UNIVERSITY OF GEORGIA
Warnell School of Forestry & Natural Resources

Publication WSFNR-21-50C

June 2021

Tree Risk & Hazard Assessment Concepts

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Management of community forests includes tree maintenance, protection and problem prevention. Management denotes resource expertise at the organism level, and familiarity and working knowledge of social systems. In addition, cost-effectiveness over the long-run binds objectives, anticipation of change, recognition of tree stress and strain, mitigating treatments, and evaluation of results into a core of resource management decision making which demands up-to-date and conscientious managers.

A manager must know the tools and expected results of urban forest maintenance. A manager must also understand how to technically assess the condition of the resource. Risk awareness and hazard assessments are critical components of urban forest inventories. These assessments should be systematically completed by trained professionals. There are several means and methods for assessing current risk and hazardous conditions, and anticipating potential risks over time within the community forest.

Appreciating Risk

Community foresters are risk managers. Most large corporations and public institutions have people assigned to risk management with the stated goal of reducing liability exposure. The community forest has many risks associated with its functions and values it produces. At the very least, trees are tall, large, and dense structures which can lose parts or catastrophically fail. Assessment of tree associated risk requires specific training and familiarity with both how the legal system treats tree issues, and how trees and their sites develop across time.

One of the most glaring word uses in risk assessment is the word "hazard." The word hazard, for both lay-people and professionals denote some threshold of risk has been surpassed. Hazard also conveys the immediacy of structural failure as determined by a tree professional. Within community forestry, it is critical the word "hazard" be used only in association with situations where an actual hazard has been identified. The hazard concept demands a completed evaluation and assessment of risk which reaches a management threshold where the situation cannot be allowed to continue. Beware of the misuse or overuse of the word "hazard."

Risk Is Everywhere

Every landscape and tree situation has risk involved. Nothing is risk free. All trees carry some amount of risk. A level of risk under some management regimes could be hazardous, while under other management objectives could be acceptable. Some situations allow more risk to be accepted and managed, while other situations would call for immediate tree removal and risk reduction.

Because all trees have risk associated with them, discussion of the structural integrity of a tree should include assessing the level of risk present. It is the amount of risk present, perceptions of the risk manager, and

willingness to accept or not accept a given level of risk which determines hazard. Any tree is not necessarily hazardous, but all carry some level of assessable risk which professionals can estimate.

Tree Values and Liabilities

One fundamental concept in community forest management is trees have value, provide benefits, and are desired by humans. People find great psychological, monetary, aesthetic, and utilitarian values in trees. Some of the benefits of trees which people enjoy include recreation, psychological calming, shade, heat dissipation, blockage of glare, blockage of noise, production of white noise, reduction of pollutants, production of oxygen, reduction of erosion, wildlife habitat, increased property values, and increased economic stability. Many more values and functions could be added.

Trees have great benefits but also have costs. Tree associated costs include capital infrastructure investments, foregone alternative investments, installation, maintenance, management, and removal. One cost is managing liability risk. Liabilities include ecological, biological, aesthetic, social, economic, and safety risks. You cannot eliminate liability risk from trees unless the entire above and below ground structure is removed from a site. With trees removed, a site still does not remain risk free. A manager can reduce liability risks and keep trees and sites below a risk management acceptance threshold, in most cases. People want trees, but they also need to be safe from threats to property and physical injury.

Decisions

Part of management is being aware of potential risks associated with trees, identifying risks, and then minimizing risks within constraints of site management objectives. This risk assessment process depends upon professional judgements and decisions (or lack of decisions). Every professional decision must be made for one or all of the following reasons: asset protection, asset appreciation, minimization of liability risks (future), public safety (present), and/or to fulfil site management objectives.

Understanding the structure of trees, symptoms of impending structural failure, treatments available to minimize the chance of structural failure, and how trees finally fail are essential knowledge to a community forest manager. Understanding the risks of structural failure is as important as any other component of a manager's job.

Tree Types

There are three classes of trees in the landscape related to levels of risk. The first is a "hazard tree." Attributes of a hazard tree are: 1) major structural faults potentially leading to catastrophic loss; 2) identifiable target (people or property); and, 3) an unacceptable management risk. The second class of tree is a "tree at risk" of catastrophic failure or with a significant target profile potentially leading to injury and harm. A "tree at risk" has potential for becoming a hazard tree. The third class is all the rest of trees present with known risk assessments, or as yet undetermined associated risks. The amount of acceptable risk is dependent upon management objectives of the site, as well as the owner's / manager's perceptions and expectations of tree performance.

Ownership

Before performing a tree risk assessment, it is critical to determine tree ownership and position of legal property boundaries or borders accepted as legal boundaries. Figure 1 shows a tree between property owners A and B. The property line is dotted and to the right side of the tree. It is assumed a major number of tree roots are on property owners B land. In this figure the tree is owned by property owner A. From the founding

of this nation, and derived from English, Spanish and French common law, a plant belongs to the property where it is attached, regardless of its extend and reach of its growth.

Figure 2 shows a tree with the property line to the left of the stem attachment point. This tree belongs to property owner B. Property owner A can remove branches and roots which are under or over the property line if it does not damage the tree. Figure 3 shows a tree split between property owner A and B. Both share responsibility and ownership. Neither one can impact the structure and health of the tree without approval of the other. A resource manager would need permission from both property owners to apply treatments or remove the tree. Tree ownership around boundaries is fraught with interpersonal and social issues regarding multiple property owners. Be sure who owns the tree!

Structural Faults

Because a hazardous condition has three components (a major structural fault relative to a target exceeding management risk acceptance), it is important to start with an examination of structural faults and tree defects. Structural defects are dependent upon fault length, width, and depth (i.e. fault size and volume), tree species, tree vigor, and associated compounding structural problems. Risk assessment is only about structure, not about aesthetics or biology. The risk of structural failure is greatest when trees are under heavy (significantly greater than average wind conditions) wind loads. This type of risk varies over time. Figure 4.

Structural defects can include large vertical (longitudinal) cracks, large decayed areas, included periderm (bark) zones, narrow crotches or forks, dead wood and branches, large cavities, large leans, major root damage, horizontal (tangential) cracks, poorly connected living branches, pest damaged or modified areas, and mis-proportioned crown / root ratio, and poor stem strength for given wind and gravity loading conditions. There are many unique forms of tree structural defects, and so tree failures.

Branch Drop

There are several structural failures that reap much attention. One structural fault of interest is branch drop caused by longitudinal cracks. These cracks can form: along compartment lines of old pruning cuts or injuries; from structural failures along cell walls due to loading stress and strain (bending, tensioning, compression, and twist); and, from negative transpirational pressures. There are several other specific causes. Cracking leads to wound colonization by wood weakening organisms, decreasing moisture content which facilitates more injury, and pest attacks which weaken structural and defensive components of the branch / stem confluence area or branch tissues. The final result is a sometimes sudden loss of living branches.

Root Anchorage

Another significant structural failure is the root plate structural area at the base of a stem. As trees sway in the wind, and are loaded by wind and gravity, structural roots and lower stem undergo alternating periods of compression and tension, with various torque applied. Tree structure is two to three times weaker in compression than in tension. Where structural areas are loaded beyond their compressive limits, fault lines develop that can expand as more compressive load is added over time and can fail under compression, tension, or torque. For example, many trees damaged in storms show compressive failures which later fail under tension in the next storm. Root pulling and shearing across their cross-section are the result.

Root collar problems are receiving much more (well deserved) attention from a structural standpoint. Periderm and cambial damage, especially if repeated over many years, lead to many types of structural

problems in a tree where stress and strain is concentrated. Injury at the stem base and root collar area can be hidden by soil and landscape features. Root collar excavations are essential as a part of risk assessments.

One associated structural component fault sometimes overlooked is girdling roots. Girdling roots are hard to diagnose and can lead to strength losses. The effect of poor root geometry development can lead to significant risks of tree failure after 10-20 years. Generally, root structural problems of any kind are difficult to ascertain, requiring additional care in assessments.

Leaners

Leaning trees have plagued people since the first lean-to was erected. The perceptions and expectations of nonprofessionals when observing a leaning tree is highly variable and govern the amount of risk accepted. Leaning trees could stand for millennium or fall tomorrow. Professional judgement about the structural integrity of leaning trees many times takes a backseat to manager / owner anxiety about impending failure. Trees with progressive leans are clear candidates for removal. Trees which have not changed stem positions relative to the ground and surrounding obstacles for decades probably carry little additional risks other than in specific directional targeting. On the other hand, it is difficult to defend having left a tree with a significant lean when it fails.

