Assessment of Likelihood of Failure Using Limited Visual, Basic, and Advanced Assessment Techniques

http://www.louisdallaraphotography.com

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University of Florida IFAS – Gulf Coast REC

Ideal Risk Assessment Traits

Norris (2007) identified the following ideal traits for risk assessment methods

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- Complete
  - target-*P* failure-consequence
  - coverage of conditions

www.timbertreeserviceinc.com

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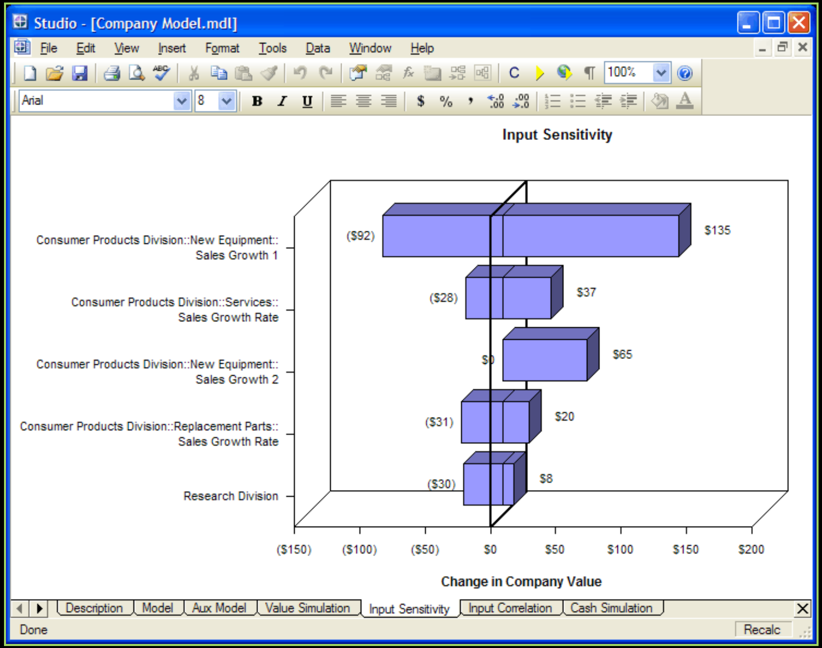
- Complete
  - target-*P* failure-consequence
  - coverage of conditions
- Robust
  - insensitive to assumptions



http://www.vanguardsw.com

Ideal Risk Assessment Traits

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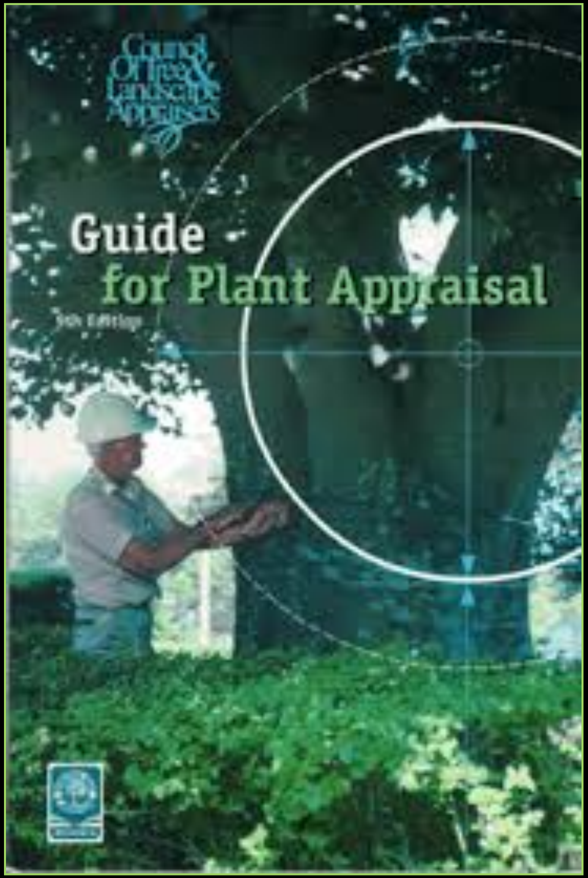
- Complete
  - target-*P* failure-consequence
  - coverage of conditions
- Robust
  - insensitive to assumptions
- Credible
  - Reasonable, believable, verifiable



Ideal Risk Assessment Traits

Norris (2007) identified the following ideal traits for risk assessment methods

- Feasible
  - Data can actually be collected

articles.chicagotribune.com

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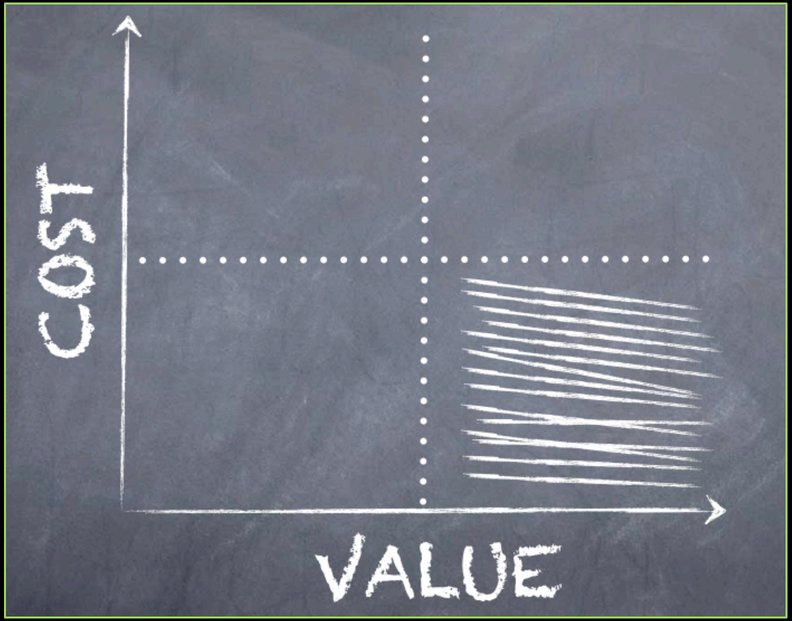
- Feasible
  - Data can actually be collected
- Economical
  - Cost of data collection, analysis, and reporting is reasonable



digitalintelligencetoday.com

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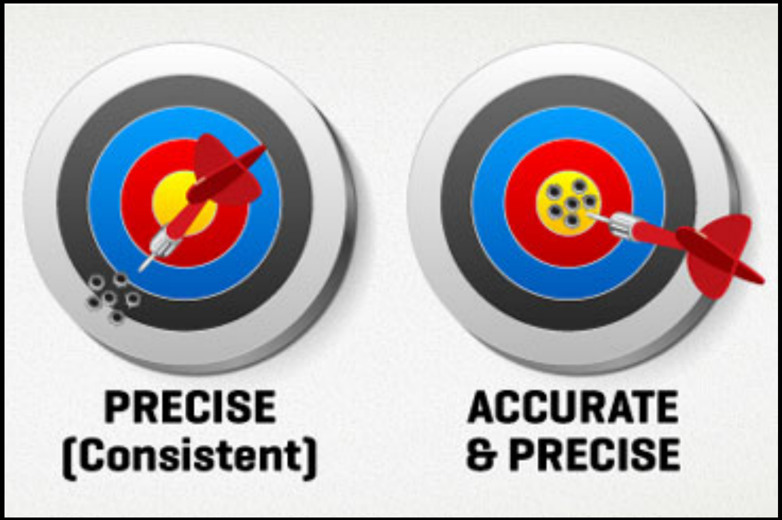
- Feasible
  - Data can actually be collected
- Economical
  - Cost of data collection, analysis, and reporting is reasonable
- Repeatable
  - -Multiple folks can come to similar conclusions



Jahschem.wikispaces.com

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- Feasible
  - Data can actually be collected
- Economical
  - Cost of data collection, analysis, and reporting is reasonable
- Repeatable

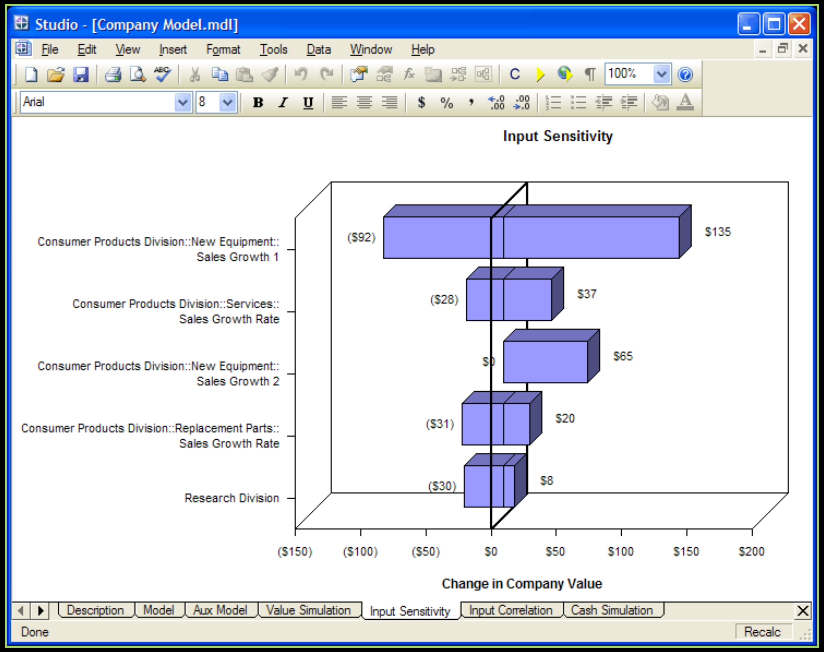
  -Multiple folks can come to similar conclusions
- Valid
  - Conclusions reflect reality

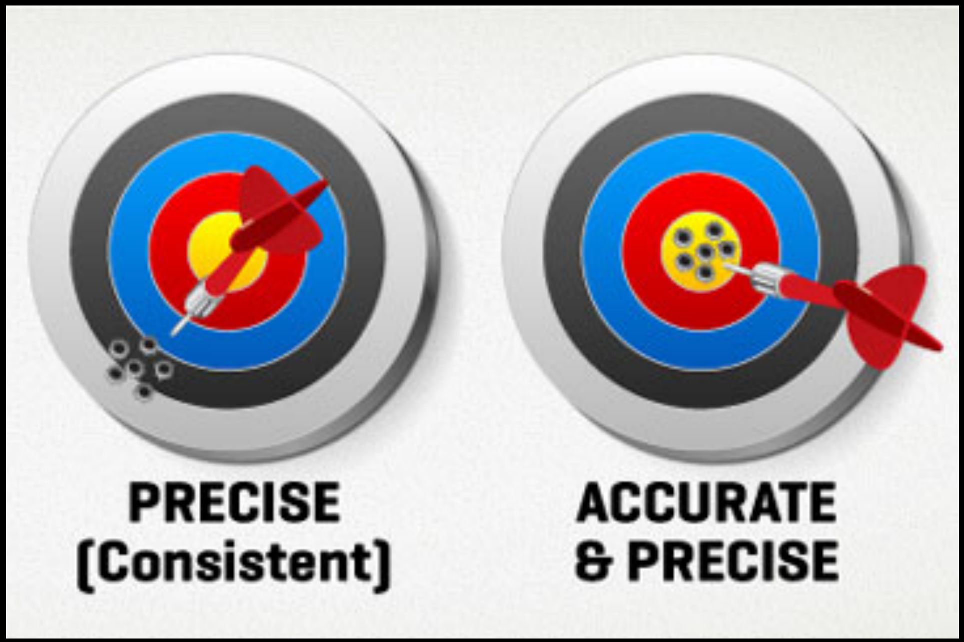
http://itstartedwithasong.com/

Tree Risk Assessment

3 inputs (target – likelihood of failure – consequences) are shared by all common assessment methods

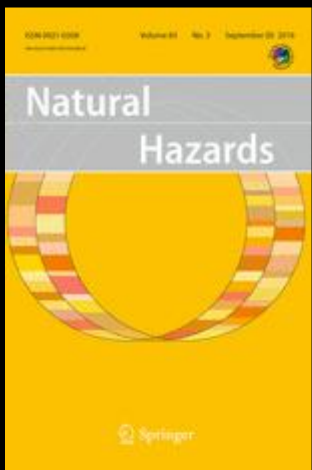
All currently accepted methods of risk assessment share a common concern…





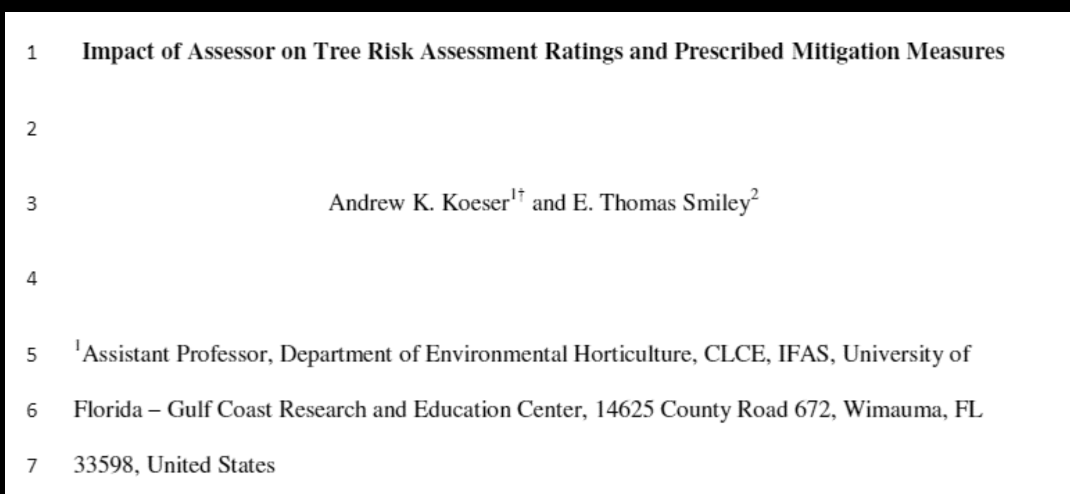
How do we limit the impact of assessor bias and risk perception to make risk assessments more robust and repeatable?

