Harvesting Biomass

A Guide to Best Management Practices

Indiana Department of Natural Resources
Division of Forestry

Acknowledgements

Interest in a variety of energy sources by expanding the production of alternative fuels and renewable energy has led to increased focus on wood-based bioenergy. The Indiana Department of Natural Resources Division of Forestry formed a group of natural resource professionals to craft a woody biomass harvesting guideline publication. The group consisted of Duane McCoy, Scott Haulton, Phil Wagner and Jeff Settle of the Indiana Division of Forestry, Mike Seidl of the Indiana Department of Agriculture, and Dan Cassens of Purdue University.

Introduction

Woody biomass harvesting is still an emerging technology, and the use of woody biomass continues to gain acceptance as an optional source of energy. As world petroleum prices rise, alternative energy sources, such as wind, solar and biomass, continue to be used and evaluated. The Indiana Department of Natural Resources is committed to supporting and expanding the role of woody biomass as an alternative energy source in Indiana. The use of biomass fuels can reduce oil imports and create new growth in the agribusiness community. Harvesting woody biomass is similar to harvesting pulpwood. We expect new equipment and methods to be developed as demand grows, but in the beginning, most harvesting will occur with existing equipment.

Woody biomass has potential to be one of several biomass solutions to reduce energy dependence and carbon emissions. Biomass has surpassed hydropower as the largest domestic source of renewable energy and provides 3 percent of the total energy consumption in the United States. This includes all plant and plant-derived materials, including animal manure, starch, sugar and crops. However, forestry operations are being conducted more frequently throughout the United States. As more wood based bioenergy plants are announced, sustainability, urban, water quality, and non-water quality issues related to biomass harvesting will need to be addressed in order for this market to develop. Woody biomass and biomass in its other forms is a renewable resource and thus invaluable as a solution to current energy demands.

Currently there are 28 states plus the District of Columbia that have a Renewable Energy Standard (RES) already in place with several other states actively involved in the process of setting their RES. Federal legislation that will set a national (RES) is on the horizon. At the center of the debate is the use of woody biomass, which is defined as the byproduct of management, restoration, and hazardous fuel reduction treatments, including trees and woody plants (i.e., limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment), according to the U.S. Department of Agriculture Woody Biomass Utilization Desk Guide.

Previously enacted renewable energy legislation regarding woody biomass has focused on closed loop systems, such as short rotation woody crops. To expand the use of this renewable energy source, safeguards are needed to address the societal and environmental concerns to natural forest lands regarding biomass harvesting.

This document has been prepared to inform forest owners, loggers, foresters and other interested persons about woody biomass harvesting best management practices (BMPs). These harvesting guidelines provide recommendations designed to protect the forest that the citizens of Indiana rely on for traditional forestry jobs, clean air and water, diverse wildlife habitat, scenic beauty, outdoor recreation and tourism.

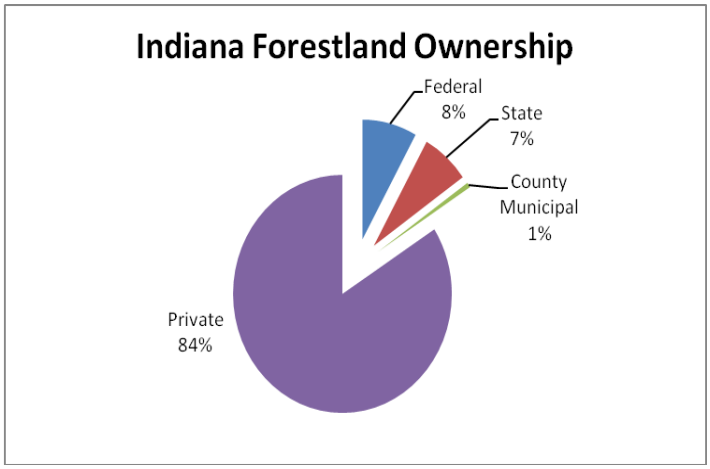
Indiana's forests provide numerous ecological functions, including water, soil and air quality protection, biodiversity, carbon sequestration, and fisheries and wildlife habitat. They also offer an abundance of recreational opportunities, landscape diversity, and cultural and spiritual experiences. These same forests also support viable, stable, rural and urban communities, and supply society with forest-based products and services. Indiana's forest products industry impacts the economy more so than any other agricultural industry with an impact of over $17 billion[1]

