

Biomass Utilization Opportunities to Achieve Diverse Silvicultural Goals

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Abstract—Silviculturists and ecologists may recommend land management prescriptions that are designed to be resilient to changing climatic conditions. When considering biomass utilization opportunities that may result from climate-change treatments, it really doesn't matter what species mix or stocking levels are to be retained: if there are trees that need to be harvested, there will usually be opportunities for utilizing woody biomass.

Keywords: biomass utilization, harvesting systems, designation by description, silvicultural prescriptions

Introduction

This paper focuses on biomass utilization opportunities in the context of Goals 2 and 3 of the recently released Forest Service Strategic Framework for Responding to Climate Change. Goal 2 is Adaptation—"Enhance capacity of forests and grasslands to adapt." Goal 3 is Mitigation—"Promote management of forests and grasslands to reduce greenhouse gases while sustaining the multiple benefits and services of these ecosystems." The take-home message is simple: it doesn't matter what management prescription you want to apply or habitat type you are working in—as long as you are proposing to cut trees, there will be opportunities to utilize biomass.

Biomass Utilization to Achieve Mitigation in Young Stands

Goal #3, Mitigation, is to promote the management of forests and grasslands to reduce the buildup of greenhouse gases, while sustaining the multiple benefits and services of these ecosystems. There is a wide variety of management scenarios that can integrate biomass utilization solutions while meeting climate change objectives. One possible way to meet the goal is to find ways to utilize logging slash that is excess to other resource needs and is normally disposed of by open burning, which releases CO₂ into the atmosphere. CO₂ emissions from open burning could be vastly reduced if the slash were instead burned in very-low emission biomass-electric generation facilities, which could convert an average-sized grapple pile of slash into about 2,000 kilowatt-hours of electricity. A single grapple pile may also contain enough biomass to convert to between 40 and 80 gallons of ethanol.

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Operational Alternatives to Piling and Burning

One of the most high-tech, and expensive, ways to remove logging slash from harvest units is to employ a “slash bundler” such as the John Deere 1490 (fig. 1). The bundler is capable of operating on slopes up to around 40 percent and can maneuver through residual stands with a leave-tree spacing of about 20 to 30 feet without excessive damage to residual trees. The cost of this machine approaches \$500,000, so it needs to be used in locations that have a high volume of biomass removed on a steady basis in order to be economically feasible.



Figure 1—Slash can be densely packaged into movable units (top) with the John Deere 1490 slash bundler (middle), and transported with a typical forwarder (bottom).

Some bundling systems include the capability of removing the bundler attachment to convert the machine to a forwarder, while others require the use of a second piece of equipment that can transport the bundles to a roadside for trucking or on-site chipping. If logging slash is needed to be left on-site in a scattered fashion for a period of time to permit nutrient cycling for instance, this system is useful because slash can be bundled at any time after the timber harvest occurs. A forwarder is the most likely equipment for yarding bundles (fig. 1, bottom), but grapple skidders or other equipment could also be used. Still other bundlers or “balers” are designed to either be pulled through the woods behind a machine or set up at a landing. Data gathered by the Southern Research Station and Forest Products Lab during a slash bundler study in 2003 (Rummer and others 2004) indicate that slash bundles contain about 750 to 1,000 kilowatt-hours worth of convertible energy.

An alternative to using the slash bundler technology is to simply remove loose slash from harvest areas on forwarders (fig. 2). Some entrepreneurs are experimenting with making “grapple piles on wheels” that can be gathered in the woods and transported to roadside for chipping or hauled off in loose form in something like a roll-off container (i.e. large dumpster). An advantage to this system over the slash bundler is that if local loggers don’t have the money to invest in the bundler, they can make do with this. Disadvantages may include slower production rates and less capability for terrain than the bundler. Probably more cost effective than gathering scattered slash from within harvest units, chipping at landings in combination with whole-tree-yarding is yet another way to utilize biomass.

Perhaps the ultimate way to utilize biomass while managing for climate change objectives is to stop thinking about biomass as a “forest residue” and start thinking about it as an energy resource to be integrated in management activities. We can begin doing this by integrating biomass utilization in young age-class timber stands and plantations to accomplish what in the past has been referred to as “pre-commercial thinning” treatments. The ultimate goal is to decide what tree species, stocking levels, coarse woody debris and other biomass we want to leave in a harvest unit to meet our climate change management prescriptions, and then remove and utilize all the excess wood for the full range of forest products, including biomass for energy.



Figure 2—Loose slash transported from harvest area on a small-scale forwarder.

Case study: Templemental Stewardship contract—The Templemental Stewardship contract “biomass thinning” unit is being conducted in a 300 acre plantation that was established in 1981 after the Templeman Lake fire in 1978. The average tree diameter is 5 1/2” inches dbh and average tree height is about 40 feet (fig. 3, top). This plantation is being thinned to spacings between 12 and 17 feet (variable-density thinning; Designation by Prescription) and



Figure 3—Young plantation (Templemental Stewardship Project, top) is subjected to variable-density thinning using Cat 314 (middle) and Rottne 2002 (bottom) mini-harvesters (shown working recently in private property areas).

requires mandatory removal of trees as small as 1-inch dbh and 4 feet tall, with the exception of leaving coarse down woody debris based on guidelines by Graham and others (1994) and also some material for slash mats. This biomass thinning treatment also includes long-term soil productivity research to be conducted by the Rocky Mountain Research Station (RMRS) and production rate and recovery research on the equipment to be used (mini-harvesters and small-scale forwarders) to be conducted by the Southern Research Station (SRS). Two of the machines to be used in the Templemental Stewardship Project are the Cat 314 and Rottne 2002 “mini-harvesters” (fig. 3). Both the Cat 314 and Rottne 2002 can cut trees as small as 1-inch diameter. The Cat 314 is less than 10 feet wide; the Rottne 2002 is less than 9 feet wide and can reach about 23 feet with the harvester head.

