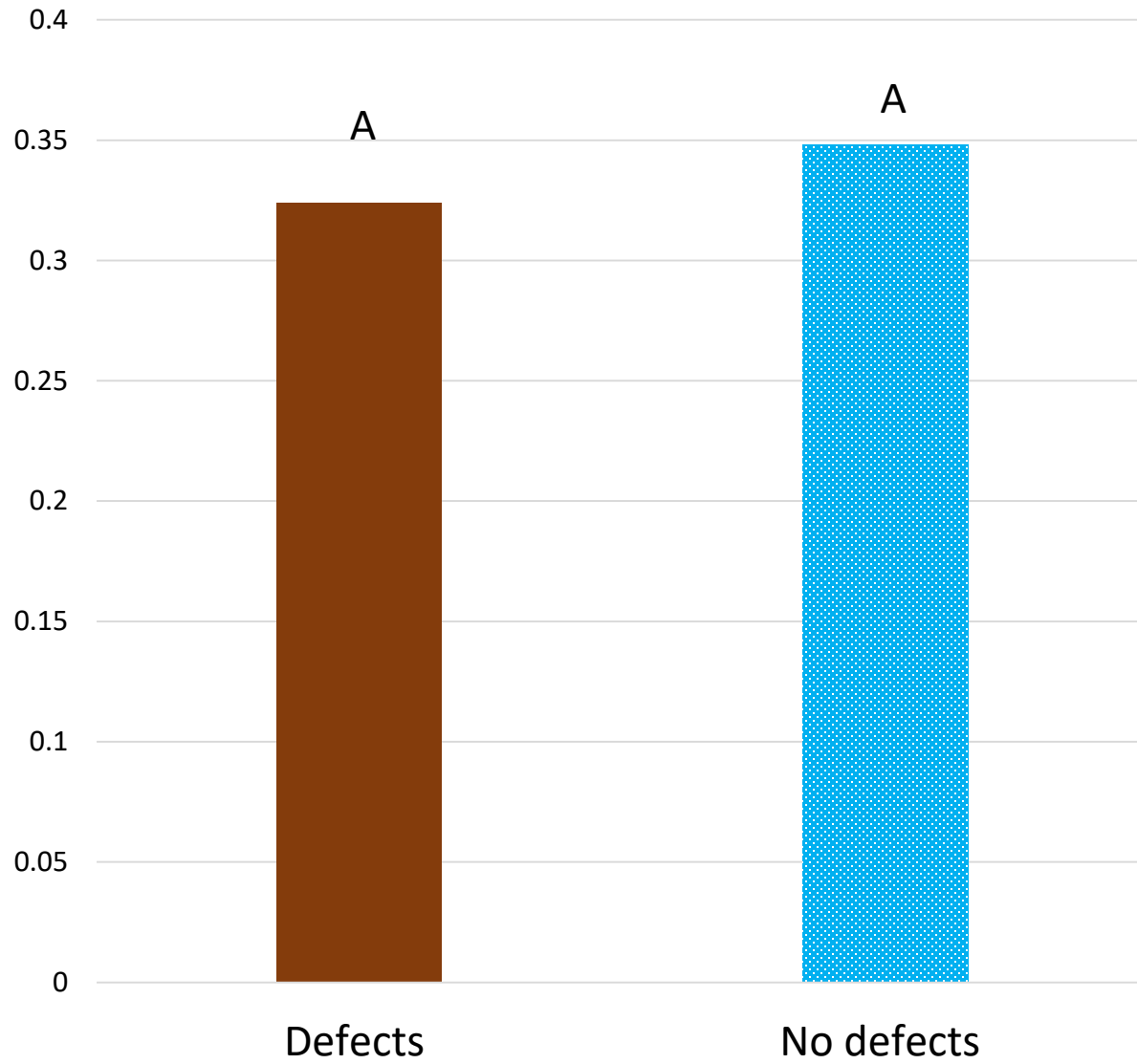


Failure and Pruning Temperate Trees



Acer species

Failure and Defects