K.T. Smith, “Tree Health and Energy Budgets
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PlantHealth

Tree health and energy budgets

From rural forests to urban green spaces, tree health is more than the absence of disease and pests. Healthy trees are naturally resilient to challenges from most pests, pathogens and environmental stresses. Much of this resilience comes from the effective allocation of tree energy.

Most mature trees show some symptoms or signs of infection, infestation or a stressful environment at some time during the year. These adversities rarely threaten tree survival. This especially holds true for problems caused by native pests and pathogens. Some problems require few, if any, control measures. For example, the fungal tar spot diseases of maple foliage (caused by several species of *Rhytisma*) can be very dramatic, but rarely require more aggressive treatment than the prompt removal of fallen leaves. Outbreaks of the forest tent caterpillar (*Malacosoma disstria*) are unsightly (photo) and can be controlled for aesthetic reasons — but rarely cause tree mortality, even following extensive defoliation.

Although the above problems cause much concern, otherwise healthy trees effectively respond to these challenges and continue to thrive. Native diseases (for example, root disease caused by species of *Armillaria* and oak wilt caused by *Ceratocystis fagacearum*) can kill trees, but are most likely to be severe after mechanical injury caused by human activity.

Introduced pests pose special problems. At the other extreme are the introduced or “nonnative” pests or pathogens. The mere presence of Asian longhorned beetle (*Anaplophora glabripennis*), emerald ash borer (*Agrilus planipennis*), hemlock wooly adelgid (*Adelges tsugae*) or ramorum blight (caused by the fungus *Phytophthora ramorum* and inaccurately referred to as sudden oak death) can initiate quarantines and aggressive eradication. The introduced organisms are a special problem in that they have not coexisted with our tree species through time, resulting in few or no natural predators nor effective defenses within the tree.

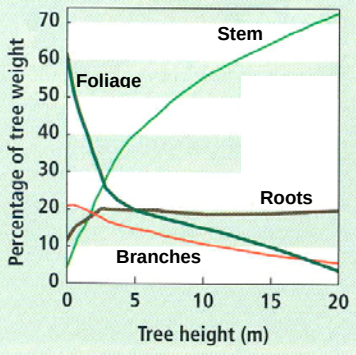
Tree energy budgets. One practical concept that relates to pests, pathogens and environmental stress is the tree energy budget and how it changes with increasing tree age and size. A budget coordinates income and expenses. Green leaves (and sometimes green-barked stems) capture energy from sunlight. Through this process, many biochemical steps produce chemical energy in the form of sugar. This chemical energy is the income for the energy budget. This energy is spent to fuel growth, reproduction, defense and maintenance of living cells. Some energy is stored to meet seasonal needs for dormancy and for potential needs for refoliation and defense.

When a tree is young and small in the nursery, much of its weight is devoted to foliage, establishing a high potential for energy capture (graph). Because of proportionately high income, small trees are better able to tolerate the removal of living wood, such as unwanted codominant stems and interfering branches.

Still, there are limits to how much of the living crown can be removed safely. Removal of living branches both reduces the foliage available for energy capture and increases the expenditure of energy to compartmentalize infections and to close pruning wounds. Compartmentalization is that part of the tree system that resists the spread of infection. It consists of constitutive anatomical features and induced boundaries. Part of the effectiveness of compartmentalization comes from innate genetic capacity and part from available energy resources and the overall health status of the tree.

Tree energy budget

A tree’s capacity for energy capture is reduced with age and size.



Although infestations are dramatic and unsightly, the forest tent caterpillar usually does not cause mortality of otherwise healthy trees.

Proper treatments respect budgets. Treatments should consider the fact that as trees increase in size and age, amounts of foliage and the capacity for energy capture are reduced. This reduction occurs as energy demands increase for maintenance of living cells in the stem and roots and for reproduction. Living tree cells in the stem are vital for energy storage and defensive responses to injury and infection. This trade-off of energy capture and increased stem size is somewhat moderated by the normal development of heartwood and the withdrawal of living cells from the central core of the maturing tree.

Consequently, the time to prune living branches and to remove unwanted codominant stems is when the tree is small. It is not possible to make a healthy, small tree out of a large tree, but it is possible to maintain a moderate size with proper pruning. As trees mature and increase in size, respect the compartmentalization process by avoiding flush cuts of branches, crown topping and root injury. This greatly will reduce the frequency of serious decay diseases and structural weakness that place people and property at risk. Modern arboriculture requires us to think about the biological basis for tree treatments; what are we trying to achieve? We can meet our tree care goals better by working within the biological system that supports safe, healthy and beautiful trees.

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PHOTO: KENNETH R. DUDZIK, USDA FOREST SERVICE, NORTHEASTERN RESEARCH STATION