so low (less than 40 square feet per acre of high quality trees in hardwoods and 60 square feet per acre of high quality trees in softwoods and mixed-woods), that even-aged management of the stand may be a better option.

- Growing high quality trees can't be accomplished through high-grading (removal of the best trees) or liquidation (removal of all merchantable trees). Diameter-limit cuts also aren't preferred. If used, must be based on an inventory and use different diameter limits by species to qualify as a quality-sustaining practice.
- Stand density varies by the species mix:

Stocking Table for Hardwood, Mixed-wood and Softwood

	HARDWOOD		MIXED-WOOD		SOFTWOOD	
Mean DBH	A-line	B-line	A-line	B-line	A-line	B-line
(inches)	sq. ft./acre		sq. ft./acre		sq. ft./acre	
4	90	54	100	81	114	100
8	117	61	155	101	199	125
12	122	63	173	106	230	137
16	125	64	180	108	240	141

Hardwood = less than 25% softwood.

Mixed-wood = 25%-65% softwood.

Softwood = greater than 65% softwood.

Stocking Tables for White Pine and Spruce/Fir/Hemlock

	White pine		Spruce/fir/hemlock	
	A-line	B-line	A-line	B-line
Mean DBH (inches)	square feet			
4				
8	240	90	205	110
12	255	100	270	150
16	285	150		

- Another approach to manage for high-value, fast-growing pine is called low-density white pine management. As its name suggests, low-density focuses on growing fewer crop trees per acre than traditional stocking charts suggest. The goal of this technique is to grow a high-quality butt log free of knots in the shortest time possible. To achieve this goal white pine crop trees (100 or fewer per acre) are heavily released and pruned to a height of (1 1/2) logs. Recommended residual stocking densities are well below the C-line on traditional white pine stocking charts.

RECOMMENDED PRACTICES

why not state the # of feet - is a log 8 ft? then this would be 12 feet. 4/5

Even-aged management:

- Measure the basal area and average stand diameter of the overstory trees only. Leave out the trees that are in the understory and are completely over-topped by other tree crowns.
- Follow the density guidelines in the stocking chart. Thin when the density is halfway between A and B.

Example: A mixed-wood stand is determined to have an average stand diameter of 8 inches and a basal area of 135 square feet per acre. Locate the average diameter in the first column and follow that row across to the mixed-wood category. Half the distance between the A-line and the B-line would be:

(155 + 101) / 2 = 128 square feet per acre.

The basal area of the stand presently (135 square feet per acre) is greater than half the distance between the A-line and the B-line.

Uneven-aged management:

- Measure the basal area of all trees down to 4.5 - 5.0 inches in DBH. (Since uneven-aged stands have a range of tree size, average stand diameter isn't used as a guide.)
- Use the following optimum ranges. Schedule a harvest when the basal area exceeds the desired residual basal area by about 30 square feet.

Stand Type	Residual Basal Area (sq.ft./acre)
Hardwood	70-80
Mixed-wood	70*-100
Softwood	70*-120

*NOTE: The lower end of the range is based on spruce fir and applies to longer cutting cycles. The suggested minimum residual basal area is higher for white pine. The higher end of the range will maximize growth.

Precommercial Treatments

- Protect crop trees susceptible to epicormic sprouting (most hardwoods) from receiving too much light. For those trees growing on good sites and not prone to epicormic sprouting, release on at least three sides of its crown light to increase diameter growth. Check with your UNH Cooperative Extension county forester to see if financial assistance is available.
- Follow the following guidelines when pruning:
  - Prune pole-sized crop trees (4 to 6 inches in diameter, and never larger than 10 inches).
  - Limit the number of crop trees pruned per acre to those that can be carried to full maturity and add enough growth of clear, knot-free wood to justify the pruning investment. No more than 100 softwood and no more than 50 to 75 hardwood crop trees per acre.
  - Follow, rather than precede, thinning. Keep damage to crop trees at an absolute minimum during harvests.
  - Document when and where pruning occurred.

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Good Forestry in the Granite State: Draft Timber Harvesting - Additional Reading

A Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters, and Landowners
Geoffrey T. Jones. Northeast Regional Agricultural Engineering Service, and Society for the Protection of New Hampshire Forests 1993

Topics in this section

Choosing the Right System
Logging Aesthetics
Aesthetics of Skid Trails, Truck Roads and Landings
Harvesting in High-Use Recreation Areas
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Good Forestry in the Granite State: Draft Timber Harvesting - Choosing the Right Systems

x.x CHOOSING THE RIGHT SYSTEM

BACKGROUND

Choosing the most appropriate timber harvesting system can meet management objectives and minimize environmental impact.

A timber harvesting system is one of several combinations of equipment used for felling and extracting timber. Every system requires (1) a mechanism for felling trees and (2) a mechanism for removing felled trees or portions of felled trees to a roadside log landing for transportation to a mill. Matching the equipment to the site, implementing proper harvest layout and hiring a skilled operator all contribute to successful logging. A licensed forester and a certified logger can help choose the right system. Landowners choosing to harvest timber on their own, must decide if they have the time, skill, equipment, and knowledge to do so or, if they wish to contract the services.

OBJECTIVE

Select a timber harvesting system appropriate to the site and landowner objectives.

CONSIDERATIONS

- Financial return is often a factor when considering which harvesting system to use. Costs associated with different logging methods vary and may impact the income received.
- Time of year can influence equipment choice. Frozen winter conditions may be suitable to almost any system while a summer or fall harvest may limit some equipment, particularly on sites with wet soils.
- Ground conditions such as wet sites, rocky terrain or steep slopes may limit the equipment.
- The size of the harvest area, the density of the trees, and the size and value of the timber may limit the practicality of using some harvest systems. Equipment should be able to efficiently fell and move timber to the landing. Equipment that is too small may struggle handling large timber and damage the remaining trees. Skidding distances over a half mile may limit the feasibility of some equipment. Using equipment that is too large may result in higher levels of residual damage in tight stands of small timber. It may be inefficient to use large machines on lots smaller than 10 acres.
- The quality and quantity of the timber and the expected products helps determine the feasibility of a method. Are there more high quality sawlogs, more pulpwood, or will the tops be chipped? If the wood is low-value, and the trees are small and scattered the cost of logging may be higher than the financial return. The ability to sort for multiple markets depends on the right mix of equipment and the experience and skill of the operator.
- Systems using the entire tree may result in an aesthetically pleasing appearance and

may be desirable on highly visible sites.

- Layout of the truck roads, landings and skid trails affect efficiency and differs for each harvesting system. If the skidding distance is great, or the landing size is limited, the choice of equipment may also be limited. Mechanized systems tend to be high production, covering more ground more quickly than conventional systems making pre-sale layout and sale supervision important.
- Operator skill plays the greatest role in determining success, regardless of the equipment chosen. A skilled operator reduces equipment impact, while an inexperienced one can do damage in a short time.
- The environmental sensitivity of a woodlot may dictate which logging equipment is most suitable. Crossing wetlands, logging near cultural artifacts and threatened and endangered plants, scarifying soil to promote regeneration, or minimizing disturbance to advanced regeneration may be some of the factors to consider. Implementing best management practices (BMPs), silvicultural prescriptions, job layout for the equipment, and carefully closing out the sale will go a long way to achieving a successful timber harvest.
- Safety is integral to all decision-making such as who operates the woodlot, what equipment they bring, and what steps they take to assure safe operating procedures. Some equipment provides much greater level of safety and control, allowing work to be conducted in hazardous conditions. Operators must make sure everyone in and around the logging operation is safe at all times.

Commonly Used Timber Harvesting Systems

The following descriptions represent commonly used systems and aren't meant to represent every possible combination.

- Conventional Logging – Uses a chainsaw and cable skidder.
- Mechanized Logging – Uses a feller-buncher, grapple skidder or other auxiliary equipment such as a loader, delimber, slasher, and chipper. Whole-tree (biomass) harvesting is a form ofmechanized logging that typically adds a chipper for processing whole trees into chips at the landing, a loader to feed the chipper, and a trailer into which the chips are blown.
- Cut-to-Length System – Mechanized logging using a processor and forwarder combination.
- Other systems include draft animals, tractors, and other machines

Conventional Logging

- **Felling System - Chainsaw**

  The chainsaw is the most common method for manually felling trees. A skilled chainsaw operator can directionally fell trees. Training in chainsaw use and maintenance is critical for safely felling trees.

- **Extraction System - Cable Skidder**

  A cable skidder uses a winch, cable and chokers (chain) to gather and drag a load (hitch) of trees or logs. A cable skidder allows the operator to pull the cable to the trees rather than driving the machine to each tree. This allows for flexibility on uneven

terrain. The cable skidder operator must exit the machine to attach each tree to the cable. The winch pulls the trees, butt first, to the skidder by reeling the cable over an arch. The arch raises the hitch off the ground reducing the friction and impact to the ground during the course of the skid.

- **Pros:**
  - Large, valuable trees can be felled without damage.
  - Allows trees to be removed from sensitive and difficult locations.
  - Trees are topped and limbed in the woods reducing the size of the hitch which may reduce residual stand damage. Tops left in the woods may reduce nutrient depletion on poor sites.
  - Cost-effective, especially on small jobs.
- **Cons:**
  - Requires extreme physical exertion and exposure to adverse environmental conditions.
  - Chainsaw operator is vulnerable to falling debris and chainsaw injury.
  - Slower than a mechanized system.
  - May damage advanced regeneration more than mechanized systems.

Mechanized Logging

- **Felling System - Feller-Bunchers**

A feller-buncher, or harvester describes any number of machines that cut (fell) and gather and pile (bunch) trees. The machine either drives to the base of the tree or reaches to the tree with a boom. The tree is severed using either a circular saw or a chainsaw-type head which cuts the tree or a shear which pinches the tree off. Shears have fallen out of favor for use in high-quality timber because the tree's fiber is crushed when the tree is severed.

After felling, trees are piled into hitches in or along skid trails for removal to the landing by a skidder. Mechanized operations tend to be whole-tree operations, removing the entire tree from the forest for processing at the landing. This requires the support of several pieces of auxiliary equipment such as a loader, delimber, slasher and chipper. The loader is used to move products around the landing as trees are processed into logs and chips. Branches are removed in the de-limber and logs are cut to length in the slasher. Poor quality stems and tops are run through the chipper to create biomass.

3-Wheeled Harvesters: The 3-wheeled harvesters are rubber tired and highly maneuverable and designed for smaller diameter trees. Typically configured with a fixed shear head, they work well in tight stands and on even terrain.

