Torrey Pine Health Assessments – Initial Results and Adaptations

Katie Heineman, Ph.D.
Program Officer – IUCN Center for Species Survival, Biobanking

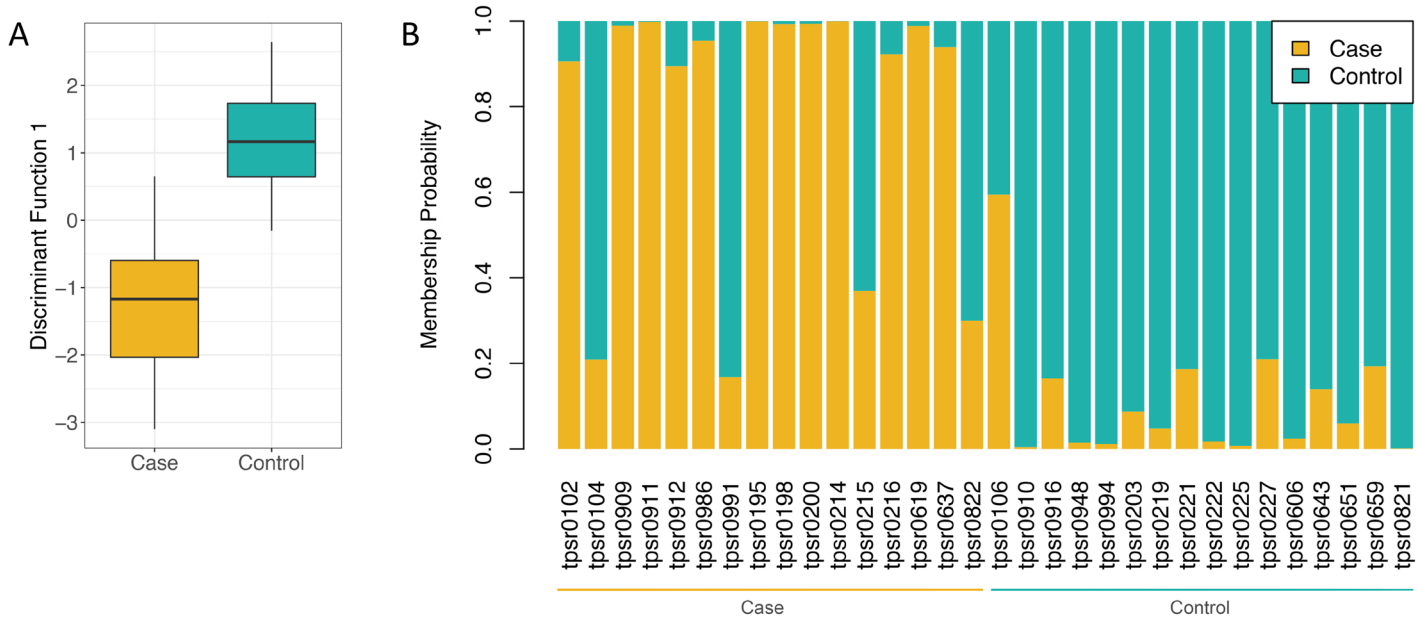
Christa Horn
Senior Conservation Program Manager
San Diego Zoo Wildlife Alliance

PROJECT BACKGROUND:
Beetle-driven mortality

- 2006 census informed 2011 research paper (Franklin and de Santos), with minimal concern for the tree…. But…
- Years of drought… *Ips paraconfusus* (California five-spined engraver beetle)
- Over 17% of canopy lost since 2010

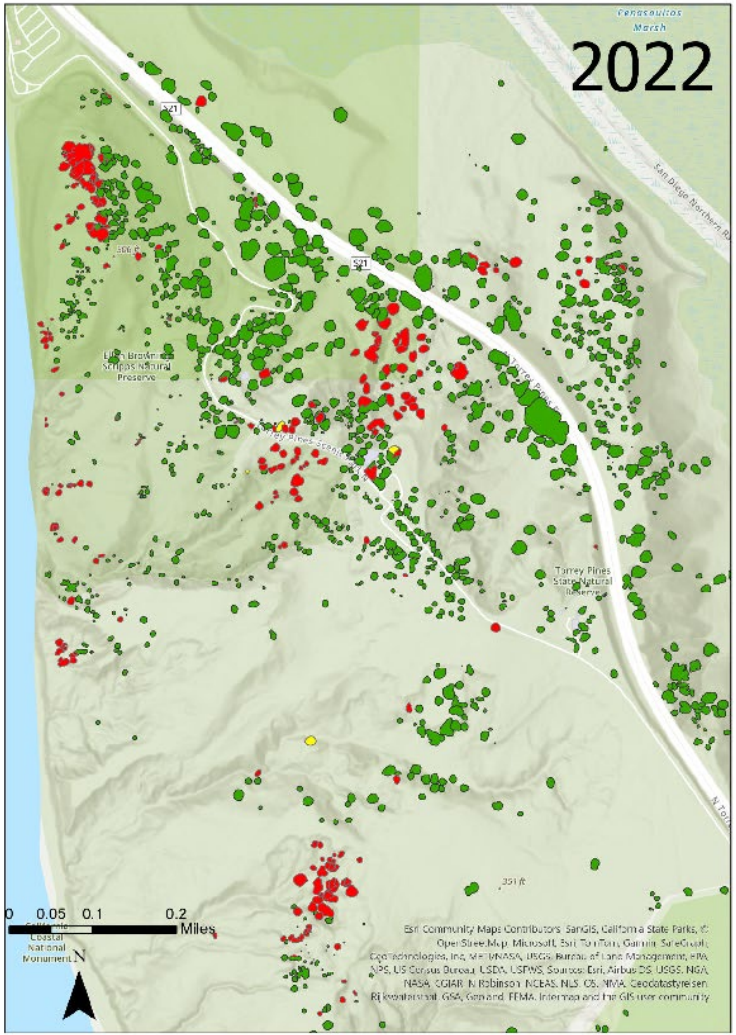
GENETICS:
Initial Study

- RNA Study comparing infected/uninfected trees in environmental conditions
- Low genetic diversity overall within populations
- Multivariate genotypes diverged between cases and controls after beetle outbreak
- **Differences map to traits known to offer protection**
- **Suggests there is adaptive potential**



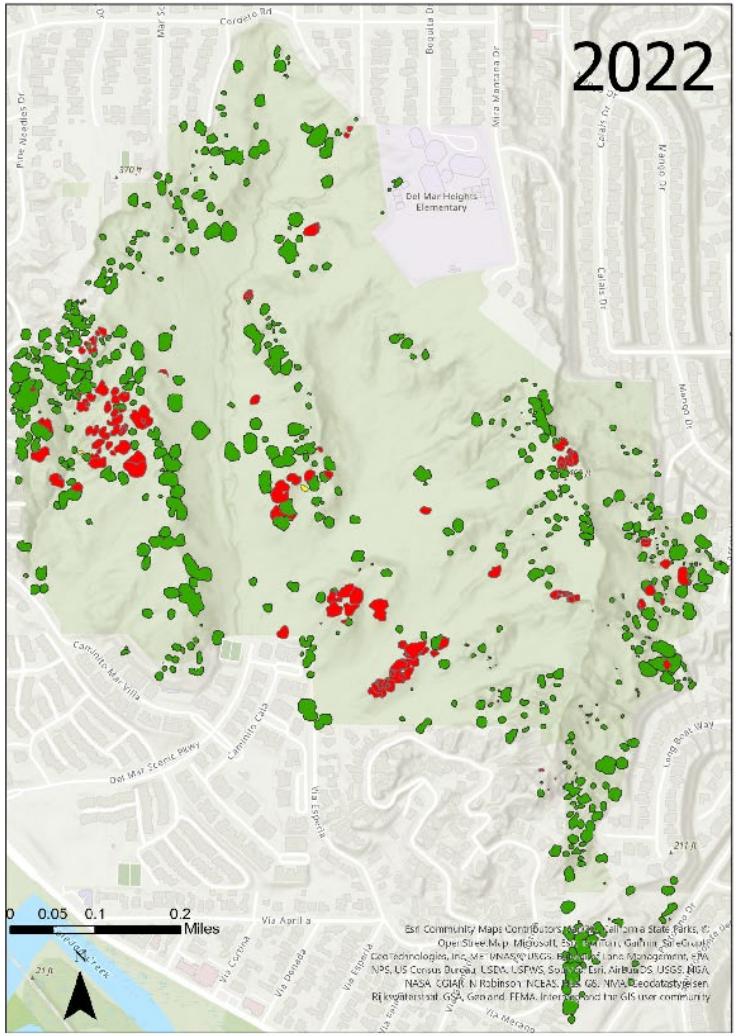
PROJECT COMPONENTS

- Imagery Analyses
- Abiotic Measurements
- Enhancement Plantings
- Beetle Data Analyses
- Stand Monitoring
- Monitoring Plantings
- Beetle Management Trials



