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Relationship between perceived and actual occupancy rates in urban settings

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ABSTRACT

Arborists and tree care professionals assess tree risk by considering likelihood of impacting a target, likelihood of failure, and consequence of failure (should a target be impacted). For basic risk assessments, these three factors are typically assessed qualitatively using visual cues, though it is possible to quantify target occupancy (as it relates to the likelihood of impacting a target) using traffic monitoring equipment. For this study, 115 arborists were surveyed to see if their visual assessments of occupancy (based on videos filmed during different seasons and time of day) correlated with the actual measured occupancy counts recorded at four different locations. While there was a significant relationship between visual target occupancy ratings and actual occupancy, ratings were improved when traffic counter data was provided. Additionally, 70% of respondents considered traffic counters a worthwhile investment as they believed they could increase the accuracy of target occupancy assessments.

1. Introduction

While offering many benefits, urban trees can also pose a risk to people and property. Arborists and tree care professionals often perform visual assessments of trees in urban areas to gauge risk and recommend mitigation measures as needed. Most of the commonly used tree risk assessment methods draw on visual indicators to gauge risk using three key factors: (1) likelihood of impacting a target (target occupancy), (2) likelihood of failure, and (3) consequences of failure if the target is struck. Typically these factors are given ordinal ratings (i.e., a number or category) which are summed or otherwise combined to yield an overall risk rating. Such methods are well outlined in the International Society of Arboriculture (ISA) Tree Hazard Evaluation Method (Matheny and Clark 1994), United States Department of Agriculture (USDA) Forest Services Community Tree Risk Evaluation Method (Pokorny 2003), and The ISA Tree Risk Assessment Best Management Practice (BMP) Method (Smiley et al., 2011; Dunster et al., 2013).

Of the three factors addressed during a tree risk assessment, target occupancy is considered by some to be the most important and most easily quantifiable factor (Ellison, 2005). During a risk assessment, target occupancy is typically the first thing considered and it is often the only factor that can effectively bring risk down to zero (i.e., no target, no risk) (Ellison, 2005). Some targets such as buildings and structures are stationary—representing 100% occupancy. In contrast, pedestrians and vehicles are often in motion and their occupancy can vary greatly, depending on the site and the time of day.

Risk assessment methods have long incorporated the understanding that trees in areas with higher target occupancy pose greater risk (Lonsdale, 2007). In the Quantified Tree Risk Assessment (QTRA) method, Ellison (2005) argues that quantifying target occupancy is a relatively straight-forward process given the use of proper equipment (i.e. traffic counters). The additional information gained from measuring target occupancy is an important part of the risk assessment process, at times lowering the potential risk of a given tree (Ellison, 2005). Given this, QTRA allows for the incorporation of measured values (i.e., use of traffic counters) when determining target occupancy for the assessment (Ellison, 2005).

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Currently, QTRA is most prevalent in Australia and the United Kingdom. In the United States, the ISA Tree Risk Assessment Best Management Practice (TRABMP) system (Smiley et al., 2011), the ISA Tree Hazard Evaluation system (Matheny and Clark, 1994), and United States Department of Agriculture (USDA) Forest Services community Tree Risk Evaluation system (Pokorny, 2003) are more common (Koeser et al., 2016). These methods of risk assessment rely on qualitative assessments of target occupancy from visual cues (e.g., road size, places of interest within proximity of a tree, presence of benches or other infrastructure which would attract occupants) to gauge how often mobile targets like pedestrians or vehicles are present in a tree's target zone. Compared to direct measurement, these subjective ratings may have a greater potential to add uncertainty and inconsistency to the risk assessment. In extreme cases, inaccurate assessments of target occupancy could alter overall risk rating—leading to ill-prescribed mitigation measures (e.g., unwarranted removal of a tree and ill-advised tree retention) and possible public disputes and legal liabilities.

This research offers a direct comparison of target occupancy ratings derived from visual cues and those derived from actual traffic and pedestrian count data. When monitoring vehicular and pedestrian movement, traffic counting equipment is often left out in the field for a week or more depending on the scope of the project (Florida Department of Transportation, 2007). In comparison, an arborist assessing occupancy as part of a basic visual inspection may only be at the site for 20–30 min (Koeser et al., 2013). Given this truncated monitoring period, time of inspection (i.e., peak hours or non-peak hours) may influence visual assessments of target occupancy. Similarly, in locations with seasonal population fluctuations (i.e., college campuses, resort towns, etc.) the time of year may also influence the accuracy of visual assessments (as well as weeklong traffic counting efforts; Papastavrou et al., 2010). The current study addresses the related issues involving target occupancy, which have yet to be touched on in the context of urban forestry and tree risk assessment

For this study, we predicted that visual assessments of target occupancy would be influenced by the time of day and season in which a site was visited (and recorded for the survey). Accuracy and consistency are two criteria identified by Norris in his assessment of multiple risk assessment methods (2007). While we predicted visual assessments would correlate with actual measured occupancy levels, we believed target occupancy ratings would be more accurate and consistent once respondents were shown the actual traffic count data.