4 to 6-Wheeled Harvesters: A felling machine with a fixed head mounted (typically) on a rubber-tired machine. The fixed head harvester requires the operator to drive to the tree base to fell the tree.

Tracked Harvester: A tracked felling machine with a cutting head mounted on a boom which reaches up to 20 feet. This reach aids harvesting on rough and steep terrain. The boom also allows the machine to harvest and carry large diameter trees as

well as direct the felling which protects the residual stand.

- **Extraction System - Grapple Skidder**

  A grapple skidder uses a grapple to bunch, hold and drag a load of trees or logs. The operator doesn't get out of the machine to assemble a load, improving efficiency and operator safety. The grapple raises the hitch off the ground, reducing the friction and impact to the ground during the skid. Because the grapple skidder requires the operator to drive to the felled trees, some also have a cable with which to pull trees.

- **Pros:**
  - Feller-buncher is able to carefully cut trees and lay them down where desired, protecting advanced regeneration, residual trees, cultural resources, and sensitive sites.
  - Tracked machines may reduce soil compaction.
  - Self-leveling, track mounted feller-bunchers aid harvesting on steep slopes.
  - Small feller-bunchers are maneuverable in tight stands.
  - High production
  - Operator remains in cab of machine.
- **Cons:**
  - May result in residual stand damage, as well as greater soil disturbance or compaction.
  - Smaller feller-bunchers may not be able to handle large trees.
  - Mechanized logging, particularly a whole-tree operation, requires larger landings and skid trails.
  - Logs may be damaged from multiple-handling, improper machine adjustment or operator inexperience.
  - Whole-tree harvesting may deplete soil nutrient levels on poor sites over time.

- **Auxiliary Harvesting Equipment**

  Delimber

  The delimber takes the limbs off of the tree either by dragging the stem horizontally through a metal frame or by passing a metal arm down the length of the stem. The delimber is also an integral part of the processing head on a cut-to-length processor.

  Slasher

  A slasher is a circular saw or chainsaw mounted on a steel frame. The stem is placed in the frame horizontally by a loader and cross-cut or bucked to length. The slasher allows for high volume processing of stems while protecting the operator in a cab.

  Chipper

  The chipper used on a logging operation is capable of processing large, low-quality stems into chips. The resulting whole-tree chips, or biomass, are used as fuel at wood-to-energy power plants. A flail chipper or chipper ~~which~~ that removes the bark from the stem prior to chipping can produce pulp quality, or clean chips used in paper or wood pellet manufacturing. The bark and other flail material can be used as fuel, mulch or matting on a sensitive logging ~~area~~ areas during. Chips are blown into tractor-trailer vans for transport.

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Cut-to-Length System

- **Felling System - Processor**

  A tracked or rubber-tired machine with a computerized cutting head used to fell, delimb and buck (cut into smaller lengths) trees at the stump. A processor combined with a forwarder is referred to as a cut-to-length system. The cut-to-length system is often used on sensitive sites. The operator doesn't have to exit the machine to harvest and process trees. Limbs and tops are typically left in skid trails.

- **Extraction System - Forwarder**

  A self-loading machine designed to carry trees or parts of trees. The forwarder, when combined with a processor forms a cut-to-length system. The forwarder may be used in combination with a feller-buncher and or a chainsaw. A forwarder is often preferred on sensitive sites because the wood is carried rather than dragged.

- **Pros:**
  - The processor head allows the operator to make decisions about the entire stem at the stump.
  - The forwarder reduces ground impact because it carries logs rather than drags them.
  - The increased surface area of the forwarder's wheels running over a mat of tree tops deposited on the trails protects the ground and distributes the weight of the loaded machine.
  - The logs may be cleaner which may be desired by some mills.
  - Smaller landing sizes
  - Processing tops and limbs in the forest may reduce nutrient depletion.
  - Operator remains in the cab of the machine.
- **Cons:**
  - A cut-to-length system is expensive.
  - The processor may have difficulty with larger trees.
  - Processor head (rollers) can damage sawlogs.
  - Hand felling and delimbing may be required especially with larger hardwood.
  - Not usually as productive as traditional mechanized logging and has a higher overhead for equipment which may result in slightly reduced stumppage prices.

Other skidding systems

like this method

Horses, oxen and mules can be used to skid trees though slow and not common. Training and care is needed to assure the safety of the animals as well as the logger. Draft animal loggers have the option of drawing stems and loads on the ground or raising them with an arch, sled or forwarder. Stems or logs are often bunched on the ground by a single animal and then forwarded by a team on an arch, sled or forwarder to minimize ground disturbance and residual stand damage. Creates narrow skid trails and may be a feasible system for removing small volumes of high-value trees from visually sensitive areas.

Farm tractors equipped with specifically designed winches may be used to skid smaller trees. Operators must not exceed the limitations of the machine.

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Other machines used to skid logs included all-terrain vehicles (ATV), dozers and trucks. Each machine has its benefits and limitations. Care is needed with any non-traditional logging machine to assure the safety of the operators ~~as well as~~ and those working in the vicinity.

RECOMMENDED PRACTICES

- Get professional help. (See below for listings of licensed foresters and certified loggers).
- Choose an experienced logger. Visit several completed harvests to see what different equipment and operators can do before making a final selection. Check references.
- Clarify expectations and objectives and use a written contract.
- Lay out truck roads, landings and skid trails and designate trees to cut (or leave) in advance. Tailor the layout to the harvest system selected, to reduce residual stand damage, soil compaction and erosion, and to preserve advanced regeneration, unique species and cultural artifacts.
- Time the harvest to avoid wet or poor logging conditions, conflicting uses and to optimize market conditions.
- Use BMPs for erosion control and to prevent sediment from entering streams or wetlands.

CROSS REFERENCES

BMPs, wildlife, safety

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Good Forestry in the Granite State: Draft Timber Harvesting - Logging Aesthetics

6.X LOGGING AESTHETICS

BACKGROUND

good

Timber harvesting creates a temporary change in the visual quality of the forest. By creating a variety of tree sizes and types and different opening sizes, harvesting can have a long-term positive aesthetic effect. Some short-term aesthetic concerns include woody debris (slash) on the ground, broken or bent trees, ruts, clearcuts, or a general change in the appearance of the forest. Improving the apppearance of a harvest may result in trade-offs with wildlife-related recommendations, resulting in fewer habitat elements such as coarse woody material on the ground or standing snags (dead and dying trees). A forest that looks "neat" may not be ecologically healthy.

In many cases, doing a lot of little things can collectively make a big difference. For example, changing the timing of forest management activities can impact how a job looks and affect recreation on a woodlot. If roads are built during dry seasons, they are cheaper to construct and look nicer. Operating on frozen ground that has good snow cover results in less damage to the soil, ground cover, seedlings, and the residual trees, which often translates into a better looking job. Many outdoor recreational activities take place during specific seasons of the year. Harvesting activities that are scheduled to avoid peak use will help to minimize potential conflicts.

Planning and adherence to some basic recommendations will balance the aesthetic outcome with ensuring the change that occurs achieves the long and short-term objectives of the landowner.

OBJECTIVE

Minimize the visual impacts of timber harvesting.

CONSIDERATIONS

- Following the recommended practices may result in a cost or less income.
- Bark on trees is very tender and easily damaged from late spring (bud break) through mid-July.
- Many aesthetic concerns are exacerbated during wet conditions.
- When operating in heavily stocked or high-value stands, planning and logger skill is more important to the aesthetic outcome than equipment size.
- Slash is unavoidable when harvesting timber.
- Slash near roads, lakes, streams, and property boundaries is subject to regulation under the slash law, RSA 227-J:10. Briefly stated, this law requires that slash be removed from within 25 feet of a property line; from within 50 feet of any great pond or body of water greater than 10 acres, public highway or active railroad bed; and 100 feet of any

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occupied structure.

- Slash helps to maintain soil on-site and protect developing seedlings from temperature extremes and over-browsing by deer and can benefit wildlife by creating microhabitats for small mammals, birds, and other species.
- Manual treatment of slash can be dangerous to the logger.
- Maximum utilization of merchantable wood conflicts with recommended practices regarding dead and down woody material.
- The branches, twigs, leaves, and needles of trees contain a higher percentage of nutrients than the trunk of a tree. On some sensitive sites, it may be more important to leave this biomass for nutrient recycling, instead of removing it.
- Slash can be a fire hazard.
- The basal area law (RSA 227-J:9) requires forested buffers along town and state roads, streams, and bodies of water following timber harvests.
- Clearcutting is a management tool used to create vistas, early successional wildlife habitat, or regenerate specific tree species. Aesthetic considerations may conflict with these objectives.
- Clearcutting can open new or historic views.
- The visual impact of a clearcut area will vary depending upon the size, shape, location, and time of year it is viewed.
- Clearcuts are most unsightly in the first few years following the harvest. The aesthetic impact decreases as the area regenerates.

RECOMMENDED PRACTICES

- Follow local and state regulations, allowing enough time to obtain necessary permits. Adhere to the basal area law (RSA 227-J:9) and the slash law (RSA 227-J:10). Refer to *Guide to New Hampshire Timber Harvesting Laws*.
- Schedule phases of a harvest with the appropriate seasons to limit costs and disturbance. Minimize the impact on sensitive sites by harvesting on dry or frozen ground. Refer to *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*.
- Minimize visual and audible impacts of forest management activities by scheduling such activities during the appropriate seasons of the year and during lower levels of recreational use where recreation is a priority.
- When operating near residential areas reduce the impact of noisy equipment, by modifying working hours, shutting down idling equipment, reducing truck noise (by using lower rpm's) to and from the landing, and consider using equipment with noise-reducing features.
- Notify abutters or others ~~that~~ who may be affected. Posting signs will help recreational users and others understand the reasons and timing of the harvest.
- Supervise the job on a regular basis so that problems can be identified and solved in a timely fashion.
- Sweep mud off paved roads whenever log trucks leave muddy landings.
- Cut stumps as low to the ground as possible. Recut multiple stems when trees are cut high on the trunk above a crotch.
- Cut whips, leaners, bent saplings, and broken trees, particularly in visible sections of the woodlot.