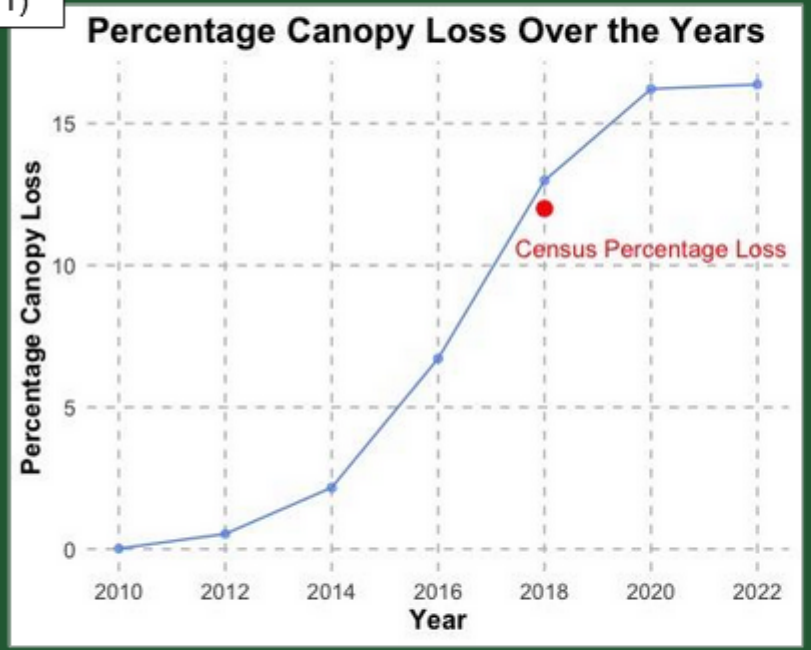
Previously dead canopy

Recently dead canopy



Results - Linear Regression + Imagery

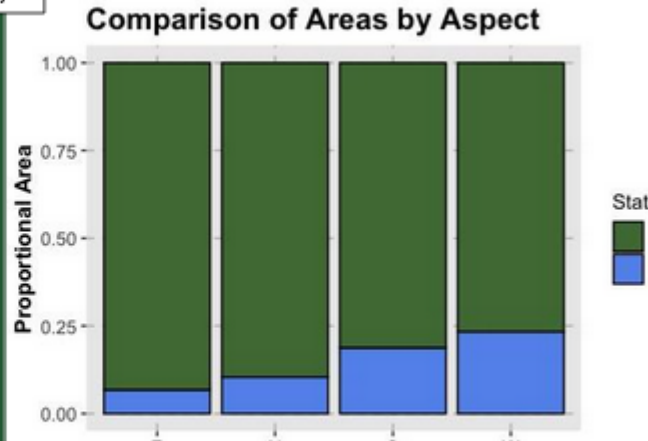
1)



2)

Covariate	χ^2	*P value*	*Description*
Patch size	13.8	< 0 .001	Mortality increases w of patch
Aspect	**54.9**	**< 0.001**	**Mortality is greater W (vs. E & N**
Slope	41.6	< 0.001	Mortality increases steeper slope

3)



Results – Linear/Spatial Regression of Census Data (2018)

Variables	*Sig in Model*
slope	linear
aspect	linear
sum basal area	linear, **spatial***
# of trunks	neither

- Spatial analysis done only on point data (census results) thus far
  - considering spatial autocorrelation changes what is significantly correlated
- Follow-up
  - Conduct spatial analysis on polygons from imagery
  - Consider time element

PROJECT ACTIVITY:
STAND MONITORING

- **Which adult trees are most vulnerable?**
  - Age, location, neighbors
- **Can we link risk to microsite variables?**
- **Are there warning signs?**

PROJECT ACTIVITY: **STAND MONITORING**

- **”Health” attributes**
  - Signs of stress including red turpentine beetle; short or yellowing needles; cankers, etc.
- **Resilience**
  - Old beetle infections (esp. red turpentine)
  - Sap production
- **Canopy shape/ quality**

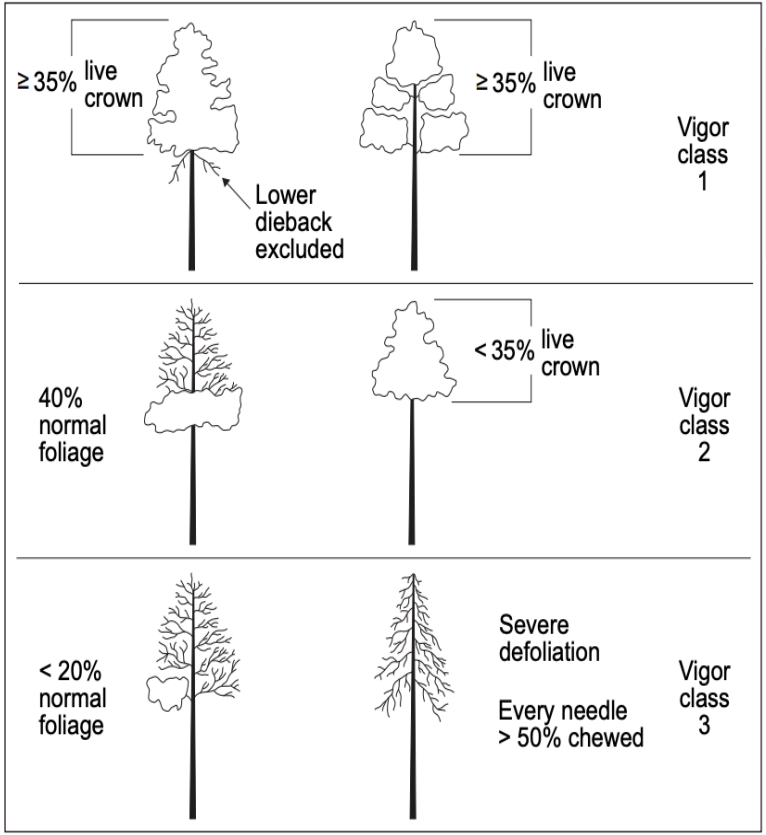


Figure 2.2—Sapling vigor rating criteria.