Impact of Arborist on Risk Assessments



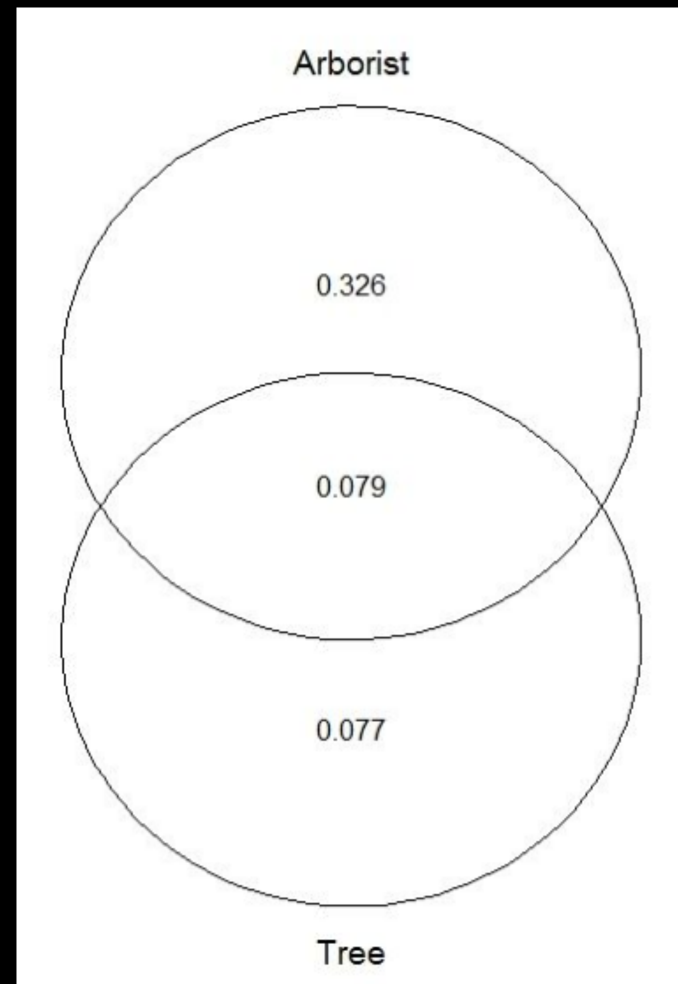
296 Arborists assessed three trees each.

Compared sources of variation among ratings/ inputs


Impact of Assessor on Tree Risk Assessment Ratings and Prescribed Mitigation Measures

Andrew K. Koeser[1†] and E. Thomas Smiley[2]

[1]Assistant Professor, Department of Environmental Horticulture, CLCE, IFAS, University of Florida – Gulf Coast Research and Education Center, 14625 County Road 672, Wimauma, FL 33598, United States



Failure Potential

Journal of Arboriculture 31(2): March 2005

Previous

QUANTIFIED TREE RISK ASSESSMENT USED IN THE MANAGEMENT OF AMENITY TREES

By Michael J. Ellison

"Accurately assessing the probability that a tree or branch will fail is highly dependent on the skill and experience of the assessor."

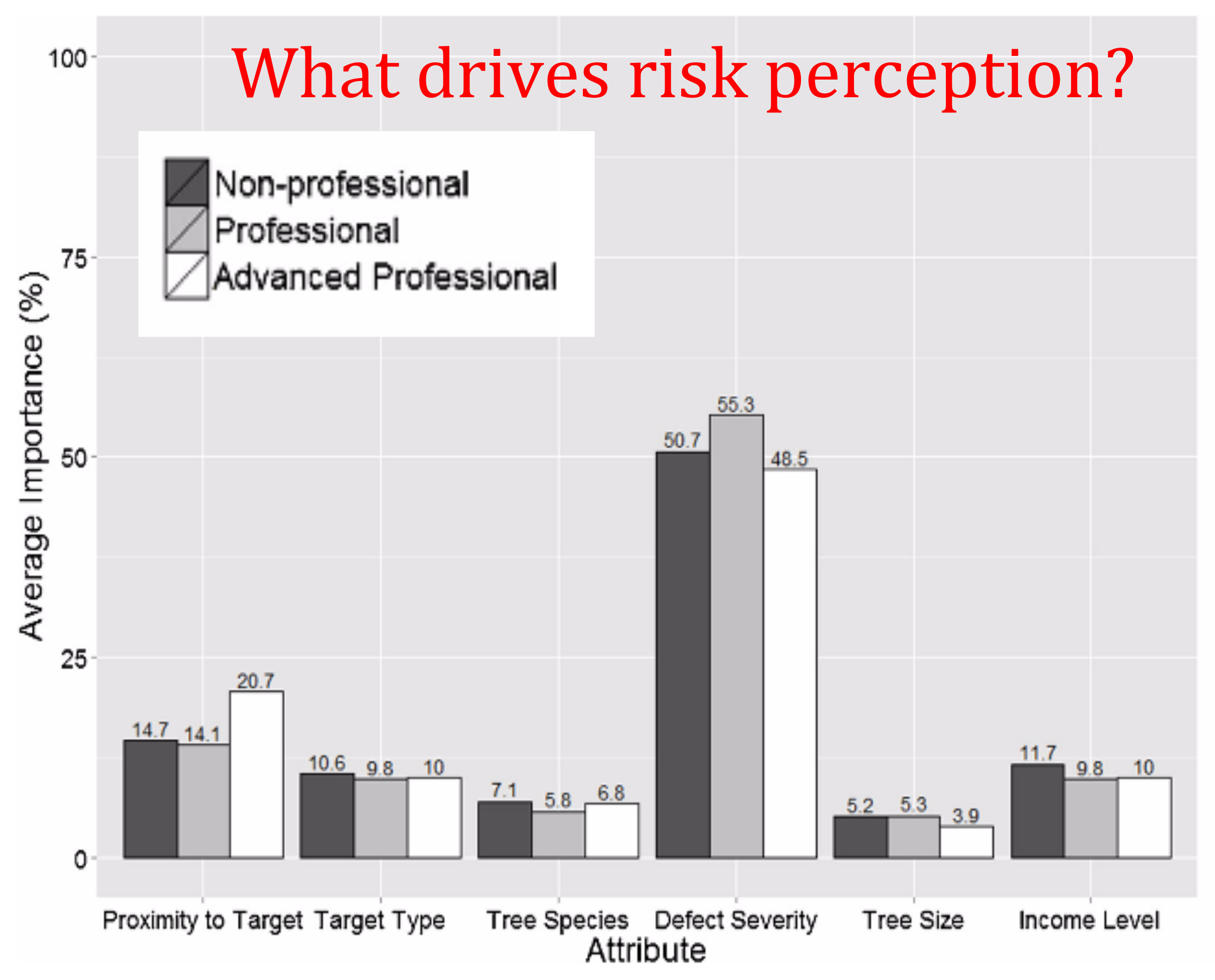
Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug

Factors driving professional and public urban tree risk perception

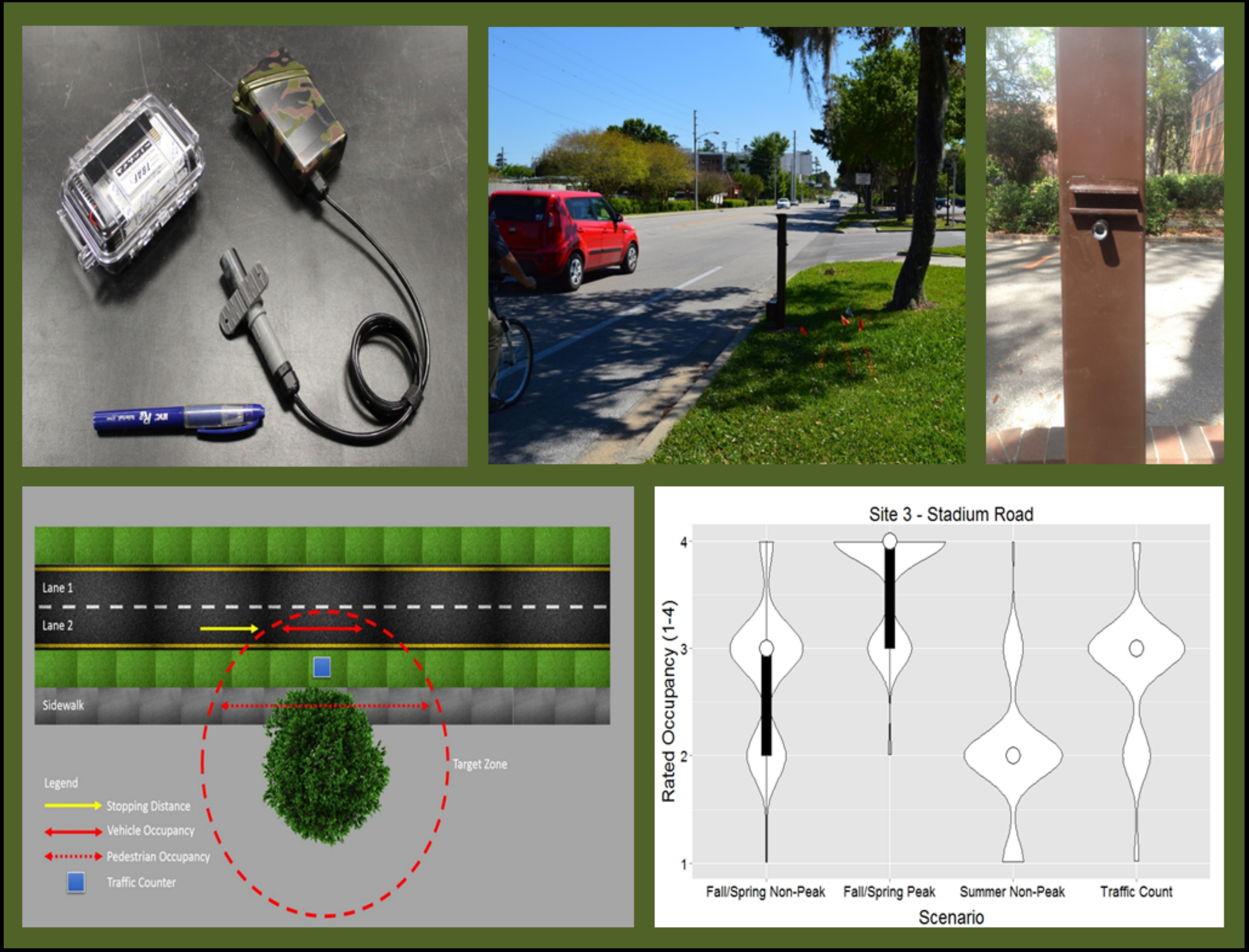
Andrew K. Koeser[a,*], Ryan W. Klein[b], Gitta Hasing[a], Robert J. Northrop[c]



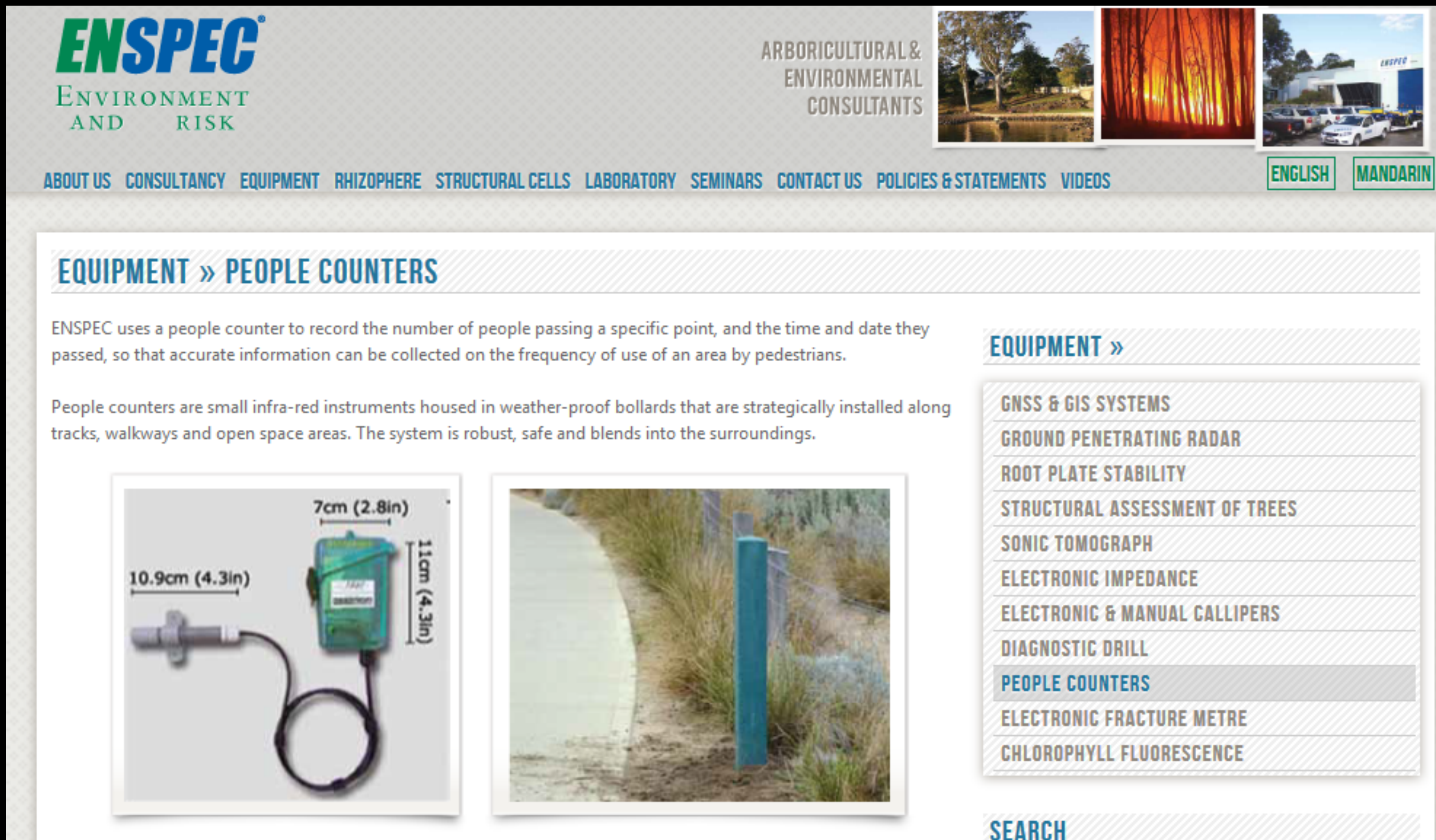
Logical Next Step…

Investigate our ability to accurately assess aspects of failure potential...

