Title: **Management Practices for Veteran Trees**

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Abstract:

Interest in the conservation of elderly trees is of primary concern in the public garden setting as well as in and around the community. The Morris Arboretum is home to several tree specimens estimated to be well over 100 years old. Although the value of these trees is difficult to quantify it increases with each season. Preserving these trees to the best of our ability is our responsibility as curators of a living plant collection and stewards of the landscape. To do this requires caretakers to fully understand the needs of an aging tree.

Over time a tree will progress through several life stages. It is important to learn to recognize the signs of each stage and cater management practices to the trees' impending needs. This project will plot the course trees follow, describe the physiological changes associated with each life stage, and describe conservation practices accordingly. Included in this paper will be a review of the efficacy of using plant growth regulators, specifically paclobutrazol, which is currently marketed under the product name Cambistat® 2SC, for use on elderly or declining trees.

TABLE OF CONTENTS

INTRODUCTION

Trees are some of the longest-lived and largest organisms on the planet. Yet their success in size and age is not indicative of their current status in our environment. Elderly trees are an increasingly rare occurrence; only a select few of each species are able to live out their full age potential. Interest in the conservation of elderly tees has increased in garden settings, as well as in and around the community. Many homeowners, arborists and garden curators are faced with management decisions for valuable trees. All too frequently these decisions are made as a result of incorrect advice and understanding. Poor management results in the loss of our valued trees.

The Morris Arboretum is home to several tree specimens well over 100 years of age. As caretakers, it is our responsibility to preserve and maintain these rare plants. Ancient trees must be venerated for their contribution to the environment. Their aesthetic beauty and their direct link to our culture and history are equally of value. While several prominent arborists, scientists, researchers, and naturalists have been working towards a better understanding of the impending needs of an aging tree, the topic remains not fully understood. This paper concludes that management considerations must change in response to a tree's growth and development throughout its life stages.

DEFINITION OF "VETERAN"

The expression "veteran tree" is a difficult one to define as there are several connotations. It is not uncommon to refer to a tree as "mature", "veteran", "ancient", or quite simply "old". One may consider a tree as mature once it has reached sexual maturity, however this is just one of several stages in the tree life cycle. It is quite natural to simply gauge a tree's "maturity" or veteran status by age, overall size, or trunk girth, but these are relative factors when dealing with trees. For example, a poplar or a balsam fir is considered to be in its later stage of its life expectancy at 100 years old, while some oak species may just be getting started. Life expectancy is genetically predetermined to species and is one of many considerations when assessing a tress's veteran status. For the purpose of this paper the term "veteran" will follow the definition that is becoming more and more widely accepted in literature, as a tree of interest biologically, aesthetically, or culturally because of its age; a tree in the ancient stage of life; a tree that is old relative to others of the same species; (Read 2000) a tree in its later half of its life expectancy, exhibiting signs of retrenchment. (Alexander 2001).

FACTORS LEADING TO THE LONGEVITY OF TREES

To understand the factors leading to the longevity of trees perhaps it is essential to discuss why trees die. Longevity is achieved through a collaboration of genetic potential and environmental conditions. Life expectancy is different for each tree species and is genetically predetermined, however environmental conditions are a major factor in determining a tree's long-lived success or failure. Trees and plants in general require certain basic necessities: adequate moisture, nutrients, light and carbon dioxide. While each tree species has amazing abilities to compensate for a lack of one or several of these necessities, there is a limit to the amount of stress a tree can handle. These abiotic stresses, such a mineral deficiencies, light competition, drought, pollution, and soil compaction, result in a reduced potential for the

allocation of resources from the environment. This resource reduction lessens a tree's ability to operate as a fully functioning living creature, thus rendering the tree susceptible to biotic factors. Biotic factors include fungal, bacterial, and viral parasitization, as well as insect and animal herbivory. Once a tree's defense mechanisms have been weakened by stress and infiltrated by other organisms it enters a downward spiral. Structural failure is the ultimate result; eventually the wind will break off portions or knock it down entirely.