Indiana has a broad forest base, 4.7 million acres of forest land, which could provide additional opportunities for the use of woody biomass through Timber Stand Improvement (TSI) activities, regeneration harvests, and harvest residues. Eighty-four percent (3.98 million acres) of Indiana's forests

[1] Indiana's Hardwood Industry – Its Economic Impact - Rob Swain (2008)

are privately owned by non-industrial landowners. Federally owned forestland accounts for a little over 8 percent (382,000 acres). The remaining 8 percent (372,000 acres) is owned by the State of Indiana or local governments.

Chart 1. Indiana Forestland Ownership[2]



Woody biomass used in alternative energy products usually is wood chips. The chips come in a variety of sizes and cleanliness depending on the final product. These chips can come from a variety of "streams" and can be put into two broad categories: mill waste and harvest residues. Harvest residue is the material left after timber harvests or land clearing operations. Harvest residue consists mainly of tops and limbs as the main part of the tree is used to produce veneer, grade lumber, or low-grade industrial products such as pallet cants, pallet lumber or railroad ties. Recent Timber Product Output (TPO) data shows nearly 100 percent of the mill residues are currently being used throughout the state. However, a large percentage is categorized as "miscellaneous uses" so the opportunity does exist for these chips currently going into miscellaneous markets to be diverted by primary manufacturers to produce energy, thus providing the potential to add value. Harvest residues, however, are more times than not left in the woods. This woody biomass, if managed wisely and sustainably, could provide the needed resource for present and future biomass plants. TPO data collected in 2008 shows that by converting industrial roundwood products, such as lumber, wood, pulp and veneer, Indiana's primary wood-using industries generated 787,000 green tons of wood residues. We also estimate the harvesting of roundwood products left 2.5 billion green tons of harvest residues on the ground in Indiana.

Opportunities for woody biomass harvesting should be considered relative to how landscapes and ecosystems function. Collectively, timber stands are part of healthy, resilient ecosystems and landscapes, and contribute a wide variety of products, services and values both economically and environmentally. Landowners and managers benefit by understanding how stand-level biomass harvesting decisions affect the larger landscape.

Landowners and managers should approach biomass harvesting based on how they prioritize the ecological, social and economic benefits that can be derived from their forests. **A number of other factors will influence opportunities for woody biomass harvesting**. Each landowner and manager has goals and objectives that guide management decisions, including what activities are undertaken, and how and when they are conducted.

[2] Forest Inventory and Analysis, USDA Forest Service 2004-2008

There are significant forest resources in Indiana, but not all forest acreage is available for harvest due to a variety of reasons. Availability is contingent on numerous factors, including concerns for ecological functions such as water quality, air quality, and nutrient cycling; wildlife habitat; biodiversity; accessibility; landowner willingness to harvest; harvesting costs, including transportation and markets for products. New technology and equipment, changes in harvesting and processing, transportation, and new markets for wood products all affect market conditions and demand. This document does not suggest guidance on the economics of biomass harvesting. Rather, it provides an overview of concerns related to woody biomass harvesting activities and recommendations for sustainable resource use.

General Guidance

The information and suggestions contained in this document support accepted forest management principles. Landowners, natural resource professionals, and forest industry professionals are encouraged to apply these principles in all phases of management, from the development of forest management plans to implementation on the ground. A variety of resources are available for landowners and managers to help with silviculture and forest management. These resources, as well as other types of forestry assistance, can be found on the Indiana DNR Division of Forestry website (www.in.gov/dnr/forestry).

