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TREE ENERGY SYSTEMS[1]

by H. Sharon Ossenbruggen

Abstract. Keeping trees healthy, safe, and attractive while keeping utility lines clear necessitates difficult choices that can be made only with a thorough knowledge of tree health. This is a significant part of any tree maintenance plan. Instituting innovative tree maintenance plans requires working closely with our communities. Communication and education are critical components.

Résumé. Garder les arbres en santé, sécuritaires et attirants tout en dégageant les réseaux électriques nécessite des choix difficiles qui peuvent être faits seulement avec une bonne connaissance de la condition des arbres. Une bonne compréhension du système énergétique des arbres nous aidera à garder les arbres en santé. Ceci représente un élément important de tout plan d'entretien des arbres. L'établissement de plans innovateurs d'entretien des arbres exige de travailler conjointement avec les municipalités. La communication et l'éducation sont des éléments critiques.

Decisions on tree health should be based on understanding the tree. There is no magic bullet, no one single thing that will solve all tree problems. There are no easy answers! One way to understand tree health is to consider it in terms of energy systems that are required to maintain it. Knowledge of tree energy systems will help us protect them, but the accumulation of knowledge is only a beginning.

Sugar is "tree food." This is the source of their energy. It comes in the form of glucose, a carbohydrate produced by photosynthesis. Trees are among the original solar generators. We cannot "feed" them in the sense of providing an energy source. We can only provide them with the requirements to make their own energy. Photosynthesis is an energy transforming process. Energy of the sun is captured in bonds of the molecule called glucose. When the bond is opened, the energy is released. This energy fuels the tree's biological work.

Requirements for Tree Energy Systems

We know what a tree requires to produce energy. We know that they need space, time, and the genetic capacity to grow successfully. There must be sufficient water, carbon dioxide, elements from the soil, and sunlight to make sugars. Remember that all of these must be in the proper concentrations. Dose is the secret. In this, they are like us. Without water, we would die in a few days, but if we have too much water, we would become very ill. This is true for trees too. Proper concentrations are critical.

At first, the effect of an improper dose may show very slowly. In fact, it may not be viewed as a factor in the decline of a tree. Trees rarely die as the result of a single problem. It is more typical to see decline as the consequence of multiple wounds, infections or improper doses. Depleted energy reserves may predispose a tree to successful attack by other, more obvious problems such as infection by a disease organism. It is hard to attribute the death of a tree to a drought five years earlier, but it may have been a significant contributing factor.

What Is Tree Energy?

Let's define energy a little more carefully. The dictionary says energy is "the capacity for vigorous activity; power, efficiently and forcefully exerted; the ability of matter to do work." To

1. Presented at the annual conference of the International Society of Arboriculture in Vancouver B.C., in August of 1988.

simplify, energy is force that moves matter. Examples of "tree work" are generating wood fiber strong enough to support the tree, producing leaves for energy production, transporting water and elements from the soil to the leaves, producing flowers and seeds for the reproduction, responding to wounding by a chemical defense process, and making and transporting sugars from the leaves to the wood and transforming them to starch for storage. Tree energy is the ability to do all of this biological work or "to move all of this matter."

The fuel for tree energy comes from the sugar it produces, releases, and stores during the growth season. Extra energy produced is stored in the living parenchyma cells of the tree. Trees have three basic types of cells: fiber cells for mechanical support, vessel cells for transport (conifers have tracheids for both of these activities), and parenchyma cells for storage. Parenchyma cells are relatively long-lived, and their living contents or protoplasm stores starch, fats, and oils. Many activities are energy intensive. Growing out of dormancy, opening flowers and leaves, producing seeds, reacting to wounds are especially energy intensive. In some situations, the tree is geneticaly committed to certain activities regardless of its existing energy level, and this can significantly affect the tree's health.

Energy Balance

Tree energy balance is like a budget. The money we make has to be at least as great as the expenses we have to pay, otherwise we are in debt. We must have a little extra to save for scheduled expenses that only come once in a while, like the taxes and insurance bills, plus a little more for emergencies. If our expenses are too high in some months, then we must draw on savings or stored earnings. This may be all right until a crisis arises and we have to spend all of our savings. Then we go into debt—we are in stress.