2. Methods

2.1. Survey design and preparation

For this experiment, four sites on the University of Florida Campus in Gainesville, Florida (United States) were chosen to provide a range of occupancies (i.e. vehicular and pedestrian) and to accommodate traffic data collection with our monitoring equipment. All four sites had sidewalks and bike lanes on both sides of the road, where they differed were that three out of the four sites had two lanes of vehicular traffic (Site 2, Site 3, Site 4), with the exception being Site 1, which had four lanes of traffic. A campus wide speed limit of 20 mph was consistent across all four sites. Vehicular traffic was measured with a magnetic traffic logger (TRAFx Vehicle Counter, TRAFx Research Ltd., Canmore, Alberta, Canada). Pedestrian traffic was measured with an infrared traffic logger (TRAFx Infrared Trail Counter, TRAFx Research Ltd., Canmore, Alberta, Canada). Vehicle and pedestrian traffic data were collected for each site over two weeks (including weekends)—one while school was in session and one during the summer vacation session. This data was weighted to account for the shorter duration of the summer session and averaged to calculate daily vehicle and pedestrian traffic counts. Target occupancy was calculated using a modified version of the method proposed by Ellison (2005). Most importantly, we estimated the time required to walk through the target zone rather than use the standard QTRA value of 5 s of occupancy per pedestrian count (Ellison, 2005). Similarly, we factored in the time it would take a vehicle to clear the target zone (including stopping distance), while Ellison (2005) only accounts for stopping distance and the time to travel one car length (6 m) in his method. For the latter approach, the risk assessor is estimating the time required to pass over a single point within the target zone.

At each site, a tree was selected as the candidate for risk/target occupancy assessment; selections were based on their overall size and close proximity to sidewalks, road ways, and bike lanes. Video scenes from each of the four sites were recorded multiple times to capture occupancy at different times of day and in different seasons. The tree was visited at peak times (i.e., 12:00–13:00 h) and non-peak times (i.e., 10:00–11:00, 2:00–3:00) during the University's fall/spring semesters and the summer session. During each visit, a 30-s video was recorded from the base of the tree to capture the actual occupancy for a site, at a particular point in time. The camera was panned 360 ° to provide a street-level view of target zone and to provide participants with a representative depiction of pedestrian and vehicular traffic at each combination of time of day and time of year. All scenes were captured on weekdays. Additionally, still images of the same 4 sites were captured so that they could be used in combination with the actual measured occupancy.

After pre-testing the survey with an undergraduate horticulture class on September 23, 2015, adjustments were made to the delivery and one of the combinations of time of day and time of year was dropped (summer session, peak time of day) to reduce the length of the exercise. The final survey had 12 randomized video clips of the 4 sites (fall/spring semester, peak time of day; fall/spring semester, non-peak time of day; summer session, non-peak time of day) followed by the 4 randomized images with the calculated occupancy rates displayed. Beyond the occupancy ratings, respondents were asked to provide information regarding their risk assessment experience. Two open-ended questions were included to assess the perceived utility and value of traffic counts data in risk assessment. A final version of the survey is included as Appendix A.

For the finalized version of the survey, participants were asked to rank target occupancy after viewing the video clips taken at the 4 sites. Rating was completed using the four-point scale (1–Rare, 2–Occasional, 3–Frequent, 4–Constant) from the ISA BMP (Smiley et al., 2011; Dunster et al., 2013). The videos were imbedded in a slide set and shown in a random order with the height of the tree (which determines target zone) provided verbally. After the videos, four still shots of the same sites were shown with the calculated occupancy values displayed on the slide. Occupancy was conveyed as the number of hours in a 24-h day where a target was present (e.g., 7 h out of 24 h; 17 h out of 24 h).

2.2. Survey delivery

The survey was administered on Thursday, October 15, 2015 as part of an educational session on risk assessment and target occupancy at the Wisconsin Arborist Association (WAA) Fall Conference in Hales Corners, Wisconsin (United States). The survey was delivered in person to 115 attendees. In addition to the general overview of key risk concepts, introductory slides were displayed at the start of the exercise to introduce key terms and define the rating scale. A 5-s pause was included between videos to give participants time to decide on an occupancy rate. Once all 12 videos were shown, the participants were shown the four remaining slides with the still images and measured occupancies. Participants were given 15 s to