among more drought tolerant species such as Douglas-fir, western-larch, western white pine, grand fir and lodgepole pine. This, of course, only covers the drought effects of warming. For species such as Engelmann spruce and subalpine fir that require the coolness found on some of these cedar/hemlock sites, we may have additional concerns that favor removal and discouragement of these species depending on the silvicultural objectives and integrated site factors.

Silviculturists, other natural resource professionals, and landowners need to think through the entire site and stand data they have gathered as part of the prescription process and understand how these factors may interact with climate change. In the future, I expect to see more exact science developed that provides more specific guidelines. As a final note, we need to recognize that "art" is an even stronger component of silviculture, and that many of the potential adaptations and ecological amplitudes of species of trees, other plants, and many animals have not been adequately studied and defined. I have bald cypress trees growing in Moscow, and while they are not thriving, they are surviving conditions unknown in their native range and growing quite well. There are many tolerances in plants and other organisms that have not been tested in current environments and a few surprises may be in store for all of us. Certainly, we may need to research and redefine seed transfer zones. Equally important, we need to place more emphasis on thresholds of response: for example, ponderosa pine has a threshold of low temperature that limits its presence on higher elevations even though other factors are suitable. Ultimately, climate change will be diverse across the landscape, and some areas my actually become cooler and wetter.

Most landowner objectives do not include surprises, and climate change poses a real challenge for silvicultural prescriptions that avoid or accommodate the unexpected, especially given the long life of trees and even greater longevity of managed ecosystems.

Forest Fire Risk Reduction Alternatives for Slash

Chris Schnepf

Leaving more slash in the woods may be good for forest fertility, but there is a fire hazard associated with slash, particularly on drier sites, where woody material decomposes more slowly. Most western states have rules to keep fire risk within acceptable limits. In Idaho, logging slash must be reduced to an acceptable level to release the landowner or operator from liability for any forest fires that start on or move through the property.

Slash is often broadly described as branches and tops from logging or accumulated from a storm, but this article focuses primarily on material smaller than three inches in diameter. Material larger than three inches in diameter (coarse woody debris) is often best left in place, as it is much less of a fire hazard and benefits wildlife and soil health.

How high is the hazard?

Before reducing slash, you must determine how high the hazard is. The most fundamental measure of slash hazard is in tons/acre, but slash hazard is more than weight. Idaho Department of Lands (IDL) fire wardens typically determine the potential fire hazard based on a number of factors, including:

- Number, size, and species of trees to be cut and resulting slash load (tons/acre)
- Size of unit (larger units are more hazardous)
- Slope and aspect (steep south or southwest facing slopes are most hazardous)
- Condition of the unit and adjoining areas prior to activity
- Proximity to structures, etc. (e.g. campgrounds, home sites, etc.)
- Presence of snags and cull trees
- Deterioration rate of slash

- Time of year activity takes place (May-June is most hazardous)

Before deciding on a slash reduction strategy, contact your local IDL fire warden to determine how much of a slash hazard you have (or are likely to have, if before the harvest). Presuming you have enough slash to warrant further treatment, there are many methods to reduce fire risk to acceptable levels. These methods may be used alone or in combination.

Pile and Burn

The most common approach to reduce slash hazard on family forests is to pile it and burn it. Piles can be created by hand or by using a bulldozer or other equipment. Typically, a piece of plastic or roofing paper is placed on top of each pile to keep a good portion of it dry. Piles are usually burned in the fall, to lessen the chance that the fire will spread or that any embers continue smoldering into the next wildfire season. For more information on constructing and burning piles, see the publications cited in the reference section of this article.

Piling and burning effectively reduces slash hazard, but it does have disadvantages. First, it costs time and money (especially hand piling), though these costs are usually figured into a logging job that removes sawlogs. Second, there is some risk associated with burning piles, both to trees on the site, if the piles are constructed too close to standing trees, and to surrounding forests, if they are not burned carefully. Finally, immediately piling fresh slash concentrates nutrients in a few piles and removes some nutrients when they are burned.