in Temperate Trees

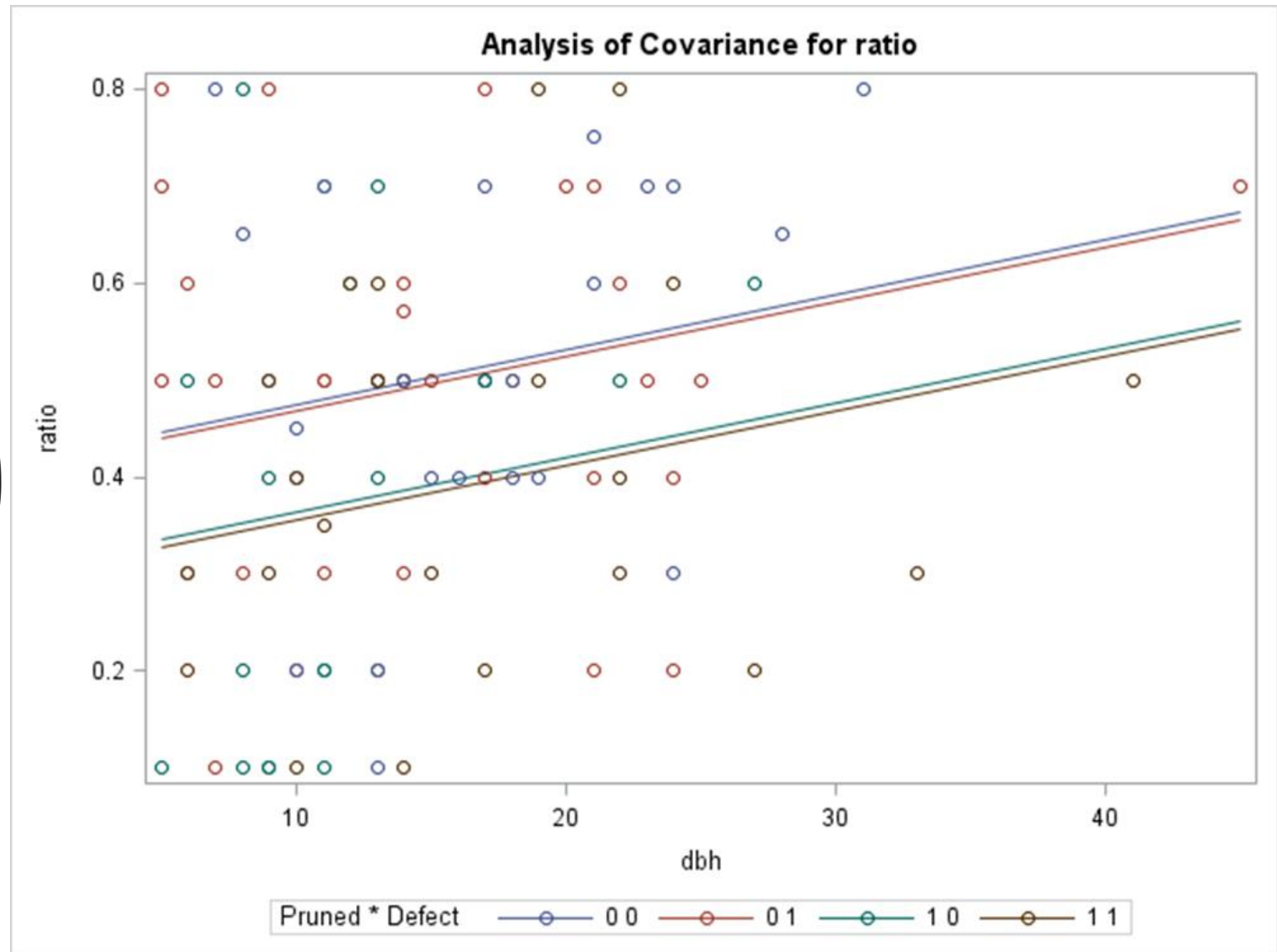


P- 0.074, F- 3.940, EDF- 96, SAS System, Scheffe's Test for ratio

