

2. Principles, Goals, Guidelines and Standards for Low-Impact Forestry

I. Introduction

Too often, landowners who care deeply about their woodlands have been dismayed at the aftermath of cutting on their land. The logger promised to cut the lot "selectively"--and he did. He "selected" the best trees and left the rest, with little care for the future. The resulting stand is so sparse that it offers little shade. Runoff from rutted and compacted trails (which seem to run everywhere) and from poorly-planned crossings have silted up the once-beautiful trout brook. Many of the remaining trees (most of which are small diameter or culls) are bruised, broken, or bent. The yard is a large, muddy mess, with unsightly slash piles. Understandably, after such an experience, many landowners are discouraged from having any more logging done to their land.

There is an alternative--low-impact forestry (LIF). Low impact forestry reduces known harmful impacts so that after the cutting is done, there is still a functional forest. The landowner, with the help of a forester, plans for the long term, not just one cut. The residual stand not only functions like a forest, it *looks* like a forest. There are enough trees, including some with large diameters, to ensure that the forest floor is shaded. Very few trees are damaged. Indeed, after the cut the average tree quality is higher--the logger removed high-risk, low-quality trees. Trails are relatively narrow and unobtrusive. They are favored by those who want to cross-country ski or hunt. The yard is small with minor soil disturbance. The stream remains clear and cold, and the trout seem happy. And so is the landowner.

For LIF to work, good communication between the landowner, forester, and logger is essential. If the logger and landowner do not have common expectations and do not communicate well, the job will not come out the way the landowner wants. Often loggers are responding to immediate economic pressures that reward more volume for lower costs, while many landowners have woodlots as a sideline rather than as a primary income source. This chapter is intended to give landowners an understanding of the reasons behind LIF so that they can better communicate their objectives. Indeed, for the system to work well, it is best if landowners have their management objectives in writing. This document lists recommended guidelines and standards for foresters and loggers that, if followed, would help meet the LIF objectives.

II. Principles and Goals

With low-impact forestry, the whole forest is considered, not just its value for pulpwood or sawlogs. Foresters must look at the crowns (tree foliage), the trunks, the roots, the soil, the water, forest stand structure, and the distribution of wildlife habitat across the landscape. For a forest to be "functional," it must have all the required parts, and all the required processes. Forests, however, are always changing due to human management and natural *disturbances* (such as wind, insects, diseases, or fire). LIF foresters must be prepared to accommodate this change so that over time, the parts and processes are still functioning in the forest landscape.

Crown

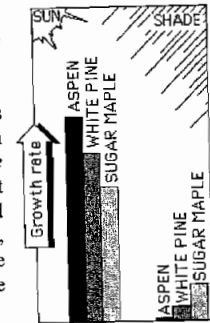
Principles. Looking up in a forest, one should see the crowns of individual trees forming the forest *canopy*. The crown includes the limbs, twigs, and leaves. The leaves are where photosynthesis takes place, capturing the carbon from carbon dioxide to build the fibers in wood. They are also where trees release water, drawn from the soil by the roots, back into the

atmosphere. This helps to regulate both the water table and the climate. Tree canopies (both living and dead) are habitats to numerous species of birds, insects, spiders, and even lichens. Damage to tree crowns, especially to the leader, can impact both the form and health of the tree. Excessive crown damage can lead to tree death, by drastically reducing the energy production from leaves or needles required to sustain the tree. As people discovered after Maine's ice storm of 1998, however, to kill a tree, such crown damage has to be severe.

The degree to which the canopy is *closed* (where the foliage of one tree tends to merge into the foliage of the next), can have profound effects on forest productivity, tree quality, forest regeneration, wildlife habitat, *windfirmness*, (the ability of trees to withstand falling over in heavy winds), and water quality. The more the canopy is filled with foliage, the more efficient the use of the growing space and the higher the productivity of the mature trees. As the canopy opens, more energy goes to the *understory*--the developing growth below the canopy.

Degree of canopy closure also affects the quality of many tree species. Increased sunlight from heavy cutting can lead to epicormic sprouting (sprouts coming off the trunk), leading to lowered quality. When the canopy is open, more growth goes onto branches. Trees therefore can have more knots, shorter boles, more taper, bigger crowns, and thus worse form for lumber. With higher degrees of crown closure, tree growth goes up rather than out. Increased density leads to trees with longer boles and smaller crowns. Lower branches tend to self-prune, yielding more limb-free logs.

Degree of shade influences the regenerating stand. Some trees, such as birch and aspen, are adapted to heavy disturbances, such as fires, and thrive under direct sunlight. These trees, along with plants such as raspberries and pin cherries, are *shade intolerant*--they must have direct sunlight. The majority of our most valued tree species, however, are *shade tolerant*--they are adapted to growing under some degree of shade. Species such as red spruce, hemlock, or sugar maple can grow under a dense shade. White pine, yellow birch, or ash do well under partial shade and are considered to have *intermediate* tolerance.



Openings in the canopy are called "*gaps*." Gaps, depending on their size, produce different types of habitat. If they are small, they might just stimulate the growth of existing shade-tolerant seedlings and saplings, leading to a *stratified canopy* (a canopy with multiple layers) and *uneven-aged* stand structure (having three or more age classes). Stratified canopies have a high diversity of invertebrates.