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- Protect the residual stand not only for aesthetics, but also for maintaining the biological and economic health of the forest, by:
  - Designating trees for removal only if they can be felled and removed without causing excessive damage to the residual stand.
  - Marking trees (to cut or leave) with paint on two sides to enable the logger to make better choices regarding directional felling and hitch selection.
  - Matching equipment to terrain, tree size and product and other site conditions.
  - Use directional felling techniques to avoid damage to unmarked trees during felling and to position the downed tree for the skidder, so that damage trees from skidding is reduced.
- Slash
  - Minimize slash consistent with the slash law, RSA 227-J:10.
  - Use tree tops down to 4 inches or less in diameter, or as markets permit.
  - Lop tops to a height of 2 feet or less within 50 feet of a recreational trail. It may be desirable to pull the tops back 50 feet or more before lopping. Otherwise lop tops 4 feet or less above the ground.
  - In areas where the presence of slash is a visual problem, consider using mechanized operations that remove slash and low-grade wood that otherwise would be left.
  - Slash can be placed and crushed in skid trails to minimize soil disturbance, but plan for the location of recreational trails before harvest ~~layout~~ laying out the. Avoid placing slash in trails destined for recreational use.
- Clearcuts
  - Design clearcuts to take into account slope, topography, existing vegetation patterns, and principle viewing points. Integrate clearcuts into trail systems in a manner that allows viewing of scenic vistas and for wildlife viewing.
  - In visually sensitive areas, clearcut in multiple stages.
  - Leave patches (or islands) of varying sizes and shapes of trees to break-up the cut area and reduce apparent size.
  - Keep openings into harvest areas narrow to limit the view from public roads, lakes and rivers, or recreation areas.
  - Use the natural terrain to minimize apparent size.
  - Using topography and vegetative patterns, shape clearcuts to resemble natural openings. Integrate partial harvests along roadsides and highly visible slopes.
  - Avoid long straight edges for harvest bounds that intersect with roads or trails at hard angles, or that are visible from roads or water bodies.
  - Maintain an uncut or partially cut buffer of 150 feet along recreational trails and in residential areas, as well as roads and streams as required by the basal area law.

CROSS REFERENCE

Erosion and Soil Damage 1.1; Woodland Raptor Nests 4.4; Dead and Down Woody Material 3.8; Aspen Management 3.4; Deer Wintering Areas 3.5; Heron Colonies 4.5; Bald Eagle and Osprey Nests 4.6; Controlling Logging Damage 5.4; Forest Structure 5.2; Clearcutting 5.5; Timber Harvesting in High-Use Recreation Areas 6.7,

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Good Forestry in the Granite State: Draft Timber Harvesting - Aesthetics of Skid Trails, Truck Roads and Landings

X.X AESTHETICS OF SKID TRAILS, TRUCK ROADS AND LANDINGS

BACKGROUND

Skid trails, permanent truck roads and landings create visually dramatic and permanent changes in a woodlot.
Without skid trails, truck roads and landings most management wouldn't be possible. Besides facilitating timber harvests, they can enhance landowner woodlot access, improve wildlife habitat, and provide a means for recreation and fire and pest control. They also can be the greatest expense of a timber harvest. Careful planning reduces costs and minimizes the aesthetic impact. When built and used during the dry season, they hold up better, look neater, erode less, and are less expensive to construct and use. On some sites, use on frozen ground may be preferable, especially for temporary winter use. Cutting and removing trees on the road right-of-way in advance of bulldozing results in better looking roads.

Landings are cleared areas where timber is brought from the woods, sorted and stored until it is trucked to a market. Many times landings are located beside a public road. People often judge the quality of a timber harvest by the appearance of the landings, both during and after the harvest, without ever stepping into the woods. A clean, properly sized, well-organized landing, will help improve productivity, provide a safer work environment, reduce cleanup costs, and draw positive attention from the public.

Economics and terrain may determine the location of skid trails, roads and landings, but pre-planning, use of best management practices (BMPs), and good close-out techniques will minimize aesthetic impacts.

OBJECTIVE

Plan, construct, use and maintain skid trails, truck roads and landings to minimize their visual impact.

CONSIDERATIONS

- The state or towns may hold landowners, loggers, or foresters responsible for damage to public roads.
- Frequency of access, amount of anticipated traffic, seasons during which access is required, and safety concerns affect the number, type and layout or roads and landings.
- Building roads and landings to accommodate visual quality concerns - or using existing roads that require traveling greater distances - may involve increased costs, or may

impact ecologically sensitive areas.

- Traffic during wet periods can increase maintenance needs and create unsightly ruts.
- Roads provide access for undesirable activities such as dumping or unwanted traffic that could damage roads and have negative aesthetic impacts.
- A well-maintained road improves recreational uses, potentially saves money, provides fire protection access, and supports other forest management activities.
- The portion of a timber sale where neatness and organization is the most noticeable is the landing.
- The volume of timber harvested, the need to sort logs by species and products, and the equipment type and size often determine landing size.
- Topography, the location of timber and the proximity of the harvest to public roads or high-use areas can affect the placement, size and number of landings.
- After the harvest, landings can be used for parking, camping, wildlife openings or future harvest operations. Their placement and size may depend on planned subsequent uses, including preventing unwanted use.
- Landing clean-up and seeding practices will increase costs.
- Leaving landings in their natural state including leaving woody debris unburied may benefit wildlife. Logging debris left on landings must comply with the slash law, RSA 227-J:10.

RECOMMENDED PRACTICES

Design and Planning:

- Follow state laws and town ordinances including filing all necessary highway permits.
- Follow BMPs. Refer to *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*
- Consult the Natural Resources Conservation Service (NRCS) or the ~~county~~ extension forester for help and to learn of the availability of federal financial assistance.
- Designate "bumper trees" along skid trails to minimize damage to the residual trees. Leave them after harvesting for future protection and as future cavity trees.
- Minimize the number of access roads approaching public roads. Curving access roads as they approach public roads makes them less obvious.
- Plan landings to access future timber sales, keeping their number to a minimum, and sizing them to accommodate products and equipment needs. Locate landings where invasives aren't growing or remove them before construction.
- Avoid placing landings within view of public roads, trails, or recreation and residential areas. Consider a short, curved road to landings.
- In sensitive areas, leave an uncut or partially cut buffer of 150 feet or more between landings and major roads, recreational trails, rivers, and residential areas.
- Identify disposal areas for blocks and other debris in advance. Push unmerchantable debris into those areas over the course of the job. Blocks, stumps and other woody debris from on-site logging buried on-site are exempt from NH Department of Environmental Services permitting requirements for stump dumps.

Construction and Use:

- When constructing a new road, if stumps can't be trucked or buried, push them off the

road and leave in an upright position. Stumps left in this manner look more natural. Hardwood stumps often sprout, further softening their look.

- Use merchantable timber within trails, roads and landings and dispose of slash without filling vernal pools or cultural features such as old cellar holes.
- When upgrading existing roads, clear trees and brush along roads for only the minimum essential width needed for basic construction, maintenance, and traffic needs. Limit the number and length of truck roads.
- Avoid tracking mud from truck roads and landing onto public roads by using clean fill, wood chips, or mats. Sweep mud from paved roads.
- Shape and seed ditches and exposed areas to avoid erosion and improve visual impact. Place waterbars as recommended in the BMPs.

When using on site gravel (borrow) pits:

- Follow state and local regulations pertaining to gravel operations.
- Avoid locating pits where non-native invasives are growing, or remove them before using the pit, to avoid moving them with the fill.
- Locate borrow pits out of the visible corridor as much as possible or screen them using existing vegetation. Avoid facing them directly toward the road.
- Before putting the pit to bed, consider stockpiling gravel for future use.
- Rehabilitate pits upon completion of use as per RSA 155-E.

During the Harvest:

- Organize landings to accommodate sorting, processing, and short-term storage and to allow safe movement of workers and equipment.
- Minimize the amount of wood waste on the landings, through good utilization, and by cutting and leaving unmerchantable sections in the woods or hauling unused blocks back to the woods.
- Remove slash from landings as soon as possible.
- Avoid creating landings that evolve into one continuous zone along public roads.
- Limit the number of skid trails entering and leaving the landing in order to minimize the amount of disturbance.
- Remove and properly dispose all trash, motor oil, and other refuse daily.

After the Harvest:

- Clear landings of woody debris by burying, piling, or moving it into the woods. Level and smooth the ground. Plant with recommended seed mix only if necessary to stabilize the soil, for wildlife, or for appearance. Otherwise, let natural vegetation establish itself. Contact NRCS for information on site-specific seeding recommendations.
- Regularly inspect roads and trails. Maintain roads on a schedule to include mowing, cleaning ditches and culverts, repairing washouts, and other activities as needed. Periodic mowing may be necessary to keep the landing open for wildlife and other future use.
- Install a gate or block access with boulders or other obstacles, to keep unwanted vehicles off roads. Post signs that help send a positive stewardship message, yet restrict harmful uses.

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CROSS REFERENCE

Erosion and Soil Damage 1.1; Wetland and Riparian Areas 2.1; Water Quality 2.2; Dead and Down Woody Debris 3.8, Permanent Openings x.x, Invasives x.x

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Good Forestry in the Granite State: Draft Timber Harvesting - Harvesting in High-Use Recreation Areas

6.7 TIMBER HARVESTING IN HIGH-USE RECREATION AREAS

BACKGROUND

Minimizing conflicts between timber harvesting and recreation use can leave visitors with a positive impression of forest management. occurs when they hike, fish, hunt, The primary exposure many people have to timber harvesting ~~is by recreating~~ on managed ski, lands. Whether harvesting near trails on their own land, or harvesting in proximity to snowshoe, etc recreational areas on adjacent lands, a landowner's actions can significantly affect the public's perception of harvesting, for better or for worse. Attention to the impact of harvesting on recreational uses can enhance the public's recreational experience and create a positive impression of forest management.

OBJECTIVE

Minimize the visual and audible impacts of timber harvesting in or near areas with recreational use.

CONSIDERATIONS

- Many hiking trails use old logging routes and many logging roads often become new hiking trails.
- Recreational use can conflict with forest management activities.
- Scheduling a timber harvest during low use may not coincide with the best season to operate.
- Limiting recreational access during harvest operations may be the safest alternative.

RECOMMENDED PRACTICES

- Before the harvest, erect signs to inform, educate, and warn recreational users regarding harvesting activities and safety concerns.
- Notify abutters, recreation user groups, conservation commissions, or others that may be affected. Consider having a local newspaper run a story on the sale.
- Monitor the job on a regular basis so that problems can be identified and solved in a timely fashion.
- Leave large attractive trees in high-use public areas.
- Lay out skid trails and roads with future recreational use in mind so they can be incorporated into trail systems.
- Leave uncut or partially cut buffer zones along recreational trails. Limit the number of skid trail crossings, keeping them at right angles to the recreational trails and angling them just beyond the buffer zone to minimize sight lines down the skid trails.
- Lop tree tops 2 feet or less in high-use areas. Otherwise lop tops 2 to 4 feet above the ground. Where deer severely disrupt natural regeneration, leave slash higher to protect new seedlings.