CARBOHYDRATE BALANCE, RETRENCHMENT AND GROWING DOWNWARDS

Trees exhibit indeterminate growth. From seeds or cuttings trees will continue to increase in girth, height, and spread through much of their lifetime. Fueled b the sun, photosynthesis provides the plant with abundant carbohydrates, roots seek water and mineral nutrients, and with a fantastically complicated series of processes, cells are created and maintained. With the creation of each new cell, a tree will require the resources to support this ever-increasing demand. Crown size and leaf area increases each season. Canopy spread must increase to provide more photosynthetic area to supply the ever-increasing demand. Similarly, the increment of new wood will increase each season until the canopy is fully developed, covering the entire tree with a layer of new wood. Given ideal conditions, free from competition or stresses, the production of new wood is constant. This growth trend will eventually reach a minimum, where canopy spread is halted; photosynthetic area cannot enlarge without causing a deficit somewhere else. At this stage increments of new wood become less and less each season until the tree is unable to add a new layer of wood over its entire surface. The tree is forced into retrenchment, a process of size reduction. This strategy for survival marks a new life stage, and may be as long in duration as the initial developmental stages. In an ideal situation carbohydrates remain in positive supply, enough to sustain growth and provide storage. Increased size and complexity, that results as a tree grows older, are all part of age-related changes. We must remember that trees are dynamic beings and with age comes compensatory changes. "Age-related changes include decreased rates of carbon assimilation, decreased rates of growth in all organs, and increased susceptibility to disease, insects, and other stresses" (Clark et al. 1991). Signs of retrenchment are often perceived as decline to tree care professionals, and spark concern with homeowners. Retrenchment is part of the natural growth and development cycle towards size reduction.

CARETAKERS FACE THE DECISION

As a tree proceeds through the formative life stage from full to late maturity, caretakers must recognize that management practices for veteran trees must be modified according to the current life stage. This can be a hard sell for many tree care professionals who do not recognize the changing needs of a tree approaching the latter stage of its life. To many, a veteran tree may appear to be in a rapid state of decline. The presence of dead wood in the canopy, fungal fruiting bodies, sap runs, progressive hollowing and trunk cavities are frequently interpreted by tree care professionals as potential hazards and an excuse to cut the tree down. However, caretakers can assume a different approach by recognizing these signs as indications of a new life stage. Much of the focus of veteran tree care is to assist the tree in its natural disassembling process towards a smaller more compact form. Removal of dead wood and retrenchment pruning are key essentials to the weight and size reduction process. Moderating stresses are also important; irrigating during times of drought, minimizing and correcting soil compaction issues, and approaching insect and disease issues with an integrated management plan. Applying a "one size fits all" approach to veteran tree care will likely end in disaster.

FUNGAL DECAY

Fungi have a bad reputation for causing death and dysfunction to plants. The truth is that the majority of fungal organisms are not parasitic but rather saprophytic and symbiotic providing on the whole more benefits to plants than detriments. Fungal decay of dead wood should not necessarily be considered harmful. "The individual tree actually benefits from the fungal decay of its dead heartwood tissues. Resources are locked up in these dead tissues. Fungal decay makes them accessible again to the tree as well as to the fungi and invertebrates. Roots may grow inwards, into the debris within the cavities and make use of the breakdown products." Alexander 2003 "One may argue that if hollowing is considered in most instances beneficial to the tree, then perhaps fungal decay of the heartwood should not be termed a fungal attack. Instead a positive term such as fungal recycling of dead wood (heartwood) should be used." (Green 2000) This idea may be considered logical considering that fungi and trees have spent hundreds of thousands of years evolving together. Included in the breakdown process are saproxylic organisms. "Saproxylic organisms are those that depend on dead wood at some stage in their life cycle. They vary from woodpeckers to fungi, but the most biodiverse groups are beetles and flies (Speight 1989). Dead wood has been called "The world's largest potential food supply" by Peter Marren in Rance Harmons article: Pennsylvania Woodlands, Number 7: "Dead Wood for Wildlife".

MANAGEMENT PRACTICES

The establishment of a management plan requires considerations for both the individual tree and the site. For example, it is important to know the tree species, assess its current health status and consider its known growth characteristics; for instance how likely is it to respond to active pruning? Equally important are the characteristics of the site such as: soil fertility and compaction issues, or encroaching competition from surrounding plants. Once these two notions have been addressed, the first step of the management plan can be approached.

Steps to Create a Management plan:

- ***Establish a purpose*:** Is there a purpose? Often the best management plan is none at all. This first step identifies the purpose. Correcting soil compaction issues or moderating drought stresses through irrigation are all valid purposes.
- ***Assessment of the tree and the site*:** Tailor the purpose to the tree and the site. Is the tree likely to respond to pruning? Does it characteristically exhibit epicormic branching in response to damage? How have trees of the same species on similar sites responded?
- ***Determine management needs:*** What will be done and who will do it? Determine the appropriate timeline.
- ***Implement Plan:*** Carry out decided plan.
- ***Monitor Effectiveness, Record Observations:*** Remember large trees are very slow to respond to change. There may be several seasons before a positive or negative response is evident. Keep good records for future reference.
- ***Review and revise:*** Look at what worked and what didn't. Was your intended purpose achieved? Review and revise, then approach the plan again.