Professional Observations

The amount of tree damage visible while still allowing a tree to remain is a professional judgement. Several systems and rules have been developed to assist professionals. Some standards have suggested when 1/2 the stem circumference is damaged, a tree should be considered for removal. From a mechanical structure standpoint, this is not risk-conservative enough. Once circumferential damage reaches 1/3 or more, removal should be considered. Err on the side of safety.

Examining trees must concentrate on determining structural integrity, not surface appearance. Small faults lay-people might consider significant should be examined for structural consequences, but discarded if found to be only a blemish. Find what is the most limiting structural component in the tree and then estimate risks associated with its failure. Experience of the assessor is critical to risk management evaluations. Do not send inventory counters to make risk assessments without training, practice, and spot-checking their performance.

Structural failures in trees can generally be summarized as 40% in branches, 30% in stems, and 30% in root crowns and roots. This near even distribution suggests several things to a tree professional. The first is trees are structurally designed not to fail at any given point more than any other. Trees are well equipped to handle stress and strain in their environments. The second suggestion is common failure patterns need to be learned and expectations developed for prudent management. Careful observation is needed over all parts of a tree to effectively summarize risk levels.

Target Risks

Once structural concerns have been reviewed, determine the second piece of a hazard tree assessment which is presence of a target(s). Risk assessment targets are people and property. Anywhere people would walk, drive, stand, lay, run, recreate, etc. could be a target area. Sidewalks, streets, parking lots, ball fields, golf courses and parks are all prime target areas. Property targets most often damaged by trees are cars, fences, buildings, roofs, pavement, yards, and gardens. Personnel injury targets and property targets are usually interrelated. At the very least, minimize risk to all personal injury targets.

There are many types or classes of targets. Some risk management systems try to prioritize management activities by target risk class. This type of target classification is dangerous in community forest risk assessment. Because of legal views of prudent and reasonable behavior by a manger, the only reasonable means of prioritizing by target are people vs. property. The more people, or the more valuable the property, the more target exposure. Figure 5 shows how non-static (usually people / animals and their conveyances) risk components change over time. Figure 6 combines structural and target risks. Note there is usually an inverse relationship between these two risk sources. At specific times when trees are most likely to fail (heavy wind loads), targets have departed or have been minimized.

Legal Responsibilities

The legal framework for working with tree risks and structural failure varies by location. A community forest manager should always seek professional legal advice when needed. The framework of negligence, injury, and legal tests for prudence and reasonableness are important for understanding implications of risk. Here will be a brief review of general legal components of risks management and hazards assessment in a community forest.

For community forest managers, actions (and non-actions) will be judged for prudence, (which is the wisdom to look ahead and develop expectations about what can happen), and reasonableness, (which is the lack of negligence), A manager's decisions must meet both of these tests under risk management programs, with the major point of contention being negligence.

Negligence

In a general sense, negligence is composed of four features that must all be true for negligence to be proved. These four features of negligence are: 1. You have a duty to exercise reasonable care; 2. You failed in that duty; 3. Failure in duty caused injury; and, 4. Injury caused real harm to people and / or property. The critical first step is determining your duty under the law.

Duty Concepts

Case law and common law has delineated a difference between duty principles in rural versus urban settings. Traditionally in rural settings, an owner / manager had a duty to correct or remove known hazards. Duty principles continue to evolve but generally suggest a greater level of duty in urban / suburban areas. In urban areas, duty has included removal of known hazards and, in addition, inspection for hazards. Inspection for hazards is a burden which must be met to prevent a failure in duty and charge of negligence. The heighten duty in urban/suburban areas carry over into areas where tree
failures could impact roads and trails.

Failure in duty can be substantiated by expert testimony and/or by not following customary practice without clear and substantial reasons. This suggests failing to follow ANSI type national consensus standards and associated BMPs would play a part in determining negligence. Ignorance by the manager or inspector is always challengeable. The action or lack of action can be questioned and supported by expert testimony for examining negligence.

One defense which falsely seems to comfort managers and owners is "act of God." This defense used with hazard trees is challengeable and dependent upon two tests. To use the act-of-God concept in denying liability, a tree must be a native tree planted by nature, and a tree must never have been significantly influenced by humans. Few trees in community and yard settings meet these two tests. Act-of-God has not proven to be an effective defense for negligence determinations.

Court Recommendations

As a manager, the court asks two basic questions after a catastrophic tree structural failure: 1) "Were the managers negligent or was the tree a nuisance?" and, 2) "Would the hazard have been recognized upon inspection." As a resource manager, you should be prepared to answer and support your answers, for any actions or inactions, you may have taken.

What do the courts recommend managers do to minimize liability risks? Three action items arise continually:

A) perform a timely systematic inspection and keep it current;

B) develop written documentation of risk management concerns; and,

C) use risk assessment inspection results in current and future management.

In many circumstances, a lack of a systematic inspection could be considered negligence.

Systematic Inspection

Systematic inspection demands observational discipline. The inspector must carefully examine a tree and make cumulative decisions about tree defects and associated target attributes. An inspection process should ideally include a root collar excavation, an aerial examination, and soil probing. Usually, some form of ground-based observation is used for cost-effectiveness. Only tree professionals experienced in risk assessment should perform these evaluations. General tree inventory crews may not be technically or experientially qualified to examine trees and sites for risk levels.

To fulfill the legal aspects of a systematic inspection for risk factors, a precise and accurate methodology must be used. A training system is presented here which has been proven to assist risk assessors and new students unfamiliar with tree risk assessments in five (5) steps. Figure 7 provides the five steps used. Appendix 1 provides an assessment form.

The basic tenet of this training system are concentarted around structural integrity observations which begin where stress and strain on a tree are greatest. Figure 8 and Figure 9 provides tree risk examination zones identified by number. Inspections begin at the tree base in zone 1 and expand outward and upward in zone order.

No Drive-Bye Assessments!

An inspection should begin with a general overview of tree structural integrity to provide for the personal safety of the inspector, and the people and property in the immediate area at the time of inspection. From a distance, and as the inspector approaches a tree and site, any immediately hazardous conditions should be noted. The assessment should not continue until these conditions have been corrected.

The next step in a risk assessment process is to survey a tree from at least three sides, close enough to a tree to notice subtle structural reactions by a tree over years. At each of these observation sites, examine a tree looking for major simple or compound structural faults. On each side of a tree begin the assessment where stress and strain is the greatest and structural faults could have the greatest impact on tree integrity and target safety.

One way of thinking about this assessment process is to start at the ground and build a good tree. Go up and out from a tree base until you have accumulated enough structural faults to put the tree at risk of failure.

Identifying major structural faults which could lead to catastrophic failure is the point of this assessment. Finding simple major faults, or compound faults where simple structural faults have coalesced into a combination of problems, is the goal of this assessment system. Of course, the extent and seriousness of a structural fault remains the professional decision of the assessor.

Fault Recognition

For training people to use this assessment system, a tree removal decision point must be set after which the risk of catastrophic failure becomes too great. This point of recommended removal is dependent upon management regime, site history and species, in addition to structural integrity. For general purposes in this training system, the value of three major simple faults or one compound major fault potentially leading to catastrophic loss are used. Assessors count faults in zone order until a tree removal point is reached, and then cease further risk assessment and move onto the next tree.

The zones for observation correspond to critical junctures or structural components in a tree. Zone 1 is the stems and root base four feet up the stem and four feet out from the stem. Zone 2 is the main stem from four feet above the ground up to where the main living branches begin. Zone 3 is the primary root support region extending out to 1/2 the drip line. Zone 4 is the primary branches out to l/3 their length. Zone 5 is the remainder of the structural roots. Zone 6 is the remainder of the crown.

Zoned

Zone 1 comprises the bottom four feet of the stem and the roots holding a tree erect under compression out to the edge of the root plate. In this zone there should never be a compromise. If in doubt, take it out! If the base has multiple structural faults, it does not matter if the rest of a tree is perfect.

Zones 2 - 4 are areas of a tree where structural faults can be correctable with large inputs of time, money, labor, materials and technical maintenance. Any corrections inserted to aid in the structural maintenance of a tree may call attention to a preexisting structural condition. Correction activities may decrease failure risks, but increase chances of successfully determining negligence.