Not every recommendation listed in this document can, or should apply to every situation. Landowners and resource professionals should assess each situation in order to reach specific management goals and objectives. When looking at woody biomass harvesting, recommendations should be considered that are appropriate for the specific site, goals, and planned management activities. Deviation from the guidance presented here may be appropriate in some cases. For example, retaining additional trees during a harvest where standing live or dead trees increase potential habitat for insect populations that pose a significant forest health risk may not be appropriate. **Table 1** describes potential sources of forest biomass and some of its functions in a forest stand.

Table 1 Potential Sources and Functions of Forest Biomass

from Michigan Woody Biomass Harvesting Guidance (2010) and Dan Cassens, Purdue University

Source	Functions Associated with Woody Biomass Harvest
Bole or trunk to 4" diameter top	Same functions as traditional removals; also a source for Coarse Woody Debris (CWD).
Limbs (Live or Dead) > 4" diameter	Same as traditional removals; also a source for CWD.
Limbs (Live or Dead) < 4" diameter	Contribute to nutrient cycling; help stabilize soil, provide wildlife habitat and Fine Woody Debris (FWD).
Vines & Shrubs	Important food source for pollinators. Some invasive and/or exotic species are detrimental and removal may be beneficial to native vegetation. Removal of vines that restrict tree growth or compete for nutrients and sunlight to the detriment of primary regeneration may also be beneficial to the remaining vegetation
Standing dead trees (snags)	Provide wildlife habitat and nutrients. Important to ecological processes, energy exchange, decomposition, and nutrient cycling.
Leaves, needles, seeds, & cones	Contribute to nutrient cycling; provide wildlife habitat, soil protection, and are a seed source for the next generation of trees.
Seedlings/Saplings < 4" DBH	Provide future stand components and soil stabilization. Removal of seedlings and saplings with poor form or undesirable species can increase stand health, vigor, and value, or in a clearcut treatment assist in natural or artificial regeneration efforts.
Below ground stumps & roots	Contribute to soil structure, stabilization, below ground ecological processes, and carbon storage.
Forest Litter & floor	Contribute to soil structure, stabilization, and below ground ecological processes.

Retaining tree tops or limbs (residues) from a portion of the harvested trees to maintain both wildlife habitat and soil productivity should be considered. The specific recommendations for the retention of tree tops, limbs and branches, will vary by site and by situation. General guidance for most situations is listed below, and additional information is offered for situations where biomass harvesting should not occur or where it may be necessary to retain additional amounts of woody material:

- While little research has been conducted as to how much woody debris to leave after a timber harvest, our best estimate under most conditions in Indiana, would be to leave from 1/3 or less of the harvested tree residues such as tree tops, and limbs less than four inches in diameter. ***Note that this recommendation is intended as a general guide, not as a precise measurement.***

In general, three main factors influence the proportion of tops and limbs that should be left on-site:
  - number of live trees left on-site,
  - time between harvests,
  - the site's nutrient availability.

As harvesting intensity increases (and the three preceding factors decrease), more slash, tops and limbs from harvests should be left on site. Another example would be on sites of normal productivity, where 1/3 of the basal area is being removed every 15-20 years, retaining one in four or five tops is suggested. In the case of a 30-acre clearcut, retaining higher amounts (i.e., one in three tops) would be suggested. Also:

  - Where practical, residues should be returned to the harvest area and dispersed rather than accumulated at the landing.
  - The amount of existing woody debris present prior to harvest should be considered when planning how much of the harvested tree residue to retain on site. For example, in stands with little woody debris on site prior to harvest, consider a greater level of retention; e.g., retaining one of every four or five tops of harvested trees. If the stand contains a moderate amount of preexisting woody debris on site, retention closer to the lower end of the range may be appropriate (i.e. retain one of every three tops).

- Limit or avoid woody biomass harvesting to bole wood in high quality natural communities, or on sensitive sites.

- Avoid woody biomass harvesting near known occurrences of state and or federally listed threatened or endangered species, or species of greatest conservation need, unless removal will improve habitat for the species.