USDS Forest Service General Technical Report SRS-102

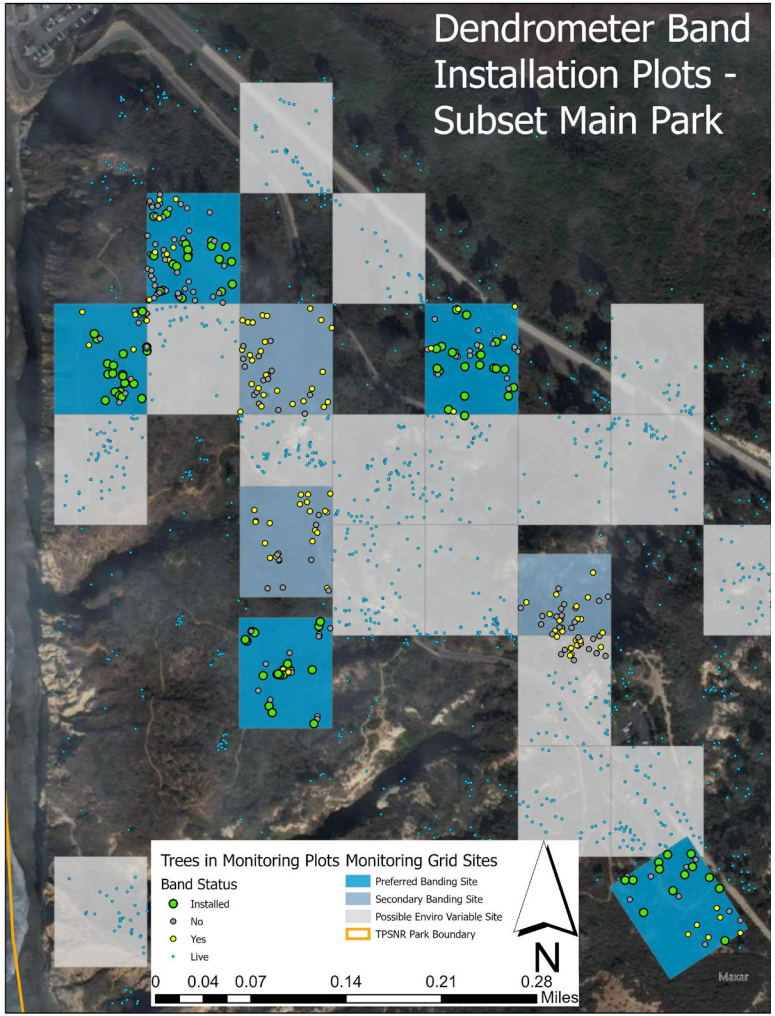
PROJECT ACTIVITY:
STAND MONITORING

Canopy Assessments

- Crown depth
- Gaps
- Dead branches (mid-canopy)
- Needle density

PROJECT ACTIVITY: **STAND MONITORING**

- **Growth**
  - Measure with dendrometer bands
  - Time to “settle”
  - ~~Spring and Fall~~ Winter and Summer measurements



PROJECT ACTIVITY: **STAND MONITORING**

- **Identified spectrum of plots**
  - Dead pine model
  - Suitability model
  - Minimum of 20 trees in 1ha area
- **Subset of trees in plots**
  - 20 trees banded, across size classes

Adult Tree Monitoring: Health Assessments

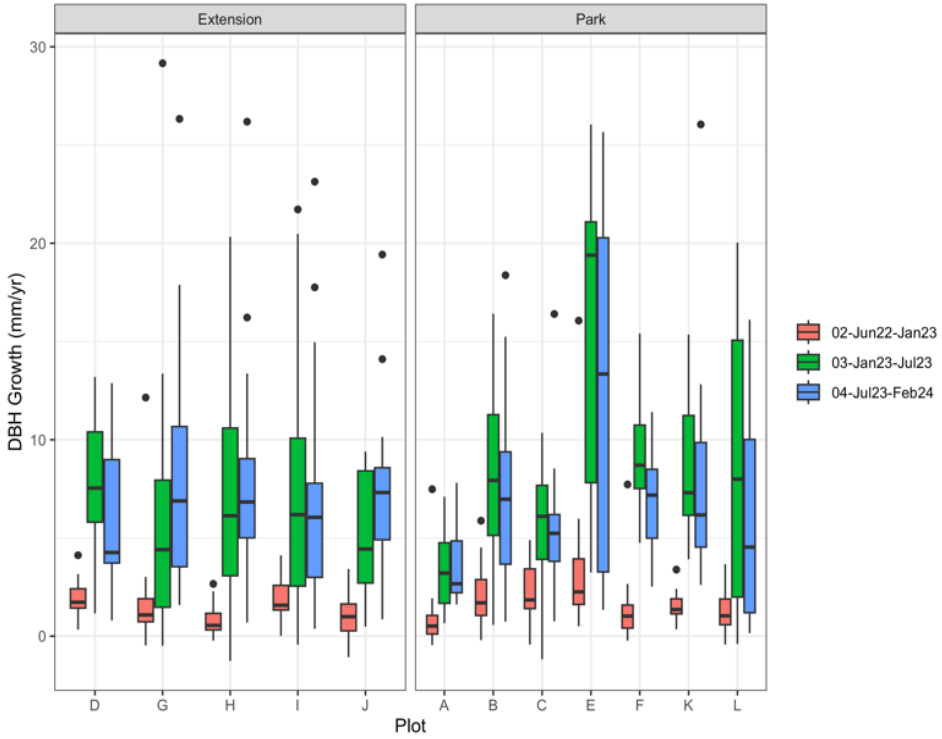
Attributes Measured

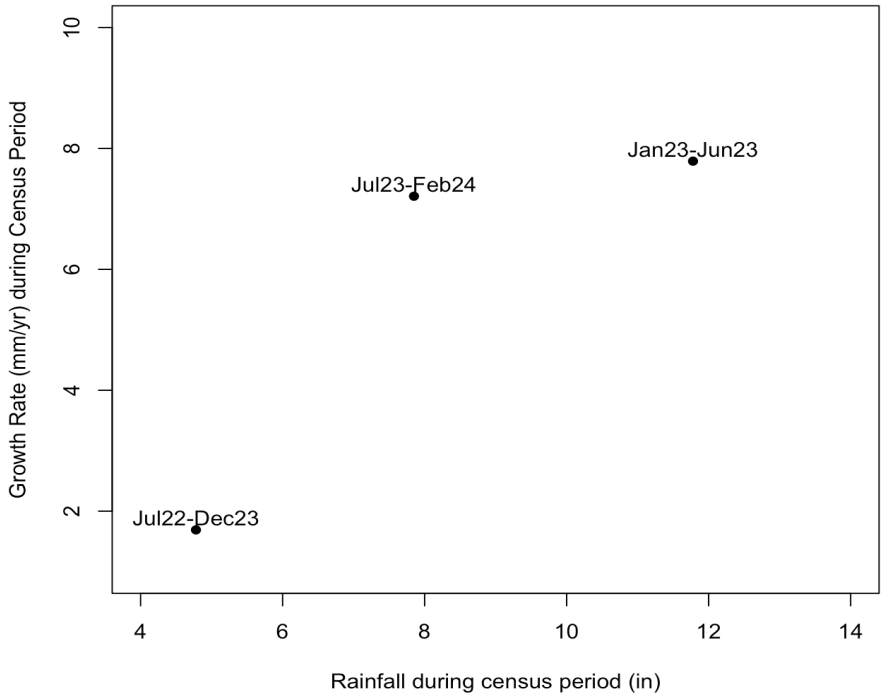
- Dendrometer band growth
- Bark flakiness (categories)
- Presence of pitch streaming
- Presence of canker
- “Sappy”ness (categories for wet and dry)
- Presence of turpentine infection
- Needle length of newest cohort (where accessible)
- Needle density (categories)
- Crown symmetry
- Crown depth
- Evidence of branch loss
- Presence of Cones (open and closed, closed = recent reproductive output)