A healthy tree makes enough energy in the leaves to run its systems with a little extra to store or "put in the bank". This energy is stored over time in the living parenchyma cells in the form of starches or oils. The tree draws energy to get through scheduled "tight times". When the new leaves are forming in the spring or when seeds are developing, the tree relies on stored starches that can be transformed back into sugars. The back-up energy must be there or the tree may be in stress. If there is an unexpected crisis, such as a severe wound or a defoliating insect attack, the tree draws stored energy too. If everything happens at once, there can be problems. Without sufficient stored energy, the tree will be stressed just as we would be without sufficient savings. If the energy is limited in a given season, some trees such as oaks, may not produce seed. By contrast, the elms are committed to produce seed every year. Obviously, stored energy is as important as the active energy needed during the growing season.

Keeping the Balance

The perfect, genetically tough tree, planted in perfect soil with just the right drainage and adequate sun and rainfall, is going to have the best chance for survival. The odds for this perfect tree remaining unwounded for 500 years are about equal to the odds for a human being remaining perfectly healthy for a lifetime. Most trees are not perfect, and even if they were, they would be subject to hundreds of wounds and infections in their lifetime. Our objective should be to optimize the tree's health within reasonable limits. This means limiting injury as much as possible. This does not require an absolute balance of all tree systems.

Let's go back to our definition. Energy is the force to move matter. Matter in the tree is its mass, and energy is moving it. Metabolism or mass to energy ratio is the sum of the chemical changes by which food is built up and protoplasm is broken down into simpler compounds with the exchange of energy. Here there is no need for perfect balance. It should be changing and constantly in motion. Balance may not be even highly desirable. It may be deadly.

Tree Energy in Defense

When all systems are generally healthy and everything is working well in the tree, the potential is for long-term survival. What happens when the tree is injured? The tree energy resources are used for defense. In a process called compartmentalization, firm boundaries are set in the tree in a two-stage process. In stage one, the boundaries resists infection of the wood present at the time of

injury. Firm chemical boundaries are set in the tissues surrounding the wound. If the microorganisms grow to increase the spread of infection, the boundaries to resist are reset. If the boundaries are set efficiently the infection will be contained in a small volume. If they are not set efficiently, infection may spread quickly and overwhelm the tree.

In the second stage of compartmentalization, a barrier zone is formed in the cambium to protect it and the wood that will be produced as the tree continues to grow. This is a highly resistant boundary. If it remains unbroken, any infection in the wood present at the time of injury will not usually move into the newer healthy wood.

This is an energy intense activity. Every time tissue normally used for storage is compartmentalized, there is less space for starch, fats and oils, ie. energy. In a sense the tree looses twice. It is using energy and loosing storage space. The more wounds it has, the more energy lost and the more storage space lost (Fig. 1). Reduced energy reserves means that the tree becomes easier prey to other infections or diseases.

Trees and Utility Lines

Healthy trees growing under utility lines present a problem for those involved with tree care. The dilemma is how to reduce tree mass without disrupting tree energy. Extreme crown reduction, flush cuts, and topping will reduce mass, at least temporarily. At the same time, they wound, divert energy systems to defensive action, and reduce the health and life potential of the tree. This sets the stage for unhealthy trees (Fig. 2).

Utility lines must be kept clear. In the process of clearing lines, the concerns for tree energy systems and quality of tree health is easily lost. This is understandable. Few customers with no power, or stockholders with no dividends will be very concerned about tree energy systems. How can we reconcile the desirability of healthy, growing trees with functioning, clear power lines? There is one solution—remove all trees under power lines, and do not plant new ones. Many have been saying this for years, but it is unlikely that we will see this happen across the nation in our lifetime. So now what? We need to set up a plan of action. Plans are easy; action is difficult.