Zone 5 and 6 in a tree are areas where structural faults are not significant problems because they do not involve catastrophic tree loss and massive weights. Faults identified in this area are usually easily corrected. This does not mean these zones should be ignored. A small branch falling from a long way can still provide life-threatening risks.

Level of Risk Acceptance

Once you have identified three major simple faults which could lead to catastrophic loss, accumulated in zone order for a tree, this tree is considered a tree at risk and a candidate for risk mitigation activities or removal. This is the last of three hazard criteria determinations. There could be historic, social significance, biological and/or aesthetic reasons for accepting more risk.

Risk acceptance is a management decision which must be woven into assessment processes. Under some management regimes (and under some resource managers) more risk can be accepted than others. This is called the risk acceptance threshold level or RAT. When RAT is exceeded, with target and structural faults already accounted for, a tree is a hazard and should be immediately removed.

Figure 10 provides three example risk acceptance levels to consider with tree risk assessment systems. The first line is a constant RAT over time. The second is an increasing RAT suggested by growing trees becoming more valuable over time and more risk accepted to reap these increasing large / old tree benefits. The third line represents a radical change in RAT at one point in time. This can occur due to manager change or

political concerns. Overnight RAT can change in an organization and on a sites for a variety of reasons. The assessor must communicate closely and often with resource managers / owners to continually ascertain the RAT level with which they feel comfortable.

Summing Up

Once all three hazard risk criteria have been evaluated, a careful and measured response is needed immediately. Figure 11 provides a combination graph of all three hazard assessment criteria, and a shaded area where structural integrity and target risks exceed the given RAT level. It is at this point the assessed tree has become a hazard.

Over Quantification

There are many ways of trying to assess structural failure in trees and determine risk levels. Presented here is a simple training method to get people started and to insure systematic inspections. Many companies and public entities have proprietary means of assessing risk. Examine different means of quantifying risk to fit your resource management situation.

The most basic revolves around a simple physic equation. A scientifically based assessment system could be built around $F = mv^2$, where "F" is the total force of the impact, "m" is the mass of the object, and v is the velocity upon impact of the object as accelerated by gravity. In other words, "force equals mass times acceleration." The bigger an object, and the farther it falls, the greater the force of impact.

No Liability Formula

Using this equation, a risk manager would determine bigger mass and greater height (greater potential energy), as a greater liability risk. The problem with this pure scientific determination is force of impact (F) is not equal to specific damage awards, precise extent of medical injuries, or total liability costs and settlements. A free-falling, unencumbered limb is not normally expected because of other branches and other lines or objects in the way. A small twig with perfect location of impact and high enough velocity can initiate severe damage and death just as well as a massive branch which crushes all below.

Liability case law paints with a wide brush. You cannot fine-tune tree hazards into a formula unless settlement values and associated costs are accounted for. Risk assessment remains a professional, subjective judgement based upon experience of the assessor and how well a manager / owner has communicated real management objectives and willingness to accept risk. Risk assessment should not be considered a black and white, scientifically determined, decision-making process.

Documenting Risk & Hazards

Managers need to help owners and resource users to appreciate and understand risks involved with trees. When writing a report or letter describing tree liability risks, be cautious of several things. The first is to carefully document how an assessment was performed by describing techniques, observations and judgments. For example, were there ground and aerial inspections, a ground inspection only, or was a root crown excavation completed? Do not use emotional, subjective, or aesthetic opinions and descriptions of a tree in documentation. For example, a tree may be described as having a "nice, full crown," but this tells nothing about the structural component of risk assessment completed.

In documentation of tree risk assessment and in professional discussions, you must be able to discuss openly and fully your reasoning behind any risk assessment value. Always use a standard form to insure

coverage of important aspects of the assessment. Finally, it is crucial that you determine the actual owner of the tree and site. Trees on border lines, or trees treated as borders, need additional review with both owners. Get the facts, not someone else's imagining when assessing a tree. Do not take lay-people's opinions for tree occurrences and conditions — see for yourself!

Non-Removal Hazards

So far we have discussed events leading to decisions regarding complete tree removal for reducing risk. There are many reasons for a tree to be considered as carrying significant risk, but these may not be enough for removal. These problems occur commonly in managed landscapes and are termed "non-removal hazards." Some of these non-removal hazards include:

-buckling of pavement by roots (do not sacrifice a tree for $25.00 worth of cement);
-damage to building foundations, cisterns, and septic systems (use root barriers, release pressure, fix engineering problems -- not biological);
-presence of surface roots;
-presence of small dead wood pieces and litter (fruits, flowers, twigs, leaves);
-trees are living centers which house vertebrates and insects that present injury, disease, and nuisance risks to humans;
-entrapment in cavities, between branches, and in soil openings for animals and humans;
-face level branches (dependent upon means of conveyance — bike, skates, walking);
-serve to block views and interfere physically with safe traffic movement;
-line of sight obstructions for safety and security concerns; and,
-risks for property damage (fences, walls, roofs, cars, etc.).

Clearly this is not a comprehensive list, but does provide suggestions for building awareness among employees, managers, owners, and users of community forest risks.

Speciality Risk Areas

There are four additional speciality subjects which can generate tremendous risk exposures. These subjects will not be reviewed here as they represent large areas of management in their own right. These risk assessment specialty areas are: storm damage management including lightning protection; development and construction activities including utility installation; and, maintenance and cultural activities on a site including pesticide and fertilizer concerns. Of these specialty areas, storm damage assessments are probably the most universally important, while at the same time most poorly completed, especially for tree loading impacts.

Trees can be major aesthetic, social, and financial losses in storms. Trees can also be liability risks to primary access corridors, emergency personnel, and utility operations in storms. It is important to work with civil defense authorities to minimize storm damage potential, especially along prioritized access corridors. Trees can be low risk as assessed under normal conditions, but become hazardous under extreme storm loads along primary access routes. Storm management objectives for a site and a tree determines liability risk acceptance levels.

Conclusions

Site managers and owners can become confused and fearful of risk management inventories and mitigation processes. Increasing exposure to liability risks is a fact of modern life. Be aware and positive about

this management opportunity. Risk assessment is an integral part of a good community forest management program. To assist in conceptualizing risk management, Figure 12 provides key definitions. Appendix 1 provides a field assessment form.

A community forest resources management program includes:

A) training and pruning;
B) tree vitality maintenance (water, fertilizer, pest control, and preventing damage);
C) planting and planting space development; and,
D) early problem identification (including liability risks).

There is risk associated with all these program components, but all can be managed to minimize liability exposure.

Citation:

Coder, Kim D. 2021. Tree risk & hazard assessment concepts. Warnell School of Forestry & Natural Resources, University of Georgia, Outreach Publication WSFNR-21-50. Pp.24.