Adult Tree Monitoring: Health Assessments

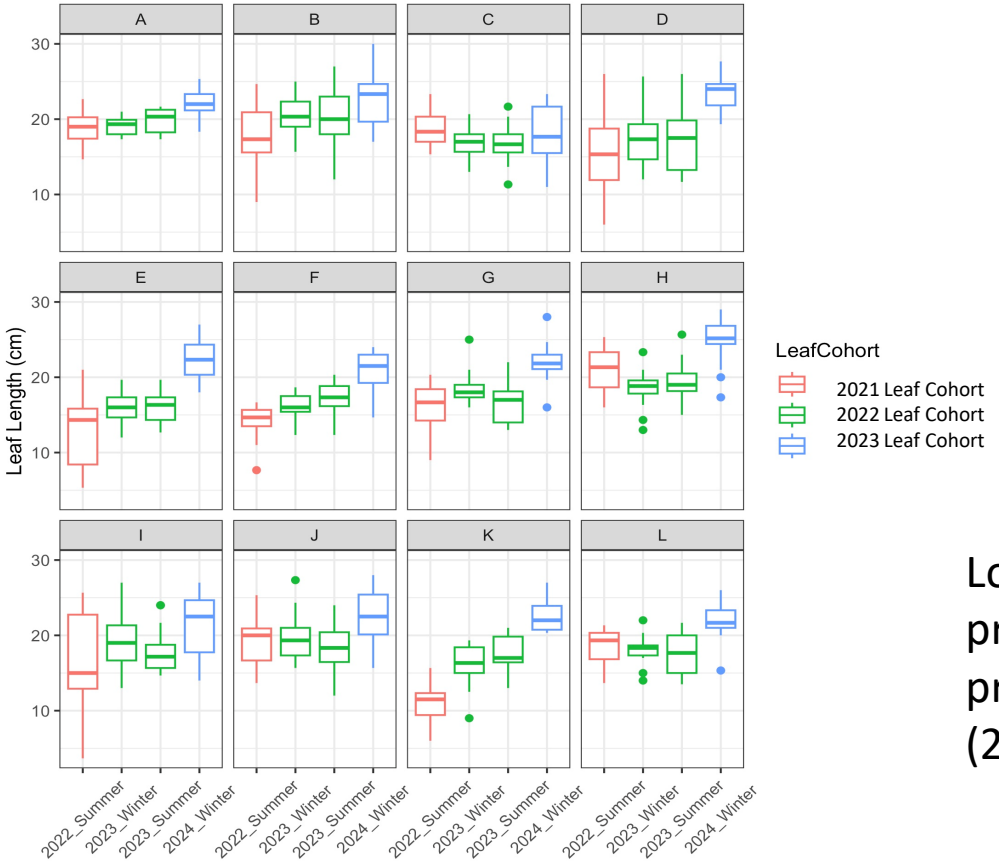
Soon Came Across Difficult to Categorize, But ‘Unhealthy’ Trees

Adult Tree Monitoring: Growth



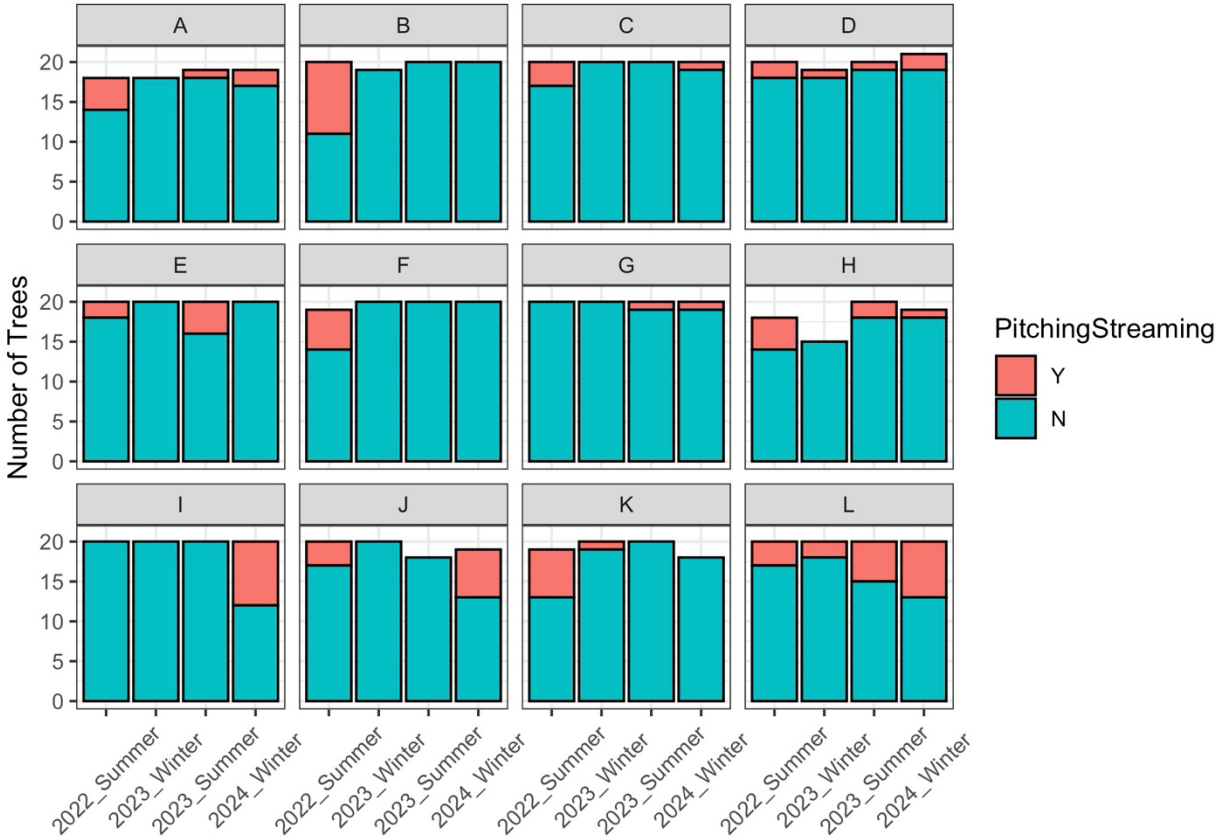


Adult Tree Monitoring: Health Assessments



Longer needles produced in higher precipitation year (2023)

Adult Tree Monitoring: Health Assessments



Adult Tree Monitoring: PC Modifications

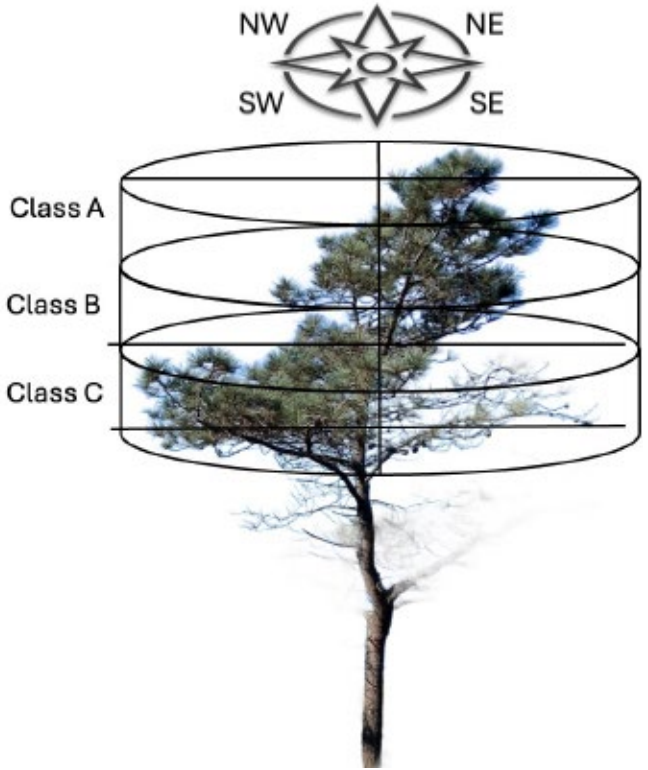
Code	Explanation
PC D	Pitch canker, dead
PC 1	Pitch canker, bole cankers
PC 2	Pitch canker, top dead
PC 3	Pitch canker, most (≥50%) branches infected
PC 4	Pitch canker, many (10–49%) branches infected
PC 5	Pitch canker, few (≤9%) branches infected
NPC	No pitch canker

