Accelerating Stump Decay Processes

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There are two phases of decay in a stump, both known by their constraints. Immediately after cutting the stem, the nitrogen content of the stump wood, and the carbon:nitrogen (C:N) ratio of the stump site, control the rate of decay. The more wood nitrogen and the lower the C:N ratio (higher nitrogen content for the carbohydrate present), the more rapid the decay process. As the stump is colonized by decay fungi and reaches more than one-third mass loss, the lack of simple carbohydrates and a greatly increasing lignin:nitrogen ratio begin to slow decay rates. For most stump sites, the C:N ratio can be used to gauge about 80% of the rate of decay.

A tree stump contains many different types of tissues. Some 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 contain living cells and actively store or transport growth resources, decays rapidly. The cambium area and phloem just outside the cambium have cells filled with easily consumed proteins and carbohydrates. The exterior is bark, which contains suberin, waxes, and water shedding materials. Bark slowly breaks down in a decay process.

The natural decay process can take many years depending upon a number of soil and stump attributes. With all other things being equal, the stump decay process accelerates as the soil temperature increases. Figure 1 is a map providing the number of years it takes for tree stumps to decay under natural open conditions. Figure 1 was derived from average soil temperatures during the growing season. Stump decay or degradation acceleration products would 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.

Critical Features & Considerations

Surface Area

One of the first attributes needed to facilitate decay is a large surface area open to the air but shielded from sunlight. In the past, multiple large drill holes (1 inch diameter) were recommended in the top and side of a stump. In addition, using a saw to roughen and cut crisscross grooves on the stump face were suggested. Today we know the more gaps, cracks, breaks, slices, holes, or saw kerf grooves cut deep into the stump, the better. The more the bark is scraped and sliced, the faster decay processes can proceed. Even pulling or pushing the stump without extraction can break and twist large roots and leave separation cracks between soil and roots. Be sure to drill into the tops of major roots as they grow away from the stump. Stump surface areas not in contact with soil will not support rapid decay. Cut the stump as low to the ground as possible and then scar-up its open face as deeply as possible.

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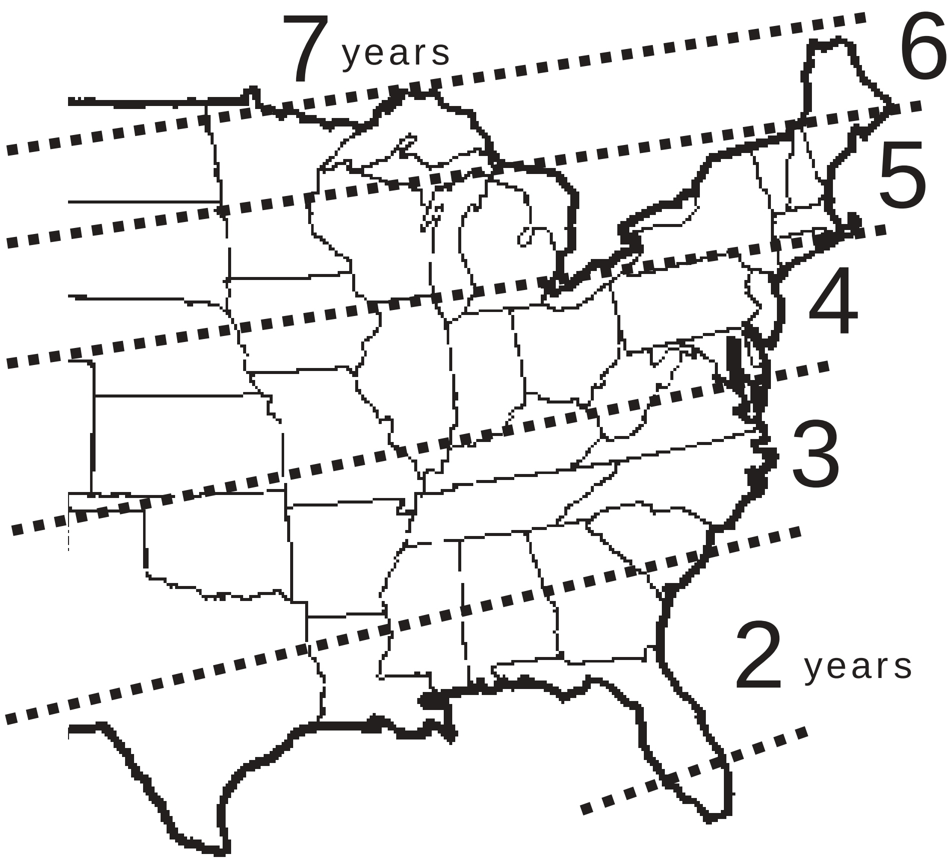
Figure 1: Map showing number of years to decay a stump under natural open conditions. This map is derived from average soil temperatures during the growing season and average stump decay rates. Note narrow or small pockets of soil temperature fluctuations caused by altitude and lake effects are not shown.