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- Conduct disruptive phases of management operations, such as road or landing construction, during periods of low recreational use.
- When harvesting operations can't avoid peak recreational use, consider the following:
  - Temporarily relocate trails away from the management activity.
  - Reduce the impact of noisy equipment by modifying working hours, shutting down idling equipment, reducing truck noise (by using lower rpm's) to and from the landing, and consider using equipment with noise-reducing features.
- Limit skidding on recreational trails. During the harvest, protect recreational trails impacted by skidding from erosion by using best management practices (BMPs). After harvesting, remove woody material, smooth ruts, and seed as necessary.
- Invite the public to tour your woodlot to learn more about harvesting operations.

CROSS REFERENCE

Truck Roads & Skid Trails 6.2; Landings 6.3; Slash Disposal 6.4; Cultural Resources 6.6.

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Good Forestry in the Granite State: Draft Timber Harvesting - Soil Productivity

X.X SOIL PRODUCTIVITY

BACKGROUND

Forest soil productivity can affect how fast trees grow and what kinds of trees grow. The characteristics of a forest soil are defined by varying combinations of mineral particles, organic matter, water, and air. Soil productivity is influenced by levels of nutrients which are determined mostly by the type of minerals from which the soil is derived. For example, limestone-derived soils tend to have a higher pH allowing nutrients to be more available and in turn, to be more fertile. Soils derived from granite tend to have a lower pH which locks up nutrients and so tend to be less fertile. Because there are few practical, economically feasible means of increasing soil productivity, maintaining existing soil nutrients is important.

Soil nutrients can be lost through leaching and timber harvesting. Acid deposition and other forms of air pollution leaches certain soil nutrients, especially calcium. These losses may equal or exceed losses from timber harvesting over the length of the rotation. Exposing soil can result in small amounts of harvest-induced leaching. Soil type and the amount of trees removed can influence the amount of leaching though prompt revegetation can minimize losses.

Nutrient loss from timber harvesting is affected by what portion of a tree is taken, the harvest method, and the regularity with which a stand is harvested. The more frequently a stand is harvested and the more fiber removed over a rotation, the greater the amount of nutrients taken. Whole-tree (biomass) harvesting removes more nutrients than bole-only harvests, because the tops, limbs and leaves are a significant reservoir for many nutrients.

The greatest concern for nutrient depletion arises when the more intense practices are routinely applied repeatedly on sites already low in nutrients. In general, whole-tree harvests by the clearcut method on short rotations (e.g. 40 years) will have the greatest nutrient impacts. Sites low in nutrients include most coarse-textured sands and some soils shallow to ledge and some soils with high seasonal water tables.

Erosion and soil compaction may also diminish soil productivity for tree growth. Soil damage can occur from timber harvesting by disrupting topsoil, mixing soil layers, creating deep ruts, or compacting soil layers. The primary factor contributing to soil erosion is the exposure of bare soil. The erosion risk increases with high levels of overstory removal, which reduces the interception of rainfall and increases runoff.

A typical soil is 45 percent mineral material, 25 percent air, 25 percent water, and 5 percent organic material. Half the feeder roots in a forest are found in the top six inches of soil. Roots need both air and water and activities that compact the soil, eliminating space for air and water, will lower

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the productivity of the site. Repeated passes of heavy equipment over certain types of soil, especially during wet conditions, can compact soil pore space reducing air and water necessary for trees, impeding root growth and allowing the entry of root diseases. To some extent, natural soil processes such as freeze/thaw cycles and activities of soil organisms help restore compacted soils to near pre-harvest conditions. The rate of recovery is dependent upon soil type, soil depth, and degree of compaction.

Low-fertility soils, those with a high silt, clay, or organic matter content, and soils shallow to bedrock may be more subject to erosion and compaction or have most of the fine roots very near the surface, where they may be easily damaged.

OBJECTIVE

Maintain the long-term soil productivity.

CONSIDERATIONS

- Nutrient loss is a concern with biomass harvests. However, knowledge is currently limited about how much woody biomass can be removed without compromising soil fertility. Nutrient response is site-dependant and difficult to apply to other soils.
- Well-planned and executed timber harvests can minimize the effects on soil nutrients, erosion and compaction.
- Exposure of mineral soil is important for regeneration of certain species such as white pine and yellow birch.
- Biosolids from municipal waste water treatment and commercial wood ash may become a common sources of soil-nutrient additives. Its application is governed by state and federal law and may be limited by local regulation.

RECOMMENDED PRACTICES

- Contact the Natural Resources Conservation Service (NRCS) for soil maps and advice on which soils may be low fertility or susceptible to erosion or compaction. Or use the NRCS Web Soil Survey, an internet tool that provides easy-access, up-to-date soil mapping, interpretations and descriptions. Incorporate soils information into forest management plans and activities.
- Limit disruption of soil organic layers except when needed to accomplish silvicultural objectives such as regeneration of species that need a bare mineral soil seedbed.
- Design roads, skid trails, and landings in advance of the harvest.
- Minimize damage to areas susceptible to erosion or compaction by:
  - harvesting during dry, snow-covered, or frozen ground conditions.
  - using designated skid trails.
  - using equipment suited to the site and the size of material being harvested.
  - using low-impact equipment..
  - spreading limbs and tops on skid trails to cushion the impact of harvesting equipment.
- Use bole-only harvesting (taking out the main portion of tree only, leaving branches and limbs in the woods) on low-fertility soils as a precaution against nutrient loss. Lopping tops in the woods where they fall will leave a greater percentage of the

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nutrients to recycle.

- Take a conservative approach when whole-tree harvesting ensuring some of the branches and small diameter trees remain lopped on the site. If whole-tree harvesting hardwoods, try to plan harvests during leaf-off periods to retain ~~leaves and~~ leaves and their nutrients.

CROSS REFERENCE

x.x Controlling Logging Damage

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Topics in this section
Water Quality
Wetlands
Riparian Areas
Stream Crossings and Habitat

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Good Forestry in the Granite State: Draft Water Resources - Water Quality

x.x WATER QUALITY

BACKGROUND

Human uses of surface waters, the survival of fish and other aquatic organisms, and the quality of groundwater supplies all depend on clean surface water.
The most important aspect of protecting water quality is maintaining the integrity of wetlands, instream and riparian areas (see other chapters in the water resources section). Guidelines for conducting forest management in and adjacent to wetlands and surface waters are known as best management practices, or BMPs. They are designed to protect water quality. These guidelines, some of which are law, are found in *Best Management Practices for Erosion Control on Timber Harvesting in New Hampshire*. ~~Some other~~ water quality topics are addressed in more detail ~~x~~ in other water resources chapters. Additional

OBJECTIVE

Protect water quality during and following harvesting and road-building.

CONSIDERATIONS

- The N.H. Department of Environmental Services (NHDES) regulates wetlands (RSA 482-A: Fill and Dredge in Wetlands). The N.H. Department of Resources and Economic Development regulates, among other things, basal area and slash (RSA 227-J).
- Forest management is exempt from RSA 483-B, the Comprehensive Shoreland Protection Act (CSPA) as long as it isn't associated with shoreland development or land conversion and is conducted in compliance with RSA 227-J:9. Forestry conducted by or under the direction of a water supplier for the purpose of managing a water supply is also exempt from the CSPA.
- Timber harvesting near surface water drinking supplies may be governed by specific statutes. Some water supply watersheds are protected by state rules establishing setbacks and/or requiring the water supplier's approval prior to timber harvesting.
- A majority of timber harvests will encounter wetlands or surface waters. Crossing wetlands or surface waters (x.x wetlands, x.x stream crossings) may require notification to the NHDES prior to the start of the operation. NHDES requires that all wetland and stream crossings follow BMPs.
- Regularly maintaining permanent culverts and other stream crossings could save a substantial amount of money in repairs in the long run.
- Aquifers, wells and municipal and public water supply reservoirs may be impacted by timber harvesting. These resources may be beyond your property boundary and are vulnerable if downstream. GIS data layers showing the location of some stratified drift aquifers, wellhead protection zones, and public water supplies are available at UNH GRANIT.

spell out on first use.

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- Vegetable-based bar and chain oils biodegrade rapidly and are virtually non-toxic to fish and algae, but they are more expensive than petroleum-based products and may not be covered under equipment warranties.
- Water quality is affected by activities throughout a watershed, many of which may be beyond the control of the landowner or land manager.

RECOMMENDED PRACTICES

- Layout timber harvests on bare ground (without snow) to identify water and other natural resources. Locate landings, roads and skid trails to minimize stream and wetlands crossings.
- Minimize soil disturbance near surface waters and wetlands. Harvesting within certain distances of surface waters and wetlands is regulated.
- Apply BMPs according to guidelines in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*.
- When stream crossings are necessary, follow BMPs and regularly inspect and maintain crossings to make sure they function properly. Temporary stream crossing structures shouldn't impede streamflow and should handle increased flow that could occur in a storm during a harvest operation (x.x Streams Crossings and Habitat).
- Monitor sites before, during and after harvesting, and preferably during rain, for visible signs of erosion and sedimentation. Signs may include:
  - cloudy or muddy water,
  - increased growth of algae in streams or ponds (green slime).
  - deposits of silt or muck on rocky or gravel streambeds,
  - new runoff channels or gullies,
- After the timber harvest water bar skid trails, remove temporary stream crossing structures and seed and mulch embankments, and apply other soil-stabilizing techniques as needed.
- In watersheds containing brooks or streams draining directly into a water supply reservoir, consult with a water company or municipal water supply representative. The water supplier may have specific recommendations to avoid or minimize water quality impacts. To determine whether a watershed is covered by special rules, consult NH Administrative Rules Env-Ws 386 or contact NHDES's Drinking Water Source Water Protection Program.
- Fill and maintain equipment well away from open water or wetlands. Park equipment and oil tanks where they won't leak into water. Keep sawdust or other absorbent material (a spill kit) on the site to soak up accidental spills or leaks. Report spills to NHDES unless:
  - the spill is less than the amount listed in the regulations as reportable for that chemical (25 gallons for oil).
  - is immediately contained.
  - doesn't threaten surface or groundwater.
  - ~~and~~ all discharge and contamination is removed within 24 hours.