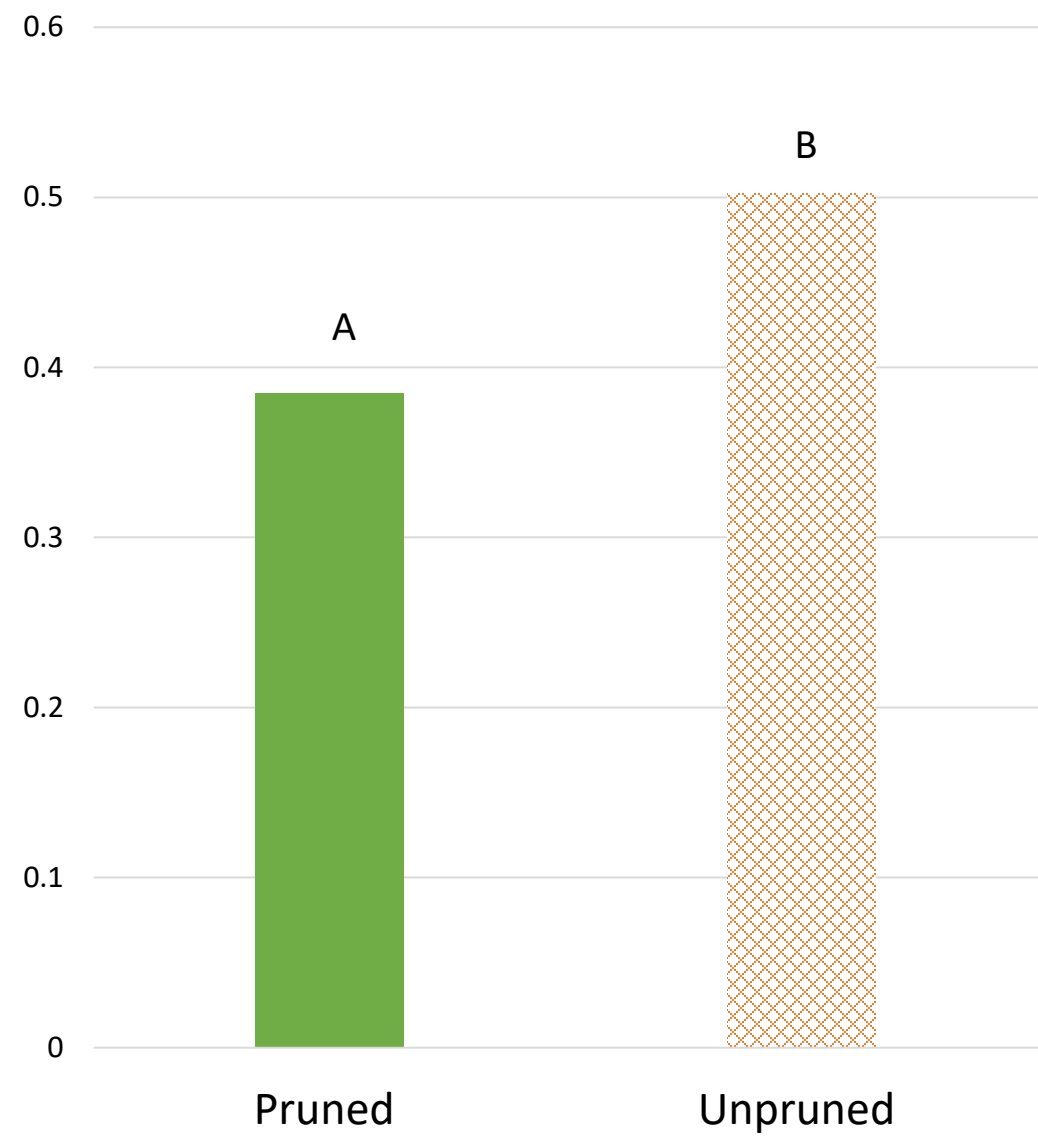


Acer species

Branch Failure in Tropical Trees