- Avoid the removal of the forest litter layer, forest floor or below-ground biomass, including stumps and roots.

- On shallow, nutrient poor soils, consider leaving additional residue; that is, more than 1/3 of harvested tops, limbs, and branches.

- To the extent possible, retain existing coarse woody debris (CWD). CWD is an important forest ecosystem component. The variation in length and diameter of coarse woody debris on site is also an important habitat factor. Size, stage of decomposition, and quantity of this debris contributes significantly to microhabitat. Consider the following:

  - Move CWD off roads, skid trails, and landings to allow for safer equipment operations in the harvest area
  - Leave CW or FWD that are used to stabilize soil on roads or skid trails in place following harvest operations.
  - Retain some snags or culls to benefit wildlife where they do not pose a safety or insect pest risk.

Biomass Harvesting and Water and Soil Quality

Indiana Forestry Best Management Practices (BMPs) focus on minimizing soil disturbance while working in the woods in order to protect the soil resource and to maintain or enhance water flowing from the forests of Indiana. Activities carried on, in and around forests impact the forest environment in many different ways. The focus of the Indiana Forestry BMP guidelines is the quality of the water flowing from forest lands. Because the reduction in water quality from soil disturbing activities can't be seen flowing from a single source, such as a pipe, but is spread across the land, the term non-point source (NPS) pollution is used. Other land uses contribute more to total NPS pollution than forestry activities. However, improvement of water quality requires reduction of NPS pollution from all sources—including forestry.

Logging has the greatest impact of the typical forestry activities. The use of BMPs by loggers, landowners and land managers offers the greatest potential to reduce NPS pollution, protect water quality and meet other forest health goals.

Like other types of forest harvesting, responsible biomass removal can be accomplished with minimal impact on soil or water quality. To minimize impacts to a site's existing soil and water resources, steps should be taken to limit soil exposure, maintain as much root structure of the herbaceous and woody plants on the site as possible, and retain course woody debris until vegetation can recover on the site.

In general, forest managers should follow the existing BMPs as outlined in the Indiana Forestry BMP Field Guide (**http://www.in.gov/dnr/forestry/2871.htm**). Specific biomass BMPs to protect soil and water resources are described below.

Woody Biomass Harvesting BMPs for Soil and Water Quality

The potential risk to soil and water quality in general increases with the amount of woody biomass removed from the site, the topography of the site, and with the frequency of removals. In addition to the three main considerations listed in the General Guidance section, the following are additional considerations related to soil and water quality:

- Topography of the site: The steeper the slope, the more material that should be left.
- Location of water resources: The closer to water the more material that should be left.

Site or Situation Specific Considerations

- Riparian Management Zones (RMZs) are the terrestrial areas directly adjacent to water bodies. The width of RMZs is dependent on the type of water body and slope of the ground within the RMZ. Refer to the RMZ section of the BMP Field Guide for widths and other information. If the water body has a watershed area larger than 1 square mile, it falls under the jurisdiction of the Indiana Flood Control Act (I.C. 14-28).
- Steeper slopes and shallower soils are easily disturbed and eroded, so retain as much of the stand as possible to minimize the soil exposure and compaction in these areas.
- Retain stumps, roots, and forest litter layer as much as possible to maintain the soil structure, especially on banks of streams and other areas that are at high risk of erosion.
- Avoid biomass harvesting in riparian management zones (RMZ), except tops and limbs of trees normally removed in timber harvests under existing RMZ guidelines and BMPs.
- Protect sensitive and unique areas such as spring seeps, vernal pools and ponds, and sinkholes. Biomass harvesting should be avoided near these sites.

Biomass Harvesting and Wildlife Habitat

Downed woody material (DWM) is a fundamental component of forest wildlife habitat, particularly once it has begun to experience rot and decay. Scores of forest vertebrates, and many more invertebrates, benefit or depend upon DWM for food, escape cover, or shelter. Standing dead wood, in the form of snags, is an essential resource for many species, and once these have fallen they enrich the forest's supply of DWM. Forest harvesting operations that do not consider retention of these resources for habitat and ecological processes risk affecting rare species and communities, reducing biodiversity, and degrading overall forest health and sustainability.