Perceived vs Real Target Occupancy



Also….



Traffic counters are rarely used in the United States for arboriculture

Tree Risk Assessment Assessment

We know overall risk ratings are quite variable, but how, how consistent are estimates of target occupation for a given site???


CWMc

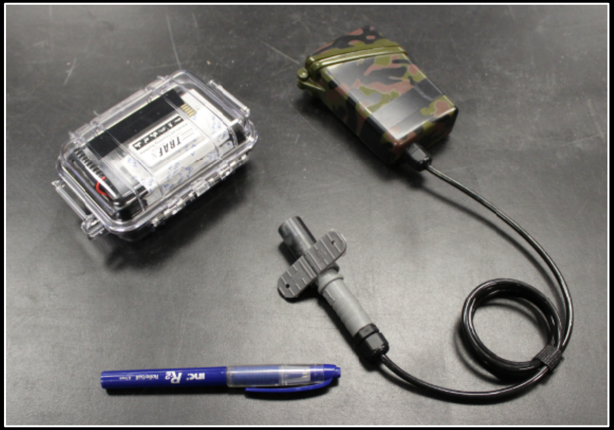

www.southeastroads.com

Actual vs real target occupancy

4 sites shown 3 times each

Video clips varied by:

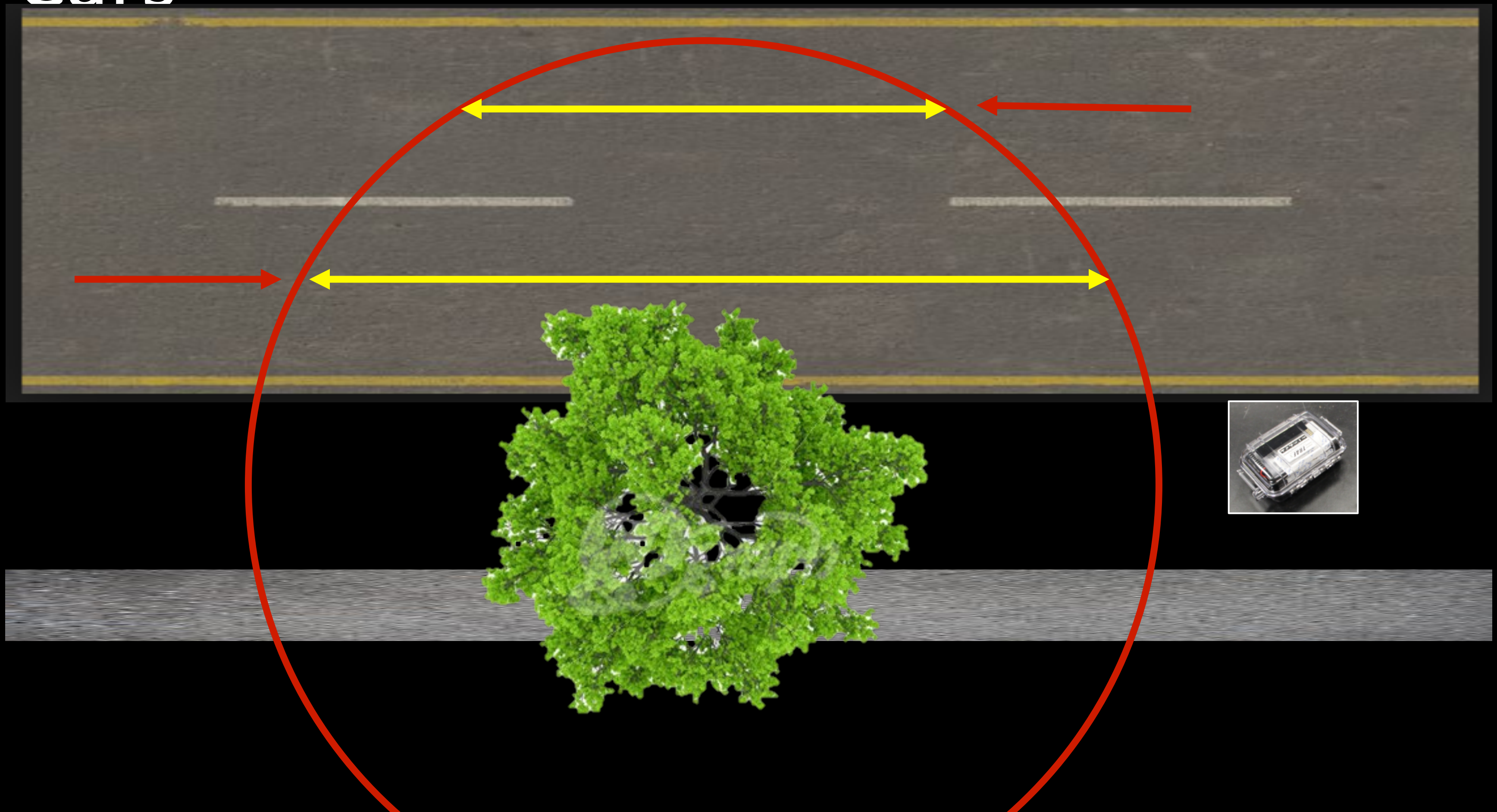
- Time Filmed (peak hours vs off hours)
- Time of year (classes in/ out of session)



4 video stills with traffic data shown after clips

How did we estimate occupancy?

Cars



How did we estimate occupancy?

People

Table 1. Regression model for predicting visual target occupancy ratings given time of assessment (i.e. time of day and season of year), actual occupancy (i.e., daily average with traffic count data), rating index (i.e., median value of all ratings from an individual), and factors related to professional experience.

Factor	Coefficient	Standard error	*P*-value	95% CI lower	95% CI upper
Intercept	2.17	0.08	<0.001	2.01	2.32
Season – Fall/Spring[a]	-0.05	0.04	0.127	-0.12	0.02
Time of Day - Peak[b]	0.63	0.05	<0.001	0.54	0.72
Actual Occupancy	0.07	<0.00	<0.001	0.06	0.08
Certified – Yes[c]	-0.09	0.05	0.058	-0.18	0.00
Risk Experience – Yes	0.02	0.04	0.587	-0.06	0.10
				Adjusted R^2	0.23

[a] Compared to base level "Summer".

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[c] International Society of Arboriculture Certified Arborist.

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Table 2. Regression model for predicting target occupancy ratings once actual occupancy (i.e., daily average calculated with traffic count data) values displayed to respondents. Predictors include actual occupancy, rating index (i.e., median value of all ratings from an individual), and factors related to professional experience.

Factor	Coefficient	Standard error	*P*-value	95% CI lower	95% CI upper
Intercept	1.95	0.07	<0.001	1.82	2.09
Actual Occupancy	0.11	<0.00	<0.001	0.10	0.12
Certified – Yes	-0.15	0.05	0.001	-0.24	-0.06
Risk Experience	0.01	0.04	0.771	-0.09	0.07
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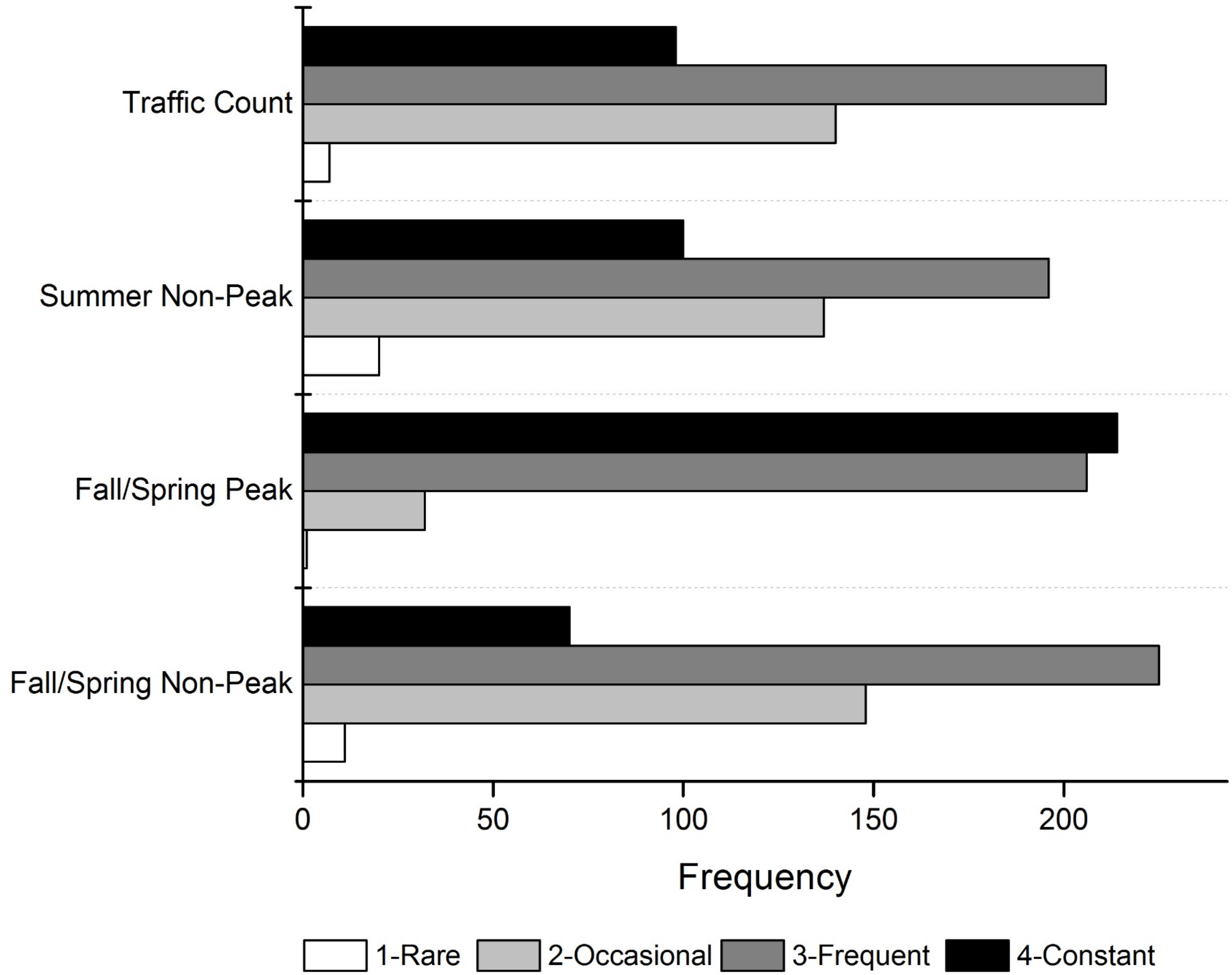
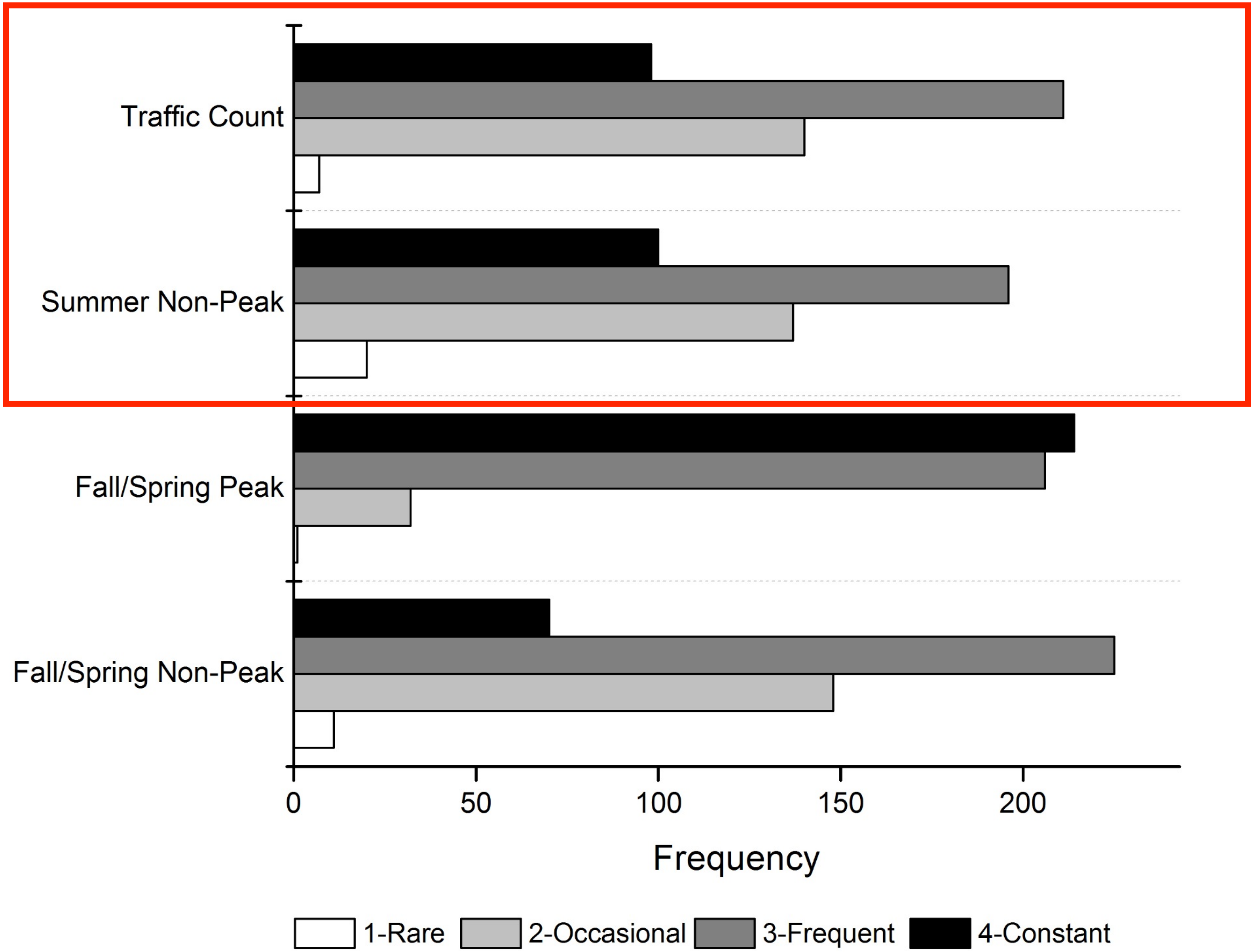

