What Does Science Say About Pruning Mature Trees?

Abstract. Recent presentations at ISA and other tree management forums have promoted retrenchment pruning as the preferred method of managing aging trees. Retrenchment intends to mimic the natural aging process of trees, during which large limbs are lost and the tree develops a smaller crown. It can include the use of natural fracture pruning techniques and coronet cuts, deliberately rough, splintered cuts as opposed to traditional planar cuts. There is little to no published, peer-reviewed experimental evidence to support this practice, so it is impossible to know whether retrenchment pruning enhances or diminishes overall tree health. This seminar will present the current state of science on the physiology of aging trees, which can be used to predict the impacts of conventional and retrenchment pruning on tree health.

I. Introduction

- A. Definitions
    - 1. Aging – "mere passing of chronological time"
    - 2. Senescence – genetically programmed
        - *a) Mutations*
        - *b) Molecular changes*
    - 3. Which is more valid for ancient trees?
- B. History of research on older trees
    - 1. Production forestry
        - *a) Timber stand management*
        - *b) Removal of lower branches to decrease knots*
        - *c) Interest in process of self-pruning*
    - 2. Fruit and nut production
        - *a) Coppicing and pollarding*
        - *b) Maintaining low crowns*
        - *c) Removal of older leaders (tall spindle production)*
- C. Literature reviewed
    - *a) Peer-reviewed, scientific articles*
    - *b) Papers published within the last 20 years*

II. General Tree Morphology and Physiology

- A. Reiteration of units
    - 1. Immediate – apical buds
    - 2. Delayed – epicormic buds
    - 3. Adaptive reiteration
        - *a) Not necessarily from trauma*

    - b) *Increases branch longevity – "bud bank"*
    - c) *May prolong tree longevity*
- B. Modeling
  - 1. Architectural – reiteration of units
  - 2. Physiological – reiteration, but pruning changes response
- C. Sapwood dynamics
  - 1. Outer sapwood connects surface roots to sun leaves
  - 2. Can be low in outermost due to underdeveloped outer xylem (newest)
  - 3. Can be low in innermost due to loss of functional inner xylem by blockage

III. Physiology of Aging Trees

- A. Ancient trees
  - 1. Extraordinary long lived
  - 2. Often harsh environments – no pests or disease
  - 3. Do not appear to senesce
- B. Why does growth decline?
  - 1. Not senescence (genetic)
  - 2. Hydraulic limitation hypothesis
    - a) *Gravity*
    - b) *Longer pathway*
    - c) *More tortuous pathway*
    - d) *Decreased allocation to roots*
  - 3. Decrease in soil nutrients
  - 4. Other environmental factors can influence
    - a) *Sudden water availability*
    - b) *CO_2 increases with climate change*
      - (1) Could increase maximal height
      - (2) More CO_2, less photorespiration
- C. Changes with maximal height reached
  - 1. Girth continues to expand (new vascular tissue)
  - 2. Stems and foliage of older trees are shorter, thicker than young
    - a) *Increased longevity*
    - b) *Foliar changes*
      - (1) Less photosynthetic ability
      - (2) Increase in astrosclerids – structural defense
      - (3) Increased chemical defense
      - (4) Increased antioxidants

c) *Will revert to primary foliage under stress*

3. Can be reversed if competitors removed; increased water availability

D. Lower branches are less productive than higher in the crown; the lower 2 m contribute very little

IV. General Effects of Pruning on Trees

A. Need to understand how live crown removal affects growth

B. Severity of wound and vigor of host influence response and survival

1. Epicormic shoots most likely when crown reduction 40% or more
2. Emerald ash borer most likely to lay eggs on trees with 40-60% of crown removed

C. Biggest impact on roots and lower stem

1. Change in carbon allocation to secondary axes
2. Secondary axes become a significant sink – no photosynthetic output
3. Creates deficit for roots
    - a) *Growth*
    - b) *Nitrogen-fixing bacteria*
    - c) *Mycorrhizal fungi*

D. Severely pruned trees most likely to die indirectly

1. Older trees are less likely to recover from pruning than younger trees (compensatory response)
2. Stressed trees attract pest insects (e.g. pine beetles)
3. New growth attracts browsers
4. Large wounds take longer to seal and increase the chance of pathogen entrance

V. Pruning Aging Trees – Natural and Artificial Methods

A. Self-pruning (cladotosis) in older trees

1. Creates abscission zone
2. Species specific
3. Decrease in light
    - a) *↓ in photosynthesis → ↓in sapwood flux*
    - b) *↓ in transpiration → ↓ in inner xylem flow*
4. Decrease in available water
5. Cladotosis is determined by physiological conditions

B. Crown removal

1. Concerns

   a) *Dead wood is a source of pathogen spores*
   b) *Damage from increased exposure of shade leaves to full sun*
2. Topping
   a) *Decay – increases dead stubs*
   b) *Structural integrity decreased*
   c) *Aesthetically unappealing*
3. Crown reduction
   a) *Cuts back to a live lateral*
4. Pollarding
   a) *Branches are young (3 years old or younger)*
      (1) Usually callus over
      (2) Disease compartmentalized
   b) *Decreases carbohydrate reserves*
   c) *Does not rejuvenate, since it does not change genetic programming*
   d) *Requires yearly maintenance*
   e) *Overmature pollards are difficult to restore and are prone to crown collapse*

Putting it all into perspective – how does current science help inform pruning of ancient trees?

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