UNIVERSITY OF GEORGIA
Warnell School of Forestry & Natural Resources

Publication WSFNR-21-53C

June 2021

Tree Stump Removal In Landscapes

Dr. Kim D. Coder, Professor of Tree Biology & Health Care / University Hill Fellow
University of Georgia Warnell School of Forestry & Natural Resources

Trees reach the end of their safe and functional lives and must be removed. The shear size and mass of a mature tree requires special skills and equipment to take-down in a controlled and safe manner. The residual clean-up and repair of the landscape can be as important to a client as stem removal. The remaining slash (leaves, twigs, branches, bark chunks, wood chips, and pieces of wood) is time consuming and difficult to completely collect, concentrate and transport.

Tree Remains

A large part of a clean-up process is dealing with roots and stump. Large woody parts of a tree in soil can represent more than a third of the entire biomass of a tree. Leaving the stump and large roots in-place is an option. Over time, soil organisms will break apart wood and periderm materials, returning component elements to the environment and giving up the volume occupied.

Organic materials will be recycled in a healthy soil over some period of time. The more soil limitations present, the larger any woody materials, and the smaller the ecological pool of resources, the slower decay. Figure 1. In a forest, trees die, fall, and are reabsorbed into the ecological systems from where they arose over many years. In the landscape, waiting long periods of time for complete tree decay is usually not acceptable.

Decayed Stuff

A tree stump contains many different types of tissues. Some stumps decay rapidly and some decay extremely slowly. Heartwood contains extractives and other secondary compounds which act as antibiotics in some trees. Different species' heartwood decays at different rates based upon anatomical layout and chemical constituents. Sapwood, the outer annual growth increments which still contained living cells before tree death, and actively stored or transported growth resources, decays rapidly. The cambium area, phloem and secondary cortex just outside the cambium have cells filled with easily consumed proteins and carbohydrates. Periderm (bark), which contains suberin, waxes, and water shedding materials, slowly break down in a decay process.

Stump Parts

A tree stump is made of three parts: 1) stem base (tissue above ground); 2) root collar (tissue at or below ground level which connects the stem to large structural roots); and, 3) structural or compression roots (large diameter, quickly tapering woody roots within 3-8 feet of the stem base). A stump can be composed of wood, periderm, and over-grown debris. Figure 2.

The amount of stem base remaining as part of a stump depends upon how low (close to the ground line) the stem was cut when the tree trunk was removed. A stump one to three inch (1-3 inch) tall and visible above the ground line is normal. In tree removals, the tree trunk is usually first removed leaving a short (½ to 2 feet tall) stump. After the weight and difficulty of trunk and branch removal is complete, the stump is recut as close to the ground as possible without damaging the cutting surfaces of the wood saw (chain saw). The amount of stem remaining will be dependent upon the size of the tree, size of the saw, and the presence of cement, rocks, metal, or other materials preventing effective and safe saw use.

Live Stump / Dead Stump

When living trees are cut, adventitious growing points can be formed at the edge of the cut and start to grow. In some species, adventitious growing points on roots will form and can be found along a healthy root for most of its length. Dormant (latent) growing points just beneath the periderm can be released and start to grow from any area on the stump receiving sunlight -- from near the stump's cut surface to just below the ground line. Both types of growing points can produce stump sprouts. Many of these stump sprouts will die, but some will survive and keep portions of the old root system and stump alive.

If space and resources once controlled by the removed tree is to be quickly reoccupied and assimilated by other trees and plants, living cells in the stump and roots must be killed. Cutting sprouts and/or herbicide treatments should be completed at short intervals (1-2 weeks) to minimize duration of the stump death process. To prevent herbicides from interfering with surrounding plants and not remaining active on-site, careful consideration must be given to herbicide use and application, always following label directions.

Stump sprouts should be killed before they reach full leaf expansion. In a large stump, there may be a lot of stored food available for generating sprouts. Live stumps will continue to defend parts from decay.

Big Roots

The root collar is a structural transition area between stem tissue and root tissue. The root collar has a large amount of reaction wood and was subject to large mechanical forces under a standing tree. The root collar area helps distribute vertical forces into soil, and helps prevent rotational and lateral forces from pushing a tree over. To fulfil these requirements, root collar areas are large and stiff, usually with 3-7 primary, large diameter roots elongating into soil. The root collar area is where tree tissues "turn the corner" from a vertical stem to horizontal roots. Root collar areas can be massive.

The structural roots diverge from each other and taper quickly to 1-5 inches in diameter within a linear distance of 3-8 feet from the stem base. Figure 3. The distance away from the stem base where these large roots can be found is dependent upon tree size and soil constraints. Small and medium-sized roots can be found many yards away from the stem base, colonizing large expanses of soil area. These smaller roots are usually not removed, but do decay over time and can cause soil to subside.

Full-Bodied Decay

Tree stumps are valuable habitat and resource centers in a forest. Stumps can be a liability and an eyesore in an established landscape. Decay processes recycle stumps in forests and yards, but decay can be slow. What is wood decay?

The building blocks of wood (carbon units) are welded together using sunlight. The raw materials needed to make wood in a tree is an invisible gas in air (carbon-dioxide = CO_2), soil water (H_2O), and essential elements from the soil (primarily nitrogen). Construction of wood can only be accomplished in a bath of warmth, moisture, and oxygen, with plenty of available nitrogen. Problems always exist in trees between the optimum amounts of water and oxygen. Too much or too little of either limits growth -- too much or too little of either also limits decay. Decay is the reversal of wood creation, and can be limited by similar site resource concerns.

Decay Light

As wood is dismantled upon death, breaking welds or energy bonds between carbon atoms, energy is released. In the presence of warmth, moisture, and oxygen, soil organisms like fungi and bacteria can use this energy to thrive. Without oxygen, bacteria can tear apart the welds, but at a rate more than 20 times (usually 400 times) slower than wood decay fungi. Fast decay requires proper management of temperature, moisture, oxygen, and available nitrogen resources around a stump.

One of the best ways to visualize wood decay is using foxfire. Foxfire is the pale light coming from decaying wood when special bioluminescent fungi are active and healthy. Too cold or too hot, the fungi is stressed and cannot produce light. Put decaying wood in a plastic bag and prevent oxygen from reaching the fungi, and light is extinguished. Allow decaying wood pieces to dry and any light is extinguished. Drown decaying wood with water and the light goes out.

To summarize, key ingredients of wood decay progression is moisture (not submersion), atmospheric oxygen concentrations (not limited oxygen), warm temperatures (not hot or cold), and wood material which supplies essential elements and energy for the decay fungi.

Sugar Stump

Wood quickly dried and kept dry, does not decay. Wood completely submerged in water decays extremely slowly due to lack of oxygen needed for the fungal decay process. Wood open to the air, constantly moist and warm, but without any available nitrogen decays extremely slowly. Moisture levels in the wood, temperature, nitrogen availability, and oxygen availability must be in the proper amounts and in the proper proportions for rapid decay to occur. A stump in moist fertilized soil, under Summer temperatures, and with adequate soil aeration pore space is primed for decay. Figure 4 lists environmental factors critical to stump decay.

As wood decay accelerates, the most limiting element becomes nitrogen. Available reduced soil nitrogen is needed to sustain and grow decay organisms. This nitrogen is essential to generate proteins and nucleic acids in fungi. Without nitrogen, decay rates grind down to an extremely slow rate. Wood is a block of complex sugars woven together -- without nitrogen, fungi cannot separate and consume these sugars.

Stump Strength

The resistance to extraction demonstrated by a stump is due to its weight and friction between soil and roots. Roots tend to loose contact with soil as roots dry and shrink. In examining extraction forces, it is not soil strength but root density which provides for most extraction resistance. In one study, individual roots were pulled out of the ground along their direction of growth. For example, a root ½ inch in diameter at its cut end required 450 pounds of force to pull from soil. Combined resistance to extraction from all roots attached to a stump clearly represent large values.

Uprooting (extraction) force for any stump is dominated by three stump characteristics: stump diameter; species resistance to decay; and, time since the living tree was cut. The simplest means for estimating resistance to extraction in stumps is by using a stump diameter measure. Stump diameter measures account for approximately 75% of the variation in stump resistance to extraction.

Tough Wood

Different woods decay at different rates. Wood substance is approximately the same across many species except for the packing density of the fibers (wood density), air pore space present from xylem elements, water content, and secondary compounds added to the cell walls (resins, waxes, extractives, terpenes, phenols, etc.). The additional materials added to wood cell wall structure are the dominant attributes determining fungal colonization and growth rates. Figure 5 provides a list of the general decay resistance of a few common woods.

The role of time on wood decay is estimated to remove 1/3 of remaining stump resistance to extraction every year under natural open conditions (i.e. 1/3 in year one, 2/9 in year two, 4/27 in year three, 8/81 in year four, etc.). At this rate, 80% of the stump structure will be gone in 4 years. For wood resistant to decay, each year removes 1/5 of remaining stump resistance (i.e. 1/5 year one, 4/25 year two, 16/125 year three, 64/625 year four). At this rate, 59% of the decay resistant stump will be gone in 4 years and 80% gone in 7 years. Time decays all, but there are interventions arborists can make to increase the rate of decay in stumps. Figure 6.

Many Choices

Stump removal is in demand within modern landscapes. Stumps can be eliminated from the landscape in a number of ways. Mechanical, chemical, and natural techniques can be used to extract or decay woody materials. Choosing the best stump removal technique for any specific set of site and client circumstances is an important decision process for trained tree professionals.

Hand or machine digging can be used around stumps to expose large roots for severing. After large roots are cut, a cable or chain can be threaded beneath or around a stump. A winch, hydraulic jack, or tractor can be used to lift or push over a stump. Some equipment may be powerful enough to simply push a stump out of the soil. Leaving a long above-ground portion of the stem attached can facilitate complete stump removal if the stem base is sound. Usually, some type of stump area soil loosening is required, especially when soils have been compacted. Soaking the soil ahead of time with water can reduce soil strength and associated root frictional forces.