CUTTING AND PRUNING CONSIDERATIONS:

One of the main practices in the management of veteran trees is pruning. Cutting a veteran in any capacity is a decision that should not be taken lightly and should be considered a long-term commitment spanning several seasons with resting periods in between treatments. As mentioned earlier much of the aim in pruning treatments is an effort to help the tree in its natural dismantling process towards a lower, more compact, centralized crown. This can be achieved quite successfully if the tree responds by activating its dormant buds and inducing epicormic, and or vigorous sprouts lower on the central trunk. Old trees are less prone to response from cutting than young ones. "Dormant buds may be in a suppressed condition for many years and then grow when conditions are favorable", but their viability does decline over long periods of time. "The longevity of buds is believed to be in the region of 100 years for oak, 60 years for hornbeam and chestnut, and less for beech and willow". (Read 2000) Maintaining young growth on trees may increase the chance for viable buds being present and the chance for regrowth responses. "Dormant buds form from the growing stem or branch of the tree, but do not develop any further at that time. Hormones such as auxins, from the crown keep buds in a suppressed condition, but if some change in the root-to-foliage ratio occurs in the tree this alters the balance of the hormones and the dormant buds may start to grow". (Read 2000)

General Guidelines for Pruning Most Veteran Tree species:

- Commence pruning in late winter between January and March.
- Maintain proper weight balance, while only removing small portions of the crown during a single treatment, 10% is recommended as the removal rate.

Two effective pruning methods are retrenchment pruning and coronet cuts. **Retrenchment pruning is** intended to simulate a tree's natural peripheral dieback, removing very small amounts of living tissue from the crown extremities over a long period of time. **Coronet cuts** is a technique for producing a natural fracture effect to mimic natural breakage. Large exposed areas of living cambium are believed to induce natural damage responses: vigorous shoots and epicormic branching.

STRATEGIES FOR REDUCING SOIL COMPACTION

Soil compaction is a common problem in gardens and parks. Traffic in the vicinity of tree roots can cause damaging effects to tree and soil heath. Problems associated with soil compaction include: destruction of soil aggregates and large pore spaces, reduced gas exchange, reduced water holding capacity, decreased water infiltration and drainage rates, increased heat transfer, decreased microbial population/action, and reduced root growth and elongation. (Brady *et al*- 2001)

Mulching

Mulching is a practice with many benefits, however; too much mulch has its detriments. Some of the reported benefits of mulching are: to preserve soil moisture, moderate soil temperature, impede competing vegetation, improve soil structure, improve soil fertility, help prevent mower injury, reduce compaction from traffic, and protect roots. There are a wide variety of mulches that provide varied appearances and functions, these materials fall into two categories, organic and inorganic. Commonly used organic mulches are composed of chipped or shredded wood. There are a few considerations, however, when using organic mulches. Freshly chipped wood is not decomposed and contains high amounts of carbon. In order for certain microbes to decompose this material, a source of nitrogen must be available. Nitrogen from the soil below the tree may be the only available source, lessening the availability of nitrogen for the tree itself. Another consideration is that chipped wood is often the product of diseased trees. Using this material brings pathogens directly to a host plant.

- The best choice is to use properly composted wood and or leaf matter from a known source.
- Application rates of mulches should not exceed a total depth of 3 inches.

Vertical drilling

Vertical drilling is another tool aimed at improving soil conditions and lessening compaction. The process entails creating holes below the canopy of a tree using a gas powered auger or something as simple as a metal rod.

A common recommendation is to create holes 2.5 feet apart, 6 to 12 inches deep, with a 6-inch diameter. The soil is replaced with a 50:50 mix of excavated soil and leaf compost. (Watson *et al* -1996)

Implementing a high-pressure Air-Spade®

This recent advancement in tree care is also aimed at increasing soil fertility and lessening the effects of soil compaction. The use of a high-pressure Air-Spade is considered the least damaging to tree roots. Common methods for using this tool are to create trenches in a radial pattern extending from the trunk to the drip line. Excavated soil is amended with leaf compost and replaced.