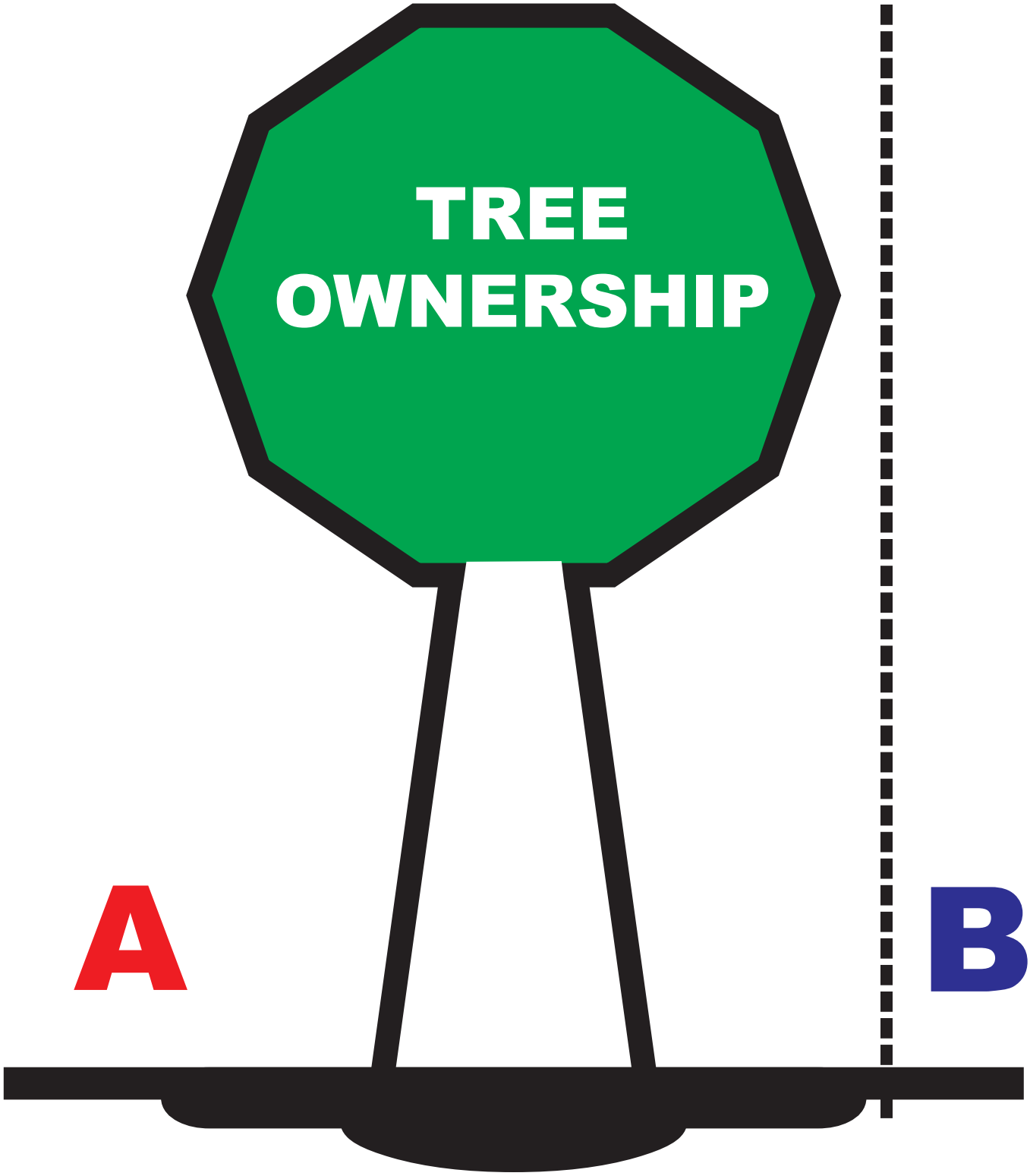


Figure 1: Example tree ownership where the dotted line is the legal or accepted ownership boundary. Here land owner A owns and is responsible for the tree.

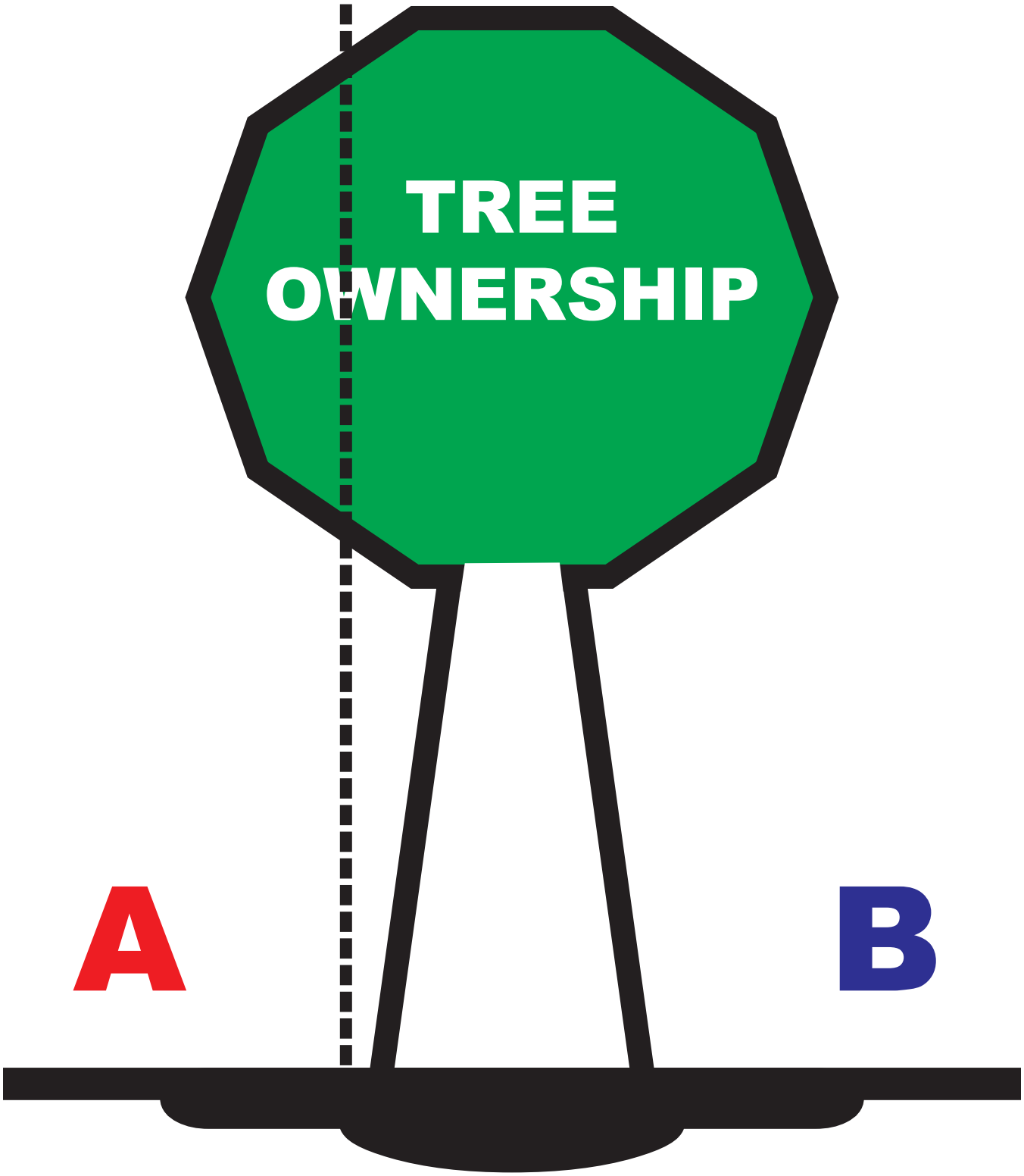


Figure 2: Example tree ownership where the dotted line is the legal or accepted ownership boundary. Here land owner B owns and is responsible for the tree.