In the past, explosives or burning were used to remove stumps. Both techniques damage or disrupt ecological processes in the soil and tend to expand the landscape area negatively impacted beyond the stump. There are legal restrictions on both burning and blasting stumps in many jurisdictions. Explosives sever roots and allow stumps to be picked-up and loaded. Explosives compress the soil beneath the stump and blow wood debris and soil all over the landscape. Explosives are dangerous and require training, experience and certifications to use effectively and safely.

Burned Down

Burning helps convert stumps from a moist woody material into a reduced size, charred, modified carbon mass much more difficult to decay. Burning stumps can be difficult. Stumps have a high moisture content and are confined within soil where oxygen contents can be limited. Burning is difficult unless the stump is pushed out of the ground to dry.

Several commercial stump removal products in their directions ask that a stump be made more porous and well aerated by drilling a number of holes into the wood. A chemical compound is then inserted into these holes to dry the stump or make it more combustible. Other stump removal products use chemical treatments which are similar to wood pulping chemicals and degrade the cell walls of a stump. As woody materials of the stump are degraded, they become more susceptible to burning and decay.

Some soil types derived from primarily organic matter (organic soils) should not have stumps burned or any fuels added. Wetland areas should not have fuels added to start or sustain stump combustion. Adding any fuel source to assist burning (an accelerant) can lead to soil and water pollution. Instead of a fuel source, a heat source can be used to ignite and sustain stump burning. Ignited charcoal briquettes can be used to slowly consume a stump.

As a stump burns, resource changes occur on-site. As organic material reaches a temperature where combustion is possible, essential elements (like nitrogen) required for decay by wood decay organisms are driven-off. Materials not converted into water and carbon-dioxide (in complete combustion), are modified enough to make it more difficult to ecologically decay the remaining wood. Heavily charred wood can remain visible for centuries.

A New Day

There has been a revolution of sorts within the stump disposal business over the last few decades. Many arboricultural and equipment rental companies have stump grinders. These are ground saws which rip and chip stumps down into a soil 4-12 inches. These grinders come in many power and feature configurations. The cutting head or surfaces, and their mechanical manipulations, vary by manufacturer and machine size. A stump grinder can quickly chew away a stump while accepting limited small stones, metal, and mineral materials in the soil. A grinder leaves the stump as shreds or chips of wood and periderm.

Stump grinders can be self-propelled, towed, or pushed into place. The stump must be accessible to equipment and allow for a minimum of 1-2 feet of working space around the edges of the stump. Some small grinders are designed to fit through standard doorways. The length and dexterity of the arm holding the grinding head will limit how the machine is positioned. Irrigation, septic systems, and buried utilities (currently in-use or old non-used lines), must be identified and avoided. Old concrete, masonry, and metal imbedded in the stump and soil may damage equipment. Each stump presents a unique situation which calls for machines with different attributes to be used. A professional arborist should be consulted to assess the site and stump.

Piles of chips produced from a stump grinder are usually carted away or used in the landscape as mulch. Depending upon the species of tree and cause of death, some chips are not suitable for use in the same landscape nor around the same or related species. The volume of wood removed can require a significant amount of soil to be replaced into the excavated hole. Soil subsidence from decay of any remaining wood needs to be monitored and holes refilled when needed. Simply placing chips back into a stump hole will require a long period of site maintenance and is usually not recommended.

Helping Nature Along

Under less formal landscaping situations, where many small stumps are present, and/or budgets are limited, other ecologically viable techniques can be used to effectively remove stumps, like accelerating natural decay processes. Ecologically accelerating stump decay is an alternative to more machine or chemical centered techniques. To understand the ecological processes harnessed to remove stumps from a landscape requires understanding soil and wood decay information. This subject will be covered in more detail later.

Hauling Parts

One of the first decision points in stump removal is whether to deal with woody remains on-site or have them removed. Mulching, composting, burning, or piling are all ways to use (recycle) woody materials within a local landscape. The smaller the pieces, the faster decay and destruction, or the easier to handle, store and transport. Pulling out a stump from the soil, grubbing out roots, and continuing to replace soil as site subsides is a traditional set of expectations in landscapes.

There are many restrictions on where and how woody materials can be discarded. Many communities do not allow these materials in land-fills, but do provide various means for recycling and reuse. Chipping materials into small pieces can be accomplished at the tree site or at a chipping yard. Fees for dumping, chipping, and removal can be significant. An arboricultural firm (tree health care professionals) can provide a number of services meeting local regulations and professional standards. In tree filled landscapes, a skilled arborist is always a wise investment.

More Decisions

Another major decision point is whether to completely extract and remove the stump, or leave some portion or all of the stump in-place within the soil. One low impact alternative includes cutting the stump low and level so a mower or other vehicle can drive over. Another low impact alternative is leaving a high stump for use as a weathered planter, temporary seat or table.

If a stump will be removed from a landscape, the next decision point is whether to extract the stump whole or in large pieces, or to break the stump apart into small pieces where it sits. In-place stump destruction usually does not pose an equipment intensive demand on landowners, nor risk extensive landscape disruption as would full stump extraction. Stump extraction usually requires plenty of space because of the power requirement of equipment used and physical size of the stump to be transported off-site.

What's Best?

There are many ways to deal with stumps in a landscape. Figure 7. The techniques involved are centered around soil weakening or loosening, excavation, extraction, and/or reduction. Reducing the stump through grinding or chipping is the most prevalent technique used in a well managed, modern landscape operation. Other means of mechanical or natural reduction can be used. For most landscape systems and objectives, quickly recycling site resources and space occupied by a dead stump is critical.

Stump removal processes can be generically described as: dig, push-up or yank stumps out of the ground; break stumps up into various sized pieces; burn any wood possible; accelerate chemical (~25% faster) or ecological (~50% faster) degradation and decay processes; or, do nothing. Stump removal techniques reviewed here are: Hand or machine digging; Mechanically pushing or pulling; Trenching and soil saws; Grinders and chippers; Water and air excavation; Blasting; Burning; Accelerate chemical degradation; Accelerate ecological decay; and, the every popular "do nothing."

Digging -- One means of removing stumps is to hand dig around a stump, cutting any large diameter roots. This job is hard and tedious. As soil is removal and large roots cut, the stump may be extracted with a lever bar, or a hand winch and chain. Cutting a stump high several feet above the ground can give additional leverage to pull and push. Once this process is completed on a small stump, you may decide other means of stump extraction is highly preferable to using a shovel and your own energy. Hand digging is strenuous work and can be dangerous when using associated equipment which may be under-powered, under-sized for the loads, or designed for another purpose. An example of inappropriate tool use is using a small soil auger for excavation.

Digging stumps with a backhoe, excavator or loader can be fast and effective. Digging does disrupt an established landscape. Machine extraction requires good access to the site for equipment as well as for debris removal and transport. The foot-print in a landscape for stump removal using mechanical extraction by digging can be large. Remember, moderate sized and large stumps can be very heavy and tax small equipment, as well as pose a soil collapse hazard into any excavation.

Pushing -- Sites where heavy equipment can be used and not compact the soil or damage landscape features, can have stumps physically pushed out of the ground. Stump pushing or grubbing is a process used in initial development clearance of forested sites and on commercial campuses where no landscape work has commenced but large equipment is available. Whole tree take-downs with stump extraction can be done effectively at the same time. A blade on a heavy tractor can be elevated and used to push a tree or tall stump until the lean from broken roots is clear. The next step is to drop the blade and push under the root ball while lifting with the blade until the tree topples exposing the woody roots and root collar.

Two stump removal procedures associated with heavy equipment use and serious site disruption are root raking and stump splitting. Root raking uses a heavy piece of equipment for pushing or pulling a heavy steel blade or a rake (blade with tines). The tines allow most of the soil to drop away but gathers and breaks large roots and stumps. Stump splitting uses an excavator with a heavy steel hooked point to pierce and yank upward on stumps. The intent of stump splitting is to break the stump into several pieces by separating and splitting the wood between major roots.

Pulling -- Equipment with cables, winches, and pulley systems can be used to drag stumps out of the ground. Both vibratory and steady pull systems are available. Deeply soaking the soil with water hours before can greatly reduce extraction power requirements. A cable, chain, or grapple is affixed to the stump and a winch is used to pull the stump. Either straight horizontal pulling, or using a lifting stand or tripod to elevate the chain or cable (i.e. adding a vertical component to pulling) can be used, although the power requirements are similar.

Usually a soil saw, trencher, or other means of excavation or root severing are used to reduce the force needed for extraction. Great forces can be generated in stump pulling and it is critical all load bearing components of any set of cables, chains, pulleys, anchor lines, or connectors be designed for the forces generated plus a safety factor. Generally, the relative Stump Extraction Force (SEF) can be estimated by accounting for three components: (0.75 X stump diameter) plus (0.15 X species decay resistance) plus (0.10 X time since death). Note every stump has different soil-root mechanical interactions, different levels of damage and decay, and different site constraints. Figure 8.

Figure 9 was developed from reanalyzing a number of studies dealing with the pounds of force needed to extract stumps of a given diameter. (Biller & Baumgras 1987; Golob et.al. 1976). It provides a rough estimate of forces and their variation caused by different stump and soil conditions. Because of the power requirements involved, most pulling systems require large equipment and a large setup area. Customized smaller pulling systems can be designed for unique situations.

Stump Features For Pulling

For effective pulling of stumps, the mechanics of how a stump is locked into the soil should be reviewed. Rooting systems are highly variable in life, and so stump structure is highly variable in death. Trees can have many small diameter roots and a few large diameter roots -- highly branched woody roots and long unbranched roots -- large angles and distances between roots and roots closely packed together.