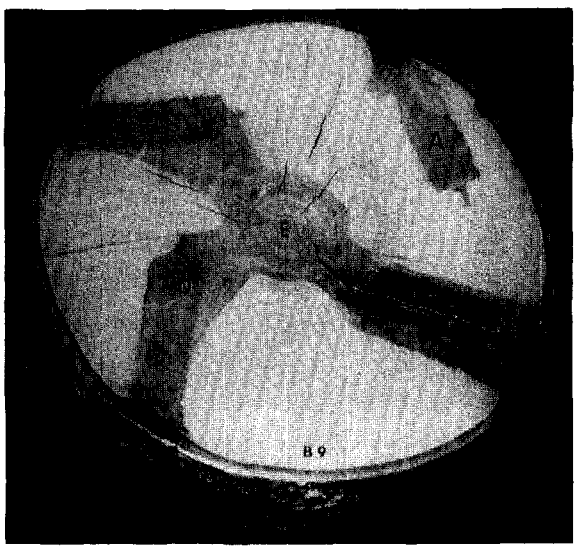

Fig. 1. Drill wound A shows a clear pattern of discolored wood. Drill wounds B, C, D, are coalescing with the older wound E. Notice the spread of discolored tissue. Multiple wounds in close proximity are generally far more injurious than a single large wound.

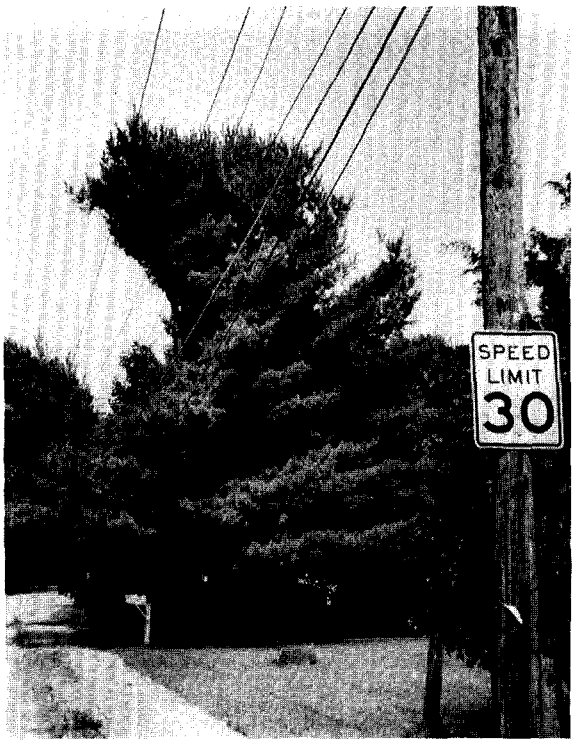

Fig. 2. This white pine was pruned to keep wires clear. Its natural shape was destroyed and flush cuts opened the stem to the risk of infection and decay.

First, determine what you know, and what you can do easily. Second, learn what new ideas are out there or create them. Exercise that rare and wonderful gift, common sense. Money is an important consideration. Take the most economical actions first. If there are savings, use them to fund more expensive solutions.

Things To Do

1. Learn about tree basics.
2. Write specifications for proper pruning practices. Insist on proper pruning on all jobs (Fig. 3). Allow adequate time to get it done properly. The return trips will be less frequent.
3. Do not plant under power lines.
4. Plant the right tree in the right place. Plant dwarf or low-growing trees under lines if planting is required.
5. Start pruning early. Maintain trees while young to keep them small. It is more cost effective and safe to prune a young, small tree than an overgrown giant tree tangled in the lines.
6. Educate and communicate. This is everyone's responsibility.