Responsible biomass removal can be accomplished without noticeable impacts on wildlife habitat, but only if consideration is given for the retention of important habitat elements. To minimize these impacts to a site's existing wildlife, steps should be taken to ensure structures such as snags and rotting logs present before forest operations remain undisturbed and on-site after harvesting. Tipped-up stumps and exposed root-wads develop into ecologically unique "pit and mound" features, a characteristic of older forests.

Just as patches of undisturbed forest should be retained as "biological legacies" within large even-age harvests to mimic the effect of natural disturbance events, the distribution of DWM retained across a forest should mimic the distribution resulting from natural events, such as windstorms.

Forest managers should plan prior to harvesting to protect ***existing*** resources like snags, logs, and unique or sensitive habitats, while removing only ***a portion*** of the DWM resulting from timber harvests. Specific Best-Management-Practices to protect wildlife habitat are described below.

Woody Biomass Harvesting BMPs for Wildlife Habitat

- Retain downed woody material present on the site before harvest operations began. Limit disturbance to existing coarse woody material, such as logs, standing structures and snags.

Snags should only be felled if they pose a risk to safety. If snags are felled, they should be retained on-site.

- Retain stumps, roots, and forest litter layer.
- Distribute tops and limbs across the site to ensure even nutrient input. Retaining occasional small slash piles may provide habitat for some species.
- Avoid biomass harvesting in riparian management zones (RMZ) except tops and limbs of trees normally removed in timber harvests under existing RMZ guidelines and BMPs.
- Protect sensitive and unique habitats such as spring seeps, vernal pools and ponds, cliffs and ledges, and entrance areas to caves. Generally, biomass harvesting should be avoided near these sites.
- Avoid biomass harvesting in reserves and unharvested “leave-tree” patches within large even-age regeneration openings.

Sources:

Indiana Logging and Forestry Best Management Practices, 2005 BMP Field Guide
USDA Forest Service Forest Inventory and Analysis, Indiana 2005-2009
USDA Forest Service, Indiana Timber Product Output Survey 2008
Missouri Department of Conservation
Michigan Department of Natural Resources and Environment Forest Management Division

Glossary of Terms

Alluvium – Clay, silt, sand, and gravel deposited by a river or other running water. It is relatively young sediment—freshly eroded rock from hillsides that is carried by streams, continually pounded, and ground smaller as it moves downstream.

Basal Area – The measure, in square feet, of area occupied by wood in standing trees at a point four and one-half (4½) feet above the ground, expressed per acre, on any given forest stand. Basal area is used by professional foresters to gauge the stocking levels within forest stands (over-stocked, under-stocked, under-stocked with good growing trees, over-stocked with dying and declining trees, etc.).

Broad-Based Dip – A drainage structure designed to drain water off a dirt road while in use for vehicles maintaining normal haul speeds. Also called a rolling dip.

Buffer Strip – A barrier of permanent vegetation established or left undisturbed downslope from disturbed forest areas to filter out sediment from runoff before it reaches a watercourse. Buffer strips help stabilize streambanks, protect flood plains from flood damage, and provide important fish and wildlife habitat.

Bumper Trees – Trees along skid trails that are used by the skidder driver to help guide a drag of logs up the hill toward the landing. These trees will be severely damaged. Trees used as bumper trees should be trees designated for harvest or inferior trees not intended or desired for future growth.

Contour – An imaginary line on the surface of the earth connecting points of the same elevation. A line drawn on a map connecting points of the same elevation.

Coarse Woody Debris – Tree tops stumps, fallen trunks or limbs more than six (6) inches in diameter at the large end.