Branch Failure and Pruning in Tropical Trees

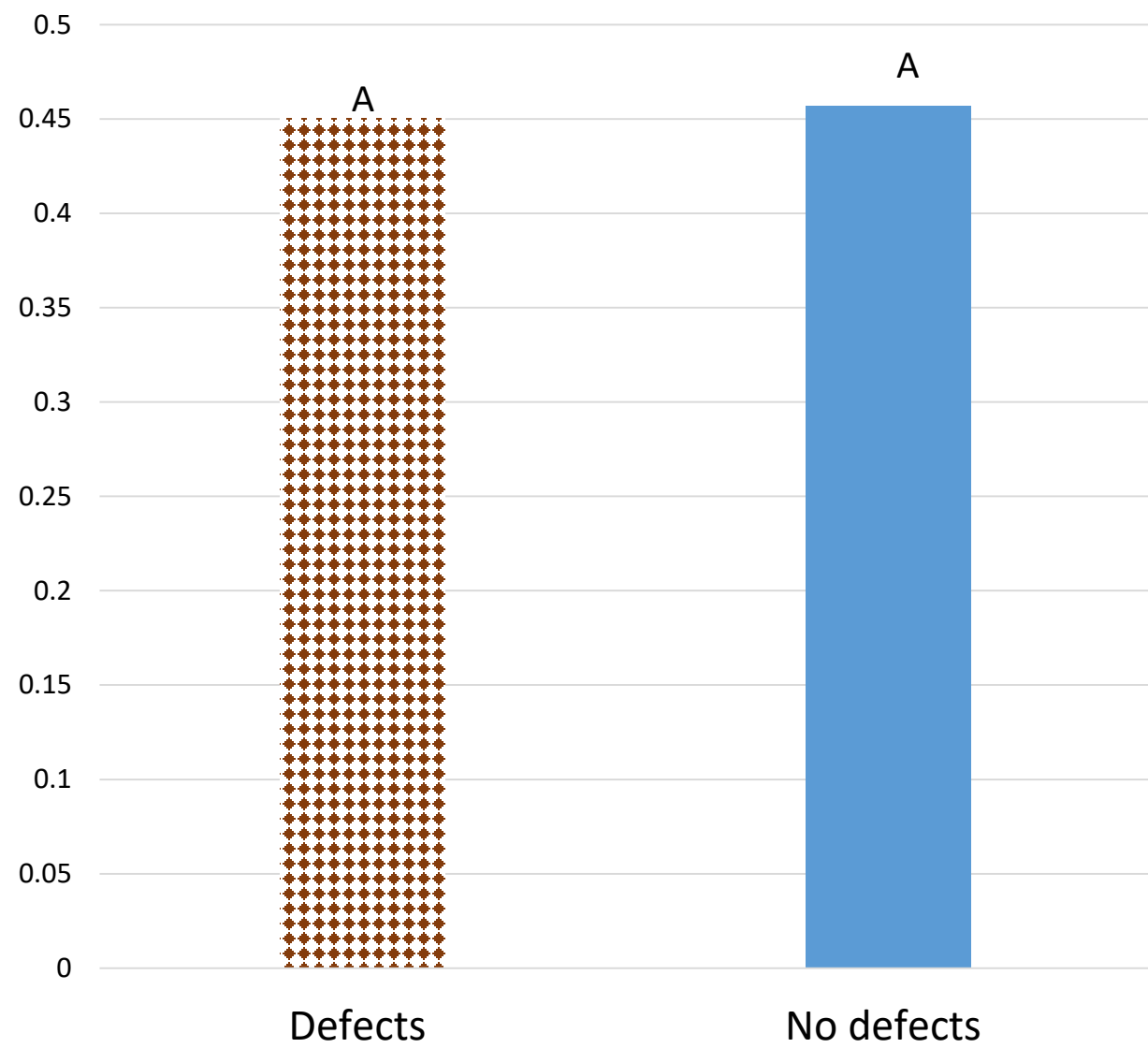


P- 0.078, F- 3.940, EDF- 96, SAS