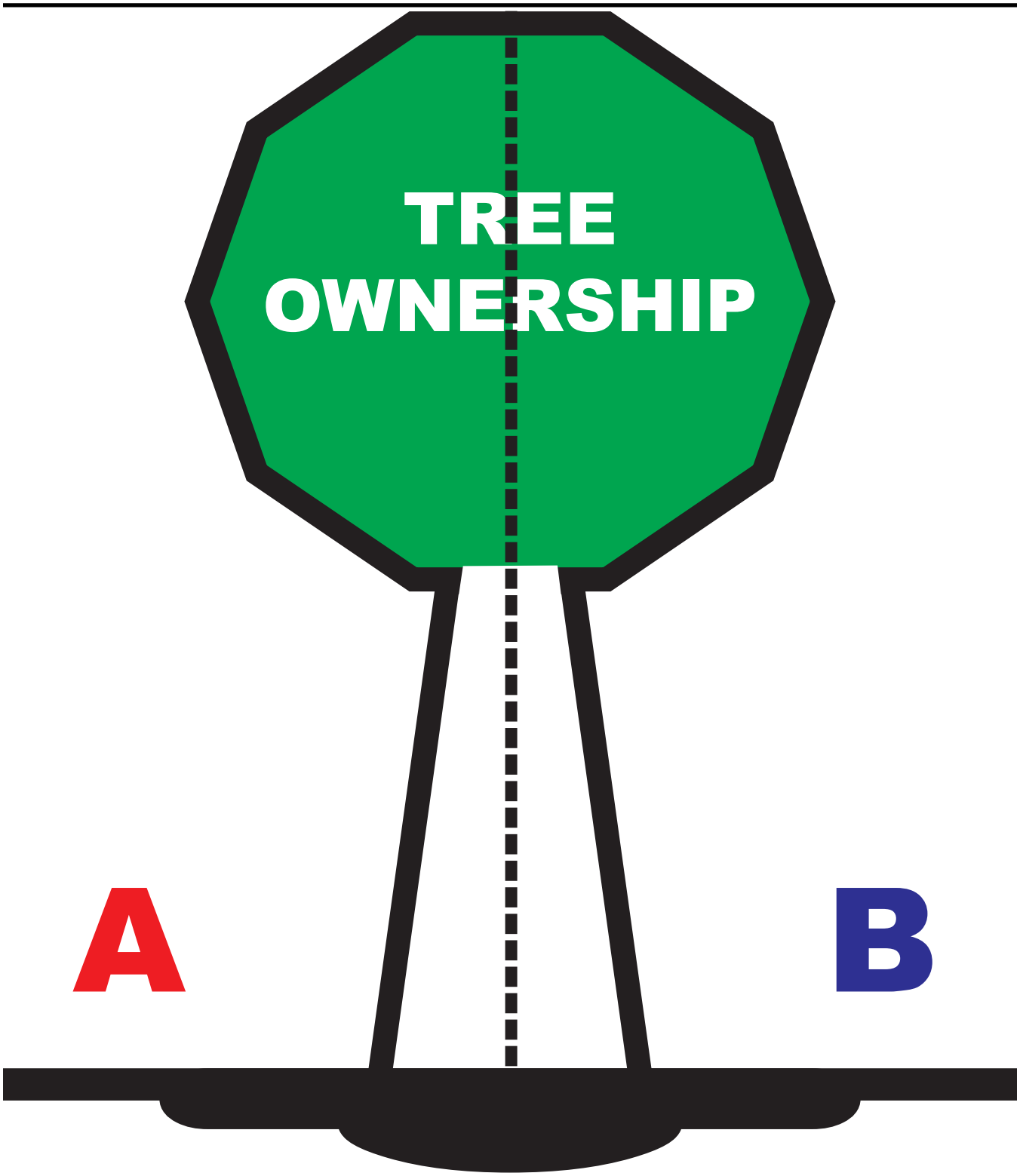


Figure 3: Example tree ownership where the dotted line is the legal or accepted ownership boundary. Landowners A & B jointly own and are responsible for the tree.

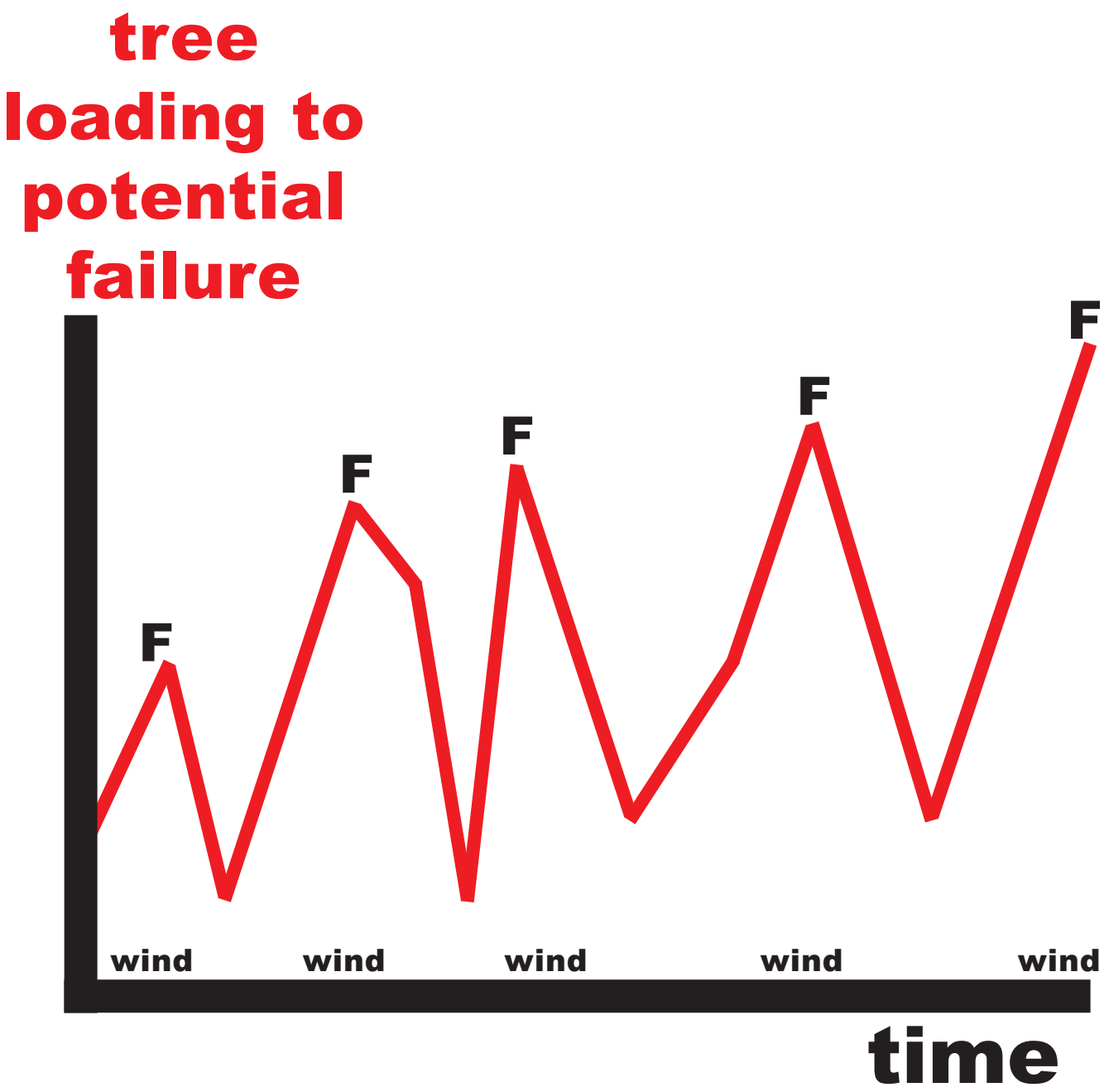


Figure 4: Example tree loading events over time when catastrophic failure could occur.

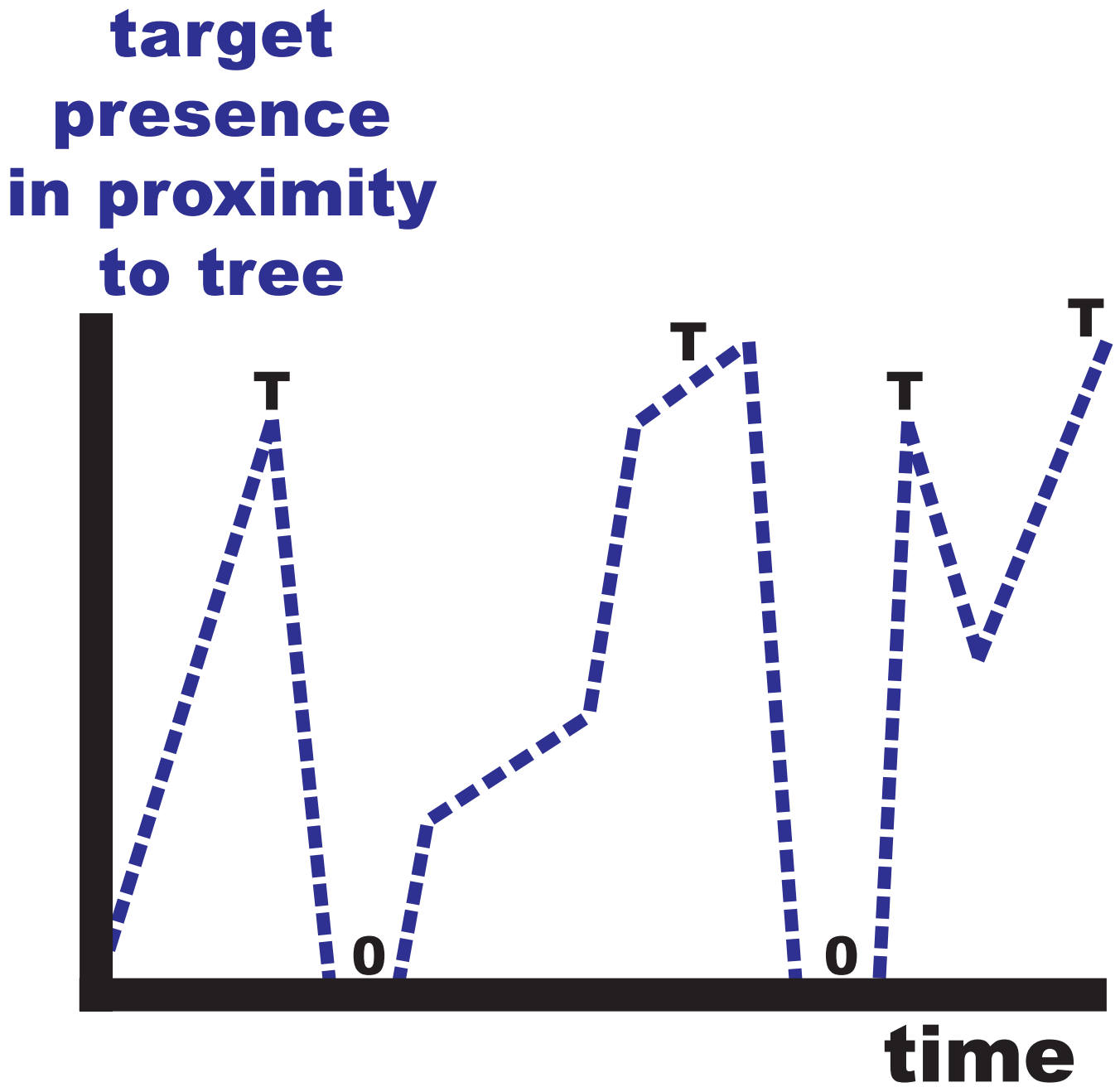


Figure 5: Example target presence occurances in close proximity to tree.