The most critical feature to consider in a stump being pulled to minimize force exerted is the large diameter roots on the same side of the stump as the pulling action – toward the winch cable. The more roots branch on the pulling side of the stump, the less stiff the stump / soil system and the nearer to the stump will be the extraction fulcrum or hinge point. Root branching points close to the stump will be the location of bending and breaking failures. Root branch points are places where large changes (abrupt reductions) in root stiffness occur. A stump with a few large diameter, unbranched roots on the pulling side will be very stiff and hard to pull. Stiffness and pulling force required will fall dramatically as the angle between neighboring large roots on the pulling side reach and exceed 60^{o} of horizontal separation.

Along with stiffness of roots and separation angle, decreasing the holding interface between soil and root surfaces is critical for pulling. Saturating the soil with water before pulling will decrease soil strength and root holding capacity by as much as four times (-4X). Under saturated soil conditions, roots are more likely to slip rather than break.

Use a trencher or soil saw to loosen stumps by severing roots, reducing root length, and reducing root holding capacity. For extracting the main stump mass only, roots should be severed close (i.e. no more than a stump diameter) from the stump on the pull side. Roots on the opposite side of the pulling force can be severed between two and four times (2-4X) stump diameter away from the stump center. Pulling stumps, in essence, means you are trying to roll the stump up and out of the ground while minimizing force expended.

Trenchers & Soil Saws -- Soil trenchers and saws can be used to cut, at some distance from the stump, roots and soil. Trenching around the stump can eliminate most of the root-soil contacts and make it easier to extract the stump whole or in large pieces. Standard trenchers are NOT designed for big root cutting, just for soil removal around a root to be cut.

Soil saws are large circular wheels with soil teeth used for cutting down through soil. Soil saws can be used to rapidly sever small roots and separate the stump from surrounding soil. Note trenchers and soil saws are designed for soil excavation, not cutting or chipping wood. Damage to equipment and dangerous conditions for the operator can arise from misuse or exceeding design specifications. Trenchers and soil saws can be effectively employed to isolate the stump from the mass of soil the roots occupied.

Grinders -- There are four primary types of stump grinders: hand manipulated handlebar machines; self-propelled machines; tow-behind machines; and, truck / tractor mount machines. Stump grinders pushed by hand can fit into small areas but may take a long time to grind. Small machines may also be limited by the depth of grinding. On the other hand, some small stump grinders can be pushed or walked through areas less than 29 inches wide. The larger the machine, usually the larger the engine and grinding head or wheel. Note stump grinders can be rented, but are powerful specialized equipment which can be dangerous. Seeking professional assistance is recommended for new operators and landscape situations.

Stump grinding is usually sold by the diameter of the stump at the widest point. Additional fees are assigned for the depth to which the stump is to be ground (4 to 36 inch depth) and how tall the existing stump is above the ground. There are specialized stump grinders used under specific conditions, like for stumps under six feet of water in lakes. When contracting with a stump grinder, be sure to explain the access width and heights, and open space available around a stump, to assure the best choice of equipment.

Extremely large stumps are difficult to cost-effectively grind with some types of equipment. For any stump grinding / chipping job a number of specifications should be outlined. The depth of stump removal below grade, the extent around a stump in which to remove large roots, clean up procedures and chip removal, and residual damage repair to the landscape and hardscape are a few of the items to be agreed upon.

Chip disposal is critical in any specification set. Stump grinding should always include a skirt or fencing around the stump to control flying debris and limit where stray pieces of stump and soil may end-up. Allow enough room inside the skirting for wood chip build-up. The chips produced will amount to approximately four times the volume as the solid stump wood occupied. Chips can be left where they fall, leveled, spread, moved elsewhere on-site, removed from the site, or dumped back into the stump excavation hole.

The stump excavation hole can have "chips only" deposited or the chips can be mixed at some concentration with clean soil or other materials. The excavation hole could also be cleaned out completely and back-filled with clean soil (the preferred method for sustainable sites). The decisions regarding material deposition are important for future use of a stump site, for values of the surrounding landscape, and for costs associated with off-site disposal.

Soft Excavation -- Removing soil from around a stump (including beneath the stump) can be accomplished using jets of water or air. A high pressure water jet can be used to separate the stump and large roots from soil. Roots can then be cut and the stump extracted. A water jet process is more effective when any water used, and soil it carries, can be vacuumed-up immediately. If a vacuum truck is not used, temporary trenches, slope dams, ditches, and water control barriers can be installed to collect all water and soil eroded from the site and to keep the stump area drained.

Using a water based excavation system can be fast and effective on many soil types, but is extremely messy with off-site impacts possible from water and displaced soil. Soil saturation can reduce soil bearing strength, accelerating site damage from equipment ruts and poor traction, but ease stump extraction.

A high velocity air jet can be used in the same way as a water jet in order to excavate a stump. Air jet products have a number of advantages over water jet products in ease of use, equipment requirements, and potential residual mess. A stump shroud or netting is usually required in established landscapes to control soil and dust. A commercial sized air compressor can be setup at some distance from the stump area. The air nozzle and hose can be snaked through small spaces. The whole stump and major roots can be exposed using soft excavation and then some means of cutting and extraction can be used. Soft extraction techniques can be difficult in compacted soils.

Blast From The Past -- Blasting or blowing stumps was a standard practice for stump extraction in the past. In rural areas and on large sites already disrupted by construction, blasting can still be used under carefully controlled conditions. Usually a hole is bored or dug beneath a stump and blasting charges inserted. In areas away from underground utilities, wells, foundations, and buildings, charges can be set and effectively used. In the past, there was a tendency to use an over-charge of explosives, spewing wood, rocks, and soil many yards. In the blast, the shockwave of the explosion and rapidly expanding gases shear off roots and elevate the stump and soil. The blast heavily compacts soil below the explosion.

Carefully controlled and directed explosive charges can be successfully used by certified explosive experts in concert with stump removal specialists. Special training and permits are required to purchase, transport, and use the explosives traditionally used to blow stumps. The extent of clean-up after the explosion can be controlled by using blast mats (i.e. like a mat of interconnected old tires) to cover and hold down flying debris.

Burning -- Another traditional means of stump reduction was to set it ablaze, usually using petroleum-based accelerants or charcoal briquets. Stumps must be dried before they will sustain ignition. Other woody parts of the tree which are already dry can be burned for heating the stump, driving off the water, and ignition. Stumps in contact with moist soil, have limited surface area open to air, and are covered with periderm will dry slowly.

Petroleum products, resin soaked wood, torches, charcoal briquets, or other external heat sources can be used to ignite and sustain stump burning. Partial excavation or extraction can aid in drying a stump and allow enough oxygen to reach applied fuels to burn the stump. Extensive large-bore drilling into stumps is cited as essential by many stump removal products.

Burning rapidly breaks apart wood bonds, releasing energy. The parts of the stump which do not burn will be covered with a charred layer, or be partially burned to charcoal, which slows decay of these residual parts. Burning can be assisted by products which either kill and dry the stump faster (salts), or make the wood more flammable (diffusible chemical fire accelerant). There have been a number of stump removal products marketed which are burning pretreatments. Note in many parts of the nation burning stumps, smoke generation, and accelerant products are NOT allowed for stump removal.

Accelerate Chemical Degradation -- Many traditional stump removal products used to accelerate the degradation and decay of stumps, contain concentrated salts to dry a stump for burning, attempt to infuse the stumps with potassium nitrate (saltpeter) to assist with burning, contain alkalis or sulfiting agents used to break down lignin, or contain enzymes which weaken wood cell walls. Many of these materials or formulations have been used in one form or another over many years. Few show any significant acceleration of decay in the short term. At the recommended application rates, many products are damaging to decay fungi. Over the long run, most products which increase nitrogen in wood and decrease the carbon:nitrogen ratio (C:N ratio) around the stump will accelerate the wood decay process.

Doing Zip -- Leaving a stump in the soil and forgetting it is easy. Forgetting a stump and trusting nature to act alone in removing associated problems may seem like an ecologically viable means to treat a site. Resource constraints, site liabilities, and forgone site usage all can haunt non-action. There are locations and circumstances when doing nothing is a real option, but in established landscapes, prompt stump removal is an important part of good management.

Stumps are a food source and a habitat which is difficult to find in many community landscapes. The creatures which inhabit and use a decaying stump change as a stump changes. Energy concentration in a decaying stump represents a rare and essential resource to a number of animals and micro / meso-organisms. If a stump can be simply left in-place and not disturbed, interesting things can happen, especially when a stump is surrounded by a healthy soil. The pieces and chips of a stump can also be used to enrich a site and provide unique, wood centered habitats.

Accelerate Natural Decay Processes -- Knowing the important components of stump decay allows for optimization of a decay environment. Providing more of whatever component is limiting decay rates, while not interfering with other soil resources, can push the decay process along. By carefully enriching resources on a site around a stump, decay conditions and organisms can be facilitated. For most stumps, aeration of soil and stump, increasing the surface area of a stump open to the air but shielded from the sun, assuring moist (not wet) conditions, and addition of nitrogen fertilizer and sugar all provide conditions accentuating wood decay.

There are a number of products available, from specialized stump removal compounds to general fertilizers, which can be added to a stump or site. Stump decay remains a long-term soil mediated process, not stumps simply melting away quickly. Expectations for stump decay should be centered upon climatic conditions and soil temperatures stretched over several years. Steps for accelerating stump decay are given in Figure 10.

Why Bother Nature?

With all the procedures and additions made to a site in order to accelerate natural decay processes, why not use a reduction or extraction technique and be done with the stump? There are some places not easily accessible. Other locations are sensitive to vibration and disruption. Still other locations are designated for natural process treatments only. Allowing stump decay is the ultimate in recycling. Although not free of expense nor risk, natural decay processes do function at a low cost if provided a few considerations. At the end of this publication is a Field Guide for Stump Removal by Accelerating Natural Decay Processes handout.