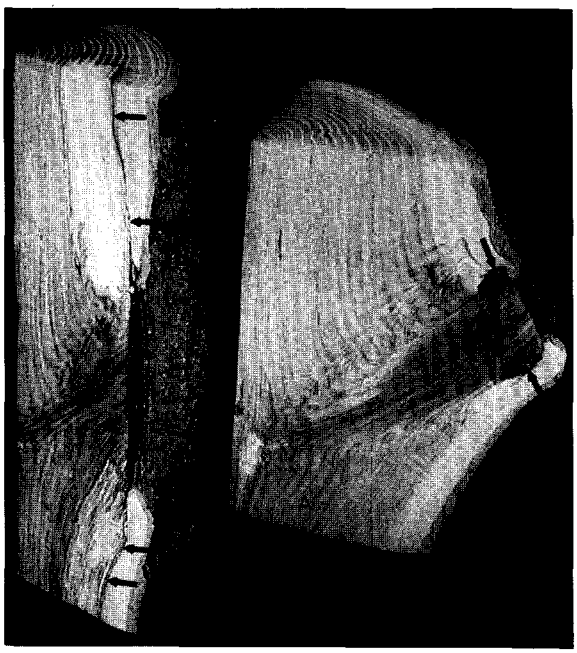

Fig. 3. Oak branches are from the same tree. B was pruned flush and A was pruned with a proper cut. Both are closing well but B has extensive decay in the stem above and below the cut where A has none. Proper pruning cuts lower the potential for hazards and may reduce the frequency of sprouting.

Learn New Things

1. Keep learning. Explore new research and cooperate with those doing the work. Keep questioning.
2. Work within communities for changes in tree regulations. There may not be any policy or regulations in place. Help formulate them.
3. Create a demand for dwarf varieties of trees and for small trees that will make it economical for more nurseries to supply them. Bob Novembri at Pacific Gas and Electric in San Francisco and Mike McNamara at Penelec in Johnstown, PA have a good idea for tagging trees as inappropriate for planting under lines (Fig. 4).
4. Expand the demand for tree replacement programs. Many are in place already.
5. Recognize the trade-offs. Tree plans and treatments must be evaluated in the light of known facts about tree health.
6. Educate and communicate.

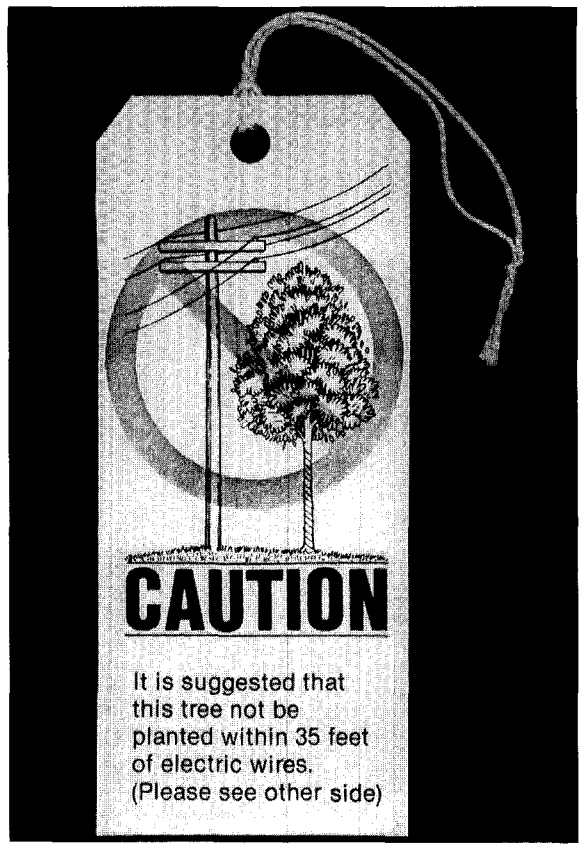

Fig. 4. This tag is used by Penelec who is working with local nurseries to permit tagging of trees as inappropriate for planting under lines.

Communication and Education

Notice that education and communication are on both lists. They should probably head both lists in capital letters and bold print. Education and communication are our most important jobs. Education offers a better chance for appropriate decisions at all levels. Everyone involved needs education. We should educate ourselves first and the work crews next. We accomplish nothing if we communicate only among ourselves. The people doing the work also need to know the proper way to care for trees and believe in it. For example, if workers are not pruning properly, it is costing time and money in the long run.