System, Scheffe’s Test for ratio



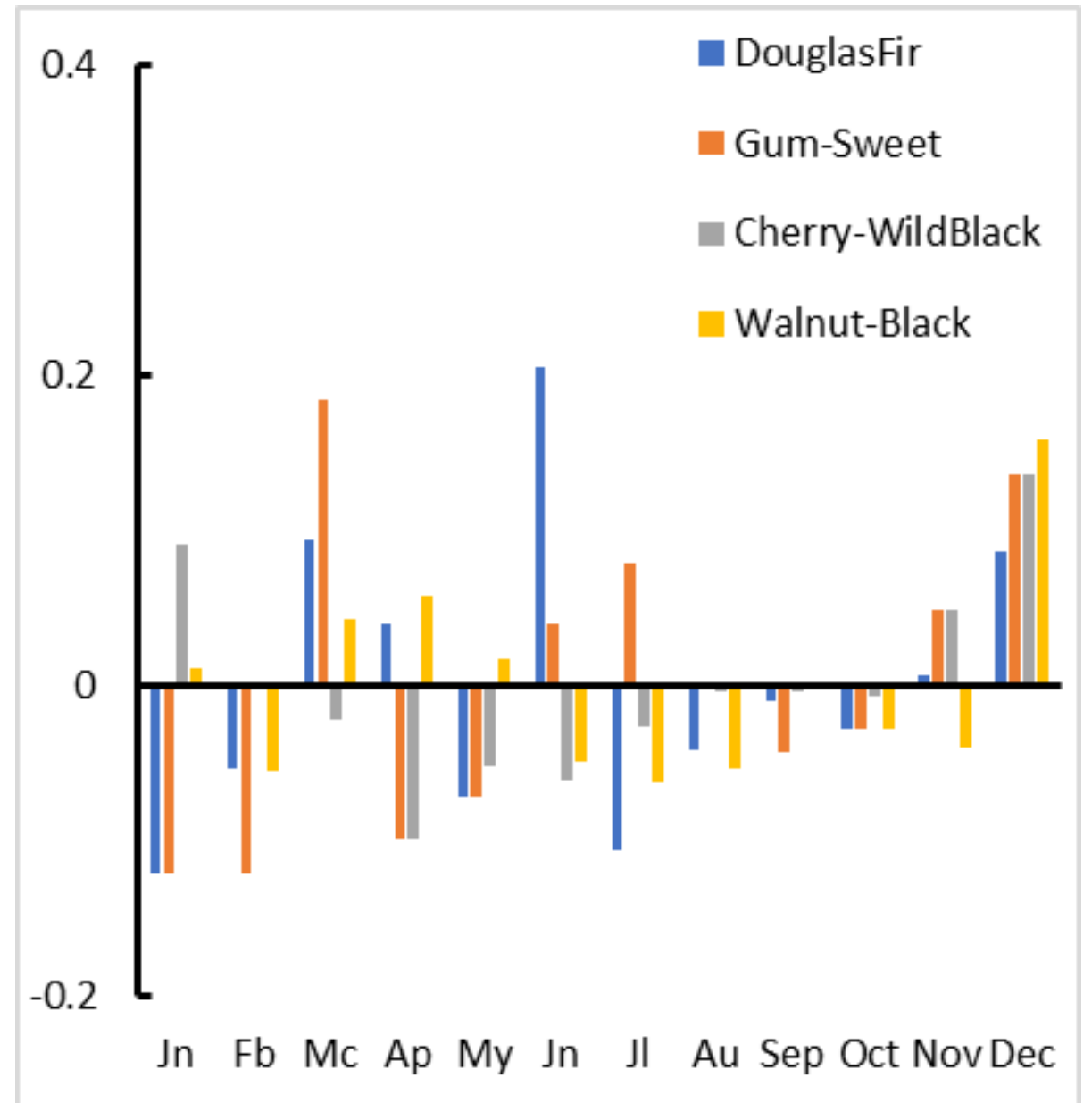
Brazil nut (*Bertholletia excelsa*)