From Auten (2000) via Piirto and Valkonen (2005)

Adult Tree Monitoring: PC Modifications

Impacted Tips Count Estimations

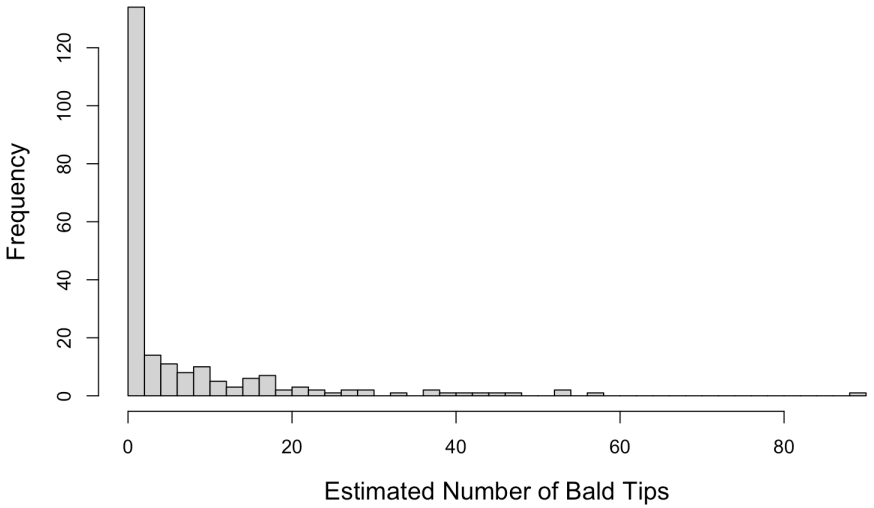
- Trees divided into 3m horizontal classes and 4 ordinal quadrants
- Quadrant randomly chosen in each class
- Potentially infected branch tips in each class's quadrant counted and multiplied by the number of quadrants containing branches in that class



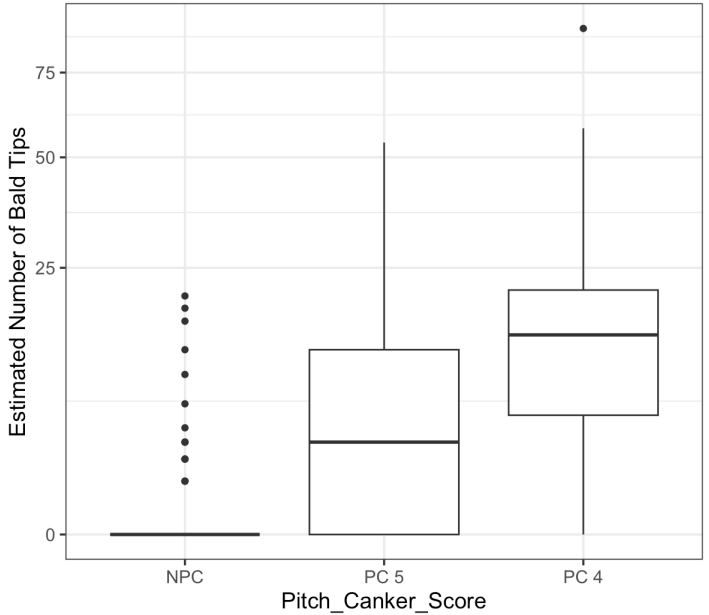
Adult Tree Monitoring: PC Modifications

Incidence of symptoms of PC and relationship between metrics

52% of Trees had at least one “impacted tip”
Median number of pitch affected twigs was 8
Max number was 90