One way to reduce nutrient loss is to let the slash sit for 6 months before piling and burning, to allow more of the nutrients to leach into the soil. Most states have some kind of grace period (e.g., a year or two) in which to treat the slash before the landowner is held liable for any fire that moves from their property to another. In some cases, you may also be able to get an extension of this time period from your local state forestry office. There will be some extra expense however, if you have to re-locate equipment back to the site to pile slash.

Lop and scatter

Relatively small amounts of slash can be cut into smaller pieces (so they lay flatter to the ground) and scattered about the forest floor. This method, commonly referred to as "lop and scatter", is fairly standard with pre-commercial thinning slash, but it can be used for logging slash as well. The objective is to reduce the slash to a depth of 24 inches (preferably less).

For the first few years after the treatment there will be some elevated fire risk (and it may not be too visually appealing either) but after one good winter’s snow, the material is typically compressed, needles fall off, and it is mostly out of sight. The slash will decompose more quickly on wetter sites.

Chipping

Chipping has been around for a long time but hasn’t been used much because of the cost. However, there is a lot of renewed interest in chipping and related technologies for biomass fuels. Many people also like the way chipping looks. Local air quality ordinances also sometimes forbid burning, and chipping on site may be cheaper than hauling slash to a dump.

There may or may not be a viable market for the chips. The quantity and quality of the chips and the distance to the site that uses the chips play into whether chip removal is economically viable. There is also a potential nutrient loss issue if chipped fresh slash is removed from the site.

If you decide to chip and leave the chips on the site, disperse the chips around so they are less than one inch deep. Chips will also help retain soil moisture, but chips piled uniformly deeper than that can interfere with air and water movement into the soil and other soil functions as they buffer soil temperature. Try not to bury or mix the chips in with the soil, as fungi take nitrogen out of the soil to decay buried chips.

Chips can also interfere with the growth of new or sprouted understory plants, which may be good or bad, depending on the species of plants and your management objectives.

Busting/Crushing/Shredding/Mulching/Masticating/Grinding

A lot of terms are used to describe different practices that use power equipment to reduce the size and stature of slash and brush into smaller pieces that lay flatter on the ground. Interest in these tools has peaked recently as groups look for lower-cost mechanized methods to create and maintain lower fire risk around homes and communities.

There are many different machines for reducing slash hazard. Typically they involve some type of attachment to an excavator, a bobcat, caterpillar, or similar machine. All of these machines vary in their maneuverability in tight stands (some can be used on sites with trees spaced as close 12-15 feet), ability to work on slopes, and degree of rutting, compacting and other forms of soil disturbance. Most forest owners will probably hire a contractor to do this work, but some forest owners may be interested in purchasing a machine, particularly those machines that can do multiple tasks, such as move snow or skid logs. The USDA Forest Service Technology and Development Program has an excellent publication reviewing many of these tools, titled "Small Scale Forestry Equipment" (see references at end of this article).

If you do bust slash into smaller pieces, be careful not to break up older or larger material. Again, Idaho fire wardens do not count pieces larger than three inches as slash hazard. Changing material that is "three-inch-plus" to "three-inch-minus" un-necessarily increases your fire hazard.

Soil disturbance and compaction

Using heavy equipment for piling and burning, slash busting, or chipping can compact soils. Compaction can be reduced by using equipment with lower ground pressure (e.g. smaller cats, tracks instead of tires), working during drier seasons when soils are less likely to compact, and limiting the surface area covered by cabling or carrying slash to the machine. Machines mounted on an excavator arm also help reduce the area covered by tracks.

Prescribed fire

There are many types of prescribed fire. After a clearcut, slash is typically burned in a *broadcast burn* that consumes the finer fuels and chars coarse woody debris. A *prescribed underburn* takes place under a canopy of trees and burns up material in the understory without killing overstory trees. With prescribed burning there is always a balance between choosing the time of the year when the fire is most controllable (e.g., when there is a certain amount of current or anticipated rain and snow), versus conditions that are dry enough to get a good burn. Air conditions and location of the site have a bearing as well. Most areas have guidelines to minimize impacts to air quality from forest burning.