  If a spill occurs, contact the NHDES for information at 271-3899 or, after hours or on weekends, the State Police at 271-3636.

- Consider using vegetable-based bar and chain oil as an alternative to petroleum-based

Redundant

bar and chain oil. Check equipment manufacturer warranties to ensure that biodegradable oils and lubricants won't damage equipment or invalidate the warranty.

CROSS REFERENCE

Erosion and Soil Damage; Soil Nutrients; Wetlands; Riparian Areas; Streams and Stream Crossings; Beaver-Created Openings; Truck Roads and Skid Trails; Landings.

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Good Forestry in the Granite State: Draft Water Resources - Wetlands

2.1 WETLANDS

BACKGROUND

Wetlands are ecologically important and should receive special consideration in order to protect water quality, wildlife habitat, and aesthetic values.
Wetlands protect water quality, help control floods, recharge groundwater, and provide recreational and scenic opportunities. Wetlands are among the most critical parts of any forest ecosystem. Forested wetlands can include economically important trees as well as rare plants and natural communities. ~~There are~~ Forty-seven rare plants ~~that~~ grow in forested wetlands in New Hampshire, including 31 listed as endangered. Riparian areas and wetlands are used by ~~over~~ more than 90% of the region's wildlife species and are the preferred habitat for ~~over~~ more than 40% of them.

Wetlands are identified using hydrology, soils, and vegetation. Hydrology is the presence of water at or near the soil surface. Some signs of wetland hydrology include swollen tree trunks, drift lines, and water or silt-stained leaves or plant stems. All wetlands have saturated soil for at least part of the growing season, and all support vegetation adapted to wet conditions.

Wetlands may be forested (such as red maple or cedar swamps) or non-forested (such as marshes, wet meadows, scrub-shrub wetlands, peatlands or beaver-created meadows). They can have open water. Shrub wetlands are dominated by shrubs and saplings and may be in a transitional state between an open wetland and a forested one, or they may remain shrubby. They include small or ephemeral areas such as seeps and vernal pools (see xx vernal pools and xx seeps). Riparian areas are associated with wetlands and surface waters (xx riparian areas). *Best Management Practices for Erosion Control on Timber Harvesting in New Hampshire* includes a basic guide to wetland identification.

Wetlands and the adjacent upland have a long history of use and alteration by humans. Combined pressures along with their ecological significance, underscores the importance of properly managing those that aren't yet heavily impacted and restoring those that are currently degraded. Wetlands protection begins with careful road and skid trail layout to minimize wetland and surface water crossings. The timing and silvicultural methods used in wetlands and adjacent uplands are also key.

OBJECTIVE

Maintain the important functions and values of wetlands.

CONSIDERATIONS

- The N.H. Department of Environmental Services (NHDES), pursuant to RSA 482-A, regulates activities in wetlands and the N.H. Department of Resources and Economic

Development, pursuant to RSA 227-J, regulates timber trespass, basal area and slash. Together they regulate forestry practices in wetlands.

- Cities and towns may have adopted their own wetland ordinance. Municipalities may further identify wetlands of significant value worthy of extra protection because of their uniqueness, fragility, or unspoiled character. These wetlands, and the 100 foot buffer adjacent to the wetland, are designated as "prime wetlands" and are afforded special protection under RSA 482-A.
- Guidelines for harvesting in and adjacent to wetlands and surface waters are known as best management practices, or BMPs. These guidelines, some of which are law, are found in *Best Management Practices for Erosion Control on Timber Harvesting in New Hampshire*.
- Proper planning reduces the number, width, and length of surface water and wetland crossings and saves money.
- Use of corduroy or tree tops minimizes impact to the ground. These materials are considered fill in wetlands and require a permit from NHDES. ~~However~~, corduroy can be left in place where ~~there is no defined~~ stream channel is not defined.
- Excessive rutting in wetlands affects the surface hydrology, severs plant root and can cause erosion.
- Identification of forested wetland boundaries may be difficult.
- The integrity of wetlands may be affected by activities of others throughout the watershed.
- Forested wetlands may be highly productive so that limiting harvesting in wetlands and upland areas bordering them will entail an economic loss.
- Some wetlands are rare, some are designated exemplary natural communities, and some wetlands are more sensitive to disturbance than other wetlands. The N.H. Natural Heritage Bureau (NHNHB) is ~~the best~~ a source for determining if a wetland is rare, an exemplary natural community, or susceptible to disturbance. whether
- Wetlands can be surrounded by productive upland forests and may be affected by cutting along the wetland edge. Uplands bordering wetlands filter runoff, capture pollutants before they enter the wetland, and are critical to the survival of wetland-dependent wildlife. A wetland buffer, as used in this chapter, is this vegetated upland area adjacent to a wetland. Deciding on the width and management actions in wetland buffers depends on what functions and values you want to preserve. It is difficult to generalize about wetland buffer widths because of the many types of wetlands and the diversity of wildlife. Different species require different widths for breeding, nesting, and overwintering. Leaving the understory adjacent to wetlands intact will provide many wildlife and water quality services. Timber harvesting within a wetland buffer can provide benefits to wildlife habitat (x.x Beaver). The size of a buffer is influenced by, among other things, the type of wetland, steepness of slope surrounding the wetland, the erodibility of soils, the size and type of vegetation within the wetland, and the landowner's objectives.
- There can be wildlife-related, ecological and silvicultural reasons to harvest in wetlands.

RECOMMENDED PRACTICES

- Survey the property (ideally in early spring) and identify important hydrologic features 73

such as streams, ponds and wetlands including seeps and vernal pools.

- Consult a natural resource professional to help identify wetlands and to determine what permit(s) may be needed.
- Check with the NHDES or the city or town before timber harvesting in or within 100 feet of prime wetlands.
- Protect surface waters and wetlands by appropriately locating roads before harvesting begins and appplying other BMPs.
- When logging in and near forested wetlands, avoid rutting and other damage by cutting when the ground is frozen or sufficiently dry to support the type of equipment used.
- Before harvesting within or near rare or highly sensitive wetlands, consult with the NHNHB for suggested management recommendations specific to the wetland type and landscape context.
- Designate a wetland buffer adjacent to forested and non-forested wetlands. Include steep slopes, highly erodible soils, known endangered species habitat, rare plants and exemplary natural communities, and heron, eagle or osprey nests. The effectiveness of the buffer increases with width. Sensitive wetlands will require larger areas of upland to reduce the risk of disturbance.
- Leave the area closest to the stream, pond or wetland unharvested to provide increased protection to aquatic habitats and allow a reliable long-term supply of cavity trees, snags, and downed woody material. Larger zones will increase the protection of non-timber values, however, no-harvest zones may not always be consistent with ecological or silvicultural objectives.
- Retain trees with cavities, standing dead trees, downed logs, and large supra-canopy trees.

CROSS REFERENCE

Erosion and Soil Damage 1.1; Beaver-Created Openings 3.3; Deer Wintering Areas 3.5; Rare Plants and Natural Communities 4.1; Vernal Pools 4.2; Seeps 4.3; Heron Colonies 4.5; Bald Eagle and Osprey Nests 4.6; Bald Eagle Winter Roosts 4.7. Riparian, Water Quality, Rare Wildlife,

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Good Forestry in the Granite State: Draft Water Resources - Riparian Areas

2.1 FOREST MANAGEMENT IN RIPARIAN AREAS

BACKGROUND

Riparian areas should be managed to protect water quality, streamflows, fish and wildlife habitat, and scenic values.

A riparian area is land adjacent to and directly influenced by streams, rivers, ponds, lakes, and associated non-forested wetlands. It forms a transition from aquatic to terrestrial ecosystems. Soils and growing conditions are often moister, more nutrient rich, and more productive than those in surrounding uplands, resulting in considerable species diversity and productivity. Because of their proximity to surface waters, these areas are vital for maintaining water quality and aquatic resources.

Riparian areas have a long history of use and alteration by humans, including urbanization, road-building, agriculture, dam-building, and timber harvesting. The combined pressures, along with their documented ecological significance, underscore the importance of properly managing the riparian forest.

The Functions and Values of Riparian Areas

Riparian areas provide many ecosystem services and benefits such as:

- Flood control and stream flow regulation especially where the riparian area includes a river's floodplain
- Water quality protection by filtering and retaining sediment, nutrients, and other pollutants from upslope areas, and through bank stabilization.
- Aquatic habitat protection including:
  - Regulating temperatures by shading streams, which is particularly important for lower order streams that support coldwater fish (e.g., brook trout). Increases in water temperature can have negative effects on stream chemistry, aquatic insects, stream flora, and fish.
  - Large woody material (e.g., fallen trees and large branches) which creates pools, riffles, debris jams, and related aquatic habitat including necessary spawning habitat for brook trout.
  - Leaves, twigs, fruit and insects contributing energy to drive aquatic food webs. Headwater streams and small rivers derive most of their energy this way.
  - Fish habitat during high flow periods.
- Rare natural communities (e.g., calcareous riverside seeps, swamp white oak floodplain forest) and many rare plants. More than 1/3 of all New Hampshire vascular plants occur in riparian natural communities, including 93 rare species. one-third
- Habitat for feeding, cover, and travel for many amphibians, birds, furbearers, and reptiles. Deer-wintering areas are often associated with riparian softwood forest. Large trees in these areas are the primary nesting sites for bald eagles, osprey, and colonial waterbirds.

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- Recreational and scenic opportunities, such as hiking, fishing, hunting, boating, bird-watching, and wildlife viewing.

Identifying Riparian Areas and Designing Riparian Management Zones

Riparian areas are defined by their location adjacent to lakes, ponds, streams and rivers, by their characteristic vegetation, and by the function they serve. Vegetation can vary from a narrow band of shrubs to floodplain forests hundreds of yards wide. The size depends on what function is being considered and may include upland forest as well as truly riparian communities.

Riparian management zones (RMZs) are linear zones along the shores of lakes, ponds, rivers, streams, and associated wetlands, within which special forest management practices are used.

Just how wide should the RMZ be? Unique combinations of ecological functions, physical characteristics, and landscape context, make it difficult to arrive at a one-size-fits-all width. An important first step is to identify what you wish to protect – the width needed to provide shade to a stream, for example, may be one tree height or less, whereas riparian wildlife habitat may extend several hundred feet into upland forests adjacent to a river or lake. Foresters and landowners are in the best position to consider and apply localized factors.