Accelerating Nature

There are two phases of natural decay in a stump, both known by their constraints -- nitrogen and sugar. Immediately after cutting a stem, nitrogen content of stump wood, and the carbon:nitrogen (C:N) ratio of the stump site, control the rate of decay. The more nitrogen in wood and lower the C:N ratio (higher nitrogen content for the carbohydrate present on a site), the more rapid the decay process. For most sites, the C:N ratio can be used to gauge about 70% of the early rate of decay.

As stumps are colonized by a series (succession) of organisms, one or many decay fungi, and have lost about one-fifth (decay resistant wood) to one-third (normal decay resistant wood) of their total mass (after 1-2 years), the lack of simple carbohydrates and a greatly increasing lignin:nitrogen ratio begin to slow decay rates. This phase of decay is controlled by a lack of easily usable carbohydrates to aid in attacking highly decay resistant materials. Figure 11.

Simple sugar containing materials can be added to a site to maintain a study decay rate. Sugar and corn syrup products are available which can be added to the site to fuel decay. Simply sprinkling granulated sugar over and around an old stump site periodically will help maintain decay processes.

Mapping Time

The natural decay process can take many years depending upon a number of soil and stump attributes. With all other things being equal, a stump decay process accelerates as soil temperature increases. Figure 12 is a map providing the number of years it takes for tree stumps to decay (70% decayed) under natural open conditions. This was derived from average soil temperatures during the growing season. Stump decay or degradation acceleration products would slightly increase the rate of decay compared with this time scale. Note stump diameter, stump volume and mass, and wood resistance to decay are not specified.

Surface Area

One of the first attributes needed to facilitate decay is a large surface area open to air but shielded from sunlight. The first step is always cutting the stump as low to the ground as possible. Multiple large drill holes (1 inch diameter) have been recommended in top and side of a stump, and into the tops of major roots. Using a saw to roughen and cut criss-cross grooves on the stump face have also been suggested. The more gaps, cracks, breaks, slices, holes, or saw kerf grooves cut deep into the stump, the better.

In addition to the stump face, the more bark scraped and sliced off, the faster decay processes can proceed. Even pulling or pushing stumps without extraction can break and twist large roots and leave separation cracks between soil and roots. The more woody stump surface area in contact with aerated soil, the more rapid decay.

Soil Aeration

Soil atmosphere around a stump must be constantly supplied with oxygen to power decay fungi. Carbon-dioxide (CO2) generated by wood decay and other organisms in a healthy soil must be removed from stump vicinity. Lack of good aeration may have led to a tree's death, and will slow stump decay. Compaction in the stump area must be alleviated to a depth of 12-24 inches. Augers and small tillers can be used to break up soil compaction, knowing there will be a number of big roots struck. Any aeration treatment which scars bark and cuts into wood carries added benefits. Installation of temporary deep soil vent pipes beneath a stump is an option for assuring aeration of natural decay processes, but alone cannot replace simple soil loosening.

Soil Moisture

Moist, not saturated soil, with adequate drainage is critical to stump decay. Excessive aeration which allows drying of the soil will actually slow decay. Soil must remain moist at all times to avoid episodic decay cycles which lengthen decay times. Irrigation around a stump site to moisten soil on a weekly basis is valuable in most soils as long as water does not accumulate. Inside living trees, moisture content and free water present in cell walls constrain decay. In a dead stump, forcing aeration deep into the stump allows some wood drying to occur which increases oxygen contents. Soil aeration vents can be used to apply water if needed. Remember, soil should be always moist, never wet / saturated.

Nitrogen

Wood nitrogen content, and the ratio between carbon content of wood and nitrogen content, are both part of what drives a decay process. Decay fungi require nitrogen to effectively attack and dismantle carbon-dense materials like wood. Most stump wood will have a low nitrogen content and a high carbon:nitrogen ratio. To minimize these constraints, the site around a stump and any stump surfaces should have nitrogen fertilizer applied. Slow release fertilizer with a low salt index is best. Avoid concentrating any high salt fertilizers in holes or piles. Surface broadcast nitrogen fertilizer across a small treatment area around a stump. Do not dump fertilizer only on the stump face. Low carbon:nitrogen ratio composted materials can be a great benefit to the site added in small amounts.

Enriching a site with nitrogen fertilizer to accelerate a wood decay process requires careful application to minimize nontarget effects like water pollution and weed growth. Figure 13 provides an estimated amount of fertilizer to be added immediately around a stump to facilitate decay. Addition of nitrogen fertilizer, measured in pounds of nitrogen per treatment area diameter, attempts to decrease the carbon:nitrogen ration in the soil surrounding a stump.

Application

Figure 13 has seven columns in four groups:

Column group I is stump diameter in two-inch classes measured one inch above ground line;

Column group II is associated diameter of treatment area in feet and radius of treatment area centered on a stump in feet;

Column group III provides amount of nitrogen to add in pounds of slow release nitrogen for treatment area as applied in three applications per growing season, or pounds of very slow release nitrogen for a treatment area applied in a single application per growing season; and,

Column group IV provides pounds of slow release nitrogen for residual area around a ground stump in three applications per growing season, or pounds of very slow release nitrogen for residual area around a ground stump in a single application per growing season.

Assumptions used in modeling decay processes for stump removal included:
- -- stump average depth was 1.33 feet;
- -- stump grinding depth was 1 foot in a cylindrical shape whose diameter was the diameter of the stump measured at one inch above the ground;
- -- 0.1 lbs of nitrogen added per cubic foot volume of space;
- -- three treatments per year at 6 week intervals across the growing season beginning just after full leaf expansion;
- -- one annual treatment made just after full leaf expansion;
- -- idealized volume of the tree rooting area estimated to be ½ the volume of a spheroid shape (result is a saucer shape) reduced to 0.4X to account for rooting density in the treatment area; and,
- -- for the stump grinding site, residual volume of a right cylinder shape with the same diameter as the stump minus the total treatment area volume, was used for the volume of treatment area after stump grinding -- reduced to 0.2X to account for rooting density in remaining soil.

Healthy Soils

Most soils which successfully grow trees for any length of time, and are not damaged by compaction or contaminants, usually have a guild of organisms which disrupt and decay wood tissues. The decay fungi are part of a healthy soil. If they were not, we would be covered with undecayed twigs, branches and stems. Disrupting a stump's natural defensive compartments is critical for fast colonization of soil micro- and meso-organisms.

In some extreme situations, soil brought from local forested areas to unhealthy soil areas may inoculate a site with additional beneficial decay organism. Rub healthy soil on the stump face and cover a stump with a thin layer of soil. Use a coarse organic mulch to protect soil of the treatment area and over the stump face. Mulch will protect organisms present from direct sun and drying.

Site Protection

Covering a stump top with geotextile or mulching fabric is important to minimize water loss and to shade soil from direct sunlight. Plastic sheeting can interfere with aeration, especially by not allowing carbon-dioxide to escape from soil. If plastic is used, it should be perforated with many small holes, and be black or white (opaque) in color. The stump site area should be covered.

Any soil or composted material over the stump should especially be covered. Porous covers like low density coarse organic mulch or mulch fabrics will allow water to reach soil and allow for gas exchange. A cover will also prevent weeds and sprouts from forming and using applied nitrogen and water.

Site Disruption

To assure rapid decay, a stump and main roots should be scarred, cut, or drilled periodically. The soil should be raked and reapplied over a stump. The site needs to be uncovered, stirred up, and recovered at least every three months. This disturbance process will help push successional decay processes forward and expose new wood surface area. Disturbing the site will also allow you to see how decay is progressing and allow for amending the site. Simply using a pry-bar, or pointed metal rod to tear and punch into a stump will help increase decay extent and rate.

Temperature

The site needs to be warm. Growing season temperatures are ideal for decay. Some areas have longer growing seasons and warmer temperatures than other. Decay will progress twice as fast for every 18°F as temperatures climb between 40°F and 105°F. Short growing seasons and cool soil temperatures will greatly slow decay rates. Mulch can insulate the site from short cool periods.

Making It Difficult

As mentioned above, different tree species generate wood with a host of different characteristics. Some of these wood characteristics we covet for panelling (and other utilitarian and artistic interests). Some of the characters we appreciate arise from the architecture and chemicals within wood. Living trees use a series of passive defence boundaries to slow pest and decay movement, and a number of active defensive systems to slow or kill pests and decay organisms.

Heartwood of a number of species of wood are resistance to decay due to chemicals impregnating cells walls. The more decay resistant stump wood, the longer it will take to completely decay. Sapwood will decay quickly, but some heartwood will take an extended time to decay. Figure 14 shows the rate of decay over a number of years for woods resistent and not resistant to decay. Note most of the mass of a stump is quickly decayed, but the remainder can take years to be fully consumed.

Soil Subsidence

As a stump dissolves back into the environment, the space it occupied will be left behind -- root channels will collapse, water will move soil around, and the stump area will develope a stump caldera. As soil subsides, new mineral soil will need to be applied to a site. Thin soil layers can be applied and then washed into the soil openings or depressions. Be careful to not use water or tamping to compact new soil into old positions.

Because stump and roots take many years to completely decay away, many years of vigilance will be needed to fill-in areas with soil. Decay near structures or pavements may require soil stabilization or injections to prevent damage. If roots or stump were pushing in or up structures when alive, wood decay will lead to more damage. After you have declared victory on a stump and walked away, periodic visits to minimize liability risks and repair unexpected problems will be needed.

Future Site Use

The site which remains after stump removal will be dominated by decay processes for a number of years. Once the decay process is functioning well, a new tree can be planted near a stump site. Planting should be completed outside the area impacted by the removal treatment. The cause of death, or need for removal of the original tree, needs to be considered in both species and site selection for a new tree. The same resource limitations (including pest problems) can impact a new tree, as they constrained the old tree, unless changes are made.

Planting back into the identical location as the original tree is possible if the old stump is broken and shattered enough to allow a new tree to colonize native soil. New soil can be used for fill into the stump excavation or caldera, but multiple openings or connections to the surrounding native soil through the old stump site are essential. Usually several years are allowed to pass, with rapid decay progression, before a new tree is planted in the same location. Do not plant a new tree in only wood chips pushed back into the caldera, as resource fluctuations and pest problems can be severe.