Traffic Count
Summer Non-Peak
Fall/Spring Peak
Fall/Spring Non-Peak
0
50
100
150
200
Frequency
1-Rare
2-Occasional
3-Frequent
4-Constant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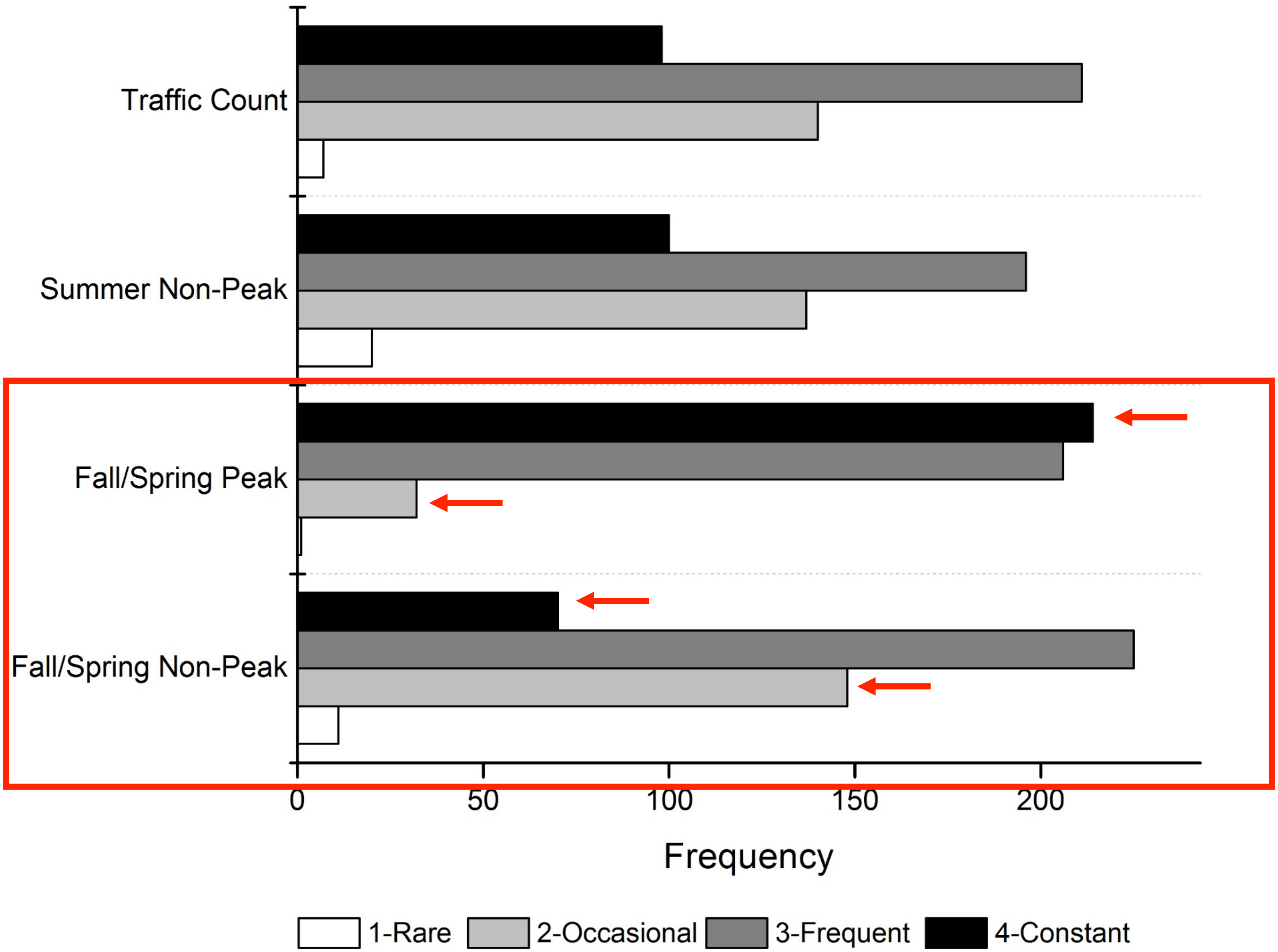

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Likelihood of failure	Consequences of failure	Likelihood of Impact			
		Very Low	Low	Medium	High
Improbable	Negligible	Low	Low	Low	Low
	Minor	Low	Low	Low	Low
	Significant	Low	Low	Low	Low
	Severe	Low	Low	Low	Low
Possible	Negligible	Low	Low	Low	Low
	Minor	Low	Low	Low	Low
	Significant	Low	Low	Low	Moderate
	Severe	Low	Low	Low	Moderate
Probable	Negligible	Low	Low	Low	Low
	Minor	Low	Low	Low	Moderate
	Significant	Low	Low	Moderate	High
	Severe	Low	Low	Moderate	High
Imminent	Negligible	Low	Low	Low	Low
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	Significant	Low	Moderate	High	High
	Severe	Low	Moderate	High	Extreme

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	Severe	Low	Low	Low	Low
Possible	Negligible	Low	Low	Low	Low
	Minor	Low	Low	Low	Low
	Significant	Low	Low	Low	Moderate
	Severe	Low	Low	Low	Moderate
Probable	Negligible	Low	Low	Low	Low
	Minor	Low	Low	Low	Moderate
	Significant	Low	Low	Moderate	High
	Severe	Low	Low	Moderate	High
Imminent	Negligible	Low	Low	Low	Low
	Minor	Low	Low	Moderate	Moderate
	Significant	Low	Moderate	High	High
	Severe	Low	Moderate	High	Extreme

Overall risk rating could be reduced 5 of 9 times if arborists visits the site during a non-busy time of day

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Improbable	Negligible	Low	Low	Low	Low
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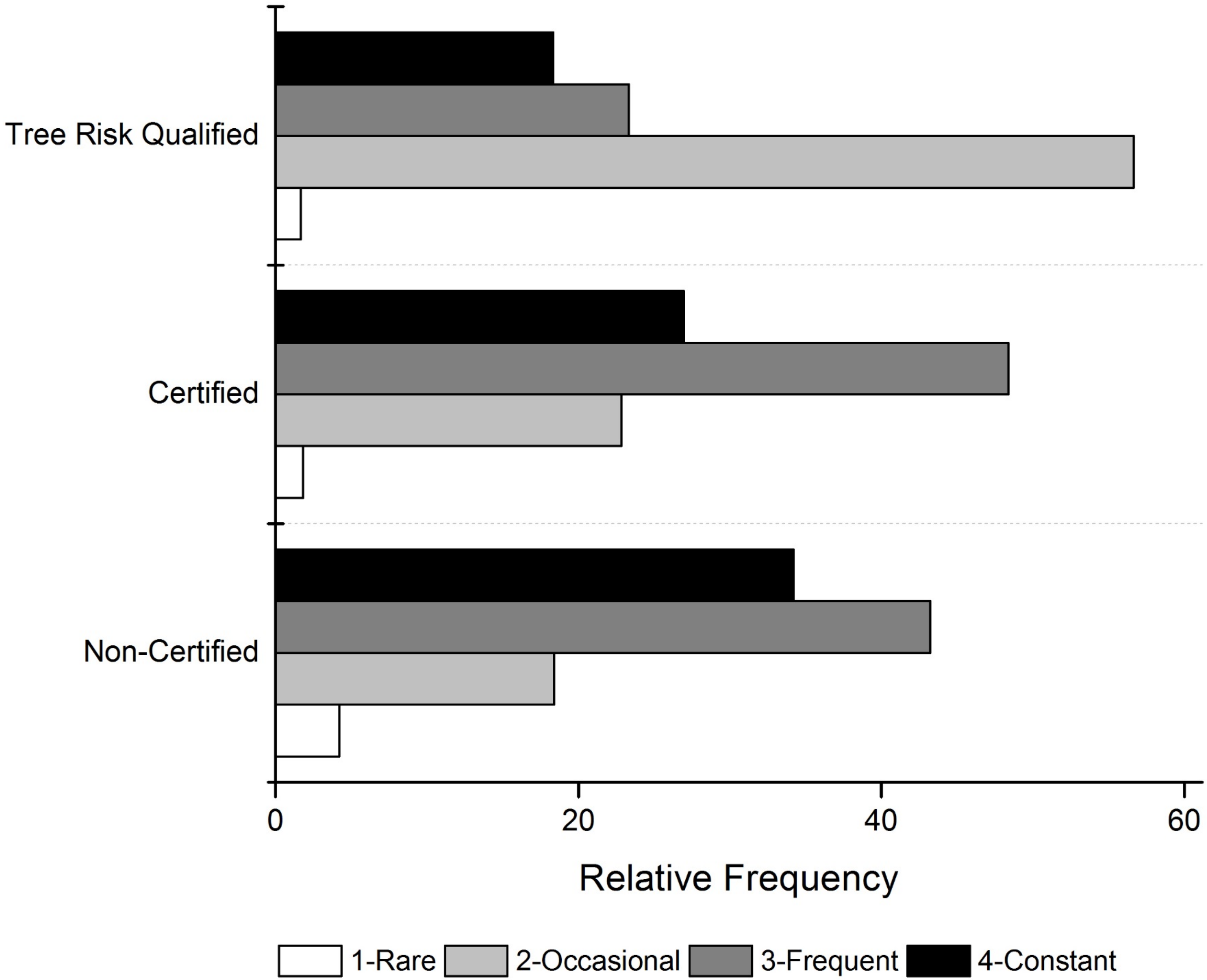
Probable	Negligible	Low	Low	Low	Low
	Minor	Low	Low	Low	Moderate
	Significant	Low	Low ↔	Moderate	High
	Severe	Low	Low ↔	Moderate	High
Imminent	Negligible	Low	Low	Low	Low
	Minor	Low	Low ↔	Moderate	Moderate
	Significant	Low	Moderate ↔	High	High
	Severe	Low	Moderate ↔	High	Extreme

Overall risk rating could be increased 7 of 9 times if arborists visits the site during rush hour


Tree Risk Qualified
Certified
Non-Certified
0
20
40
60
Relative Frequency
1-Rare
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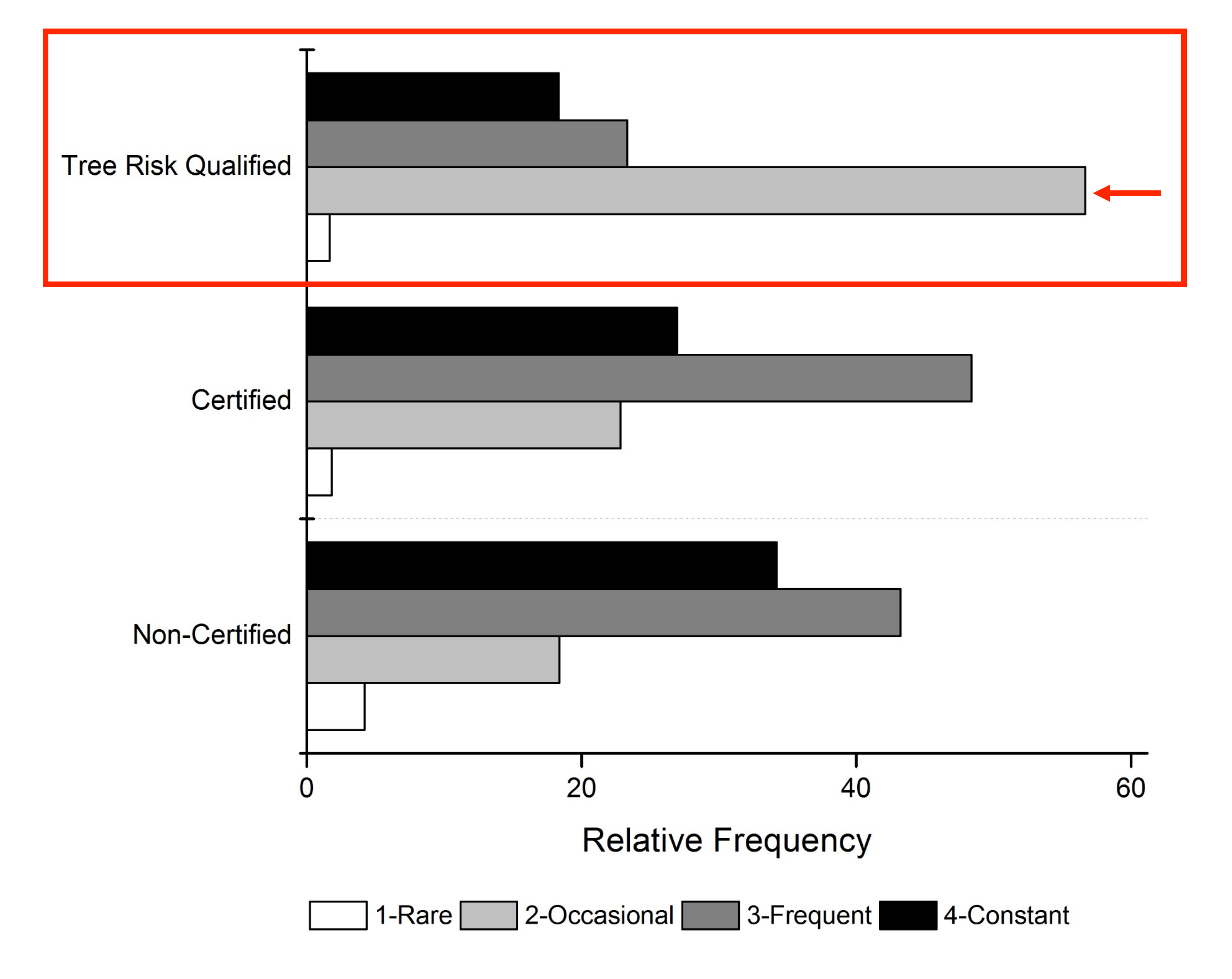
3-Frequent
4-Constant