Soil Aeration

The soil atmosphere around a stump must be constantly refilled with oxygen to power decay fungi. Carbon-dioxide (CO_2) generated by wood decay and other organisms in a healthy soil must be removed from the stump vicinity. Lack of good aeration may have led to the 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, knowing there will be a number of big roots struck. Any aeration treatment which scars bark and cuts into wood carries an added benefit. Installation of temporary deep soil vent pipes beneath the stump is an option for assuring aeration but 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 and stump will actually slow decay. Soil must remain moist at all times to avoid episodic decay cycles which lengthen decay times. Irrigation around the stump site to moisten the 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.

Nitrogen

Wood nitrogen content, and the ratio between the carbon content of the wood and the nitrogen content, are both part of what drives the 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 the stump and any stump surfaces should have nitrogen fertilizer applied. Slow release fertilizer with a low salt index is best. Avoid concentrating any salt in holes or piles. Surface broadcast nitrogen fertilizer across a small treatment area around the stump. Do not dump the fertilizer only on the stump face. Low carbon:nitrogen ratio materials which have been composted can be a great benefit to the site in small amounts.

Enriching a site with nitrogen fertilizer to accelerate the wood decay process requires careful application to minimize nontarget effects like water pollution and weed growth. Table 1 provides an estimated amount of fertilizer to add in the area 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 the stump.

Table 1 has seven columns in four groups: Column group I is the stump diameter in two-inch classes measured at one inch above the ground line; Column group II is the associated diameter of treatment area in feet and the radius of treatment area centered on the stump in feet; Column group III provides the amount of nitrogen to add in pounds of nitrogen for the treatment area as applied in three applications per growing season, or the pounds of nitrogen for the treatment area applied in a single application per growing season; and, Column group IV provides the amount of nitrogen to add in pounds of nitrogen for the residual area around a ground stump in three applications per growing season, or pounds of nitrogen for the residual area around a ground stump in a single application per growing season.

Assumptions used in modeling stump removal in Table 1 were: 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 below ground was estimated to be ½ the volume of a spheroid shape (result is a saucer shape)

Table 1: Estimated amount of nitrogen (pounds of nitrogen) needed to accelerate stump decay processes in a treatment area (diameter or radius in feet from stump center). Note table values were rounded for ease of use and understanding. **(* = do not apply more than 10 pounds of nitrogen in any one application.)**

			full stump decay		**decay after stump grinding**	
stump diameter (inches)	diameter of treatment area (feet)	radius of treatment area (feet)	split application (1/3 annual) of nitrogen (pounds N)	annual application of nitrogen (pounds N)	split application (1/3 annual) of nitrogen (pounds N)	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
65	26	13	6	18*	3	9
70	28	14	7	21*	3.5	10*
75	30	15	8.5	26*	4	12*
80	32	16	9.5	29*	4.5	14*
85	34	17	11*	33*	5	15*

reduced to 0.4X to account for rooting density in the treatment area; and, for the stump grinding site, the 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 the 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 the natural stump 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 the site with additional beneficial decay organism. Rub healthy soil on the stump face and cover the stump with a thin layer of soil. Use a coarse organic mulch to protect the soil of the treatment area and over the stump face. Mulch will protect organisms present from direct sun and drying.

Site Protection

Covering the 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 the 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 for water to reach the 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, the stump and main roots should be scarred, cut, or drilled periodically. The soil should be raked and reapplied over the stump. The site needs to be uncovered, stirred up, and recovered at least every three months. This disturbance process will help push the 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 the 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 temperature climbs between 40°F and 105°F. Short growing seasons and cool soil temperatures will greatly slow decay rates. (Note Figure 1) Mulch can insulate the site from short cool periods.

Making It Difficult

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 in the wood. Living trees use a series of passive defence boundaries to slow pest and decay movements, and a number of active defensive systems to slow or kill pests and decay organisms. The heartwood of a number of species of wood are resistance to decay due to chemicals impregnating cells walls. The more decay resistant the stump wood, the longer it will take to completely decay the entire stump. Sapwood will decay quickly but some heartwood will take an extended time to decay. Figure 2 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 the stump dissolves back into the environment, 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 the site. Small 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 the stump and roots will take many years to finally decay away, many years of vigilance will be needed to fill-in areas. Decay near structures or pavements may require soil stabilization or injections to prevent damage. If the 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.

Why Bother?

With all the procedures and additions made to a site 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, natural decay processes do function at a low cost if provided a few considerations.