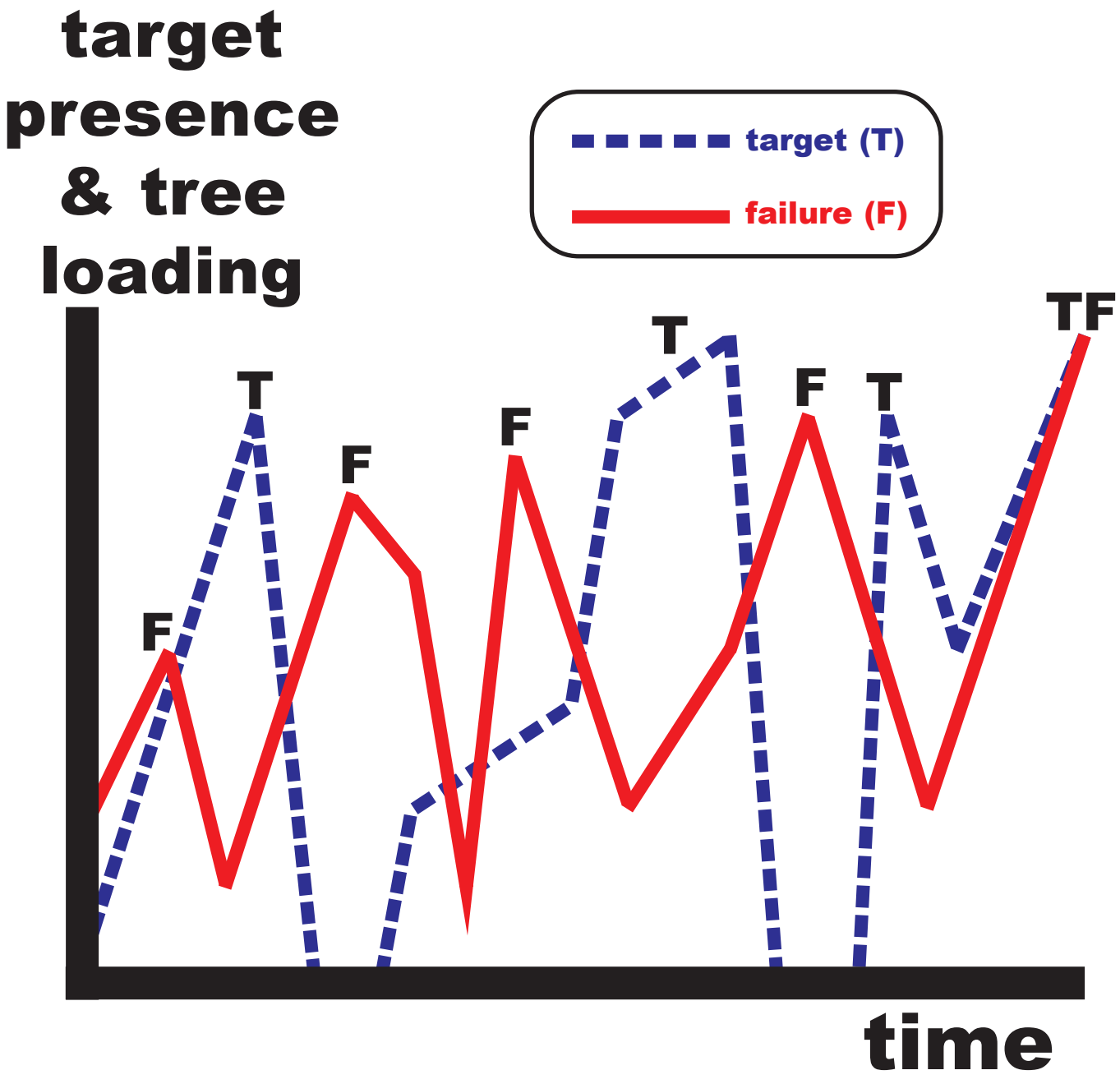


Figure 6: Example combination tree loading events and target presence events over time when catastrophic failure could occur.

STEP #1:

Identify tree species, location & owner

STEP #2:

Examine tree from at least three sides using ground observations, crown branch base review, & root excavation

STEP #3:

Look for three (3) significant simple faults --

OR

One (1) significant compound fault --

identified in zone order, any of which could lead to catastrophic loss

STEP #4:

Once catastrophic loss potential is identified stop examination & assess targeting aspects of area

AND

Evaluate site management objectives & risk acceptance

STEP #5:

Determine risk designation, appropriate response to risk & tree removal priority

Figure 7: Five primary steps in understanding Tree Risk Assessment -- Systematic Evaluation Process.

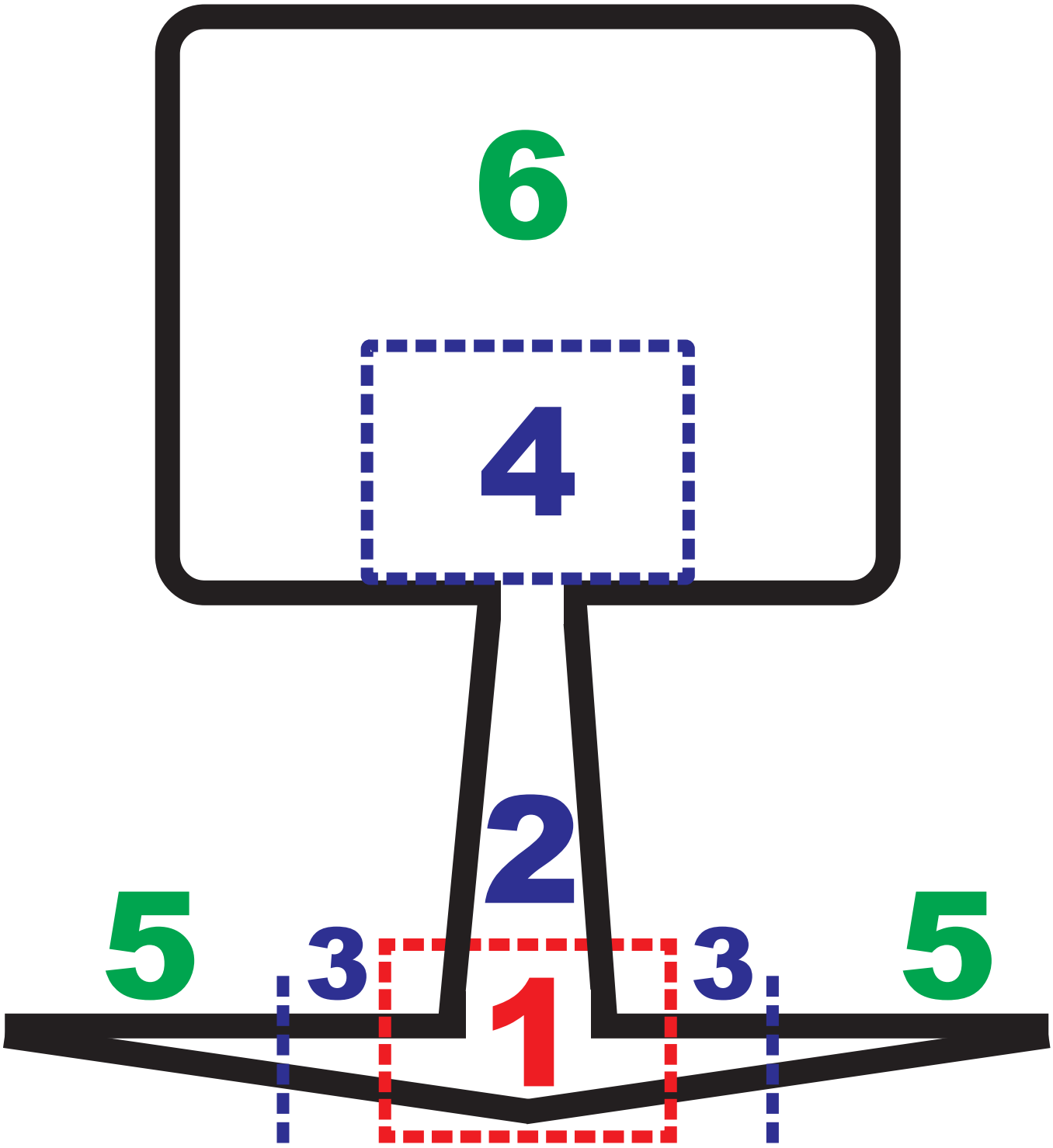


Figure 8: Tree risk assessment zones examined in numeric order (assigned by areas with greatest stress / strain & associated failure potential), used to determine potential risk of catatrophic failure.