Crop Tree – A tree having a dominant or co-dominant crown and stem having good form and little to no defects that would prevent the tree from reaching biological maturity. Crop trees are selected for special treatment due to certain virtues, usually with a future product in mind. Virtues include species, form, growth rate, potential future products, match to site growing conditions, etc.

Culvert – Either a metal or concrete pipe, or constructed box-type conduit, through which water is carried under roads.

DBH – The diameter of the stem of a tree measured at breast height (4.5 ft or 1.37 m) from the ground.

Ephemeral Stream – Water flows only during or immediately after rain. Channel not well defined.

Erosion – The process by which soil particles are detached and transported by water, wind and gravity to some downslope or downstream point.

Evenage Management System (EAM) – A forest management strategy that results in stands of trees all nearly the same age.

Felling – The act of cutting down standing trees.

Fine Woody Debris – Leaves, twigs, tops, limbs and other woody debris less than six (6) inches in diameter at the large end.

Fords/Stream Crossings – A place in a stream or river that is shallow enough to be crossed by wading, on horseback, or in a wheeled vehicle.

Forester – (1) "… any individual who holds a Bachelor of Science degree in Forestry from a regionally accredited college or university with a minimum of two years of professional forest management experience…" as defined in Senate Bill 931, 2008. (2) In general, a professional engaged in practicing the science and art of forestry. Foresters may be credentialed by states or other certifying bodies, and may be licensed, certified, or registered. An example is the Society of American Foresters Certified Forester credential. The requirements for each credentialing program differ but usually include at least a baccalaureate degree in forestry and passing a comprehensive examination.

Forest Road – An access route for vehicles into forestland.

Harvesting – The felling, skidding, loading, and transporting of forest products such as sawlogs, stave logs, veneer, pulpwood, pine poles, posts, etc.

High Grading – The removal of the most commercially valuable trees (high-grade trees), often leaving a residual stand composed of trees of poor condition or species composition – NOTE: High grading may have both genetic implications and long-term economic or stand health implications.

Intermittent Stream – A watercourse when water flows in a well-defined channel nonperiodically. Same as a wet-weather stream.

Invasive Exotic – Any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem; and whose introduction does or is likely to cause economic or environmental harm or harm to human health (from www.invasive.org). Examples of invasive exotics are kudzu, emerald ash borer, Japanese honeysuckle, euonymus, Asian long-horned beetle, tree-of-heaven, gypsy moth, Japanese beetle, garlic mustard, tall fescue, and zebra mussel.

Karst – Topography with sinkholes, caves, and underground drainage that is formed by dissolution of a layer or layers of soluble bedrock, usually limestone, dolomite, or gypsum.

Log/Woody Biomass Landing – A place where logs or tree-length materials are assembled for loading and transport. Also called log deck, log yard, or bunching area.

Logging Debris – Unused and generally unmarketable woody material such as large limbs, tops, cull logs and stumps that remain after timber harvesting.

Landform – Literally the "lay of the land" (i.e., terrain features such as hills, plains, bottomland).

Lopping – Cutting large branches on tree tops to reduce their visibility near roads and other areas where the public may find the view offensive.

Low Soil Fertility – Soils that are poor in nutrients, limiting the growth of trees.

Mast – Fruit, seeds, and nuts from trees that provide food for wildlife. Mast is further defined into soft mast, such as persimmon, and hard mast, such as acorns.

Mineral Soil – The portion of soil originating from rock that has eroded and broken down into small particles.

Mulch – Any loose soil covering of organic residues, such as grass, straw, or wood fibers, that help check erosion and stabilize exposed soil.

NRCS – Natural Resources Conservation Service. Formerly known as the Soil Conservation Service. A federal agency in the U.S. Department of Agriculture.

Perennial Stream – A watercourse that flows throughout the year in a well-defined channel. Same as a live stream.

Pesticides – Chemicals that are used for the control of undesirable insects, disease, vegetation, animals, or other forms of life.

Regeneration – 1) The young tree crop replacing older trees removed by harvest or natural disaster; 2) The process of replacing old trees with young trees.