Conclusion -- Don't Be Stumped !

There are many ways to get rid of stumps in landscapes. Some have a great impact on sites and some have little impact on anything but the stump and the space it occupies. Time and money do play a great role in all the different stump removal alternatives. Usually stump reduction and residual material removal is the best overall option. Sometimes, specialized techniques are needed for special client and site concerns. Tree health care professionals can help make these informed decisions.

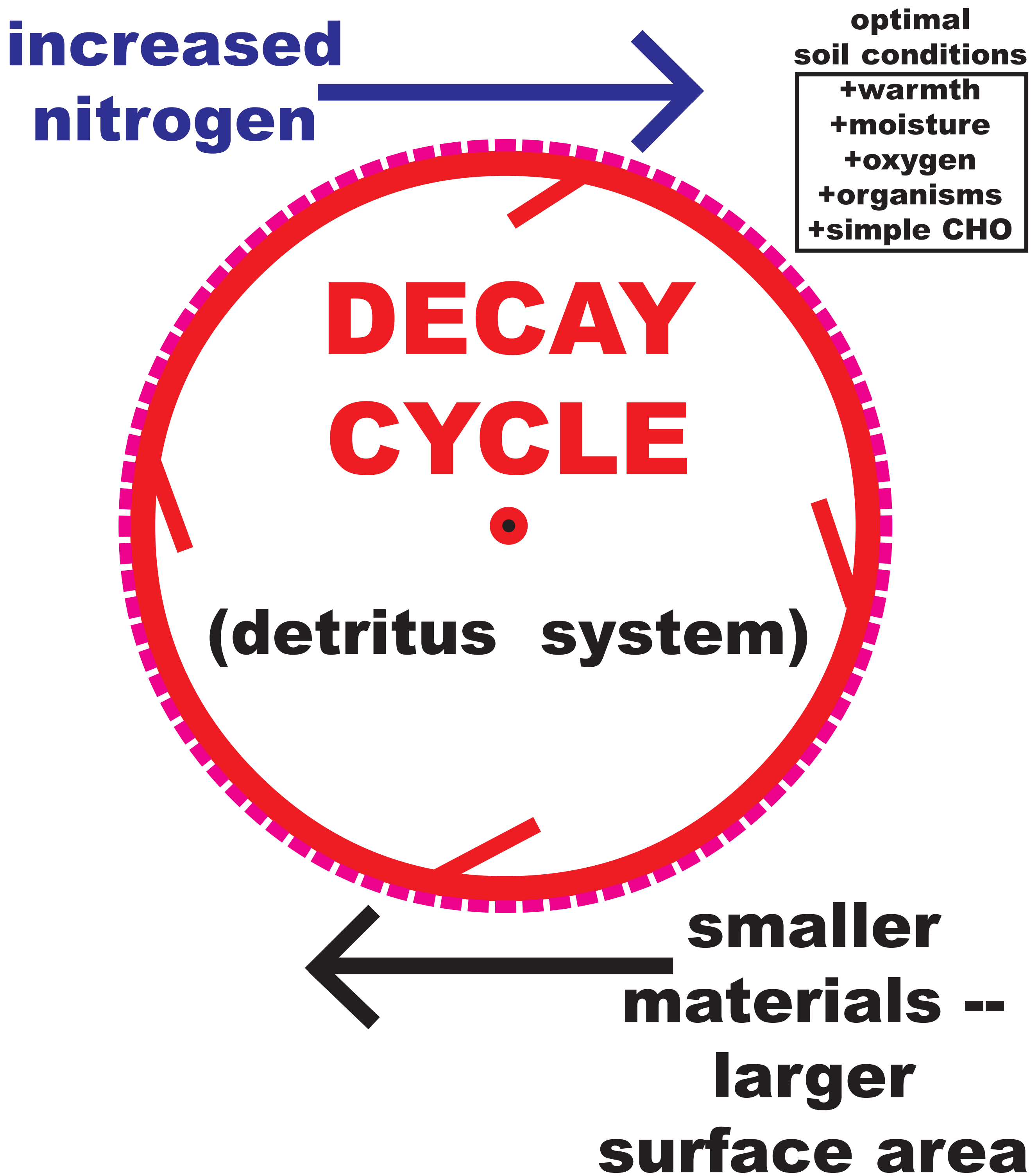

Figure 1: Decay cycle accelerated by: favorable soil conditions; increased available nitrogen; and, smaller sized materials with greater surface area, all exposed to a healthy soil.

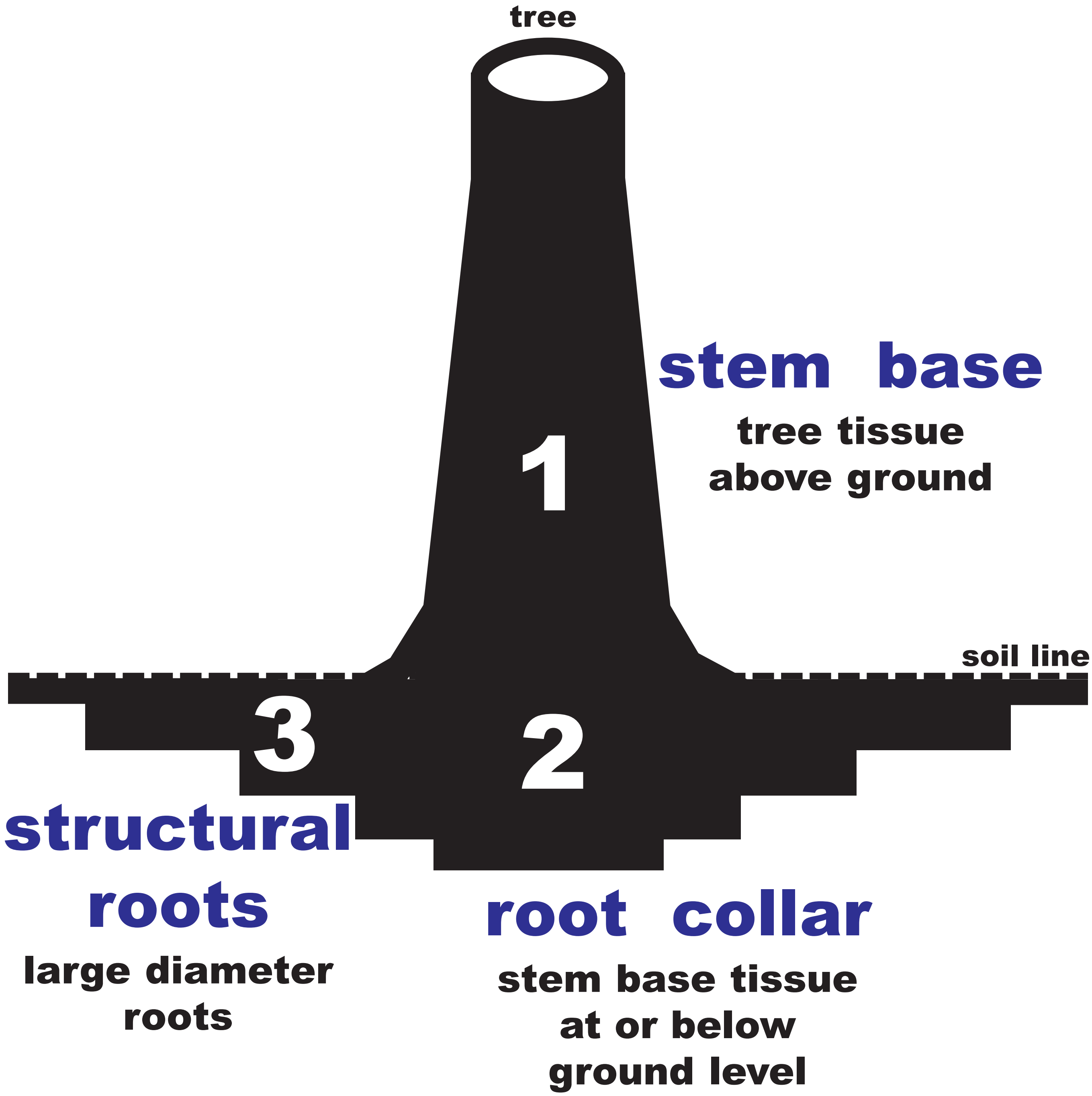

Figure 2: Three primary components comprising a tree stump: stem base, root collar, and structural roots radiating from the root collar.