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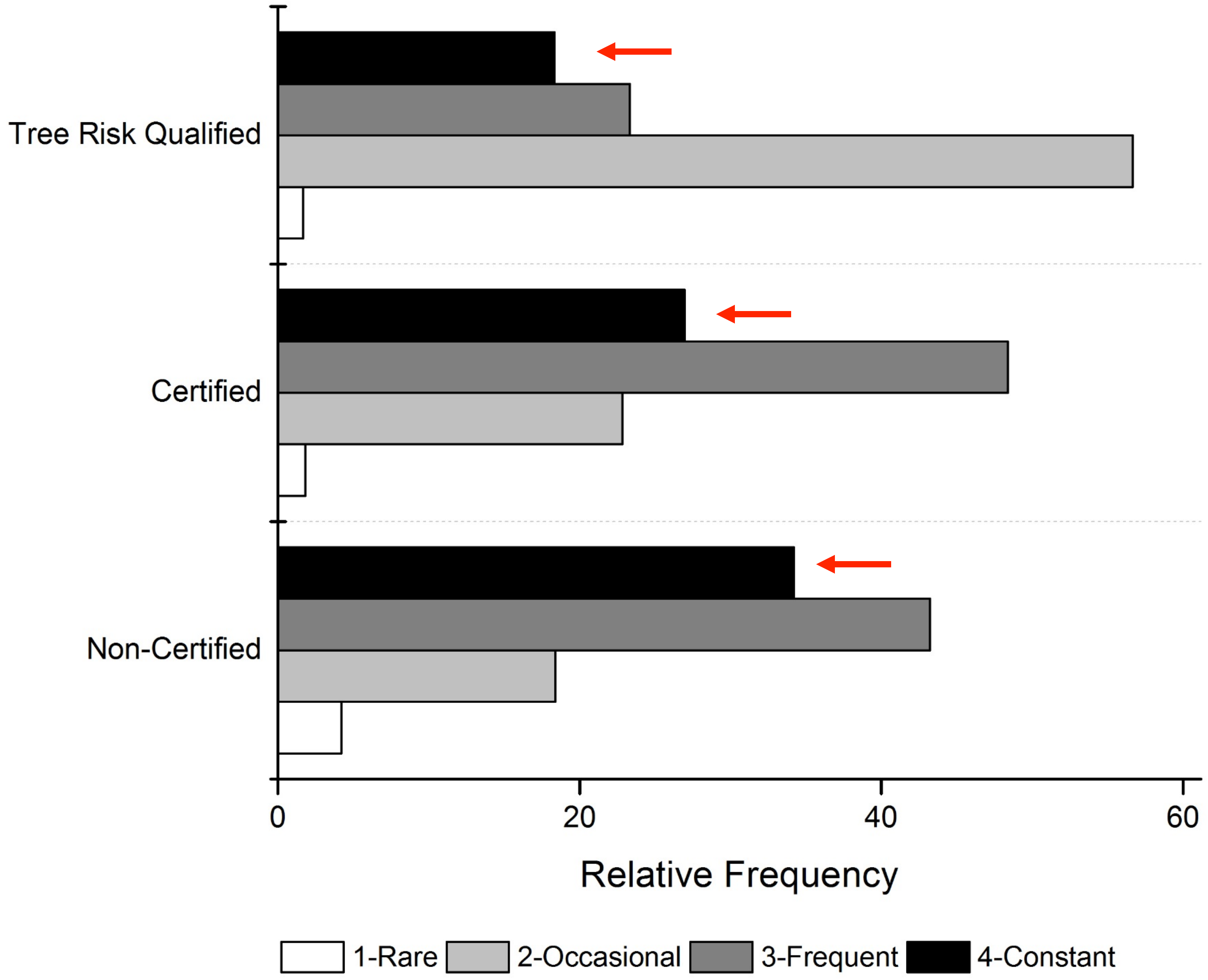
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Results

- Time of day (*P*-value < 0.001) significantly influenced ratings, but not time of year (*P*-value = 0.130).
- Risk ratings derived from the video clips did correlate actually occupancy (r = 0.29; P-value < 0.001) , but seeing the data helped significantly (r = 0.62; *P*-value < 0.001)

Detecting Decay With Visual Indicators

Arboriculture & Urban Forestry 42(4): July 2016 217

Arboriculture & Urban Forestry 2016. 42(4): 217–226

ISA

ARBORICULTURE & URBAN FORESTRY

Frequency, Severity, and Detectability of Internal Trunk Decay of Street Tree *Quercus* spp. in Tampa, Florida, U.S.

Andrew K. Koeser, Drew C. McLean, Gitta Hasing, and R. Bruce Allison

153 *Quercus virginiana* (Southern live oak)

86 *Quercus laurifolia* (laurel oak)

Table 3. Comparison of laurel oak (*Quercus laurifolia*) street trees in Tampa, Florida, U.S., with visual decay indicators and internal stem decay (n = 86). Trees were assessed visually prior to advanced assessment with a resistance-recording drill.

Decay severity	Trees with positive/potential decay indicators	Actual number of trees with decay at this level[z]	Percent identified correctly with visual assessment
0%	10	28	64.3%[y]
1%–10%	14	22	63.6%
11%–20%	5	9	55.6%
21%–30%	3	7	42.8%
31%–40%	5	6	83.3%
41%–50%	4	4	100%
51%–60%	2	3	66%
61%–70%	5	5	100%
71%–80%	0	0	n/a
81%–90%	2	2	100%

[z] Based on resistance-recording drill measurement data.

[y] To calculate this percentage, researchers compared the number of trees without positive/potential decay indicators (18) to the actually number of trees without decay (28).

Table 4. Comparison of live oak (*Quercus virginiana*) street trees in Tampa, Florida, U.S., with visual decay indicators and internal stem decay (n = 153). Trees were assessed visually prior to advanced assessment with a resistance-recording drill.

Decay severity[z]	Trees with positive/potential decay indicators	Actual number of trees with decay at this level[z]	Percent identified correctly with visual assessment
0%	7	108	93.5%[y]
1%–10%	4	18	22.2%
11%–20%	1	16	6.3%
21%–30%	1	3	33.3%
31%–40%	0	2	0.0%
41%–50%	0	3	0.0%
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Take Home Message….

For some species, visual tree assessment (basic) can be quite effective in detecting internal decay.

A basic assessment from a trained arborist (CA/TRAQ) with minimal experience was very much in line with the output from a resistance recording drill

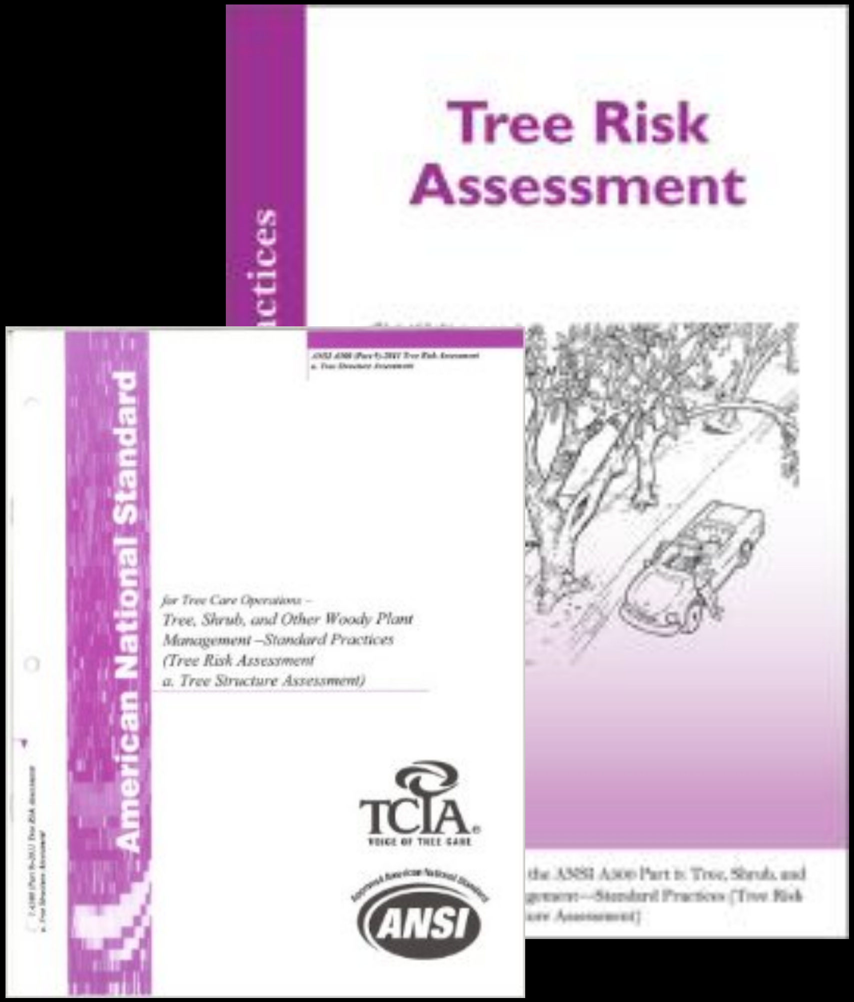
Next Logical Questions…

- How do likelihood of failure ratings derived from basic assessments (VTAs) differ from those derived from other levels of assessment (i.e., limited visual/drive-by and advanced assessment)
- Was this just one arborist getting lucky? What happens when multiple arborist perform a similar experiment?

Assessment of Likelihood of Failure Using Limited Visual, Basic, and Advanced Assessment Techniques

Three Levels of Risk Assessment

- Level 1 – Limited Visual (Walk- or Drive-by)
- Level 2 – Basic Assessment
- Level 3 – Advanced Assessment



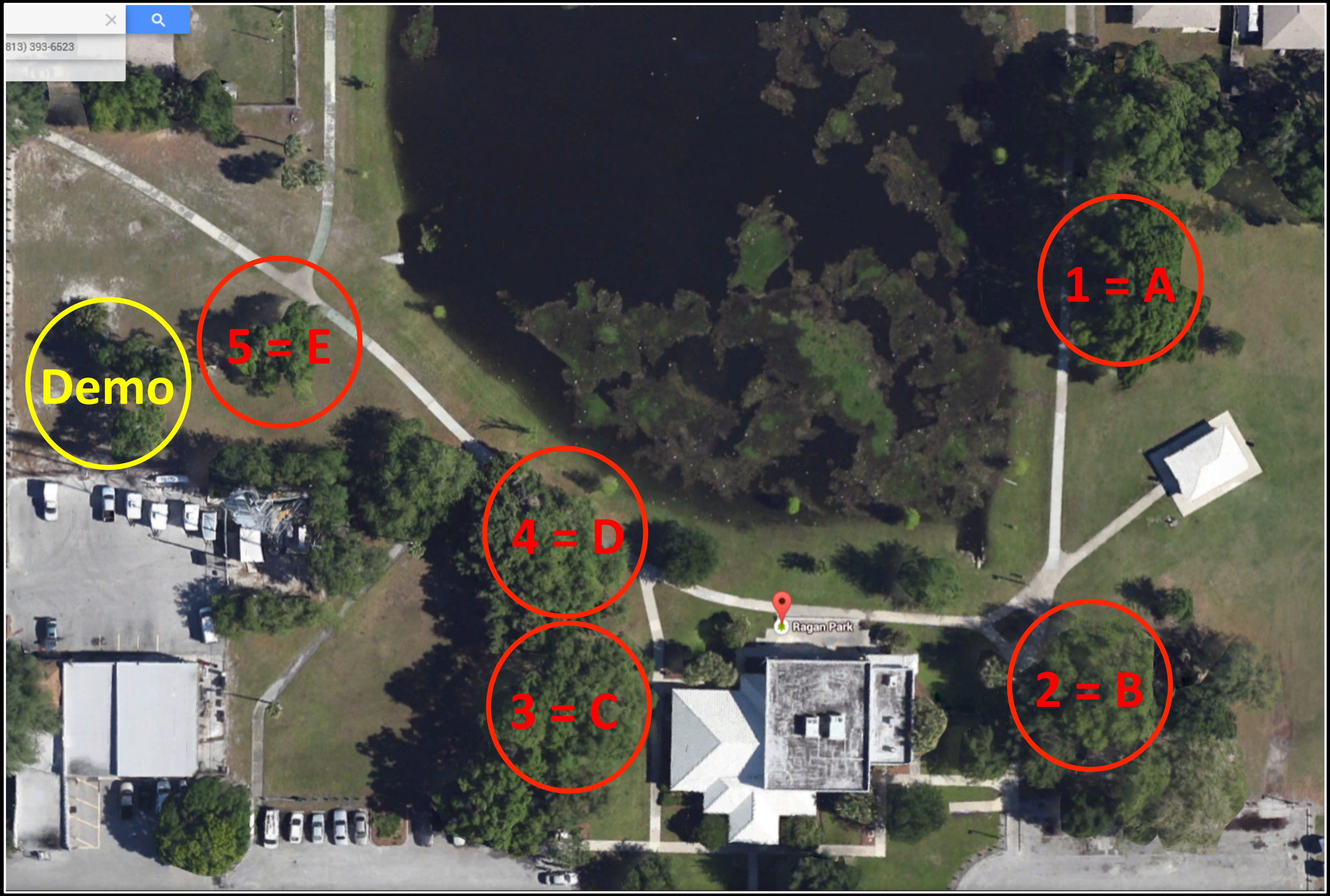
Impact of Level of Assessment on Failure Potential Rating

- 70 Arborists assessed 5 trees going from LV to AA

Impact of Level of Assessment on Failure Potential Rating

- At what point did the added info cease to impact rating?