Regeneration Cutting – Any removal of trees intended to assist regeneration already present, or to make regeneration possible.

Retirement Of Road – Preparing a road for a long period of non-use. Methods include mulching, seeding, rehabbing or installing waterbars, etc.

Riparian Management Zone (RMZ) – An area along the banks of streams and bodies of open water where extra precaution is necessary in carrying out forest practices to protect the streambank and water quality.

Rotation (Period) – The period of time required to establish a forest stand from seed or planted seedling, grow the trees to financial or biological maturity, harvest the crop, and prepare for the next stand.

Sawtimber (Tree) –Logs cut from trees with minimum diameter and length and with stem quality suitable for conversion to lumber. Hardwoods must be at least 11 inches DBH or larger to be considered sawtimber.

Silviculture – The art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis.

Sinkhole – A sinkhole is a surface depression resulting from the solution of underlying carbonate bedrock and possibly the collapse into an underground cavern. Sinkholes shall have delineated protection zones when the sinkhole contains vegetation, natural communities, and/or geological features distinguished from the surrounding area.

Site Preparation – A forest activity to remove unwanted vegetation and other material, and to cultivate or prepare the soil for reforestation. Includes bulldozing, brush hogging and use of herbicides.

Skid – Moving logs or felled trees along the surface of the ground from the stump to the log landing.

Skidder – A large tractor like machine used to pull logs from the place where they were cut to the log landing/deck. Skidders have very large rubber tires with 4-wheel drive. They have a blade in the front used to push dirt and small trees out of the way. There are cable skidders and grapple skidders. Cable skidders require the driver to stop, get off the skidder, and set the cable around each log. Grapple skidders allow the driver to back up to each log and grab it. Good work can be done by both types of skidder if the driver is skilled, but grapple skidders generally do more damage.

Skid Trail – A temporary, heavily used pathway to drag felled trees or logs to a log landing.

Slash – Tree tops, branches, leaves and other tree parts left after a timber harvest.

Slope Percent – The grade of a hill expressed in terms of percent. A vertical rise of 10 feet and a horizontal distance of 100 feet equal a 10 percent slope.

Snag – 1) A standing dead tree from which the leaves and most of the branches have fallen.
NOTE: For wildlife habitat purposes, a snag is sometimes regarded as being at least 10 inches in diameter at breast height and at least 6 feet tall; a hard snag is composed primarily of sound wood, generally merchantable; a soft snag is composed primarily of wood in advanced stages of decay and

deterioration. 2) A standing section of the stem of a tree, broken off usually below the crown. 3) A sunken log or submerged stump or tree. 4) The projecting base of a broken or cut branch on a tree stem.

Streamside/Riparian Management Zone (SMZ) – An area along the banks of streams and bodies of open water where extra precaution is necessary in carrying out forest practices to protect the streambank and water quality.

Timber Stand Improvement (TSI) – A thinning made in immature stands to improve the composition, structure, condition, health and growth of remaining trees.

Uneven-Age Management System (UAM) – A planned sequence of treatments designed to maintain and regenerate a stand with three or more age classes.

Waterbar – A hump or small dike-like drainage structure used to divert water in closing skid trails, retired roads, and fire lines.

Watershed – An area of land that drains rain and snowmelt into a stream or river. Size is relative to the use of the information. Size may range from a single creek draining only a few acres to a large river where water comes from many states, like the Mississippi River.

Water Turnout – The extension of an access road's drainage ditch into a vegetated area to provide for the dispersion and filtration of storm water runoff. Also called a wing ditch.

Wetland – 1) A transitional area between aquatic and terrestrial ecosystems that is inundated or saturated for periods long enough to produce hydric soils and support hydrophytic vegetation. 2) A seasonally flooded basin or flat. NOTE: The period of inundation is such that the land usually can be used for agricultural purposes.

Woody Biomass – "…small-diameter trees, branches, and the like (brush, tree tops) —that is generated as a result of timber-related activities in forests…" (U.S. Government Accountability Office).