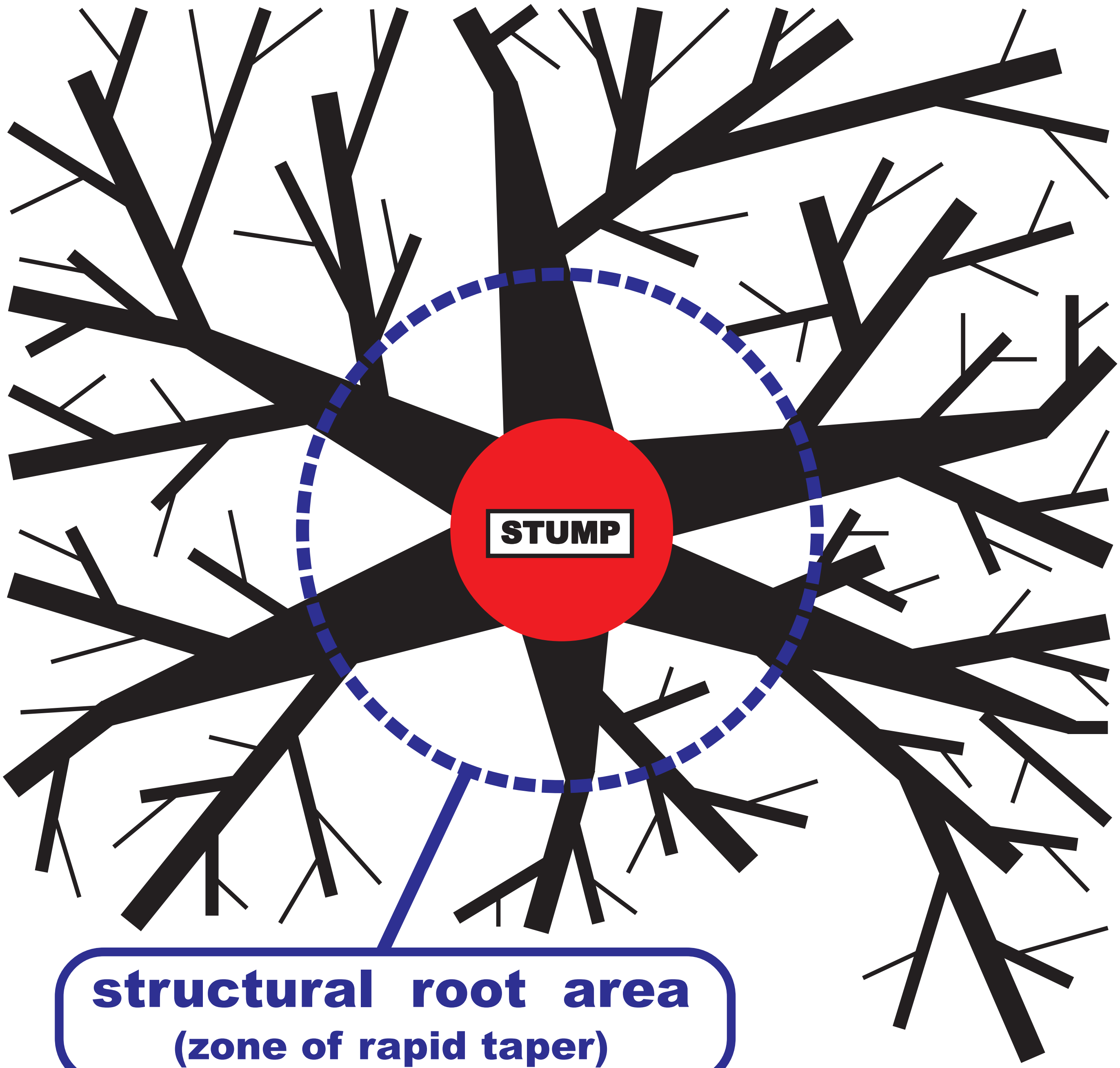

Figure 3: View from above of a tree stump and root area.

STUMP DECOMPOSITION

soil aeration / decompaction

soil moisture / adequate drainage

soil temperature / no extremes

soil organic matter / detritus system fuel

soil trophic health / richness & diversity of soil organisms

---

site nitrogen availability

site disruption / soil cultivation

site protection / micro-site conservation

---

stump surface area increase by gouging & bark piercing

stump tissue contact with soil & decay organisms

stump wood decay resistance

Figure 4: Critical features and considerations for decay processes within tree stumps.

resistant to decay	intermediate resistance to decay	not resistant to decay
American mahogany	African mahogany	alder
Arizona cypress	Douglas-fir	ash
baldcypress	eastern white pine	aspen
black cherry	longleaf pine	basswood
black walnut	slash pine	beech
black locust**	swamp chestnut	birch
bur oak	oak	black oak
catalpa**	tamarack	buckeye
cedars	western larch	butternut
chestnut		cottonwood
chestnut oak		elms
honeylocust		fir
juniper		hackberry
lignum vitae**		hemlock
Osage-orange**		hickory
post oak		magnolia
red mulberry**		maple
redwood		pecan
sassafrass		pine
teak		red oak group
white oak		spruce
yew**		sweetgum
		sycamore
		tanoak
(** = extremely decay resistant)		willow
		yellow-poplar

Figure 5: Relative decay resistance of various heartwoods.
(Listed as relative resistance of heartwood to decay because sapwood of almost all species is not decay resistant.)

year	removal of woody materials per year by decay: poorly decay resistant heartwood		removal of woody materials per year by decay: highly decay resistant heartwood	
0	1	(1.0)	1	(1.0)
1	1/3	(0.33)	1/5	(0.2)
2	2/9	(0.22)	4/25	(0.16)
3	4/27	(0.15)	16/125	(0.13)
4	8/81	(0.01)	64/625	(0.10)
	80% gone in 4 years		59% gone in 4 years	

Figure 6: Timelines for wood decay (i.e. stump resistence to extraction) for both poorly (1/3 loss per year) & highly (1/5 loss per year) decay resistant heartwood species.

1. Digging
   - Hand
   - Machine
2. Mechanical Pushing / Pulling
3. Break Stumps Into Pieces
   - Piercing / Splitting
   - Trenching / Soil Saws
   - Grinders / Chippers
4. Soft Extraction
   - Water
   - Air
5. Blasting
6. Burning
7. Accelerate Chemical Degradation
8. Accelerate Ecological Decay
9. Do Nothing

Figure 7: General stump removal processes & techniques.

Relative Stump Extraction Force (SEF)

=

0.75 X stump diameter +

0.15 X species heartwood decay resistance +

0.10 X time since stump death

Figure 8: Variation of relative stump extraction force.

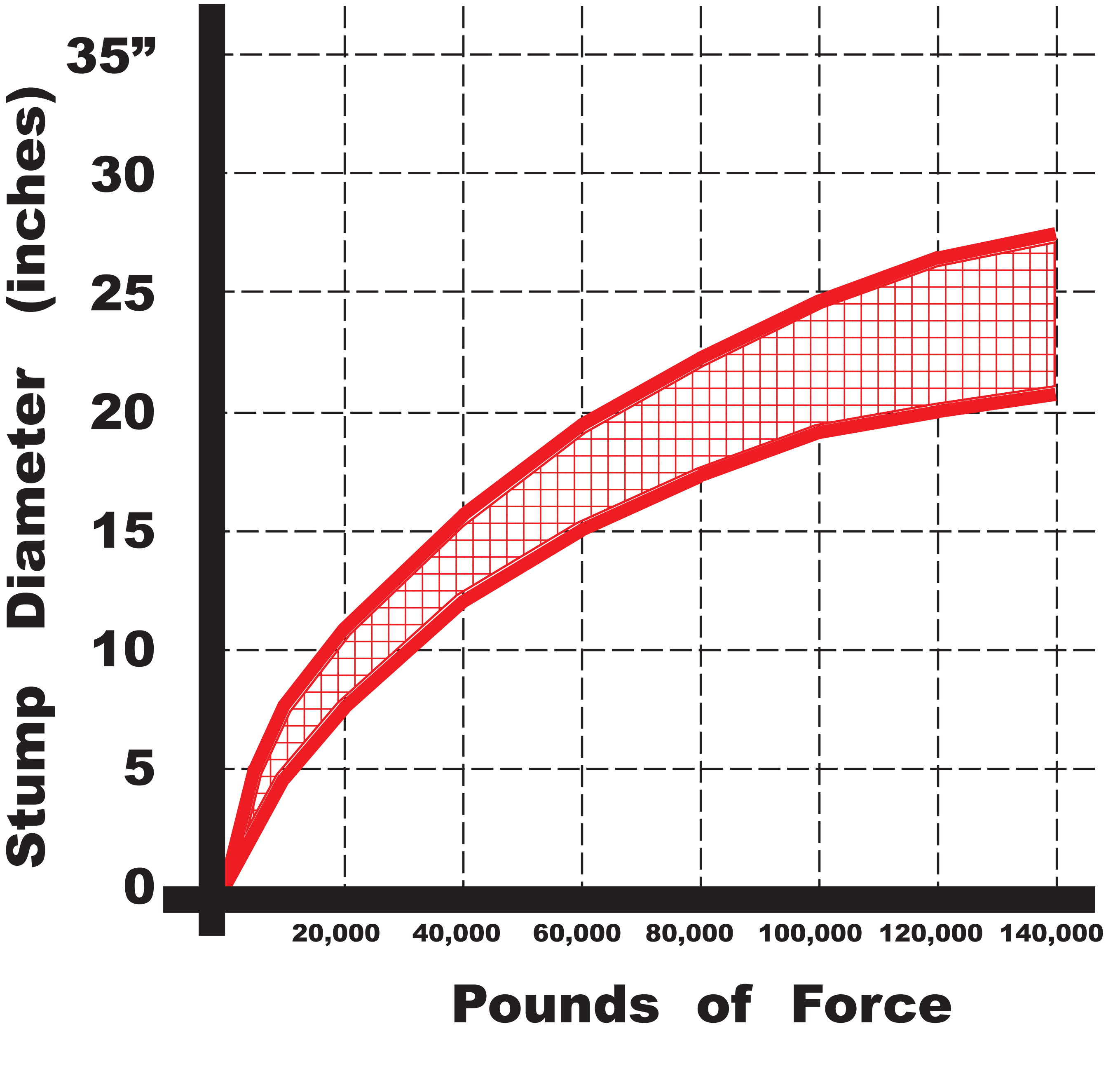

Figure 9: Rough estimate of pounds of force, and force variability, required to extract a stump of a given diameter.
(derived from Biller & Baumgras 1987 & Golob et.al. 1976).

A. Initial	**1. Cut low**
	2. Kill stump
	3. Scar up surfaces
B. Start	**4. Add nitrogen fertilizer**
	5. Add good forest soil
	6. Cultivate soil
	7. Water till moist
C. Protect	**8. Mulch**
	9. Permeable cover
D. Add	**10. Year one -- add nitrogen**
	11. Year two -- add sugar & nitrogen
	12. Year three -- add sugar
E. Facilitate	**13. Continue to water, not saturate**
	14. Disrupt stump

Figure 10: Steps for naturally accelerating stump decay.