Biomass Utilization to Achieve Resilience in Mature Stands

Improved biomass utilization can be achieved while harvesting mature timber stands using conventional and cut-to-length harvest systems. Goal #2, Adaptive Climate Change strategies, can be achieved through biomass utilization by restoring resiliency in timber stands.

This section provides examples wherein biomass utilization advances Goal #2. Requiring smaller diameter trees, smaller top diameters and shorter minimum pieces to be removed during initial harvest treatments not only improves timber stand resilience, but also increases biomass supplies and could also reduce the footprint of management activities by eliminating the need to have follow-up slash disposal treatments.

Case Study: Deerskin Roundwood Timber Sale Unit 26

This case study of the Deerskin Roundwood timber sale is to illustrate how a prescription for a small diameter timber sale was implemented using Designation by Description (DxD), weight-scale contract and utilization of smallwood material having minimum specs of 5 inch dbh to a 3 inch top on a 16 foot piece. This treatment would probably be considered a “restoration” treatment, promoting a condition that is more resilient to climate change.

The long-term objective for Unit 26 is to develop large diameter western larch and white pine, while maintaining a mix of other species and also maintaining coarse woody debris on-site. A reconnaissance cruise collected current stand composition data within the proposed harvest unit in order to determine the best mix of species and diameters to be left in the residual timber stand. Contract provisions for Designation by Description were then designed to meet the objectives of the silvicultural prescription, while at the same time providing a cost savings for sale preparation of about \$50 per acre.

Extremely dense understory (fig. 4) illustrates why DxD is a necessary cost-saving tool for managing these kinds of stands. DxD should be considered the “leatherman tool” of sale preparation foresters, in that there are many ways to use it, but site-specific stands usually require only a combination of 2 or 3 tools (i.e. designations). This stand used two designations, which included a diameter limit cut (understory removal) along with a requirement to maintain a minimum spacing of 15 feet between leave trees if 8-inch trees were available.

Because resource protection measures were built into the contract to protect soils from excessive compaction and disturbance, harvesting was accomplished in a low-impact manner. Soil compaction and disturbance in these types of stands with these types of equipment can be kept to a minimum. An in-woods processor



Figure 4—The dense understories of some restoration treatments make the Designation by Description contract provision approach invaluable (Deerskin Roundwood Timber Sale).

(fig. 5, top) not only sorted small sawlogs and small pulplogs, but also provided a slash mat for operating on along with grapple skidders. The system's grapple skidder (fig. 5, middle) operated on slash mat and elevated most logs completely off the ground, further reducing soil disturbance. Even with utilization set at 5 inch dbh to a 3-inch top on a 16-foot piece, substantial slash was left after grapple piling and leaving the recommended level of coarse woody debris (fig. 5, bottom).

Two More Scenarios

An example is the 2001 Kat Tail 2 timber sale on the Bonners Ferry RD Idaho Panhandle National Forests (IPNF) (fig. 6). The minimum size tree to be cut and removed in this project was 4 inches dbh having a minimum top diameter of 2½ inches on a 13-foot piece. Small trees were removed from the understory, leaving larger overstory trees in a more resilient condition.

Perhaps one of the most challenging opportunities for biomass utilization is being accomplished on the Apache-Sitgreaves NF White Mountain Stewardship project. This project includes a range restoration treatment area designed to reduce the grossly overstocked condition in a pinyon-juniper habitat type, with utilization of the “trees” for biomass-electric energy at the nearby Renegy electric facility near Snowflake, Arizona. Trees were whole-tree harvested, roots and all, and were to be chipped on-site and then transported to the Renegy facility (fig. 7).



Figure 5—Slash and soil management at the Deerskin Roundwood Timber Sale. Slash mat created by in-woods processor (top) cushioned the grapple skidder (middle). Most slash was grapple-piled (bottom) yet sufficient coarse woody debris was retained.



Figure 6—Kit Tail 2 Timber Sale on the Bonners Ferry RD before (top), during (middle), and after thinning of smallwood to promote stand resilience.



Figure 7—Biomass utilization as part of range restoration on the Apache-Sitgreaves NF White Mountain Stewardship Project. Biomass in this project is utilized as feedstocks for the Renegy electric facility.

Conclusion

Silviculturists and ecologists may recommend land management prescriptions that are designed to be resilient to changing climatic conditions. When considering biomass utilization opportunities that may result from climate-change treatments, it really doesn't matter what species mix or stocking levels are to be retained. If there are trees that need to be cut as a result of the prescription, there will usually be opportunities for recovering these as woody biofuels.

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