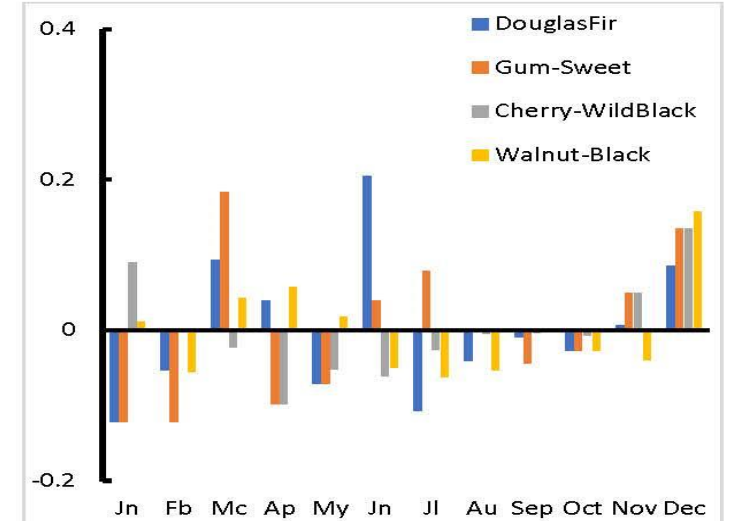
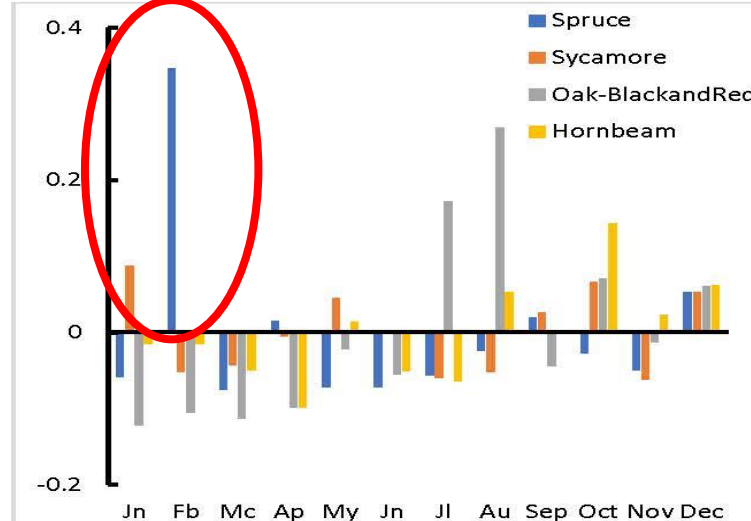
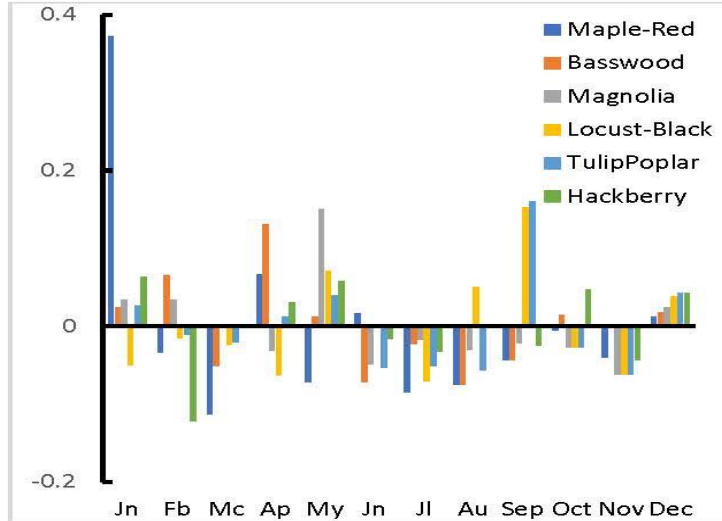