ZONE 1: STEM / ROOT BASE
(4 feet up & out)

ZONE 2: MAIN STEM
(up to live crown & base of scaffold branches)

ZONE 3: PRIMARY ROOT SUPPORT
(out to 1/2 drip line)

ZONE 4: PRIMARY BRANCH SUPPORT
(major branch bases plus basal 1/3 of branch length)

ZONE 5: REMAINDER OF WOODY ROOTS
(out to 1.5 times dripline)

ZONE 6: REMAINDER OF CROWN

Figure 9: Definitions of Tree Risk Assessment Zones (note previous figure for diagram)

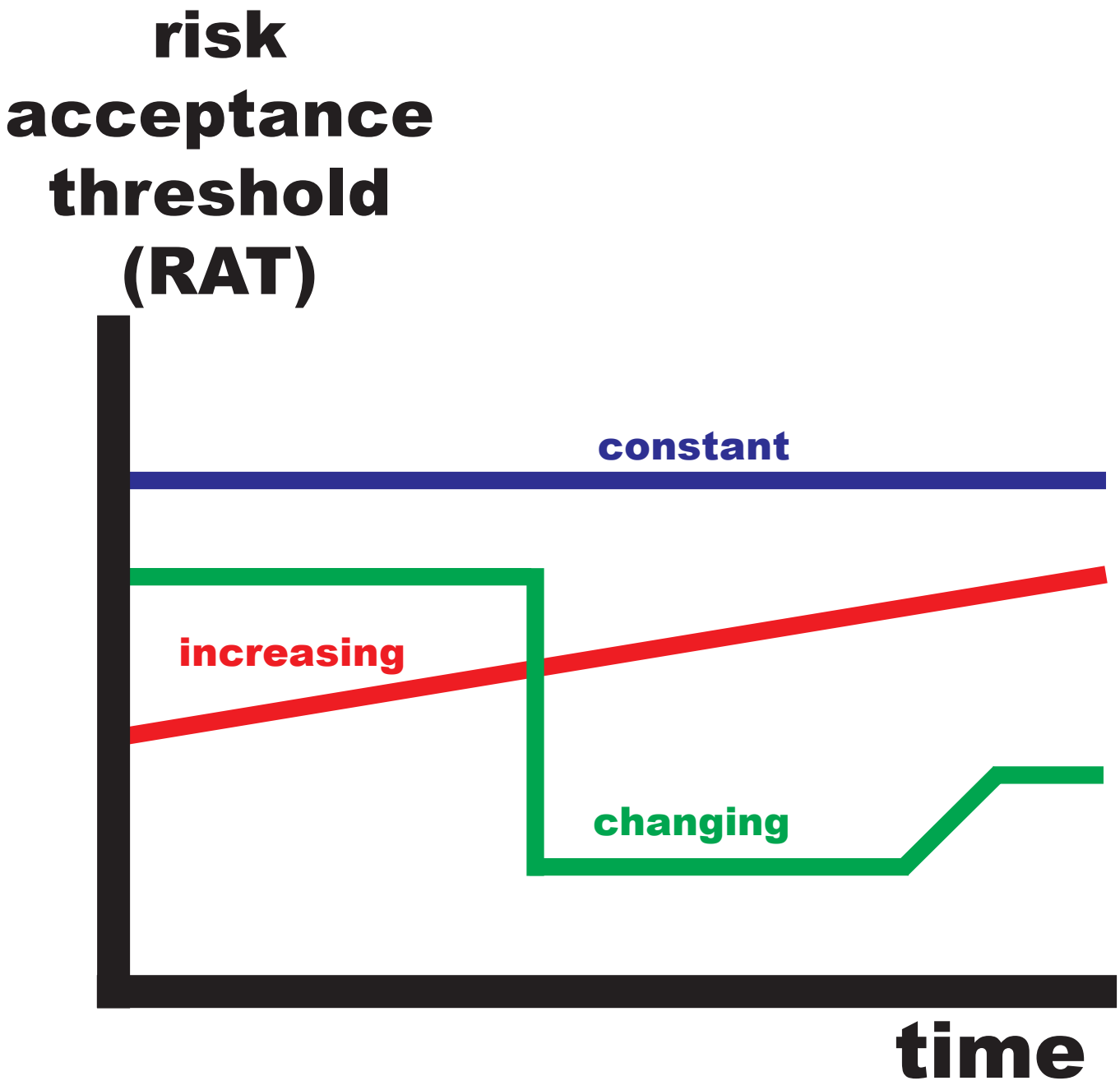


Figure 10: Example tree risk acceptance threshold (RAT) levels for three main types of risk change over time.