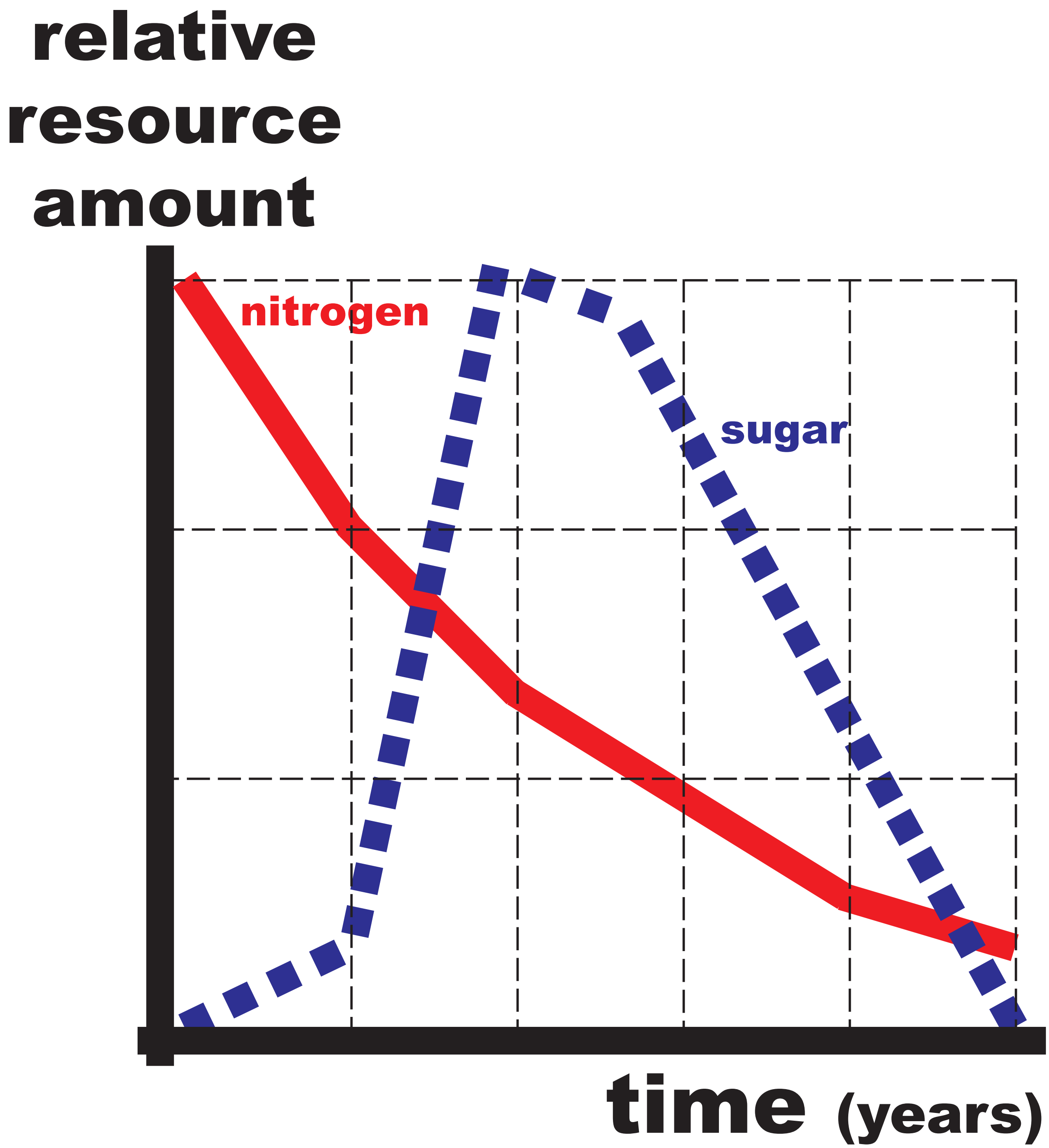

Figure 11: Changing levels of resources required for accelerated stump decay over time.

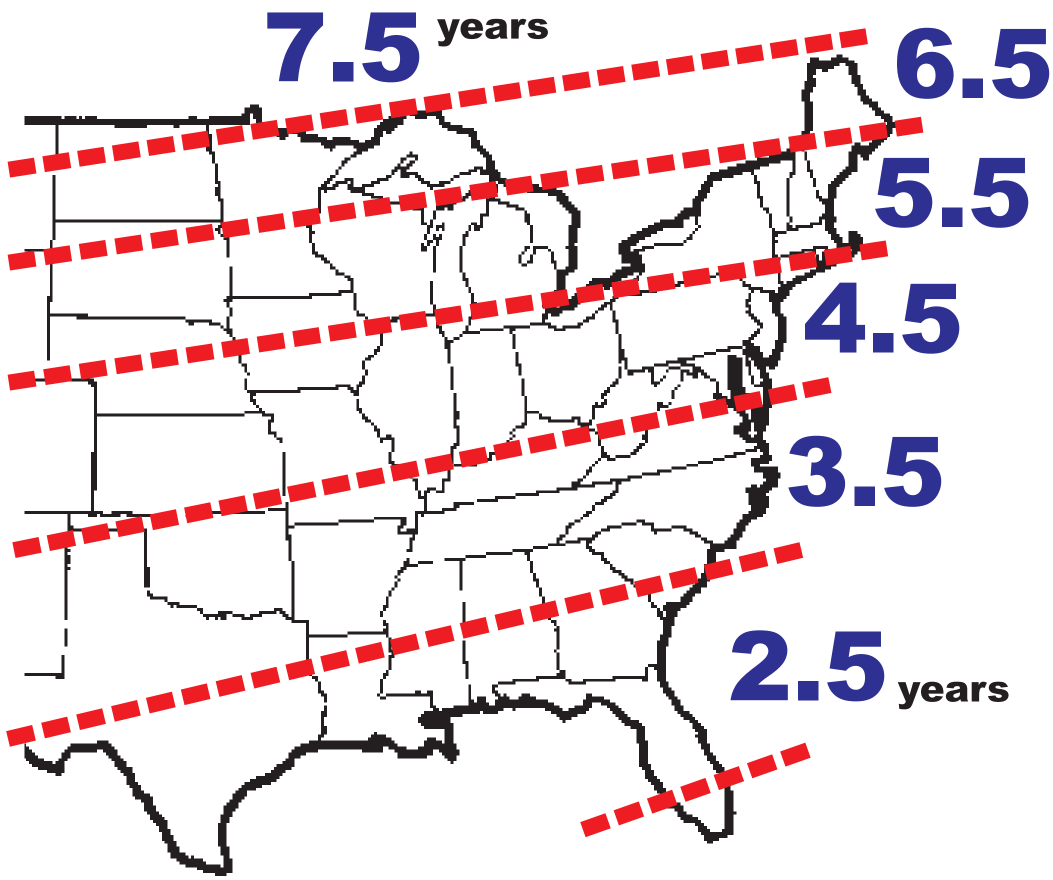

Figure 12: Map showing number of years to decay (75%) a completely dead stump under natural open conditions in the Eastern United States. This map is derived from average soil temperatures during the growing season and average stump decay rates.

stump diameter (inches)	diameter of treatment area (feet)	radius of treatment area (feet)	***full stump decay*** split application (1/3 annual) of nitrogen (pounds N)	***full stump decay*** annual application of nitrogen (pounds N)	***decay after stump grinding*** split application (1/3 annual) of nitrogen (pounds N)	***decay after stump grinding*** annual application of nitrogen (pounds N)
2 in.	0.8 ft.	0.4 ft.	0.01 lbs.	0.02 lbs.	0.003 lbs.	0.009 lbs.
4	1.6	0.8	0.02	0.07	0.01	0.03
6	2.4	1.2	0.05	0.2	0.03	0.09
8	3.2	1.6	0.1	0.3	0.05	0.15
10	4.0	2.0	0.15	0.5	0.07	0.21
12	4.8	2.4	0.2	0.6	0.1	0.3
14	5.6	2.8	0.3	0.9	0.1	0.4
16	6.4	3.2	0.4	1.1	0.2	0.6
18	7.2	3.6	0.5	1.5	0.2	0.7
20	8.0	4.0	0.6	1.8	0.3	0.9
22	8.8	4.4	0.7	2.2	0.3	1.0
24	9.6	4.8	0.9	2.6	0.4	1.2
26	10	5	1.0	3.0	0.5	1.4
28	11	5.5	1.2	3.5	0.6	1.7
30	12	6	1.3	4.0	0.6	1.9
32	13	6.5	1.5	4.6	0.7	2.2
34	14	7	1.7	5.2	0.8	2.5
36	14	7	1.9	5.8	0.9	2.8
38	15	7.5	2.2	6.5	1.0	3.1
40	16	8.0	2.4	7.2*	1.1	3.4
42	17	8.5	2.6	7.9*	1.3	3.8
44	18	9	2.9	8.7*	1.4	4.1
46	18	9	3.2	9.5*	1.5	4.5
48	19	9.5	3.4	10*	1.6	4.9
50	20	10	3.7	11*	1.8	5.3
52	21	10.5	4.0	12*	1.9	5.7
54	22	11	4.3	13*	2.1	6.2
56	22	11	4.7	14*	2.2	6.7

Figure 13: Estimated amount of available nitrogen needed to accelerate stump decay processes.
(* = do not apply more than 7 pounds of nitrogen in any one application.)