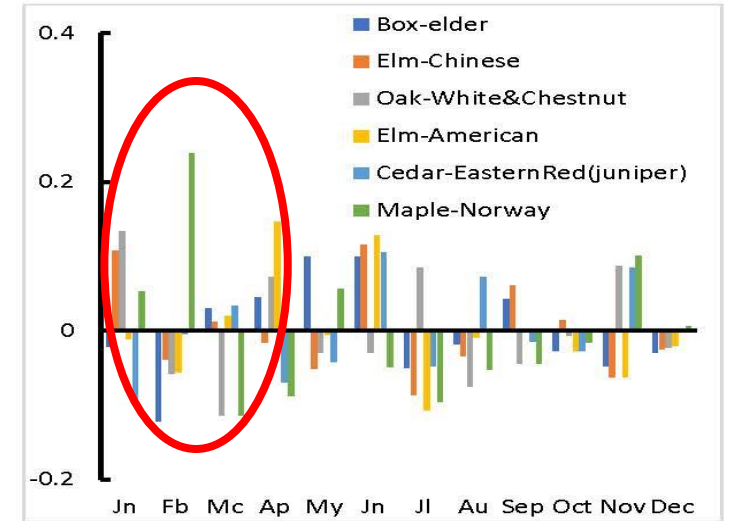
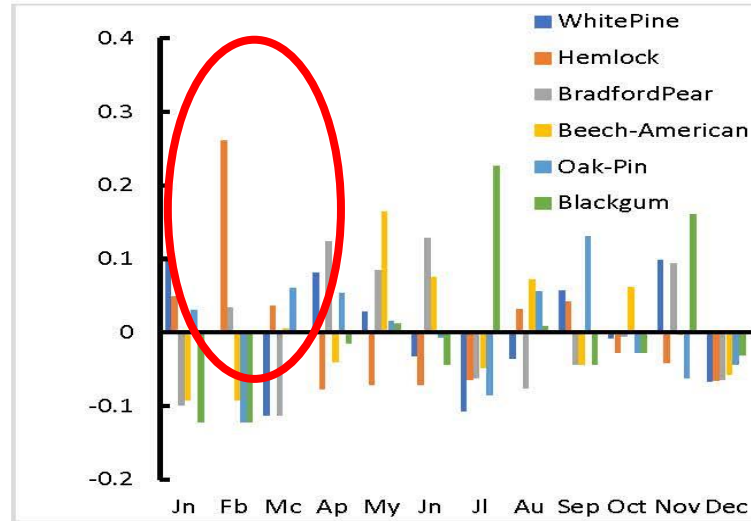
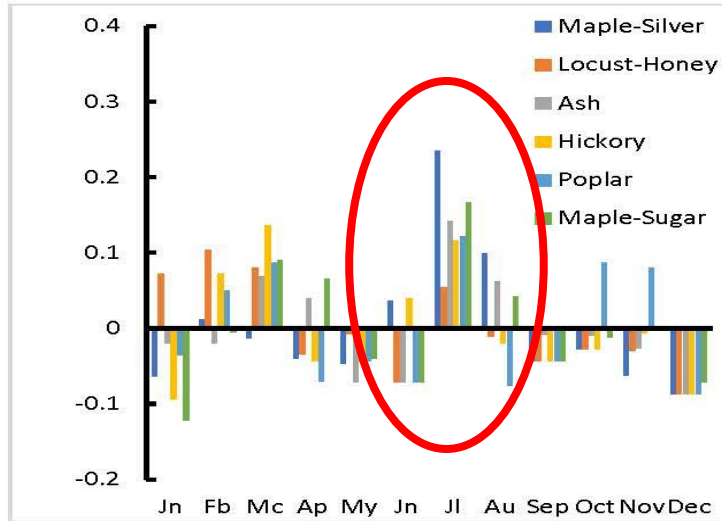
Tropical Tree Defects