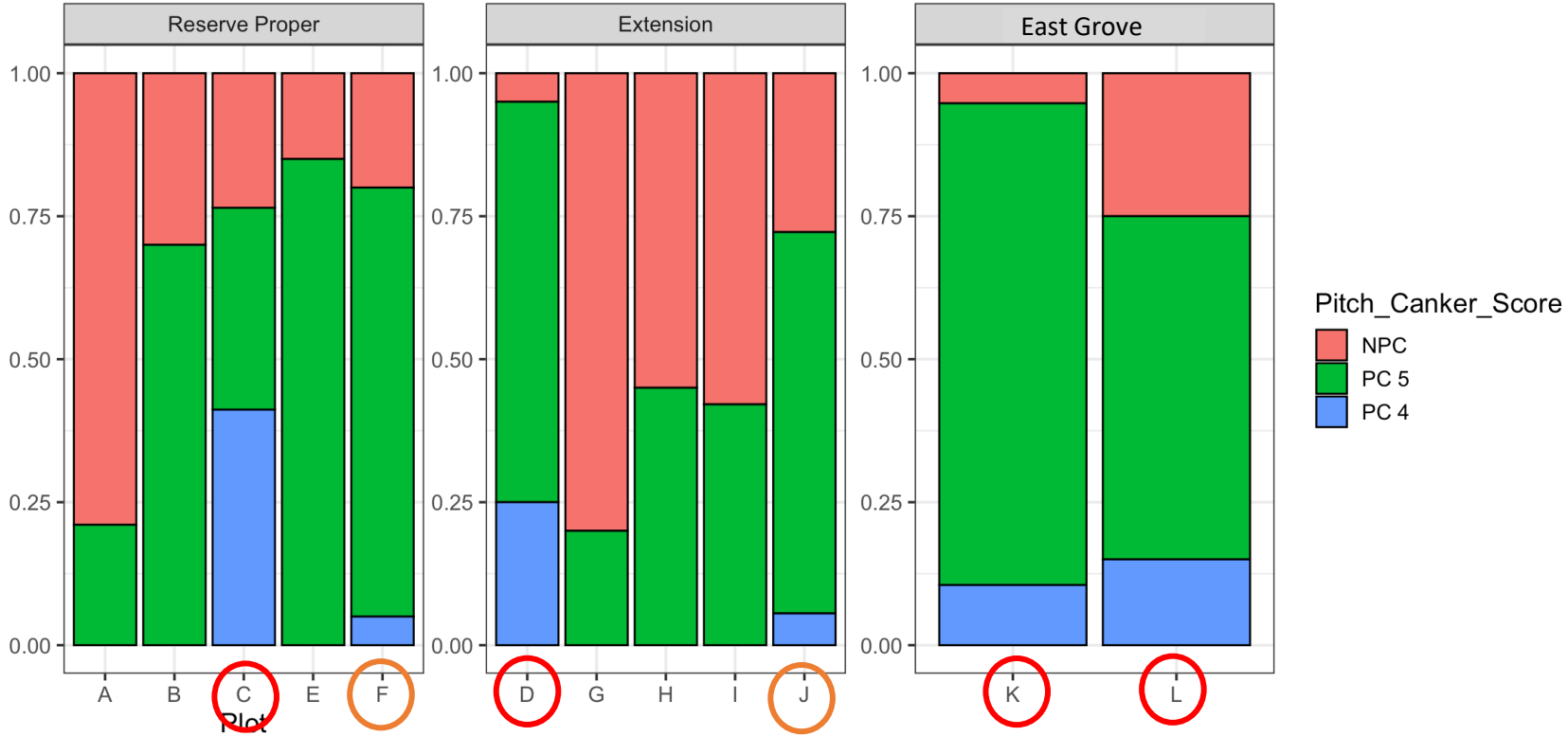
64% of Trees scored as PC4 or PC5



# of impacted tips increased with intensity of Pitch Canker Score

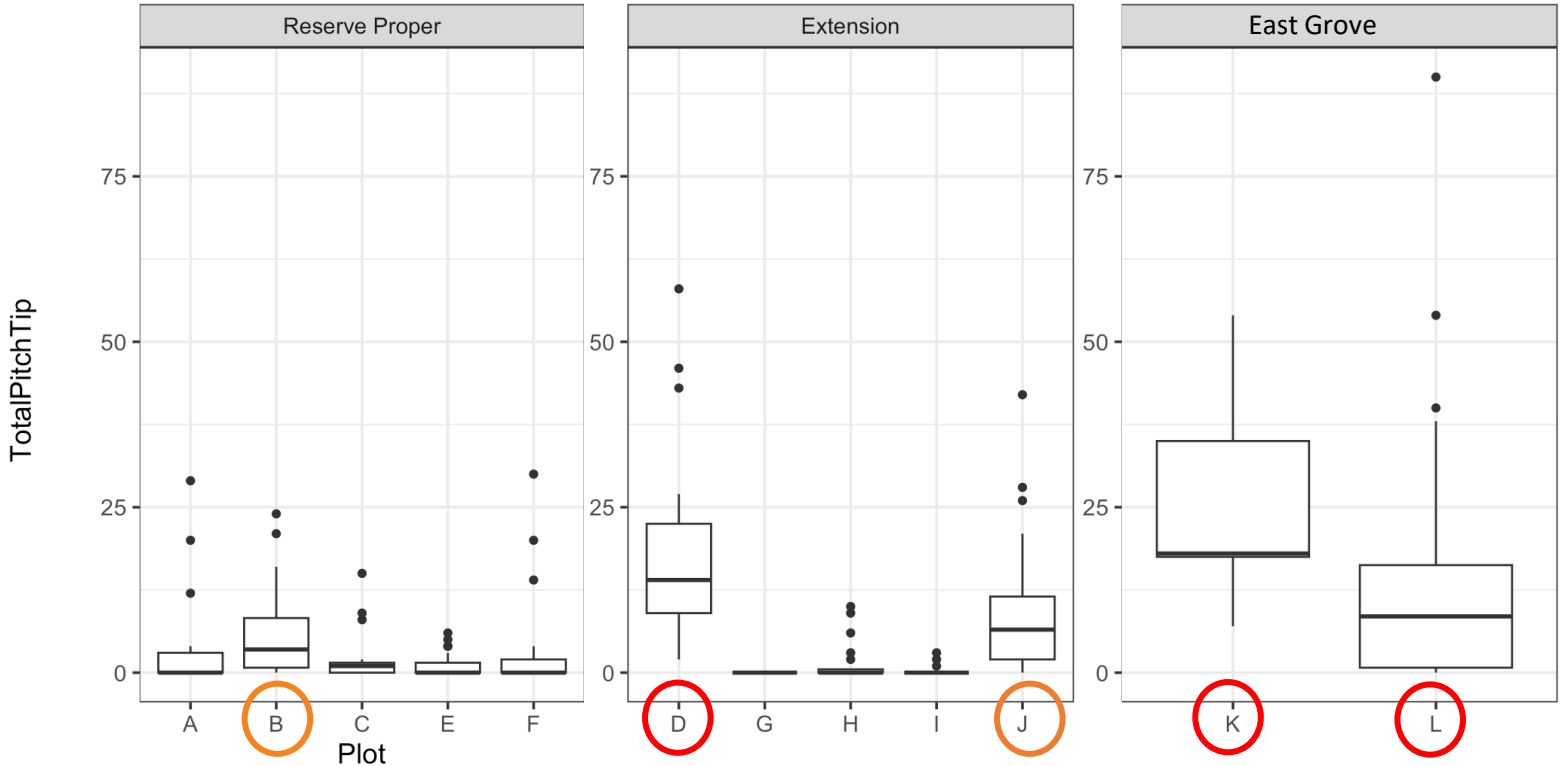
Variation in Pitch Canker Scores among Torrey Pines Sites

Stand level estimates ranged from 21% to 95% trees scoring PC5 or PC4
East Grove had the highest proportion of severe PC4 scores



Adult Tree Monitoring: PC Modifications

Variation in Impacted Tips among Torrey Pines Sites



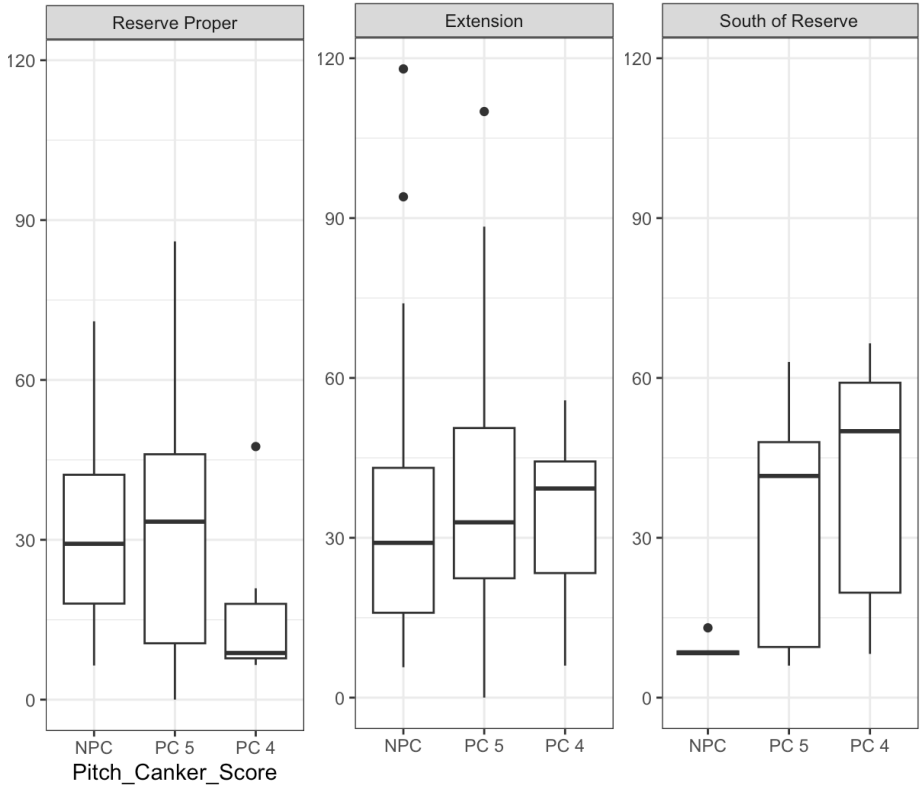

Main Park
A
B
C
L
E
F
K
TPSNR Park Boundary
MonitoringPlots
Dendrometer Bands
Other Trees
Banded Trees
N
0
0.13
0.25
0.5 Miles
I
J
G
H
D
Extension
N
0
0.13
0.25
0.5 Miles