Impact of Technology in Risk Decision Making

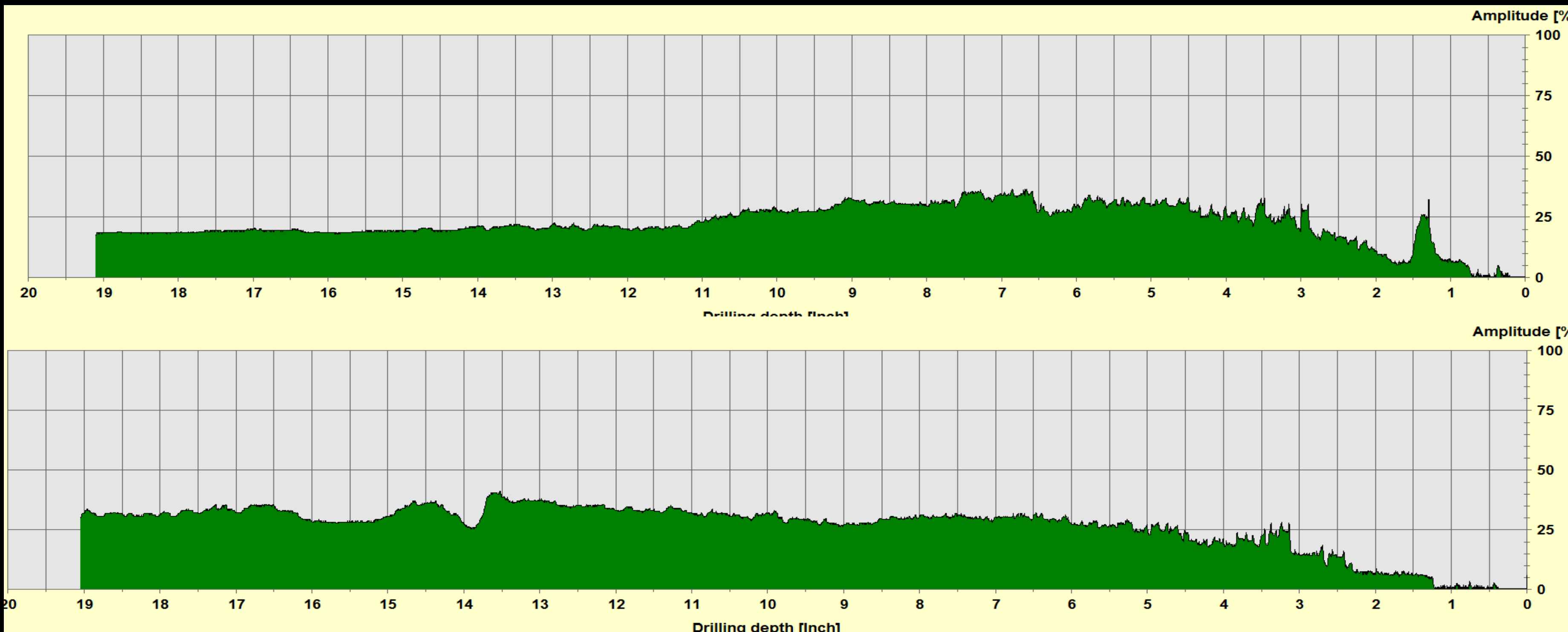


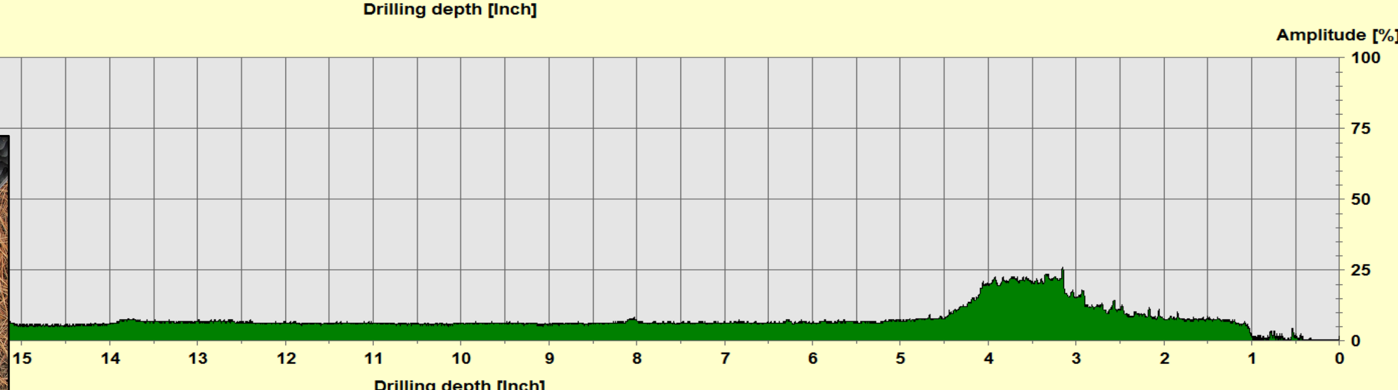
Limited Visual

Basic Assessment

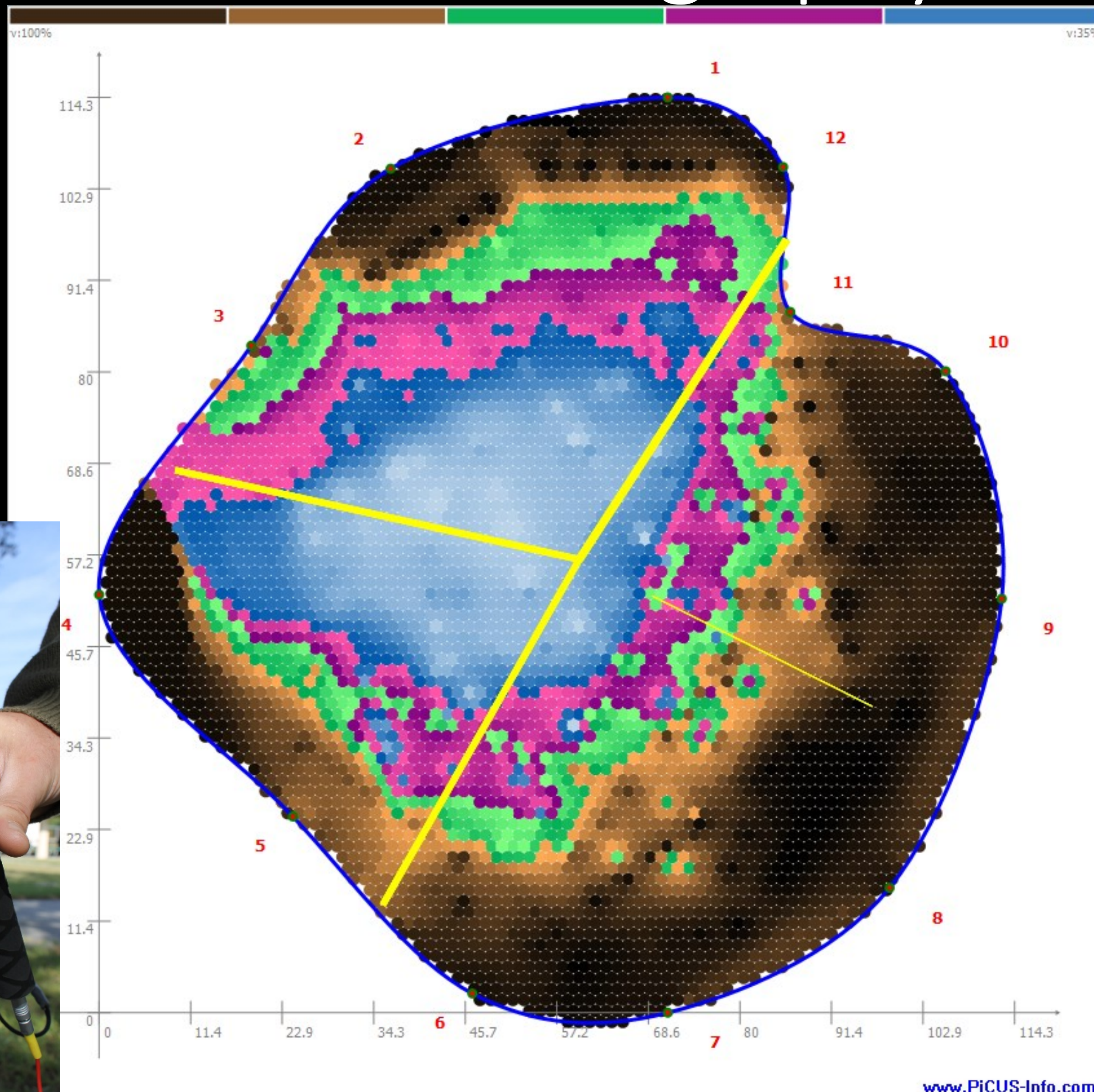
Basic + Mallet

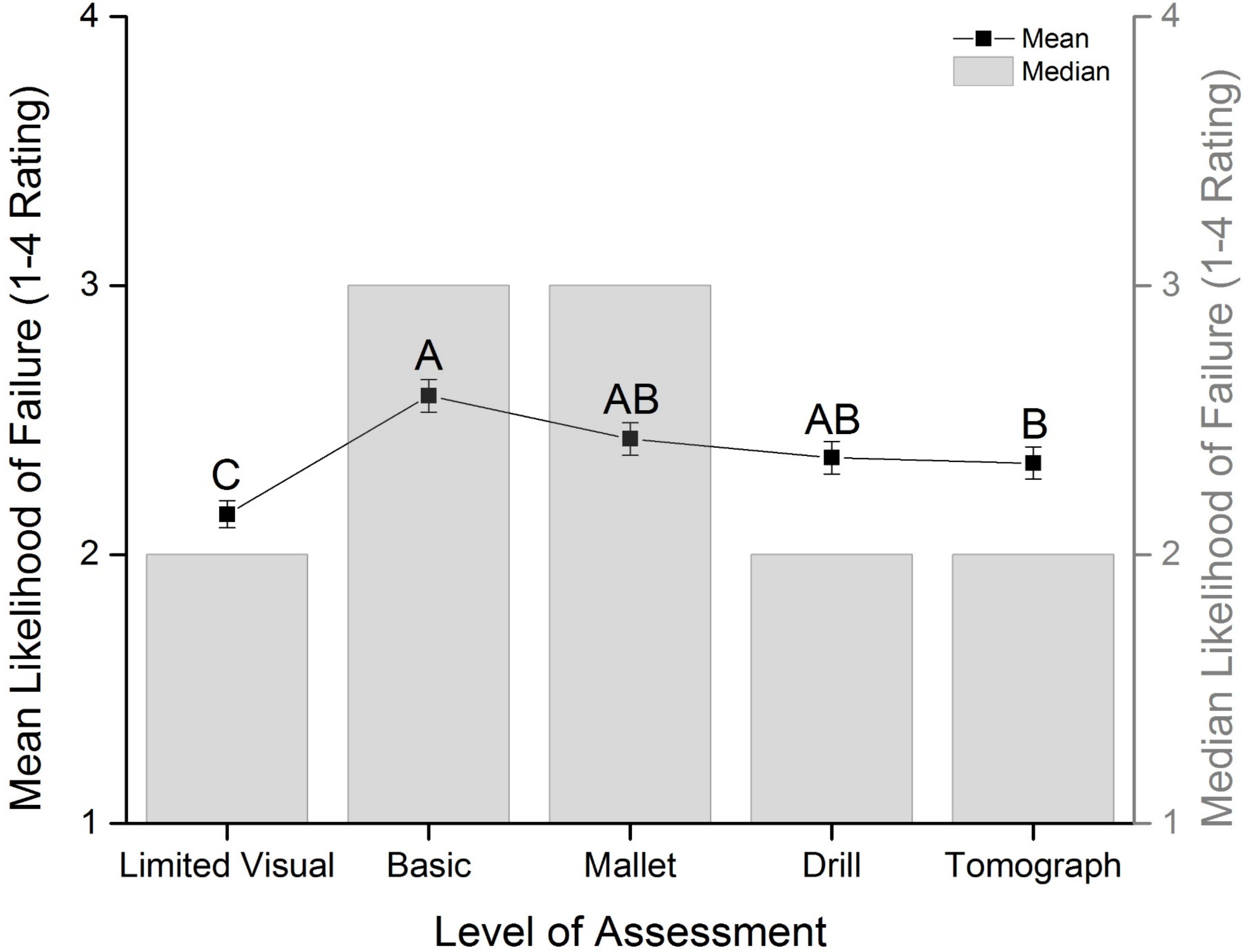
Resistance Recording Drill

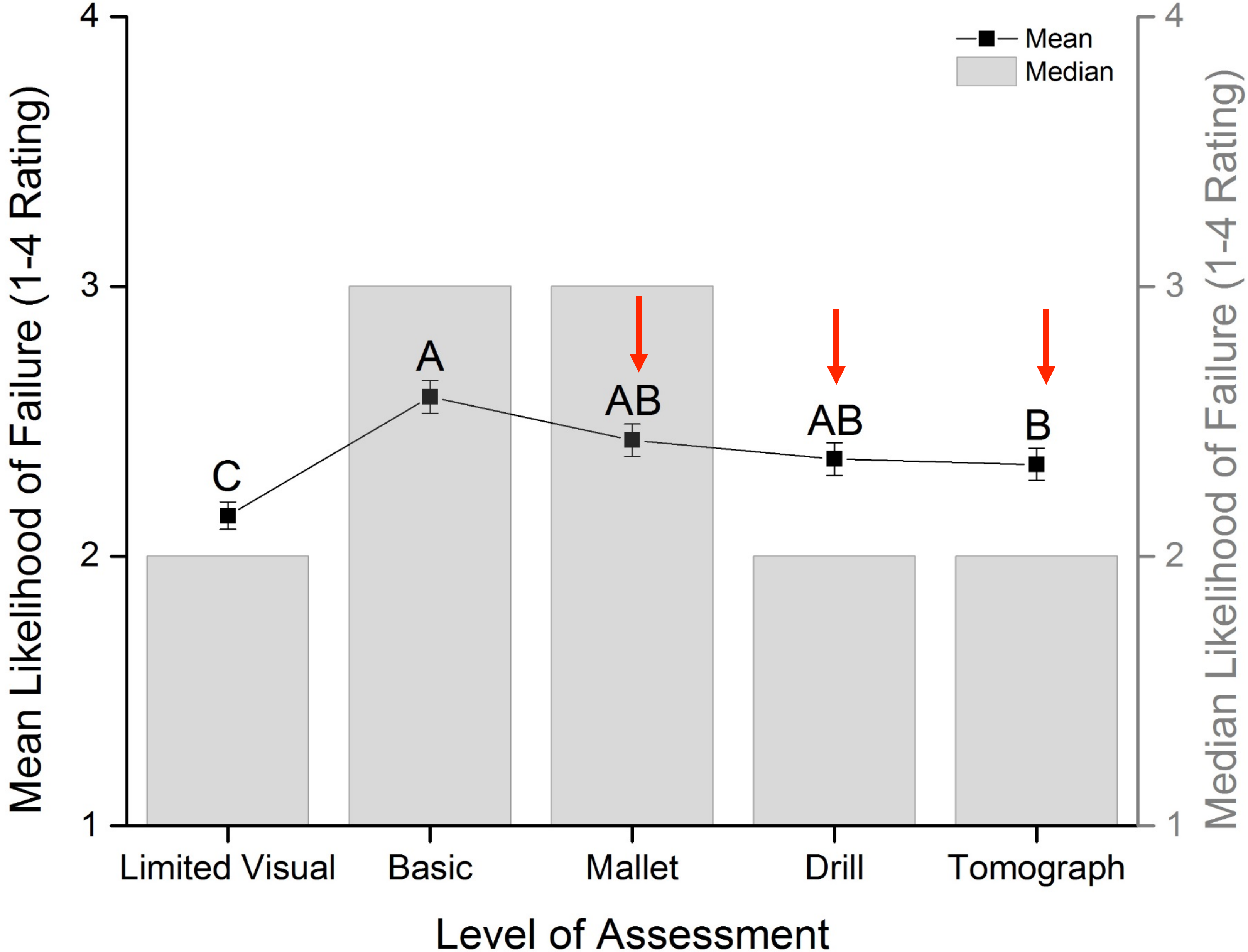




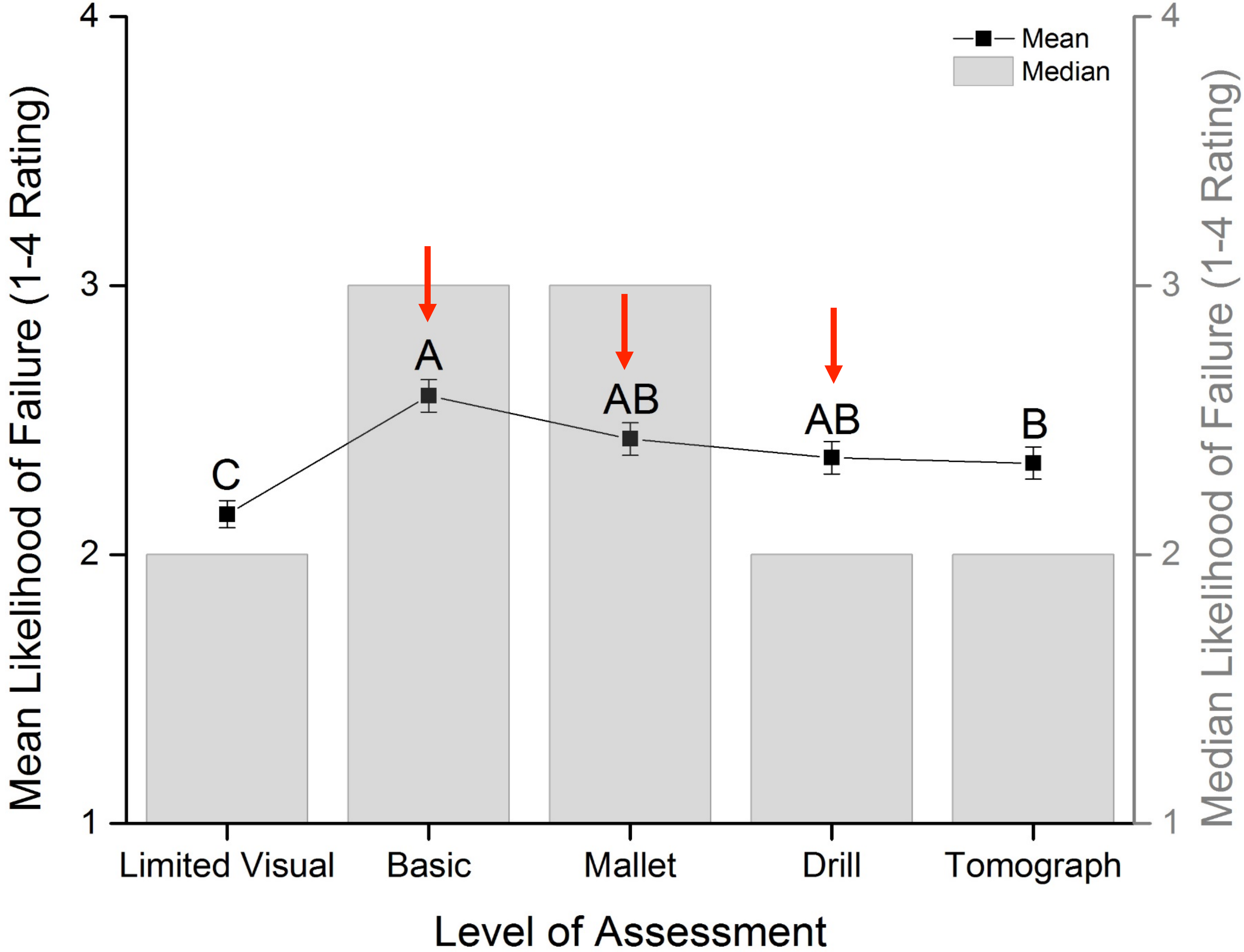
Sonic Tomography



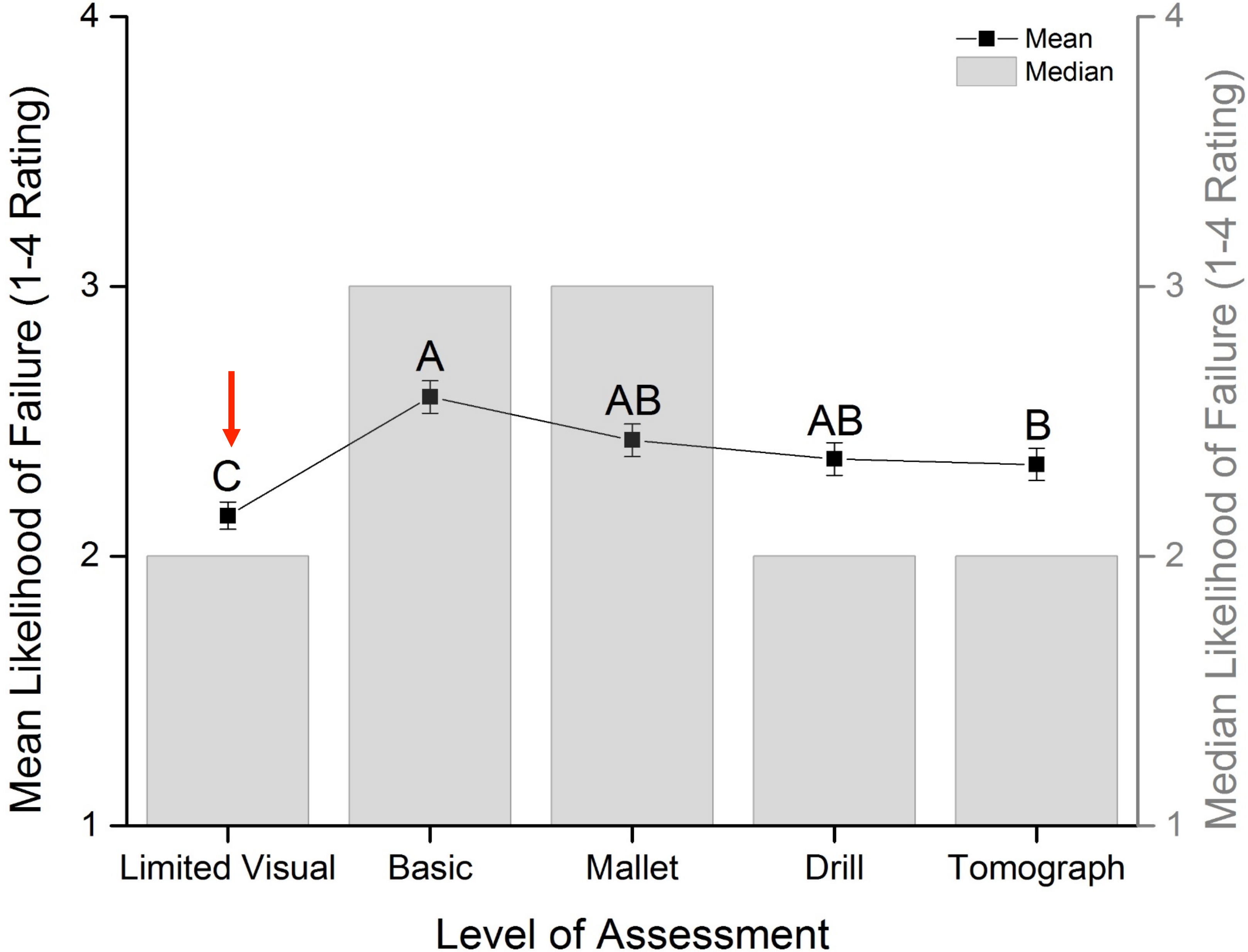

Mean Likelihood of Failure (1-4 Rating)
Median Likelihood of Failure (1-4 Rating)
Mean
Median