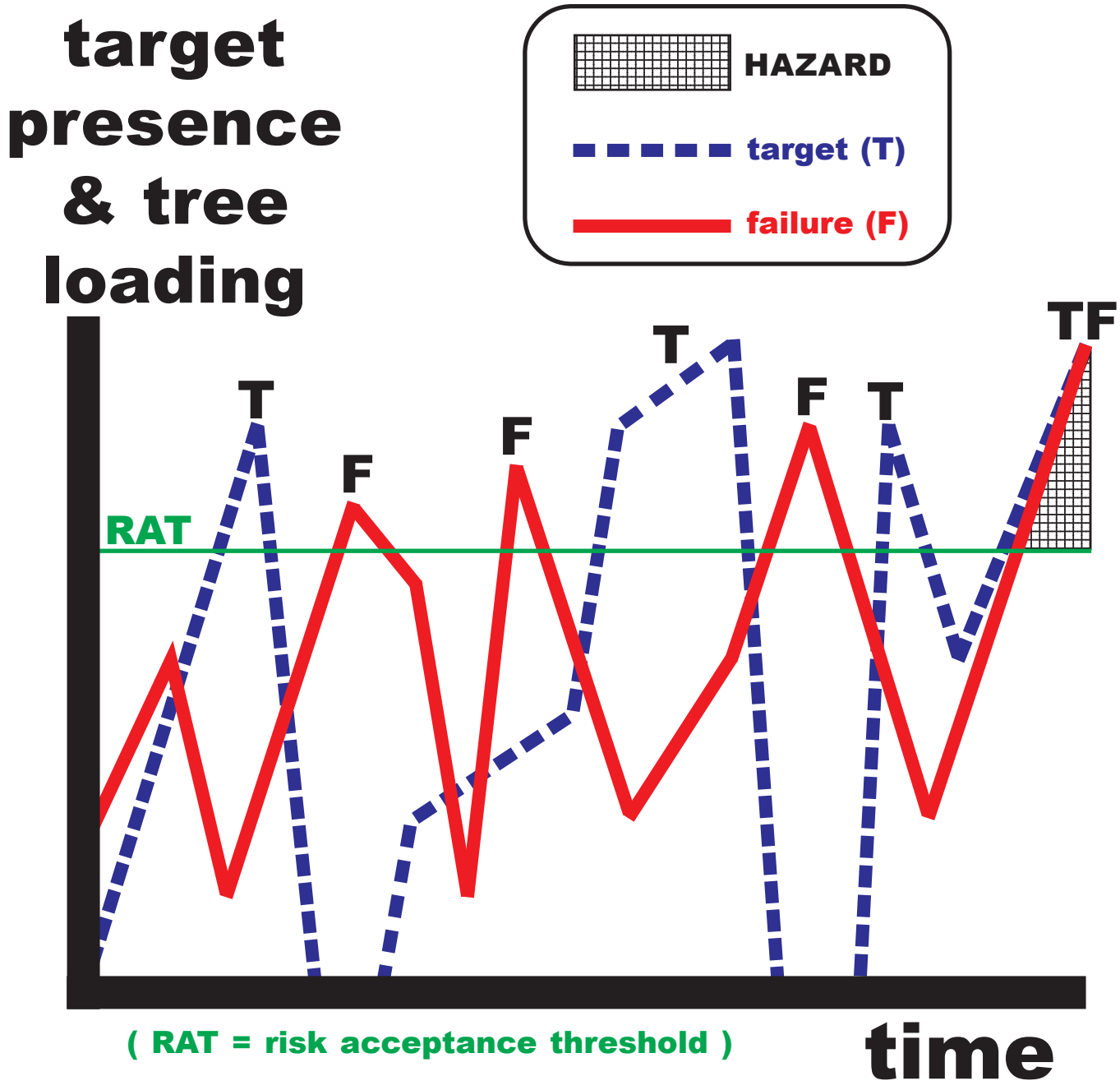


Figure 11: Example (shaded area) showing where tree loading events and target presence occurances exceeded the managerial risk acceptance threshold (RAT) for an individual tree and its site.

Assessment = an act of appraisal or evaluation where current and future values and risks are estimated.

Defect = a fault, flaw, or abnormality of normal tree structure and function resulting in inadequate performance or failure.

Failure = an insufficient or inadequate performance event from expected tree structure.

Harm = loss of, or damage to, the ownership and use rights, appearance and expectations of continuing value, reputation, and/or physical / mental well-being of a target (people or property).

Hazard = a condition which significantly increases the possibility of injury or harm, and includes an uncertainty and lack of predictability, as well as an identifiable recognition of risk. A hazard tree jeopardizes, by exposing to danger and peril, targets.

Injury = form of harm from impairment, wounding, deformation, loss, or destruction.

Mitigation = to decrease, moderate, or minimize severity of risk and its associated consequences.

Qualitative = attributes or character combinations defined by educated human senses, experienced over similar situations and time, regarding potential tree / site values and benefits.

Quantitative = tree / site attributes and characteristics susceptible to direct, indirect, or estimation measurements.

Reasonable Response = non-threshold based concept requiring appropriate or reasonable responses for changing (i.e. ascending) levels of risk, remembering both actions and inactions might be an appropriate response in risk management.

Risk = a combination of both foreseeable and chance exposure to potentially damaging conditions where future tree and site values are jeopardized.

Risk Assessment Threshold (RAT) = organizationally established, or individual human education, perception and experience established, level where existing risk becomes unacceptable without a mitigating response.

Target = person or object influenced, threatened, or affected by a tree defect or failure.

Unacceptable = a state or change which is not capable of being endured or tolerated.

Figure 12: Tree risk assessment definitions.

TREE RISK ASSESSMENT: SYSTEMATIC EVALUATION PROCESS

ZONE 1: STEM / ROOT BASE (4 feet up & out) -- Bottom four feet of main stem & root plate / zone of rapid taper (ZRT) out four feet.

NO COMPROMISE -- NO DOUBT

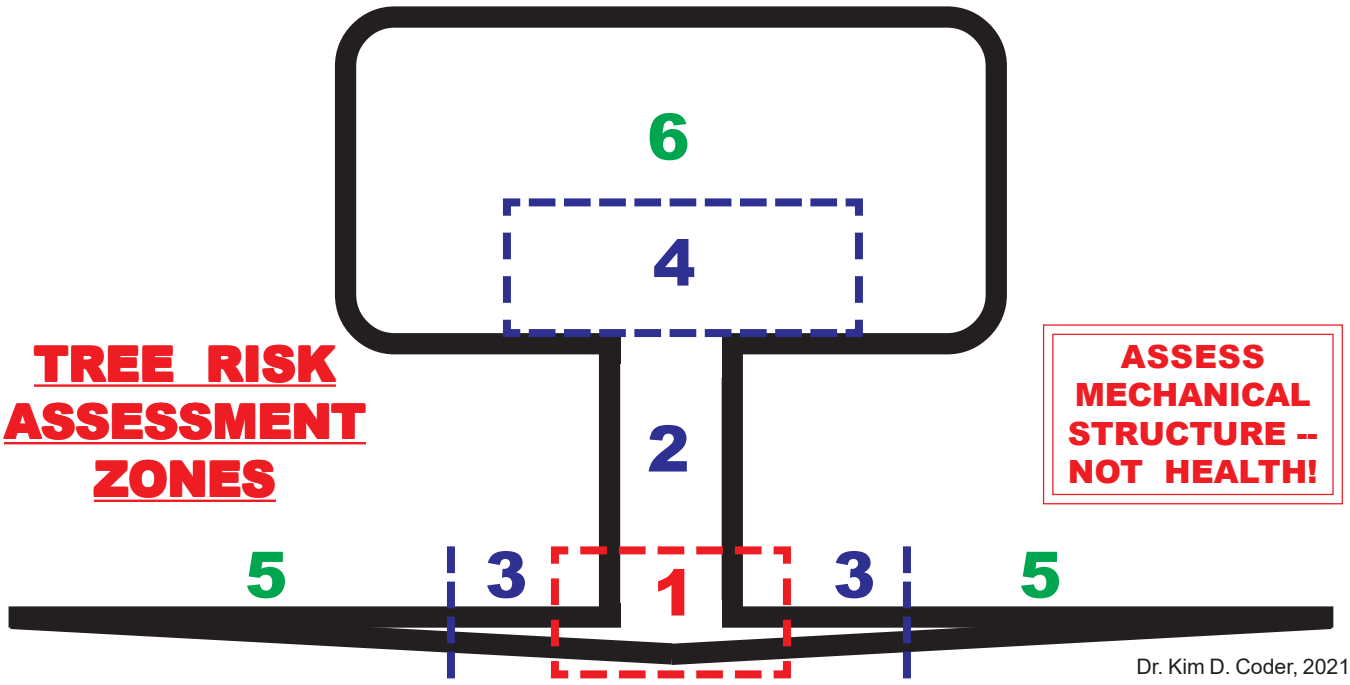
ZONE 2: MAIN STEM (up to live crown & base of scaffold branches)
ZONE 3: PRIMARY ROOT SUPPORT (out to 1/2 drip line)
ZONE 4: PRIMARY BRANCH SUPPORT (major branch base area plus basal 1/3 of their length)

Faults in zones 2, 3, & 4 correctable with large inputs of time, money, materials & technical maintenance. Corrective measures may represent a notification of problems.

ZONE 5: REMAINDER OF WOODY ROOTS (out to 1.5 times dripline)
ZONE 6: REMAINDER OF CROWN

Zones 5 & 6 are not of primary structural concern, but any faults can still represent significant risks.

Criteria: When three significant simple faults which could lead to catastrophic loss are identified (in zone order), or one significant compound fault which could lead to catastrophic loss are identified, stop & assess targeting aspects of the area and reexamine site management objectives to determine a risk designation and removal priority. Examine tree from at least three sides.



TREE RISK ASSESSMENT ZONES

ASSESS MECHANICAL STRUCTURE -- NOT HEALTH!

TREE RISK ASSESSMENT FORM

TREE NUMBER:
DATE:
ASSESSOR'S NAME:

TREE SPECIES:
TREE DIAMETER:
SPECIFIC TREE LOCATION:

OWNERSHIP:

OWNER'S NAME & PHONE:

BOUNDARY LINE TREE _____
SINGLE OWNER TREE _____
FEET FROM BOUNDARY (falling in / falling out):

RISK ASSESSMENT:

MAJOR STRUCTURAL FAULTS (describe type and location):

FAULT #1 (ZONE= ____):

FAULT #2 (ZONE= ____):

FAULT #3 (ZONE= ____):

OTHER STRUCTURAL FAULTS:

MINOR RISKS:

TARGETING (people / property / resources over space and time):

RISK ACCEPTANCE OF MANAGEMENT (hazard thresholds):

ACTIONS:

_____ NO REMOVAL
_____ MANAGERIAL NOTICE OF RISKS
_____ MINOR FAULTS & CORRECTIONS / RISK REDUCTION
_____ REMOVAL

**_____ PRIORITY REMOVAL **