Ideally "cool" burns - prescribed burns where temperature is high enough to reduce slash hazard but not so high as to volatilize most of the nutrients - are desirable. Burning when the lower duff layers are moist helps retain nutrients. Typically this has meant burning in spring or fall.

One down side of burning in the spring is for birds that nest on the ground that time of the year. The impact of prescribed burning on ground-nesting birds has not been studied formally, but as long as a relatively small percentage of a watershed is burned in any one year, bird populations should not suffer too greatly.

Obviously, prescribed burning has risks. If the fire gets away, a landowner can be held responsible for damage to others' properties and the cost of suppressing the escaped fire. Professional foresters who are trained and experienced with assessing the risks associated with prescribed fire and implementing appropriate safeguards, are indispensable to family forest owners wishing to prescribe fire on their forests.

Customize a strategy for your property

All of the fire risk reduction strategies referred to thus far are ways of directly reducing or modifying slash fuels from logging or thinning. There are other ways to reduce fire risk that should be used together with these methods. If fire risk is low and slash loads are relatively small, some of these approaches may be sufficient in of themselves. They include:

- making water available;
- limiting access (e.g., gating roads); and
- creating fuel breaks, fire trails, or fire lines to isolate the slash into smaller subunits and break up the continuity.

No strategy will eliminate fire risk completely, especially when fire danger is extreme. But looking at a combination of different strategies for each site, gives you the best chance of reducing fire risk and meeting other objectives, such as forest nutrition. For on-site help in devising a strategy to reduce fire hazards from slash, check with your local Idaho Department of Lands Fire Warden.

For more information

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Selecting the Right Equipment for Your Forestland Needs

Randy Brooks

A good friend of mine just moved from the city and bought some land with timber on it. He wanted to become a "hobby" logger/farmer. He told me he wanted to purchase a piece of equipment that could serve several purposes, including some light log skidding and snow plowing, among other things. He didn't think he could afford a new piece of equipment, and was in the market for a good used 4WD tractor or cat. After giving it some thought, I did a little research for him and here is what I came up with.

To properly select equipment, you must predetermine a number of factors, including size and/or number of machinery/ equipment needed, features needed, and where to buy equipment. You should also be aware of some of the pitfalls you may encounter when purchasing equipment.

The advantages of buying new machinery include income tax considerations and new technology (resulting in increased efficiency, productivity, etc.). Financing also may be easier to obtain on new purchases.

Small operations might find advantages in buying used equipment if the owner wishes to maintain control over certain functions but finds that a new purchase is not economically viable. Used equipment would also be appropriate when buying a back-up unit. Used tractors are useful for small scale logging jobs or to tow equipment during harvest when the tractor will run a few hours seasonally. Used equipment can also be used for less-critical and/or low annual usage tasks.

When you purchase used equipment, you are buying the remaining, unused service life of the apparatus. All equipment is designed with a certain number of hours in it. Depending upon how it is used, maintained, and repaired, the equipment will use up these hours at a faster or slower rate. Some typical machinery wear-out life is as follows: tractors, 12,000 hours; crawlers, 16,000 hours; combines, 2,000 hours; drills, 1,000 hours; planters, 1,000 hours; swathers, 2,000 hours, tillage equipment, 2,000 hours. Wear out life is the point at which it is not typically economically feasible to continue repair of the equipment.

What's going on before the wear-out life of a tractor? Engine overhauls. A minor overhaul would generally consist of new rings, grinding the valves, etc. A major engine overhaul would consist of new pistons, new sleeves (liners), new bearings, new injectors, etc. New tires are necessary approximately every 2,000 to 3,000 hours, depending upon use and soil/ground/road conditions. Batteries should be replaced approximately every three to four years.