1
2
3
4
C
A
AB
AB
B
Limited Visual
Basic
Mallet
Drill
Tomograph
Level of Assessment



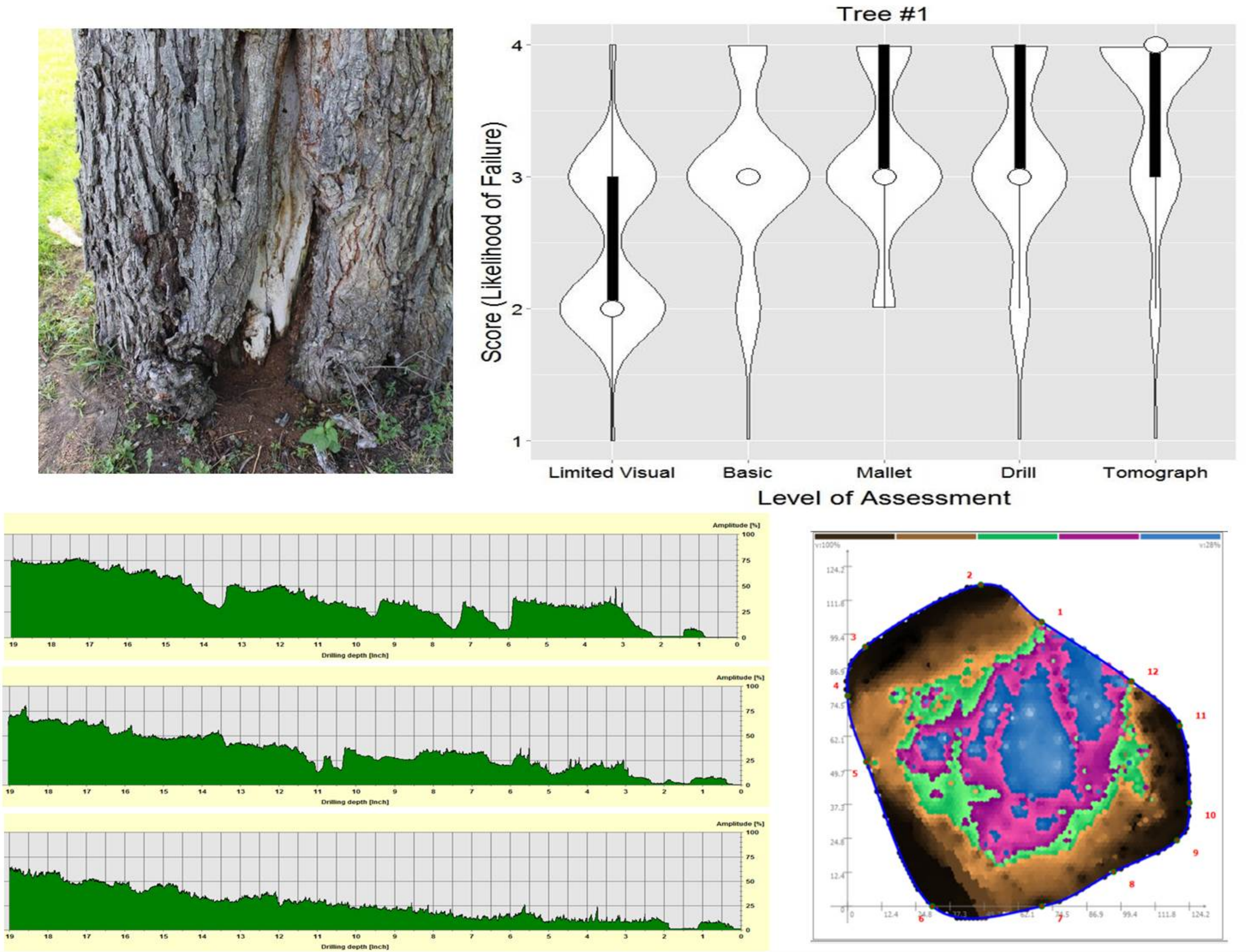
Mean Likelihood of Failure (1-4 Rating)
Median Likelihood of Failure (1-4 Rating)
Mean
Median
C
A
AB
AB
B
1
2
3
4
Limited Visual
Basic
Mallet
Drill
Tomograph
Level of Assessment



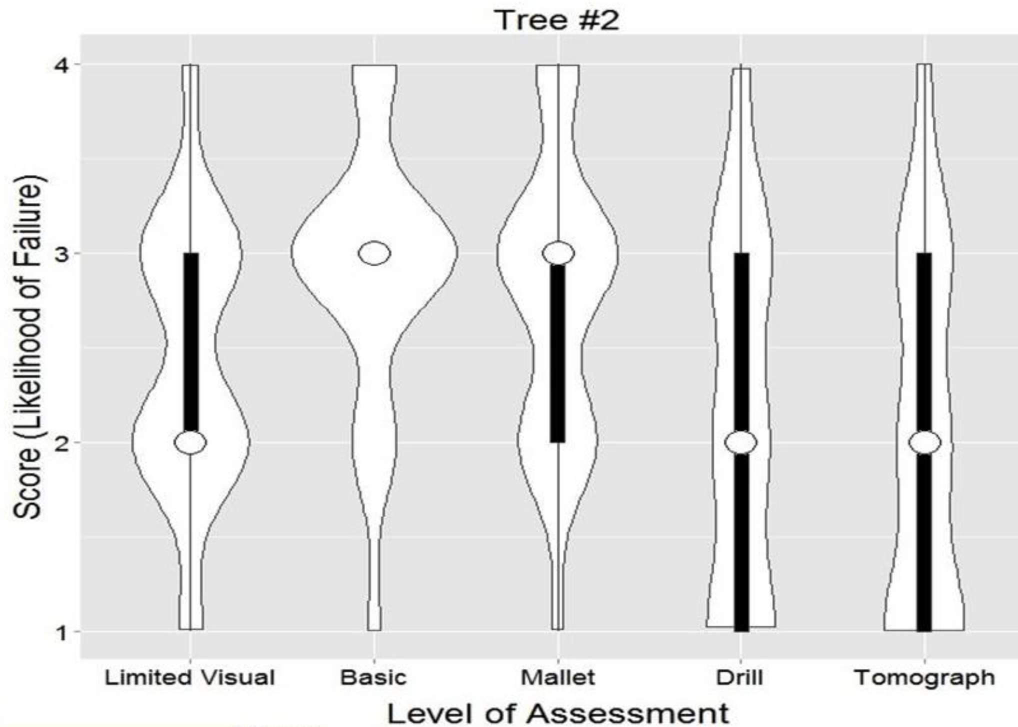
Mean
Median
Mean Likelihood of Failure (1-4 Rating)
Median Likelihood of Failure (1-4 Rating)
4
3
2
1
C
A
AB
AB
B
Limited Visual
Basic
Mallet
Drill
Tomograph
Level of Assessment