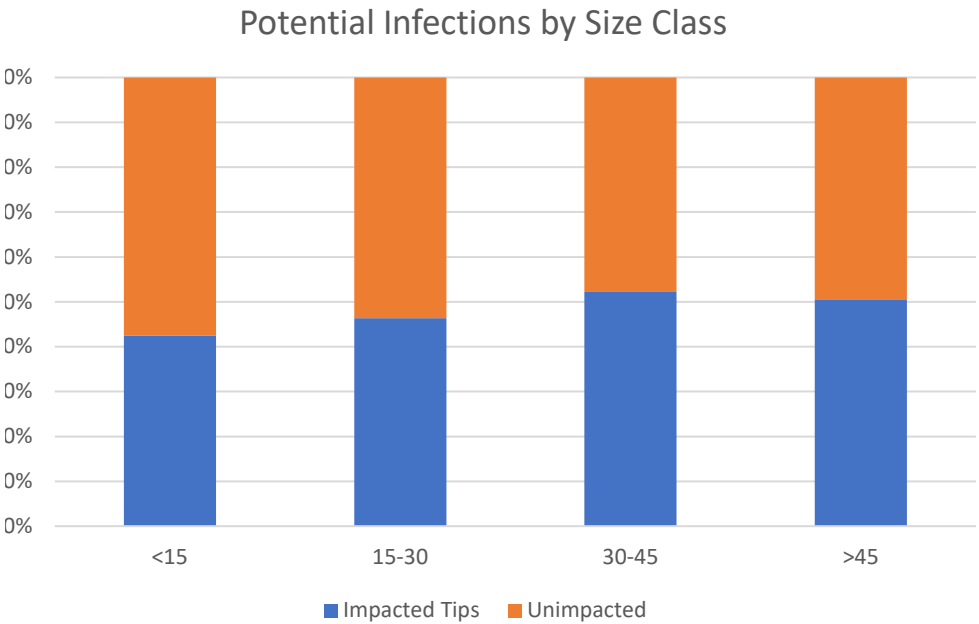
Adult Tree Monitoring: PC Modifications

	DBH size class			
	<15	15-30	30-45	>45
NPC Score	14	26	19	24
No Impacted Tips	12	22	13	20
Yes Impacted Tips	2	4	6	4
PC Score 4 or 5	26	43	27	65
No Impacted Tips	11	15	9	24
Yes Impacted Tips	15	28	18	41

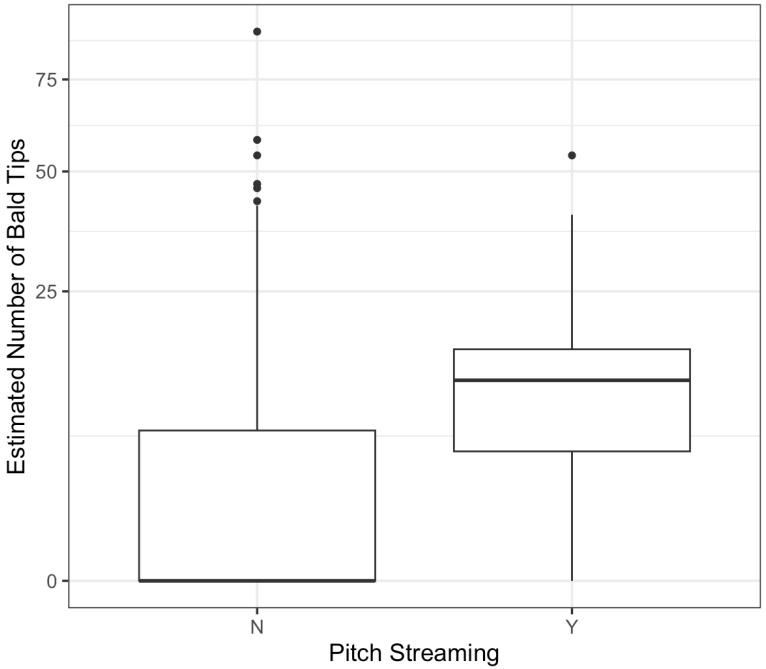
False positives with scoring system?

Tree Size and Potential Infections





Trees that exhibit pitch streaming on bole more had higher mean number of infected tips



Adult Tree Monitoring: PC Modifications

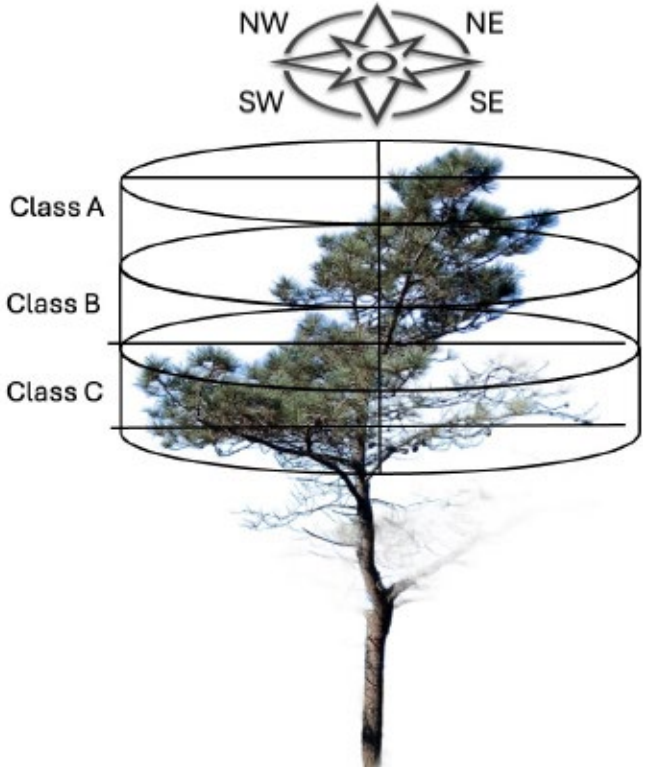
Year 1 takeaways

- Better alignment/training for using pitch canker score
- PC Score likely better for comparisons between plots and across size classes
- Tip counting method could allow for more-fine tuned monitoring of individuals