Variable, tailor-made RMZs reflect localized site conditions, but are generally more complicated to consistently define, apply, and monitor. Fixed-width RMZs have the practical benefit of being clear, consistent, relatively simple to apply and monitor, and provide reasonable confidence that RMZ values and goals will be attained. We suggest a tiered approach that provides the practical benefits of a fixed-width, but includes key modifiers offering some added benefits of a variable-width approach.

The following widths are recommended as general guidelines. The RMZ extends upland from the top of the streambank or from the upland edge of any stream-, pond-, or lake-side wetlands (see illustration). For additional information about establishing RMZs, see chapter 2 in *Riparian Management in Forests of the Continental Eastern United States*.

Guidelines for Riparian Management Zones

	Legally Required (1)		Recommended	
	Riparian Management Zone	No Harvest Zone (2) 2	Riparian Management Zone	No Harvest Zone (2) 2
Intermittent streams	none	none	75 ft.	none
1st and 2nd order streams	50 ft.	none	100 ft.	25 ft.
3rd order streams5	50 ft.	none	300 ft. (4) 4	50 ft. (3) 3
4th order and larger streams (5) 5	150 ft.	none	300 ft (4) 4	25 ft.

maybe make it easier for reader to understand what the numbers in the chart refer to.

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Pond <10acres (see footnote 1)	50 ft.	none	100 ft.	none
Lake or Great Pond (>10 acres)	150 ft.	none	300 ft.	25 ft.

1 Width required under RSA 227-J:9 (basal area law). Within a 12-month period, no more than 50% of the basal area may be cut in these areas. Includes ponds less than 10 acres associated with a stream or brook that flows throughout the year.

percent

2 Portion directly adjacent to the water body in which no cutting is recommended. It may be desirable to expand if there are steep slopes (>25%), unstable soils, sensitive wetlands, or exemplary natural communities. Increasing the width of the no-harvest zone will provide greater protection of non-timber values, but will also encumber a larger amount of timber. There may be valid ecological and silvicultural reasons to harvest in the no-harvest zone.

3 A 50-foot no-harvest zone is recommended for 3rd order streams because of the importance of large woody material on streams of this size.

4 RMZ width on 3rd & 4th order and larger streams and rivers may expand to encompass known wildlife travel corridors, drinking water supply considerations, and the full extent of the 100-year floodplain.

5 For a list of fourth-order and higher streams see NHDES Consolidated List of Waterbodies Subject to RSA 483-B.

OBJECTIVE

Maintain the important ecological functions and values of forested riparian areas.

CONSIDERATIONS

- Wetland permits (RSA 482-A) or other legal requirements (RSA 227-J) may apply to forestry operations in riparian areas (x.x wetlands). Timber harvesting is exempt from RSA 483-B, the Comprehensive Shoreland Protection Act, so long as it isn't associated with shoreland development or land conversion, and is conducted in compliance with RSA 227-J:9.
- Landowner objectives, water body size, landscape context, vegetative composition, slope, and other factors helps determine the appropriate width and management of RMZs.
- There are benefits to managing riparian areas with a long-term perspective (>100 yrs). Some potential effects of harvesting in riparian areas may be short-lived while others, such as reduced input of large woody material, are much longer lasting. Trees retained today will be the source of key terrestrial and in-stream habitat structure many decades into the future.
- Active forest management can be compatible with maintaining riparian functions and values. Trees regenerated today will be the future source of cover, cavity trees, woody material, and snags. Some silvicultural and wildlife habitat objectives can conflict with

no-harvest or limited harvest RMZs. For example, maintaining beavers at an active flowage within a particular stream reach may require active tree harvesting within these zones (x.x Beaver-Created Openings). Soil scarification improves the likelihood of regenerating white pine, red oak, or red spruce and may conflict with the recommendation to minimize ground disturbance.

- Riparian forests may be highly productive. Limiting harvesting in RMZs will entail some financial loss to riparian landowners.
- The integrity of aquatic, and riparian ecosystems may be affected by activities of others throughout the watershed.

RECOMMENDED PRACTICES

- Survey the property (ideally in early spring) and identify important hydrologic features such as rivers, streams, lakes and ponds.
- Establish RMZs along streams, rivers, ponds, and lakes. Recommended minimum zone widths and key considerations are described above.
- Include maintaining or restoring riparian functions and values as a silvicultural objective in RMZs.
    - Retain trees with cavities, standing dead trees, downed logs, and large supra-canopy trees (especially white pine).
    - Leave windfirm trees that are well-distributed. Leave other vegetation, including existing groundcover.
    - Choose a regeneration system most likely to maintain riparian functions and values and rapidly regenerate the site with the desired trees. Choosing a method is complicated by wet soils and the desire to maintain forest structure that contributes to wildlife habitat and other ecological values.
        - Use uneven-aged techniques such as single tree or small group selection, maintaining 60-70% crown closure or full stocking as recommended in silvicultural guides. (To convert crown closure percentages to basal area, see Leak and Tubbs 1983).
        - Use even-aged techniques such as shelterwood or patch cuts to achieve regeneration goals when rapid regeneration is likely (x.x silviculture).
- Locate new truck roads and log landings outside RMZs, except where doing so would result in greater overall adverse environmental impacts.
- Design roads and skid trails within RMZs to minimize the long-term impacts on water quality and wildlife habitat. Put roads to bed at the end of the harvest operation.
- Minimize ground disturbance. Operate ground-based equipment when the ground is dry or frozen.
- Time harvesting to avoid disturbance to nesting birds (x.x woodland raptors) and other sensitive species (x.x wetlands).
- Leave the area closest to the stream, pond or wetland unharvested to provide increased protection to aquatic habitats and allow a reliable long-term supply of cavity trees, snags, and downed woody material. Refer to the table for guidance. Larger zones will increase the protection of non-timber values, however, no-harvest zones may not always be consistent with ecological or silvicultural objectives.
- Keep trees along banks to stabilize shorelines.
- Avoid leaving isolated riparian management zones with long distances of abrupt edge.

percent

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Riparian forests next to heavy cuts, agricultural, or urban land uses may be subject to increased edge effects (e.g., invasives, nest predation) and risk of blowdown. Practices that minimize these risks include limiting harvest within the riparian management zone, increasing the width of the zone, or feathering the edges of the heavy cut.

- Refer to the x.x wetlands for recommended practices specific to wetlands.

CROSS REFERENCE

Erosion and Soil Damage 1.1; Beaver-Created Openings 3.3; Deer Wintering Areas 3.5; Rare Plants and Natural Communities 4.1; Rare Wildlife X.X; Vernal Pools 4.2; Heron Colonies 4.5; Bald Eagle and Osprey Nests 4.6; Bald Eagle Winter Roosts 4.7; Wetlands X.X; Floodplain Forests X.X.

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Good Forestry in the Granite State: Draft Water Resources - Stream Crossings and Habitat

x.x STREAM CROSSINGS AND HABITAT

BACKGROUND

Does this reflect the new stream-crossing rules?

Roads are necessary for forest management and allow access for outdoor activities such as hunting, fishing, hiking, wildlife watching and snowmobiling. Roads that cross streams can impact stream habitat and impede stream-flow.

This chapter addresses the needs of fish and other aquatic organisms. The importance of intermittent streams is also addressed. Best management practices (BMPs) to prevent erosion can be found in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire* and additional practices in *Best Management Practices for Forestry: Protecting New Hampshire's Water Quality*. Using BMPs minimizes the impact of crossings on streams and stream habitat during timber harvesting.

Aquatic organisms move upstream and downstream throughout their life cycles. The survival of a population depends on access to spawning habitat, feeding areas, shelter, and the dispersal and colonization of available habitat by juveniles. A healthy population also depends on unrestricted gene flow and crossings may isolate populations, making them vulnerable to extirpation. Many species of amphibians, reptiles, and mammals use riparian zones as travel corridors, and their movement may be impacted by certain crossings.

Instream wood (trees and branches), sediment and ice transport are important. Trunks and branches (1) retain nutrients within the stream and keep excess nutrients from going into waterbodies downstream, (2) create pools for fish and other aquatic animals, and (3) are used by fish as refuges to avoid predators and high water velocities that occur during floods. Downed trees are a natural component of streams, and they are often transported long distances from where they initially entered the stream channel. It is important to not create conditions that cause downed wood from upstream to block the stream crossing. Sediment and ice are also integral parts of stream systems, and like branches, can plug undersized stream crossings. Erosion can cause an increase in nutrients which reduces water quality especially in downstream waterbodies. (see x.x riparian areas).

These same processes occur in intermittent streams and perennial (year-round) streams. The surrounding forest provides leaves and coarse woody material critical to the food web along the entire stream course. These materials are carried downstream, as are the invertebrates that feed on them. Crossings on intermittent streams should also allow for aquatic organism passage, as aquatic invertebrates, some unique to intermittent streams, occupy these streams year-round.

The following is a brief discussion of the more common types of crossing most often used in timber harvesting operations:

Bridges

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Bridges span streams entirely, and can be the best way to protect the stream and the crossing structure itself. They can be permanent or temporary, and made out of wood, metal or a combination. Permanent bridges are often used for truck roads, while temporary bridges may be used for skid trails. Sited properly, bridges won't affect water flow, and the erosion of the bank is much reduced or eliminated. Improperly constructed abutments can cause bank erosion.

Culverts

A culvert is a corrugated pipe, well casing, or other type of pipe placed under a truck road or a major skid trail to permit the crossing of an intermittent or perennial stream. A culvert can either be temporary or permanent. (Culverts used as cross drainage in truck roads aren't covered in this chapter, see Cullen, 2004). In general, culverts installed within truck roads are permanent crossings.

A culvert can block fish, other animals and natural materials from moving downstream. Culverts can lead to streambed and bank erosion on the downstream side of the culvert due to the increased water velocities exiting the pipe. The result is a perched culvert with its downstream end above the water. The resulting waterfall can prevent aquatic animal passage.

Fords

Poled Fords: A poled ford is a temporary stream crossing in which natural materials are used to fill a defined channel to allow for the passage of vehicles. Per RSA 482-A, poled fords are a BMP and must be removed as soon as the site is closed out. Leaving them in place after the permit expires is considered fill and a violation of state law. Leaving them in place can also lead to streambed and bank erosion and reduced aquatic animal passage. Corduroy, used to fill wet places that aren't streams, aren't considered poled fords and may be left in place.