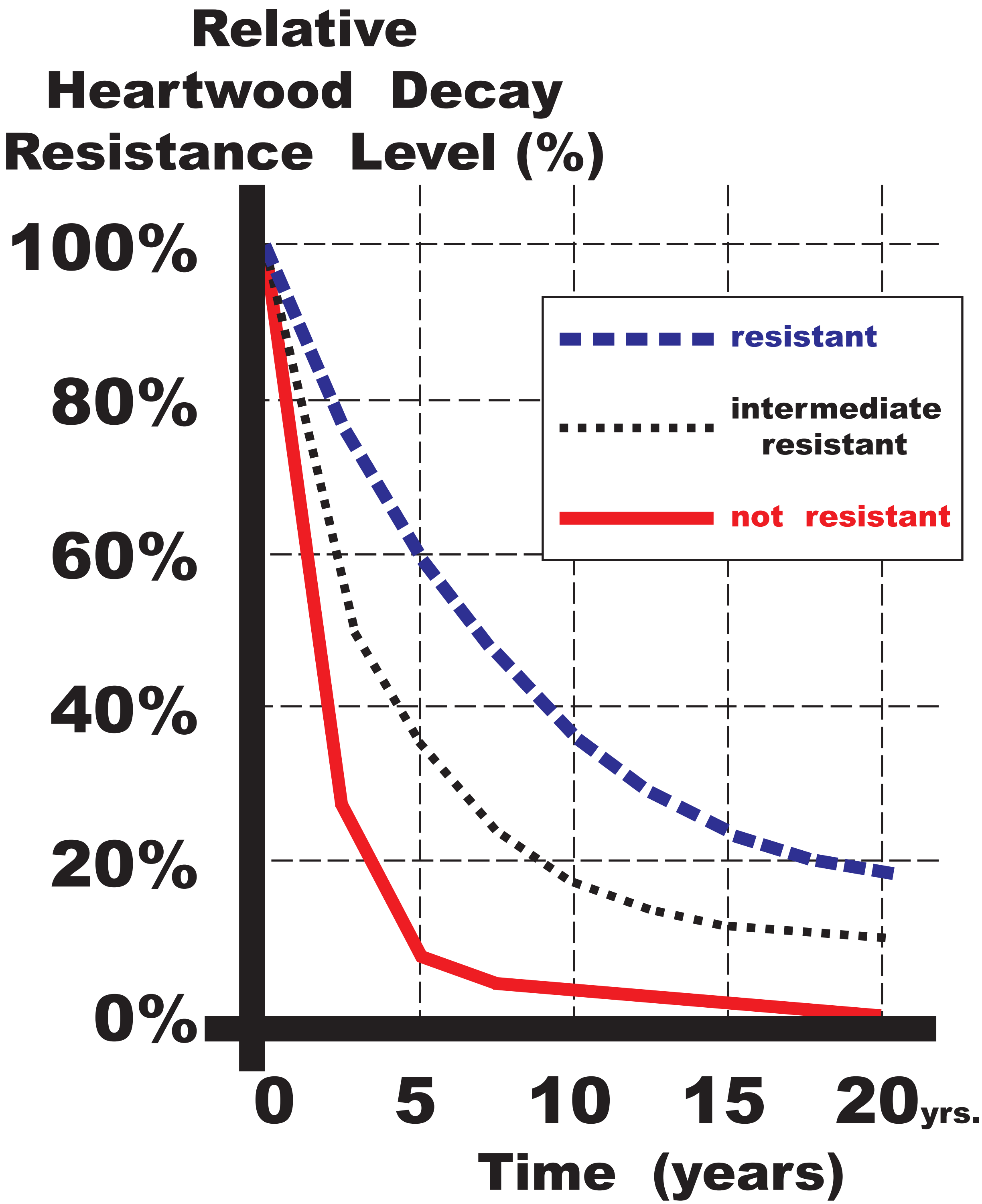

Figure 14: Graphical description of how rapidly wood decays from various tree species with different levels of heartwood resistence to decay. (after Sidle, 1991)

Selected Literature

Anderson, C.J., M.P. Coutts, R.M. Ritchie, & D.J. Campbell. 1989. Root extraction force measurements for sitka spruce. Forestry 62(2):127-137.

Biller, C.J. & J.E. Baumgras. 1987. Failure loads of small diameter hardwood stumps. Transactions of the ASAE 30(6):1587-1590.

Coutts, M.P. 1983. Root architecture and tree stability. Plant and Soil 71:171-188.

Deans, J.D. & E.D. Ford. 1983. Modeling root structure and stability. Plant and Soil 71:189-195.

Entry, J.A. & C.B. Backman. 1995. Influence of carbon and nitrogen on cellulose and lignin degradation in forest soils. Canadian Journal of Forest Research 25(8):1231-1236.

Golob, T.B., T.B. Tsay, & D.A. MacLeod. 1976. Analysis of forces required to pull out stumps of varying age and different species. Canadian Forestry Service, Forest Management Institute (Ottawa, Ontario), Information Report FMR-X-92. Pp.28.

Hickman, G.W. & E. Perry. 1994. Evaluation of products to enhance tree stump decay. HortTechnology 4(4):367-368.

Howard, P.J.A., D.M. Howard, & L.E. Lowe. 1998. Effects of tree species and soil physico-chemical conditions on the nature of soil organic matter. Soil Biology and Biochemistry 30(3):285-297.

Lu, H. 2002. Design and test of the tree stump excavation robot. Transactions of the Chinese Society of Agricultural Engineering 18(6):169-172.

Mackenzie, J.R. 1988. A reappraisal of stump blasting. Quarterly Journal of Forestry 82 (1):33-36.

Sidle, R.C. 1991. A conceptual model of changes in root cohesion in response to vegetation management. Journal of Environmental Quality 20:43-52.

Taylor, B.R., D. Parkinson, & W.F.J. Parsons. 1989. Nitrogen and lignin content as predictors of litter decay rates: A microcosm test. Ecology 70(1):97-104.

Waldron, L.J. & S. Dakessian. 1981. Soil reinforcement by roots: Calculation of increased soil shear resistance from root properties. Soil Science 132(6):427-435.

Watson, A., C. Phillips, & M. Marden. 2000. Root strength, growth, and rate of decay: Root reinforcement changes of two tree species and their contribution to slope stability. Pages 41-49 in A. Stokes, editor, **The Supporting Roots of Trees and Woody Plants: Form, Function, and Physiology.** Kluwer Academic Publishers, The Netherlands. (also Plant & Soil 217:39-47, 1999)

Wilson, K.W. 1983. Tree stumps. Unasylva 35(139):32-38.

Wray, P.H. 1992. How to remove stumps. Iowa State University, Department of Forestry, Extension Publication PM-706.

Citation:

Coder, Kim D. 2021. Tree stump removal in landscapes. Warnell School of Forestry & Natural Resources, University of Georgia, Outreach Publication WSFNR-21-53C. Pp.33.

Stump Removal By Accelerating Natural Decay Processes

-- Field Guide --

by Dr. Kim D. Coder Warnell School of Forestry & Natural Resources University of Georgia

Increase Surface Area of Stump & Major Roots
-- drill stump top and sides
-- drill top of major roots beyond stump
-- scar stump surfaces

Increase Soil Aeration
-- till, cultivate, loosen soil
-- auger and trench to reduce compaction
-- install deep air vents below stump if needed

Maintain Optimum Moisture
-- provide plenty of water and drainage
-- keep soil moist not wet through proper drainage
-- irrigate to maintain optimum moisture

Maintain Healthy Soil
-- keep soil well aerated and properly drained
-- inoculate with healthy forest soil if needed
-- apply sugar to sites with old stumps after first year

Site Protection
-- cover stump with soil
-- cover soil and stump with permeable mulching fabric
-- use coarse organic mulch over area to reduce weeds

Site Disruption
-- every few months damage, pierce, and break-up stump
-- every three months replace soil on stump
-- keep punching holes or slice into ground around stump

Enrich Site With Nitrogen
-- use nitrogen table to determine amount
-- broadcast over entire treatment area
-- use slow release, low salt index fertilizer

Over Time
-- check for and replace soil which has subsided
-- replant

Estimated pounds of nitrogen needed to accelerate stump decay processes in treatment area.

(* = do not apply more than 7 pounds of nitrogen in any one application.)

stump diameter (inches)	diameter of treatment area (feet)	radius of treatment area (feet)	full stump decay: split application (1/3 annual) of nitrogen (pounds N)	full stump decay: annual application of nitrogen (pounds N)	decay after stump grinding: split application (1/3 annual) of nitrogen (pounds N)	decay after stump grinding: annual application of nitrogen (pounds N)
2 in.	0.8 ft.	0.4 ft.	0.01 lbs.	0.02 lbs.	0.003 lbs.	0.009 lbs.
4	1.6	0.8	0.02	0.07	0.01	0.03
6	2.4	1.2	0.05	0.2	0.03	0.09
8	3.2	1.6	0.1	0.3	0.05	0.15
10	4.0	2.0	0.15	0.5	0.07	0.21
12	4.8	2.4	0.2	0.6	0.1	0.3
14	5.6	2.8	0.3	0.9	0.1	0.4
16	6.4	3.2	0.4	1.1	0.2	0.6
18	7.2	3.6	0.5	1.5	0.2	0.7
20	8.0	4.0	0.6	1.8	0.3	0.9
22	8.8	4.4	0.7	2.2	0.3	1.0
24	9.6	4.8	0.9	2.6	0.4	1.2
26	10	5	1.0	3.0	0.5	1.4
28	11	5.5	1.2	3.5	0.6	1.7
30	12	6	1.3	4.0	0.6	1.9
32	13	6.5	1.5	4.6	0.7	2.2
34	14	7	1.7	5.2	0.8	2.5
36	14	7	1.9	5.8	0.9	2.8
38	15	7.5	2.2	6.5	1.0	3.1
40	16	8.0	2.4	7.2*	1.1	3.4
42	17	8.5	2.6	7.9*	1.3	3.8
44	18	9	2.9	8.7*	1.4	4.1
46	18	9	3.2	9.5*	1.5	4.5
48	19	9.5	3.4	10*	1.6	4.9
50	20	10	3.7	11*	1.8	5.3
52	21	10.5	4.0	12*	1.9	5.7
54	22	11	4.3	13*	2.1	6.2
56	22	11	4.7	14*	2.2	6.7
58	23	11.5	5.0	15*	2.4	7.2*
60	24	12	5.4	16*	2.5	7.5*

Dr. Kim D. Coder 2021