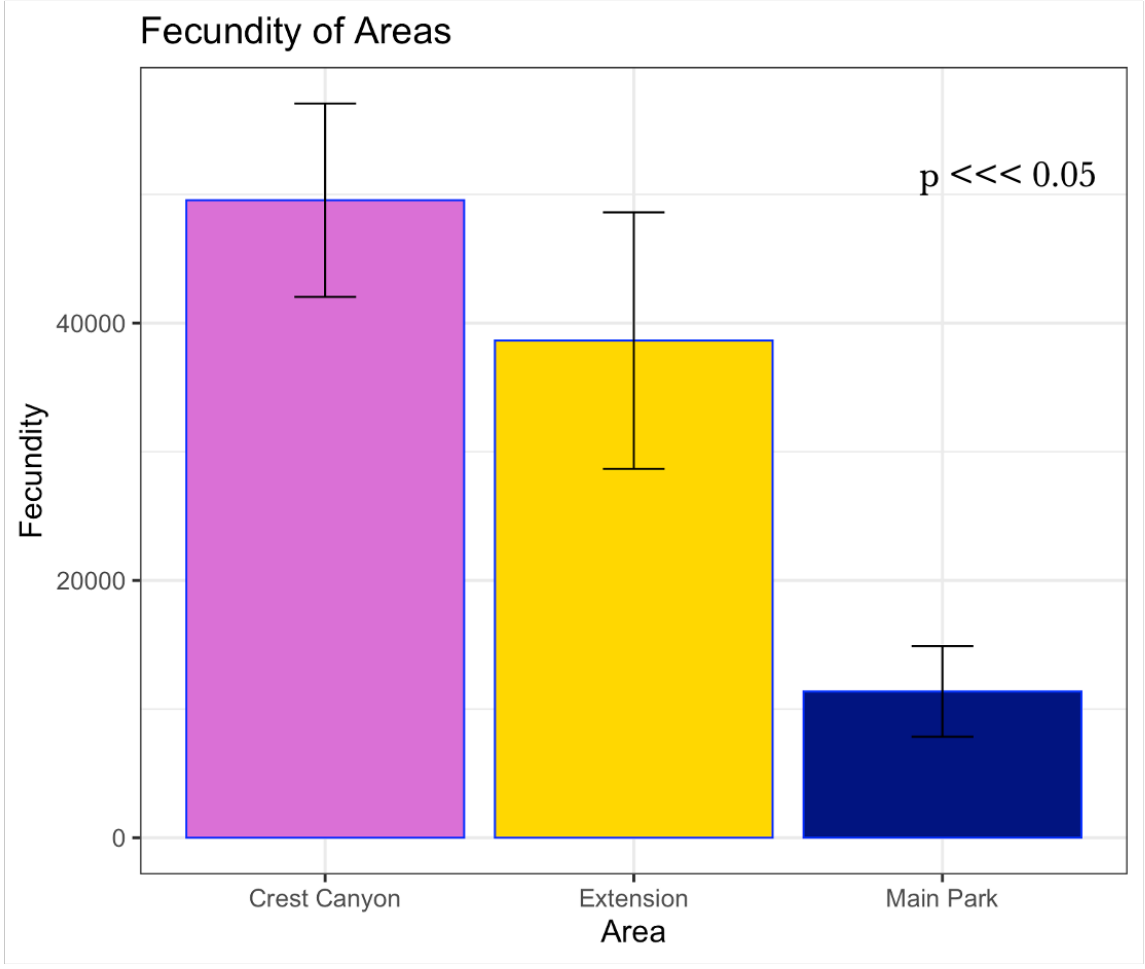
Adult Tree Monitoring: Fecundity

Cone Count Estimations

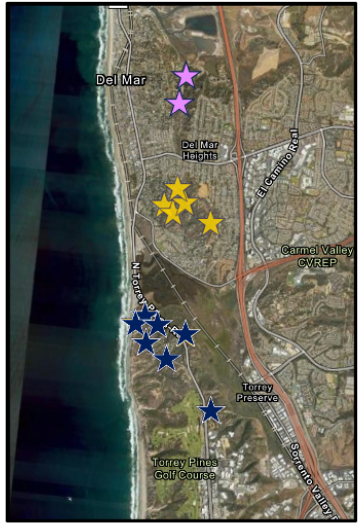
- Trees divided into 3m horizontal classes and 4 ordinal quadrants
- Quadrant randomly chosen in each class
- Both closed cones and total cones remaining in each class's quadrant counted and multiplied by the number of quadrants containing branches in that class
- Closed cones collected from subset of trees – processed for seed
- Conducted float test to determine seed fill



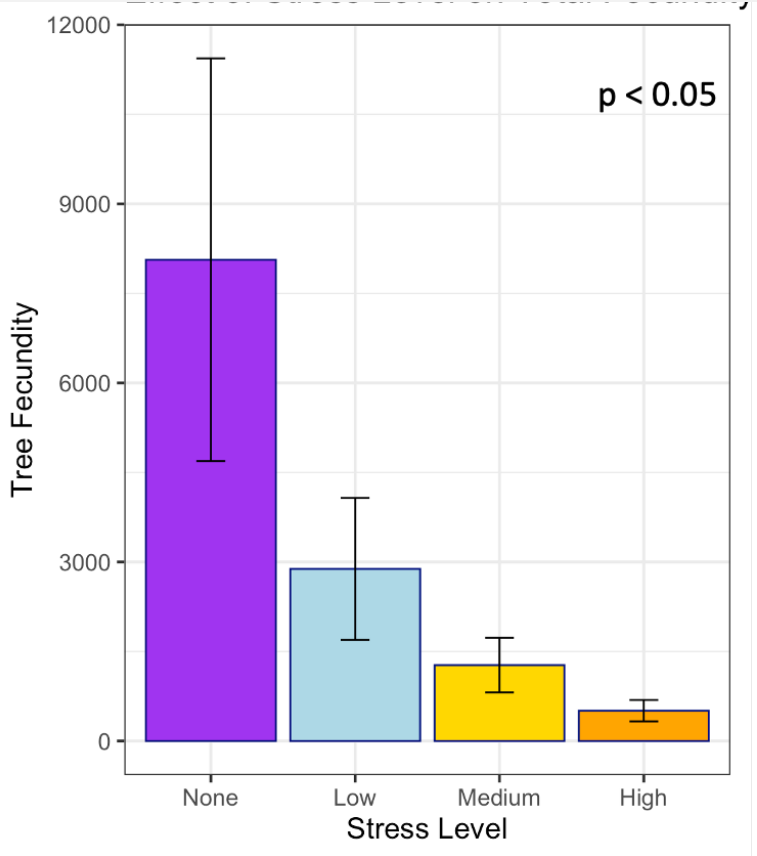
The Main Park exhibits lower fecundity than both Crest Canyon and Extension areas

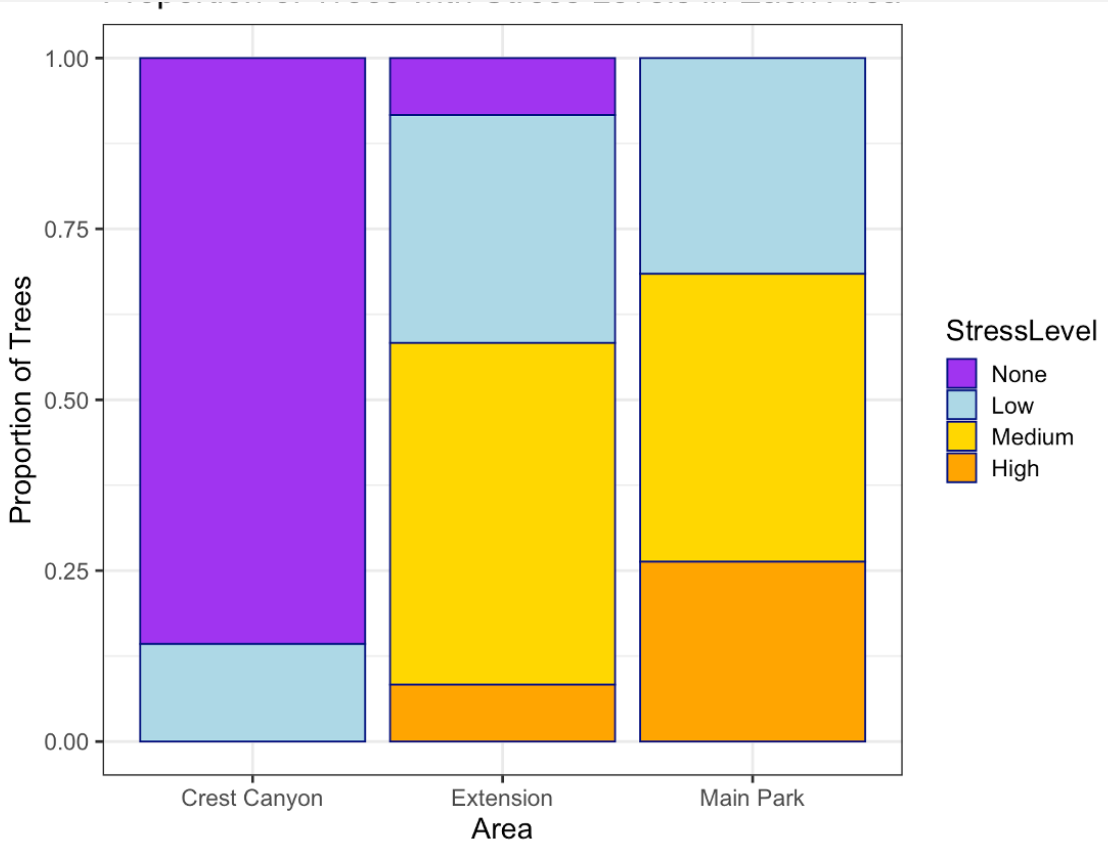


- No significant difference in fecundity between Crest Canyon and the Extension
- The Main Park has a much lower fecundity
  - More stressed trees in main park
  - Past beetle outbreaks
  - More pitch canker relevance



Adult Tree Monitoring: Stress and Fecundity





Health Monitoring: Thoughts and Next Steps

- Pitch canker may be prevalent in TPSNR, but individuals are at low levels of infection *currently*

- Continued monitoring needed to see how progresses
    - Refine protocol and improve training

- Look for correlations and further explore data

- Cumulative stresses (drought, beetles, now PC) may have been and continue to impact recruitment – needs further exploration

Questions?