P- 0.078, F- 3.940, EDF- 96, SAS System, Scheffe's Test for ratio







Trees in Temperate Regions: Species Specific Failure by Month



Summary of tree and branch failure

- Trees of tropical origin had high branch failure rates after wind loading
- Trees of tropical origin exhibited higher **AR's**- may benefit significantly from pruning management and influencing aspect ratios early in establishment.
- Trees pruned for structure at either origin benefitted from pruning and did not fail as often as unpruned trees.
- *Visible defects* were not a factor in tree failure at either origin.
- High failure in temperate tree *spp.* may be aligned with weather patterns (warmer and drier) and calendar month and worthy of further study.

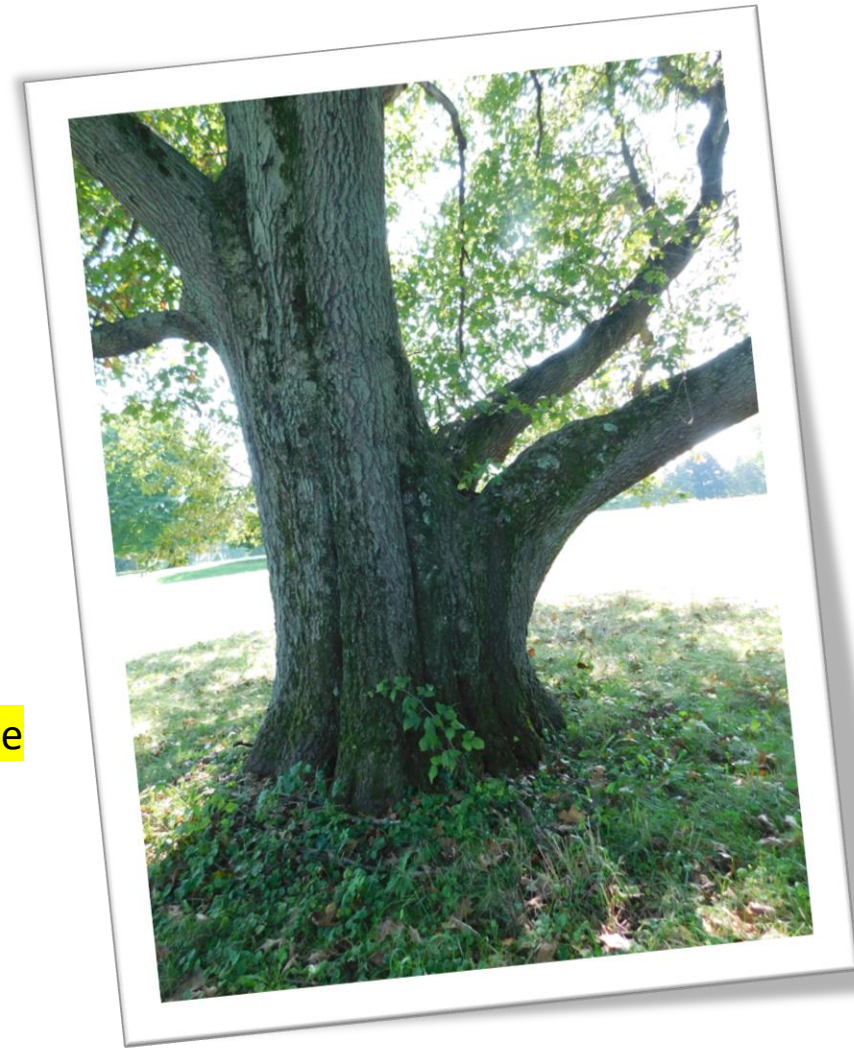
Biomechanical Stability of Common Tropical and Temperate Tree Species

Tropical

- Angelin
- Ficus benjamina
- Spathodea campanulata
- Caesalpinia ferrea
- Terminalia catappa
- Calophyllum calaba
- Albizia procera
- Swietenia mahogany x macrophylla
- Pterocarpus indicus
- Delonix regia
- Lagerstroemia speciosa
- Bucida buceras
- Mangifera indica

Temperate

- Birch
- Basswood
- Black cherry
- Black locust
- Elm
- Hackberry
- Silver maple
- Magnolia
- Eastern white pine
- Maple red, sugar
- Red oak
- Arborvitae
- Ginkgo
- Linden
- White oaks



Changing Weather Patterns: Expand on *spp.* with > Biomechanical Stability in Temperate Regions

A satellite map of the Caribbean Sea and surrounding landmasses, including North America, Central America, and the Caribbean islands. The water is dark blue, and the land is green. The text "Questions ?" is overlaid in white.

Questions ?

Anand.Persad@Davey.com