IRRIGATION

Maintaining water availability during times of scarcity is a major component of the strategies aimed at reducing or moderating environmentally imposed stress to trees. Drought conditions can cause severe stress and compromise the long-term health of trees. It should be noted however that trees have an inherent ability to compensate for a lack of available water through various water conserving adaptations. In order for a tree to use these adaptations requires the use of carbohydrates. Irrigation prevents the tree from tapping into its carbohydrate stores.

Irrigation Considerations:

- Establish an irrigation plan to implement during times of drought.
- Irrigate before signs of dehydration occur.
- Maintain a consistent level of moisture, do not start and stop.
- Irrigation in early morning is the most effective.
- Consider levels of soil compaction.

AN EVALUATION OF PLANT GROWTH REGULATORS

Recent advancements in tree care have led to the use of various chemicals. Chemical growth regulators have become increasingly popular. They are commonly referred to as PGR's or TGR's (Top Growth Regulators). Paclobutrazol is the active chemical constituent in products such as Profile® 2SC and Cambistat® 2SC, two products currently on the market. Paclobutrazol has evolved from chemicals initially developed as a sterol inhibiting fungicide but researchers quickly noticed its growth inhibiting properties. Paclobutrazol's mode of action is as a gibberelin synthesis inhibitor, blocking three steps in the biosynthetic pathway. Its effect on growth suppression is attributed to the reduction in natural cell elongation, a process controlled by the plant hormone gibberelin. These chemicals are applied according to the manufacturer's recommendations as a basal drench or soil injection. Uptake is through the roots by way of the xylem vascular system; the material is transported to the growth tips where a portion of gibberelin synthesis occurs. Plants treated with this chemical have reduced internodal growth and reduced growth of all vegetative parts.

Power utility companies recognized the potential of paclobutrazol and began using the TGR in line clearance operations. By applying this chemical, utility companies could achieve effective control for 3 seasons of growth, displacing mechanical trimming and reducing labor

expenses. Utility companies have been the sole users of paclobutrazol since the late 1950's.

It wasn't until recently that research demonstrated secondary effects, specifically increasing the production of the hormone absicic acid and the chlorophyll component phytyl, both considered beneficial to tree health and growth. (Chaney 2003) In addition research claims increased root growth in trees treated with paclobutrazol. The understanding is that there is a re-allocation of energy from reduced vegetative growth to the root system. (Watson 1996) The unique structure of paclobutrazol allows it to bind to enzymes necessary for the production of the hormone sterol in fungi as well as those that promote the destruction of abscisic acid. This effect as well as morphological modifications of leaves induced by treatment with paclobutrazol- such as smaller stomatal pores, thicker leaves, and increased number and size of surface appendages on leaves - may provide physical barriers to certain fungal, and bacterial infections. All these findings as well as documented effects reducing drought stress have led to the belief that TGR treated trees have a greater tolerance for environmental stresses.

Rainbow Treecare Scientific Advancements, St. Louis Park, MN is a company that has compiled these findings towards a well-marketed product — Cambistat® 2SC aimed at tree care professionals for use on elderly trees and trees showing signs of decline. Cambistat@ 2SC may very well be a useful tool when used with other management practices, but should not be considered a stand-alone, a panacea or cure-all for stressed trees. Caretakers should approach the use of this product with caution, as it has only been available for this use for 3 seasons. Long-term effects have not been adequately researched. It should be noted that the company points out that there are inconsistent results on different tree species.

LITTLE TOLERANCE FOR AGING

It is no wonder that there are few remaining true veteran trees. With modern day concerns over public safety, injury and lawsuits, parks and gardens are quick to remove an old tree that exhibits signs of perceived decline. It is a common misconception that a lack of vigor, dead branches or cracked trunks are a sign of imminent death. If trees appear to be aesthetically unacceptable for a particular setting or pose a potential hazard, removal of a few dead branches is usually all that is needed. Often trees will respond with renewed vigor. Attaining veteran status requires the co-operation of caretakers, to respect, and understand a tree's inherent ability to rebound and overcome the downward spiral. Trees are true fighters, their success as a species depends on it. Veteran trees are not pretty in the common sense, often they are haggard, ragged, gnarled creatures. Portions may be missing, the trunk may be hollow and they may have lost their adolescent symmetry. They have become true veterans. A veteran tree not on1y supports itself but provides a place for a myriad of fungi, lichens, birds, insects and mammals. It provides us shade and oxygen; its roots enrich and preserve our soil. Its value cannot be quantified, and in this sense they are indeed beautiful.

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