Future Site Use

The stump site will be dominated by the decaying stump for a number of years, however the stump was removed or reduced. Once the decay process is functioning well, a new tree can be planted near the site. Planting should be completed outside the treatment area as given in Table 1. 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 will impact the new tree as constrained the old tree, unless changes are made. Planting back in the identical location as the original tree is possible if the old stump is broken and shattered enough to allow the new tree to colonize the native soil. New soil can be used for fill in the stump caldera, but multiple openings or connections to the surrounding native soil 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 in only the wood chips from a stump pushed back into the caldera, as resource fluctuations can be severe for a new tree, as will access to the new roots by pests.

Summary

Chop, split, drill, and scrape stump -- water and fertilize site -- alleviate site compaction, and assure aeration and drainage -- cover and protect site -- periodic checks and disturb stump -- keep adding good soil -- patience!

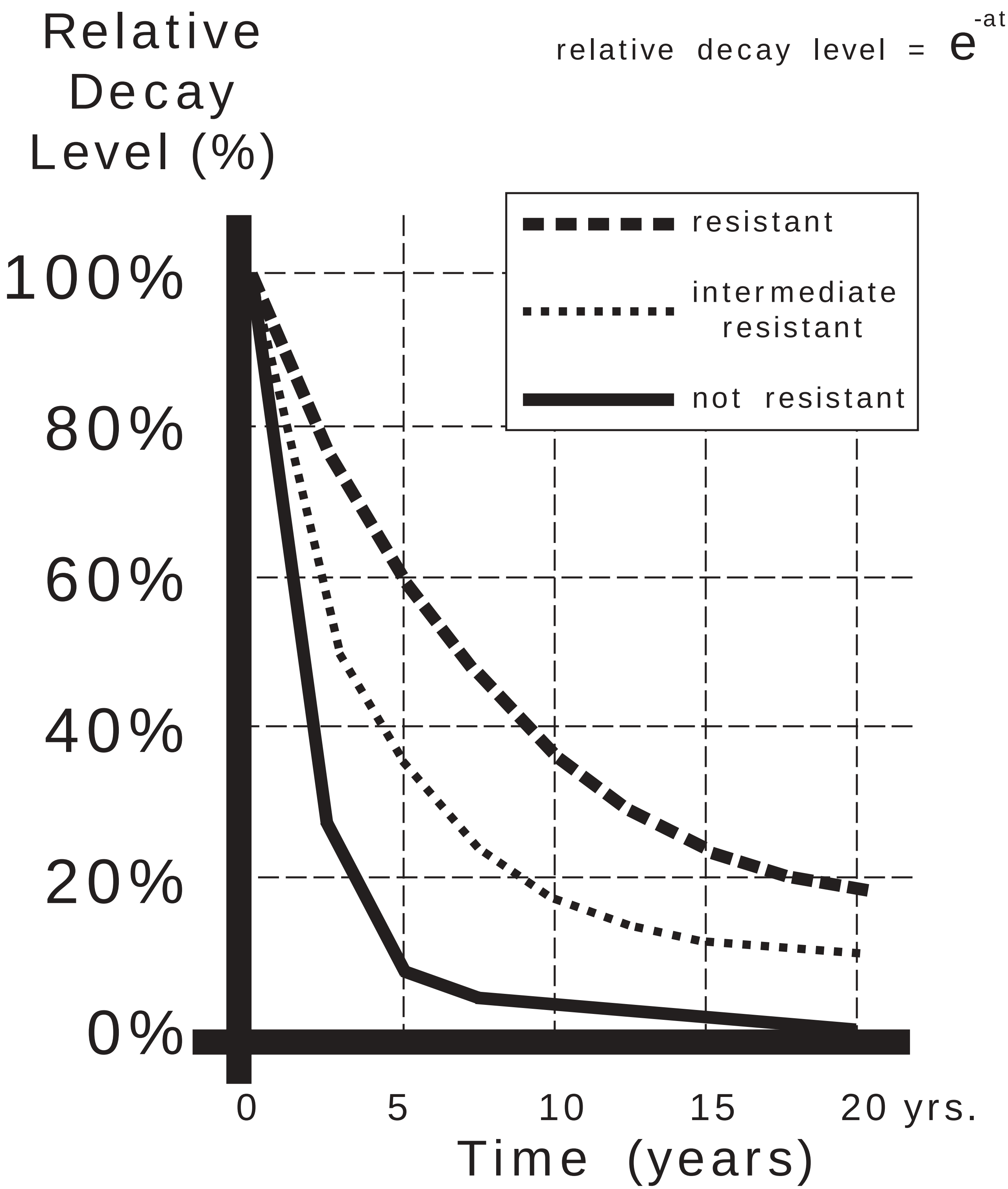


Figure 2: Graphical description of how rapidly wood decays from various tree species with different levels of resistence to decay (after Sidle, 1991). The formula used t = time in years, and two constant values (a & b) which represented integrated climatic and wood resistance factors.