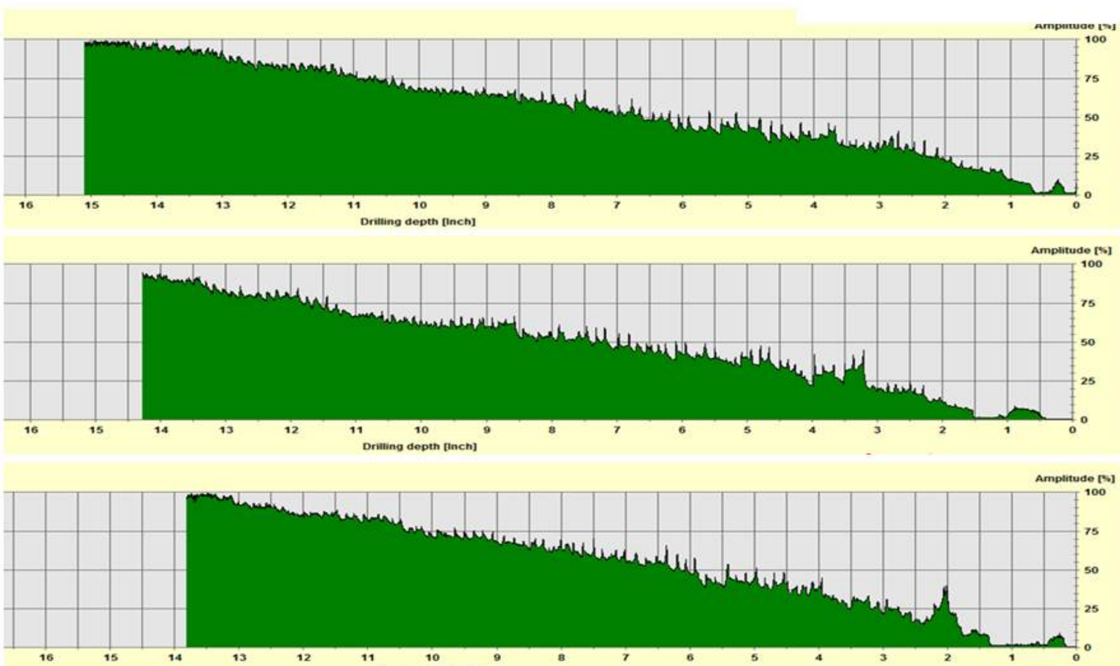
Mean Likelihood of Failure (1-4 Rating)
Median Likelihood of Failure (1-4 Rating)
1
2
3
4
Mean
Median
A
AB
AB
B
C
Limited Visual
Basic
Mallet
Drill
Tomograph
Level of Assessment



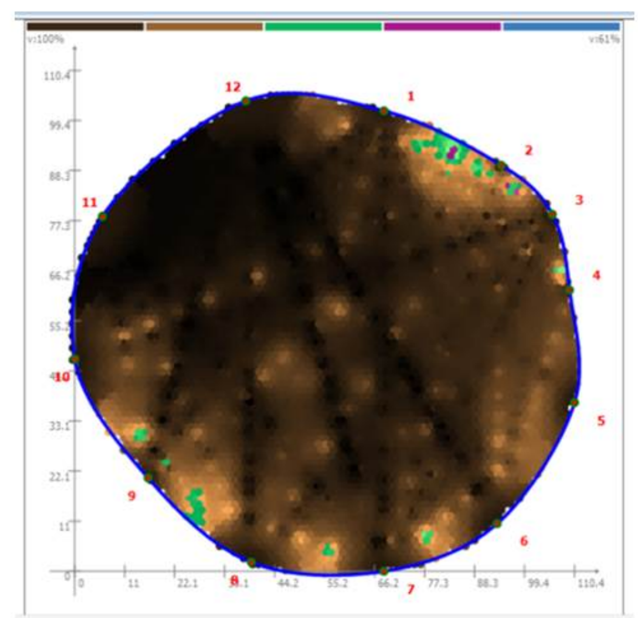
Tree #1
Score (Likelihood of Failure)
1
2
3
4
Limited Visual
Basic
Mallet
Drill
Tomograph
Level of Assessment
Amplitude [%]
100
75
50
25
0
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Drilling depth [inch]
v:100%
v:28%
124.2
111.8
99.4
86.9
74.5
62.1
49.7
37.3
24.8
12.4
0
1
2
3
4
5
6
7
8
9
10
11
12



Tree #2
Score (Likelihood of Failure)
4
3
2
1
Limited Visual
Basic
Mallet
Drill
Tomograph
Level of Assessment



Amplitude [%]
100
75
50
25
0
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Drilling depth [inch]

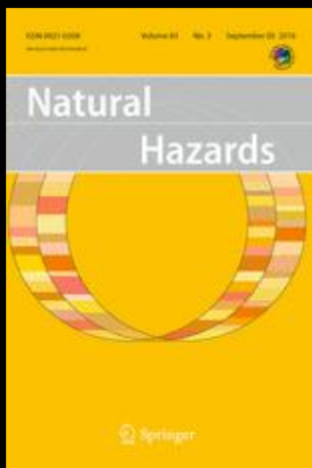


1
2
3
4
5
6
7
8
9
10
11
12

Conclusions

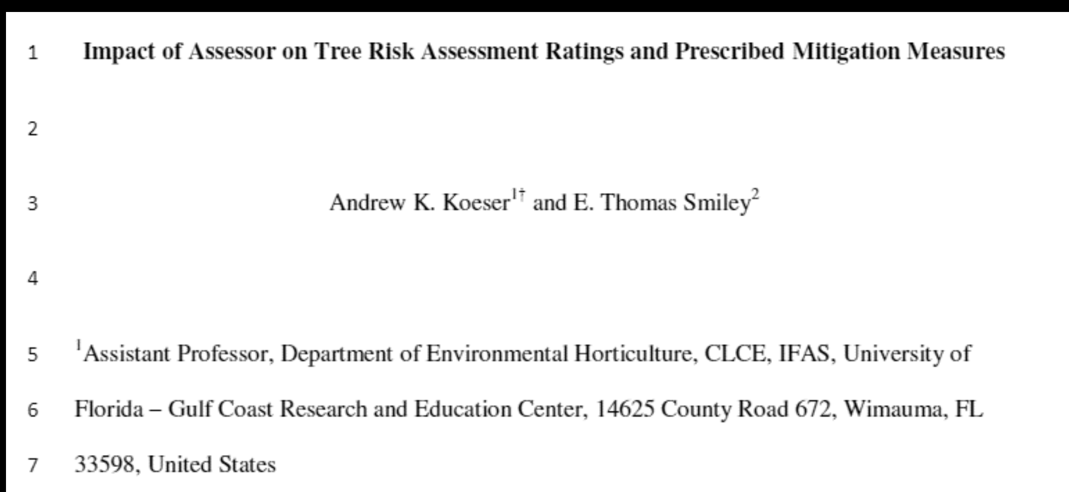
- Increasing the level of assessment often made assessments most variable…not less.
- Ratings were highest for basic assessments (visual and mallet), but still similar to the drill
- Limited visuals ratings tended to be lower (less seen)
- Sonic tomography ratings also tended to be lower (eased concerns)

Remember this study? The plot thickens…



296 Arborists assessed three trees each.

Compared sources of variation among ratings/ inputs


Impact of Assessor on Tree Risk Assessment Ratings and Prescribed Mitigation Measures

Andrew K. Koeser[1†] and E. Thomas Smiley[2]

[1]Assistant Professor, Department of Environmental Horticulture, CLCE, IFAS, University of Florida – Gulf Coast Research and Education Center, 14625 County Road 672, Wimauma, FL 33598, United States

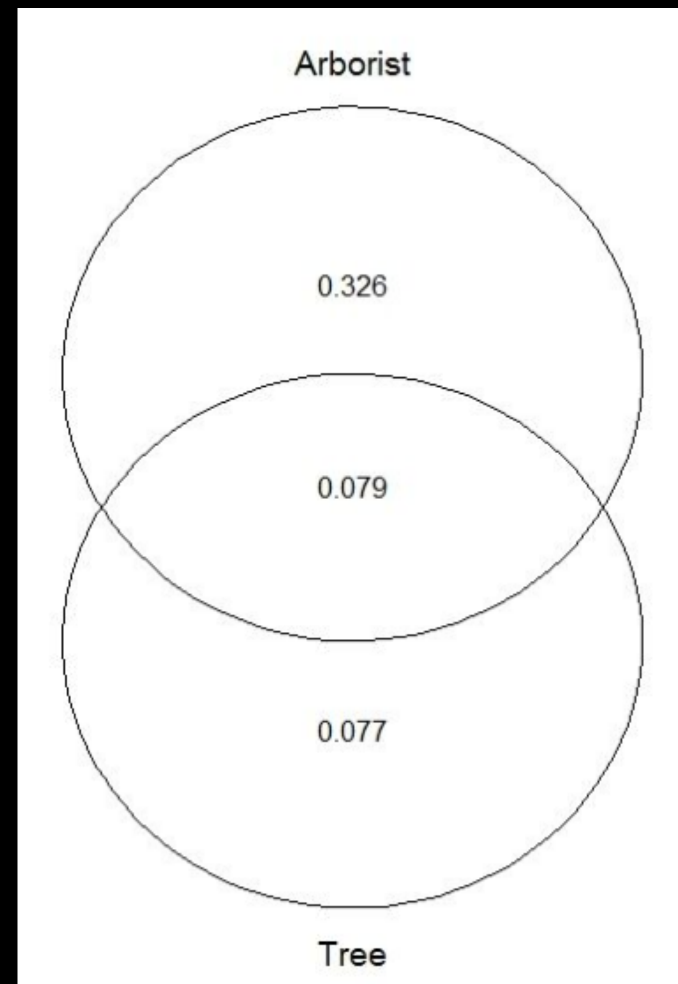


Table 3. Instances where the risk assessment inputs (i.e., likelihood of impact, likelihood of failure, and consequence of failure) were the most variable (only looking at cases where tests of equal variance were significant).

	Statistical Test of Equal Variance		
	Significant Bartlett's Test (n = 46)	Significant Levene's Test (n = 32)	Significant Fligner-Killeen Test Outcomes (n = 30)
Likelihood of Impact	28	21	19
Likelihood of Failure	2	2	2
Consequence of Failure	16	9	9
Significance (*P*-value)	<0.0001	<0.0001	<0.0001

Target Occupancy

Journal of Arboriculture 31(2): March 2005

QUANTIFIED TREE RISK ASSESSMENT USED IN THE MANAGEMENT OF AMENITY TREES

By Michael J. Ellison

- "…target value is the most significant and most easily quantified element of the [risk] assessment"
- Echoed by in ISA TRAQ Training…now multiple targets can be listed

Urban Forestry & Urban Greening

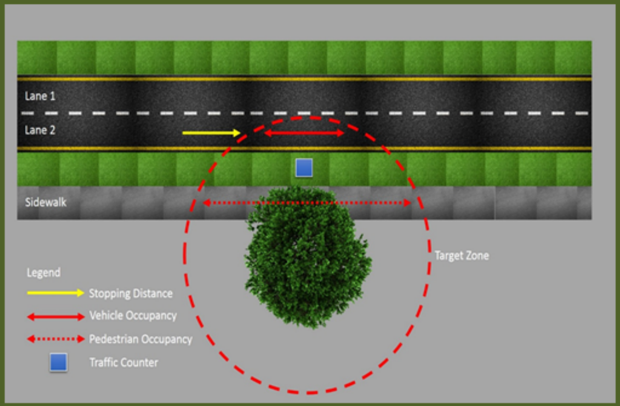
Volume 19, 1 September 2016, Pages 194–201

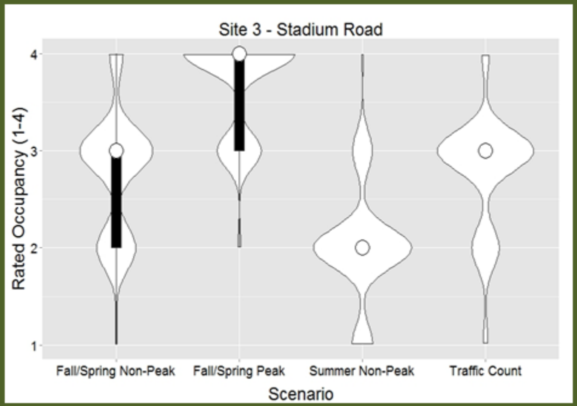
Relationship between perceived and actual occupancy rates in urban settings

Ryan W. Klein[a], Andrew K. Koeser[b], Richard J. Hauer[c], Gail Hansen[d], Francisco J. Escobedo[e]

Time of day influenced ratings…

Ratings more consistent with traffic data.





Conclusions

North American arborists have long focused solely on tree defects. This played out in several studies.

We should take heart in knowing our basic assessments can be quite consistent with regard to failure potential.

Conclusions

Industry knowledge of tree biomechanics remains a limitation when using advanced assessment techniques, especially decay detection devices which have been vetted in peer review.

As with anything, these limitations can be address with focused research and training efforts.

Conclusions

For ISA TRAQ, LoI and CoF are low-hanging fruit which, if addressed, could greatly increase reproducibility.

Scientifically sound and unbiased research may benefit risk assessment beyond those commonly used in North America.

Conclusions

- Fancy equipment can give precise estimates of decay and occupancy
- However, without defendable thresholds or decision rules, risk assessments will remain variable (if not more variable).

Conclusions

- Variability exists even in relatively straight-forward comparisons (occupancy in hours per day vs 4 point rating for occupancy)
- Need to test to see how experience and training (TRAQ) influences variability (and these results) for basic assessments and for the advanced methods tested here