Stone Ford: Stone fords use the stable stream bottom or stone fill as the road bed. They are intended as permanent crossings since their removal can cause erosion and turbidity. On roads where the wide width and shallow water combine to make a bridge or culvert unworkable, a stone ford combined with a culvert sized to accommodate fish and other aquatic organism passage is an option.

OBJECTIVE

Provide safe stream crossings which allow passage of aquatic animals up and down the stream as well as protecting water quality.

CONSIDERATIONS

- The N.H. Department of Environmental Services regulates the design and installation of temporary and permanent stream crossings. A wetlands permit may be required prior to the installation of a temporary or a permanent stream crossing, including bridges that don't run bank to bank. Bridges running bank to bank may not need a permit.
- Streams are inherently dynamic, and natural processes in stream morphology can have dramatic impacts on stream crossings and associated roads. Undersized crossings can become plugged with downed wood and sediment, leading to increased maintenance costs and sometimes to the failure of the stream crossing.

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- Watershed size and topography will affect the amount of water and flashiness of flood events.
- Planning road, landing and skid trail layout without snow cover makes it easier to see intermittent and perennial streams.
- Limiting stream crossings can reduce costs.
- The type and size of crossing will affect both cost and permitting requirements. Appropriate designs can minimize installation costs and reduce cost over the expected life of the crossing. Costs depend on the structure, site conditions and expected lifespan.
- A permanent crossing is generally installed within a truck road. Temporary crossings are generally installed within a skid trail.
- Portable bridges are an option for skid trails that are expected to be used for a short period of time.
- The installation cost of a permanent bridge may be more than that of a culvert, but the savings over the course of its life may be less due to reduced maintenance needs and costs. There may be increased liability if you don't maintain the bridge.
- Although a temporary crossing can remain for the life of the wetlands permit (two years), removing it as soon as the harvest is complete and the ground conditions allow minimizes the impact to aquatic animals.
- Culvert size, placement and bottom substrate are all important considerations.
    - Sizing guidelines are available in *Best Management Practices for Forestry: Protecting New Hampshire's Water Quality*.
    - Continuing the natural substrate of the stream through the culvert ensures aquatic animal passage. Open bottom culverts maximizes aquatic organism passage by maintaining a natural streambed.
    - The practice of laying two or more small culverts side by side blocks flow and can require higher maintenance due to the blockage of natural material that floats downstream.
- While fords are appropriate for maintaining water quality, they block the stream channel, even when used in combination with a culvert.
- Bridges and culverts are preferred over stone fords for permanent crossings to accommodate aquatic animal passage.

RECOMMENDED PRACTICES

- Consult your natural resource professional for permitting requirements and to determine which type of crossing is best suited for your particular situation.
- Per RSA 482-A:3, use BMPs as detailed in *Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire*. Also refer to *The Guide to New Hampshire Timber Harvesting Laws*.
- Locate landings, roads and skid trails to minimize the number of stream crossings.
- Construct during periods of no- or low-flow and in as short a period of time as possible.
- Design the crossing to fit the stream channel. Locate crossings where:
    - Stream alignment is straight and has a uniform profile so as not to obstruct the flow of water. Avoid bends in the stream.
    - Banks are firm and level.

    - Road and trail approaches are reasonably level for a distance of 50 feet on each side of the crossing, avoiding sharp curves in the road.
- Crossings shouldn't be sited where there is an accumulation of instream downed wood or sediment. This is a sign that it is likely instream wood will clog the inlet of the crossing.
- Design crossings to handle the largest stream flows.
    - Design temporary crossings for a 10-year flood.
    - Design permanent crossings for at least a 25-year flood.
    - See *Best Management Practices for Forestry: Protecting New Hampshire's Water Quality* pages 45-47 for easy calculations.
- Minimize water from the road entering the stream by:
    - Constructing the road so the grades approaching the crossings divert water from the stream.
    - Directing roadside ditches away from the stream well before the crossing.
    - Using water bars to divert road runoff from streams.
    - Using brush, slash and tops to stabilize skid trail approaches.
- For temporary crossings:
    - Consider using a portable skidder bridge. See *A Guide for Constructing and Using Portable Skidder Bridges*.
    - Site the approach to the ford as carefully as for other crossings.
    - Remove the structure and stabilize the bank as soon after the harvest as ground conditions permit.
- Use bridges and culverts as the preferred method over stone fords, where possible. Span streams with a bridge in which the abutments are beyond the top of the stream banks.
- When installing stone fords with a culvert:
    - Size the culvert wide enough to accommodate fish and other aquatic organism passage.
    - Place the culvert at the deepest point of the stream.
    - Choose ford material that allows water to flow through it, so the ford does not act as a dam. Use a minimum 6 inch angular stone anchored by large boulders on the downstream side.
    - Design the ford to minimize the risk that the addition of stone material will direct the stream, during low or high flows, around the ford, causing erosion.
    - Make the ford at the same elevation as the natural substrate at the ford location.
    - Protect entry points at the streambank from erosion due to the travel of equipment.
- Culvert Recommendations:
    - Avoid side by side culverts.
    - Size culverts to provide uninterrupted flow of water, sediment, downed wood and ice. There are two suggested methods to determine the minimum size of a round culvert. See pages 45-49 in *Best Management Practices for Forestry: Protecting New Hampshire's Water Quality* or consult with the Natural Resources Conservation Service for assistance with using the watershed drainage method or visit NH StreamStats (see additional information).
    - When conditions permit, install an emergency spillway adjacent to a culvert by making one section of the road lower in elevation so flood water goes over the

road at that point instead of around the crossing. This spillway should have a stable base.
- Protect the upstream end of the fill around the culvert from erosion by placing rock headers.
- Install the culvert so it is in line with the existing stream. A maximum of 15 degree skew is acceptable as an exception where approach conditions are difficult.
- Align the approach and exit of the road with the culvert crossing center line with as little curvature as possible.
- To maximize aquatic organism passage, consider several options to maintain a natural streambed. Techniques vary in effectiveness and cost and include:
  - Placing culverts in the natural channel.
  - Digging culverts into the stream bed so that the inside of the culvert has the same substrate as the natural streambed.
  - Using open bottom culverts.

CROSS REFERENCES

Riparian, Water Quality, Wetlands

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Good Forestry in the Granite State: Draft Forest Health - Additional Reading

Topics in this section

Insects and Diseases
Invasive Plants
Ice and Wind Damage
Logging Damage

None listed

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Good Forestry in the Granite State: Draft Forest Health - Insects and Diseases

X.1 INSECTS AND DISEASES

BACKGROUND

Endemic populations of native insects and pathogens are important in healthy forest ecosystems. However, introduced non-native exotics can cause excessive damage. Insects are prey items at the very bottom of the food chain. Along with other decay organisms they transform plants and trees into nutrients to feed new plants. Insects and diseases become problems when populations reach out of balance, epidemic levels. Tree growth loss and mortality can occur and the economic impact can be severe. The most devastating insect and disease outbreaks are often when non-native pests are introduced where their natural enemies don't exist. Throughout North America, exotic insects like balsam woolly adelgid, gypsy moth, pear thrips, Asian longhorn beetle, and emerald ash borer have all caused growth loss and mortality. Exotic diseases such as Dutch elm disease, chestnut blight, and butternut canker have virtually eliminated these host species.

OBJECTIVE

Reduce undesired mortality and growth loss from native pests and limit introductions of exotic pests, eradicating new introductions as they occur.

CONSIDERATIONS

- Well-recognized benefits from natural-disturbance factors include the provision of dead and down woody debris, snags and cavity trees for wildlife, and openings for regeneration. While native pests are part of natural functioning of ecosystems, many of the most destructive insect and disease problems are the result of exotic pests introduced into the state.
- While predators such as birds can't control outbreaks, they provide important constraints on insects at endemic population levels, and can extend the period of time between outbreaks.
- Recommended pest control can conflict with other recommended practices. For example, removing trees with beech bark disease may conflict with recommendations to protect mast-producing beech showing evidence of bear use.
- Many regional and national activities to limit damage by forest pests exist. Some examples are biological control, federal quarantines, and pheromone trapping.
- Many exotic invasive pests found in neighboring states threaten New Hampshire's forests. Early detection is the difference between success and failure with regard to their eradication. Knowing their signs and symptoms, where they are, and how they spread improves chances of detection and eradication. Internet searches and direct contact with state and federal forest health specialists can provide the latest information.
- State law (RSA 227-K:3) allows the director of the Division of Forests and Lands to

designate control areas when localized infestations of exotic, non-native insects or diseases threaten to spread to adjacent lands. The law also requires landowners to undertake actions to control the infestation; if the landowner is unwilling, the State may take such actions.

- Forest pest quarantines are under the authority of the N.H. Department of Agriculture, Foods and Markets and the N.H. Division of Forests and Lands (NHDFL).
- Pesticide applications in any form, from aerial applications to systemic applications, can have secondary consequences. Pesticide applications are strictly regulated and require several permits and licenses.
- The emphasis in this section is on silvicultural methods that may limit undue losses on individual ownerships. Where severe infestations from insects are already underway, regional biological or chemical control programs may be necessary. Maintaining populations of native predators will help reduce intensity of infestations.

under way

RECOMMENDED PRACTICES

Defoliators

Defoliators feed on leaves and needles during the growing season. Common examples include spruce budworm and large aspen tortrix in the north, saddled prominent and forest tent caterpillar in central New Hampshire, and gypsy moth and hemlock looper in the southern part of the state. A diversified forest both in age structure and species composition limits susceptibility to defoliators. Most insects are host specific and prefer one or two species of a particular age group. A large uniform area of sugar maple is highly susceptible to forest tent caterpillars and a large area of mature fir to spruce budworm .

- Avoid partial harvests during an outbreak which diverts the epidemic insect population to fewer and more exposed trees. Defoliation and subsequent stress and tree decline is likely exacerbated.
- Don't partially harvest a stand until at least three years after the last major year of defoliation. After three years the weakest trees will be dead or evident. Until three years have passed, the defoliated stand is highly susceptible to residual logging damage. Defoliators reduce the amount of carbohydrates stored in the root system during the dormant season. Root damage and basal wounding from logging equipment compound the stress to residual trees and may cause growth reductions and branch dieback.
- Aerial pesticide applications are rare. When an outbreak is severe and the forest value exceptional, it may be an appropriate option. A special pesticide application through the N.H. Division of Pesticide Control is required. Contact the NHDFL forest health office for guidance.
- **Spruce Budworm:** Increasing the proportion of spruce to fir and developing a mix of forest types and ages over several thousand acres will minimize spruce budworm. Consider the forest structure over the landscape rather than focus on a single, small property.
    - Spruce budworm prefers balsam fir and white spruce. Spruce budworm is most destructive and epidemic in 60 to 80-year-old stands with a high proportion of balsam fir. Approaches for avoiding serious damage are (1) to harvest fir stands prior to over-maturity, (2) to encourage higher spruce-to-fir ratios through

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regeneration practices and early cultural work, (3) to break up extensive stands of fir and spruce-fir with intervening stands of hardwood or mixed-wood provided that management objectives and site conditions permit, and (4) to encourage budworm predators.