Tree Dignity Ordinance

The most significant groups to reach are the town planners, town councils, and public works administrators, anyone making decisions on tree care in the cities and towns. Ordinances are passed for other situations in towns including tree planting. As a citizen, why not write a model ordinance mandating proper attention to trees under power lines? It could define and require removal of hazardous trees. Perhaps this could be written broadly along the lines of a nuisance ordinance, but it should be called a "Tree Dignity Ordinance".

There is a point in time where an old tree loses its dignity, is no longer beautiful, and should be removed. Permitting a potential hazard tree to stand is irresponsible, and could prove very costly if it causes property damage or personal injury. A replacement policy could state that trees will not be replanted under the lines, or if they are, trees selected will be smaller at mature size. In addition, the trees will be maintained when young so they retain the restricted size before they begin to interfere with the lines. This statement is important and is part of the public education process. Poor pruning is the only pruning many people recognize. They wouldn't notice a properly pruned tree. It is much less noticeable. If a few model ordinances were passed in some key locations, we could begin to move the idea. We need to take a leadership position and do it properly.

All of this requires work. Some of the work may be on our own time, especially if we were to approach tree care managers in towns where we live. We could come forward as concerned citizens, not as company representatives with ulterior motives. This strong a commitment is difficult to make but utility companies as a group may be responsible for more tree work than any other single group. Think of the people power in that. A united effort could be highly significant in a movement toward proper tree management in urban and exurban areas.

The Public

Communicate and educate the general public. In some ways this is the most consequential group. Education can be done at many levels: through company newsletters that go out in the bills, posters and brochures, advertising campaigns, and personal contact. Many have experience with this already. Be sure the message is well defined and limited. The public can be a significant ally. People are very curious and interested in trees and tree health. At a "Trees in Communities" workshop held in New Hampshire recently, the topic of greatest concern was education. There were people from all six New England states. These people wanted better information about trees and tree care. Our group was broadly mixed to include foresters, arborists, tree wardens, public works people, town officials, and citizens. The group overwhelmingly recommended more educational programs for professionals and for the public. They were concerned about good tree care.

Enlist the local garden clubs, shade tree commissions, or conservation groups. Tap service clubs. They are all powerful advocates. In many small towns and cities, garden clubs and local citizen groups are responsible for beautification. Sometimes they do the actual planting and maintenance themselves. Do not underestimate their influence.

Public opinion is influenced by the media. Approach the local newspapers, particularly the garden writer. If you are planning a planting program, approach the local TV station to show good work in progress. Another group of citizens to educate are the future decision makers. Some companies have programs to educate children on electricity and safety. Why not an education program on trees and proper tree care? Children can influence parents' opinions, but the main interest

is children themselves. We are working toward their future. We need to care for trees not just because they are our livelihood, but because they are our responsibility to the future. There is an old saying, "We do not inherit the earth from our parents, but we borrow it from our children". There are no easy answers, but there are many options for action.

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Technology Transfer Specialist
USDA Forest Service
P.O. Box 640
Durham, New Hampshire 03824

3PF—WHAT IT MEANS TO YOU![1]

by James F. Wilkinson

Pesticide applicators today are confronted with a rapidly changing (and generally adverse) environment. Public perception of pesticides and pesticide applicators is at an all time low. Federal, state and local regulation of pesticides increases almost daily. Environmental concerns from ground water contamination to endangered species will continue to generate regulations imposed on applicators for many years to come. And the non-agricultural user of pesticides, those applicators using pesticides in the urban setting (trees, lawns) or for vegetation management (utilities, rights of way, forestry) will face even stiffer rules and regulations due to a perceived lack of "benefits" from their use of pesticides and the availability of alternatives to the use of pesticides.

This paper first will present legislative and regulatory concerns for the arborist which the Pesticide Public Policy Foundation (3PF) is currently involved with. The issues facing pesticide applicators will undoubtedly have a major impact on the way in which pesticides are used in the future. Next, the paper will review the need for arborists to begin to help formulate reasoned pesticide public policy through cooperation with other pesticide applicator groups. Otherwise, future regulations may jeopardize the pesticide application industry itself.

1. Presented at the annual conference of the International Society of Arboriculture in Vancouver, B.C. in August 1988.