- At least 49 bird species are known to prey on budworm pupae, and 11 species are considered important predators at low to moderate levels. The most effective predators include: (1) in mature conifer mixtures - blackburnian warbler, golden-crowned kinglet, yellow-rumped warbler, and red-breasted nuthatch; (2) in brushy openings and edges - Nashville warbler, white-throated sparrow, and black-capped chickadee; and (3) in somewhat open, immature conifer stands and hardwood regeneration - magnolia warbler and solitary vireo.

capitalize bird names Follow Audubon Field Guide.

Piercing-Sucking Insects

Hemlock woolly adelgid, balsam woolly adelgid, and elongate hemlock scale are common peircing-sucking insects. These insects are more chronic than the defoliators. Once infested, a stand remains infested for a long time.

- Though silvicultural practices don't result in true control, they can help reduce stand susceptibility to attack and vulnerability to damage.
- Proper stocking improves tree and stand vigor. Trees competing for growing space and nutrients are far more likely to succumb to chronic infestations..
- Cut stands infested with balsam woolly adelgid in the winter because nymphs attached to tree tops can't survive. If the trees are cut in the summer, they are mobile enough to spread to uncut trees.
- Consult the quarantine map for hemlock woolly adelgid before harvesting hemlock. Any hemlock material from within the quarantine area needs to be certified clean of adelgid before shipment out of the zone (RSA 227-K). Hemlock stands can be certified clean of adelgid prior to harvesting by licensed foresters, Extension foresters, NHDFL personnel, or other professionals specifically trained by the NHDFL.
- If a hemlock woolly adelgid infestation covers less than 1/4 acre, cut and burn the hemlock foliage, before harvesting. If the infestation is larger than 1/4 acre, it's likely the infestation can't be eradicated before harvesting. The infested products must remain inside the quarantine area. Contact the NHDFL for further information and for mills and burn facilities inside the regulated area.
- Insecticides work well for these insects, however access and tree size may limit their use. Adelgid populations are most successfully treated with soil injections or soil drenches to limit exposure to non-target insects. Contact the NHDFL forest health office for specific information on products, dosages and application methods.
- **Beech Bark Disease:** Managing to reduce or eliminate beech bark disease will take several generations of silviculture. Some beech trees, recognized by their clean, smooth boles with a minimal presence of the white woolly scale, are resistant to the beech scale insect that precedes infection by the Nectria fungus.
    - In thinnings, selection cuts, and other partial harvests, remove trees that are heavily infested with the white, woolly scale or red, small fruiting bodies of the Nectria fungus, including those rough-barked trees that show evidence of previous beech-bark damage. To minimize regeneration by root suckers from these nonresistant trees, avoid damage (even slight damage) to beech roots by

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logging on snow and keep skidding activity away from the cut beech trees to the extent possible. Alternatively, when the clean-barked, resistant trees are removed, encourage root-suckering by logging during snow-free season and allowing moderate skidding activity near these resistant trees or groups of trees. Summer cut sprouts of diseased beech have low vigor and don't persist well as compared to regeneration of healthy northern hardwood regeneration on the same site.

- To reduce the percentage of beech, use larger openings to regenerate less tolerant species to out-compete the beech sprouts. Winter harvesting also will reduce sprouting due to reduced root damage.
- Leave trees with evidence of bear claw marks.

Wood Borers and Bark Beetles

Sugar maple borer, oak borer, Ips beetles and Dendroctonus beetles are native New Hampshire borers and beetles. They tend not to grow past endemic levels and only attack stressed, dying and dead trees. White pine weevil is a native borer, however, that attacks healthy trees. The number of non-native, invasive wood boring insects in North America such as Emerald ash borer, Asian longhorned beetle, and sirex woodwasp is growing. Infestations continue to spread closer to New Hampshire each year. Once infested with these exotic pests, trees rarely survive more than a few years.

- Keep the forest in diversified species, properly stocked, and minimize logging stress such as soil compaction and mechanical damage to residual trees.
- The only treatment for heavily infested monocultures like red pine plantations may be complete removal.
- In the event of an infestation by non-native exotics, follow recommendations for control developed for the specific pest.
- **White Pine Weevil:** To avoid excessive white pine weevil injury in the regeneration, maintain partial overstory shade.
  - Grow white pine seedlings and saplings in shade (40-80 square feet of basal area or in small openings less than one tree height in diameter) until at least one unweeviled log height (18 feet) is attained. Conifer shade may provide more protection than hardwood shade since early spring weevil activity (before hardwood leaves are out) is the most damaging to terminals. In addition to the direct effects of shade, overstory trees reduce the size and vigor of the leader, making it less attractive to weevils.
  - In young even-aged stands experiencing weevil damage, maintain high stand density to minimize the deformations caused by weevil injury. An approximate spacing of less than 6 feet by 6 feet is required for maximum effect.

Root Diseases

Root diseases are a broad group of fungi that cause decay, stress, reduced growth, and death. Common examples are Armillaria,and *Heterobasidion annosum* (formerly *Fomes annosus*). Root diseases like armillaria are present in almost all forest soils. For fungi to become a problem it requires favorable moisture and oxygen conditions, a point of entry into the host tree, and low tree vigor making it difficult for the tree to defend itself.

- Armillaria travels from cut stumps to stressed trees through the maze of root grafts in the soil. Spacing harvests more than 10 years apart will minimize root rot infections from previous timber harvests.
- Limit damage to the roots and boles of residual trees.

Stem Canker Diseases

Stem canker diseases are fungi that attack the stem, shoots and branches and cause lesions or dead areas on the stem. Common examples are Nectria canker, caliciopsis, blister rust, chestnut blight, and Eutypella cankers.

- Remove trees with stem cankers. Spores are produced from the margins of infected areas and can infect surrounding trees.
- For rust diseases that require an alternate host, eliminating the non-timber alternate host is the best control. Gooseberries and currants should be absent within several miles of a young white pine stand.
- Caliciopsis canker on white pine appears like a black mold on the upper stems of the tree. Often the lesions weep pitch in streaks. Thinning infected stands to allow more sunlight and warmer air conditions improves the vigor of the residual trees and reduces the moisture conditions needed by the fungi. Remove the trees with heaviest infections.

Foliage Diseases

Foliage diseases are those organisms that attack the needles and leaves. Common examples are anthracnose, needlecast, tar spot, and sooty mold.

- Hardwood foliage diseases are generally less serious than softwood foliage diseases because hardwoods can drop the infected leaves and refoliate in subsequent years. The specific conditions of moisture, temperature, and host susceptibility is sporadic and most heavy infections in hardwood forests last just one year. No control is usually needed
- Spores overwinter on fallen leaves. In an urban setting, reduce the annual inoculum by raking and removing infected leaves.
- Softwood foliage diseases most often affect older needles and lower needles on the live crown. Thin stands to reduce the amount of spores and to reduce high moisture conditions around the base of the trees.
- Remove the most infected trees in the stand.

Heart Rots

Heart rots are the decay fungi that penetrate to the center of a tree and rot the core from the inside out. There are white rots that feed on lignin and cellulose and red rots that feed just on cellulose. The red rots leave a brown or red brittle material while the white rots leave a white coloring where lignin has been removed. Fruiting structures of these diseases are often shelf-like conks attached to the sides of the tree.

- Remove trees with conks during harvesting, if leaving them poses a risk to property or personal injury.
- Avoid logging damage, specifically broken branches in the residual stand, to minimize the entry points for wind blown spores.

Other Diseases

Other diseases are viruses, mycoplasma-like organism (MLO), and bacteria. Ash yellows is an MLO. The microbe is thought to be carried from tree to tree by leaf hoppers. These insects spend a period of time in open grassy areas which may explain why ash yellows is more common in urban settings than in the deep forest.

- There is no control for ash yellows. Cut declining ash with serious signs and symptoms such as witches brooms and epicormic branching on the bole of the tree.

CROSS REFERENCE

ADDITIONAL INFORMATION

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Good Forestry in the Granite State: Draft Forest Health-Invasive Plants

X.2 INVASIVE PLANTS

BACKGROUND

Invasive plants can pose a threat to forest ecosystems and forest productivity. Foresters, landowners, and loggers can play important roles in slowing the spread of invasive species.

Invasive plants are non-native species that invade natural communities and develop self-sustaining populations. The start of many infestations is often tied to a disturbance and once established they spread into undisturbed landscapes. They out-compete native species, disrupting ecological processes, and cause a loss of economic value or output. The economic impacts are often hard to detect and may be the result of environmental impacts.

The NH Invasive Species Law (RSA 430:52 and AGR 3800) defines an invasive species as "an alien species whose introduction causes or is likely to cause economic or environmental harm or harm to human health". These species come in a variety of forms: trees, vines, shrubs, terrestrial herbaceous and aquatic. (Call-out box: list of invasive species)

As a group invasive plants are generalists. There is at least one invasive plant for every habitat. Many terrestrial invasives have a wide tolerance of environmental conditions allowing them to thrive at a variety of sites. Glossy buckthorn successfully invades sunny and shady sites and wet or dry conditions. Oriental bittersweet, a strangling woody vine, may languish in the shade of a forest until a canopy gap opens or its leading branch reaches the canopy. It grows rapidly across the forest canopy, strangling trees and weighing them down.

Some of the impacts on forests include:

- Reducing the abundance, density and richness of tree seedlings.
- Displacing natural plant and animal communities or alterating species composition.
- Competing with native species for space, nutrients, and water.
- Altering soils which may impact their ability to retain or shed water and may increase soil erosion.
- Increasing fire hazard.
- Acting as host for other damaging organisms.
- Decreasing the quality of forest habitats for native wildlife.
- Cost/ loss of forest productivity / timber value

OBJECTIVE

Prevent the dispersal and establishment of invasive plants, and mitigate their impacts on the forests.