If the gaps are bigger than two tree heights in diameter, the forest floor may be bathed in sunlight, encouraging shade-intolerant species, starting the process of *succession*. Since shade-intolerant species cannot grow under their own shade, more shade-tolerant species tend to succeed them. Young trees and shade-intolerant trees are found in *early-successional* stands, which are *even-aged* (having only one or two age classes of trees). Mature and old intermediate and shade-tolerant species are found in *late-successional* stands.

In Maine's *presettlement* forest (the forest before Maine was settled by Europeans), most of the northeastern portion of the state was in relatively-closed-canopy stands of more shade tolerant species. Large, severe disturbances (such as fire or windthrows) happened on a given acre hundreds of years apart--early-successional stands only represented a small percentage of the landscape. Stands dominated by seedlings and saplings may have represented only 2% of the

landscape. Smaller disturbances led to an uneven-aged structure and stratified canopy, with most stands having trees older than 150 years.¹

In some counties, such as Aroostook, Piscataquis, Somerset, and Washington, seedlings and saplings now make up around 30% of the landscape with most trees under 80 years. Mature saw-timber stands (stands dominated by trees large enough for saw timber) are a minority in these counties.²

Goals. Low-impact practitioners strive to manage for *well-stocked* (having optimal spacing for productivity and quality) stands with minimal crown damage. LIF foresters favor, over time, late-successional species and canopy structures. Large gaps and early-successional stands should be a minor part of the landscape.

Trunks

Principles. Tree trunks, or boles, hold up the canopy to catch the sunlight. The trunk carries food made from the leaves down to the roots through the inner bark (*phloem*), and the water and minerals are taken by the roots up to the leaves through the sapwood (*xylem*). A thin layer (one cell thick) called the *cambium* is where the tree trunks grow. Tree trunks are most vulnerable to damage when the sap is flowing, in the spring and early summer. Damage to tree trunks leads to a response called "*compartmentalization*" to isolate the wound. This takes up precious energy, slowing growth. If the damage is severe, this can cause extensive rotting and decay, lowering value for timber products and eventually killing the tree.

As the diameter of the trunk increases, its value for timber and wildlife increases as well. The highest-quality trunks are formed in relatively-closed canopy stands where limbs self-prune. There can be a major jump in economic value as a tree becomes big enough for sawtimber, rather than pulpwood. A softwood sawlog starts at 8-10 inches and a hardwood sawlog starts at 10-12 inches, while prime veneer starts at 16-18 inches. The difference in value between a 12-inch sawlog and an 18-inch veneer log can be 400-500%.³

One therefore grows more value per acre per year on trees than on saplings, on sawlogs than on pulp, and on veneer than on sawlogs.



Tree damaged by mechanical harvester. Photo by Mitch Lansky

¹ Craig Lorimer. "The presettlement forest and natural disturbance cycle of northeastern Maine." *Ecology*, Vol. 58 (1977): 147

² Douglas M. Griffith and Carol L. Alerich. *Forest Statistics for Maine, 1995*. Resource Bulletin NE-135. USDA Forest Service. N.E. Exp. Sta. Broomall. 1996. p. 112.

³ New Hampshire Forest Sustainability Standards Work Team. *Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire*. NH Div. Of Forests and Lands, DRED, and the Society for the Protection of New Hampshire Forests. 1997. p. 103.

Tree trunks create habitat for many forms of wildlife. Some, like certain types of lichens, prefer the rough bark of very old trees. Many bird and mammal species use cavities in dead or dead-topped trees. The bigger the trunk, the more wildlife varieties that can be accommodated.¹

Minimum tree diameters for cavity-using species (from NH Forest Sustainability Standards Work Team, 1997)	
<8"	12-18"
Black-capped chickadee Downy woodpecker* Boreal chickadee Tufted titmouse House wren Winter wren Eastern bluebird	Eastern screech-owl Three-toed woodpecker* Black-backed woodpecker* Northern flicker* Great crested flycatcher Keen's myotis Indiana myotis
6-12"	>18"
Northern saw-whet owl Hairy woodpecker* Yellow-bellied sapsucker* Red-breasted nuthatch* White-breasted nuthatch Brown creeper Chimney swift Southern flying squirrel Northern flying squirrel ermine	Wood duck Common goldeneye Turkey vulture Barred owl Pileated woodpecker* Silver-haired bat Gray squirrel Red squirrel Porcupine Martens Fisher Long-tailed weasel
	>24"
	Little brown bat Northern long-eared bat Gray fox Black bear raccoon
*Primary excavators	

Goals. Low-impact practitioners encourage an increase in average diameter, and an increase in quality leading to the highest value forest products. They also leave some large-diameter "wildlife trees" for cavity-nesting species. They take special care not to break the bark of residual trees, especially during seasons of highest vulnerability.

Roots

Principles. The roots are where the tree takes up water and nutrients. The roots are also the anchors that prevent the wind from blowing trees over. Damage to tree roots, especially at the drip line, can degrade the value of forest products by leading to rot and decay in the stem, and can slow growth or even kill the tree.

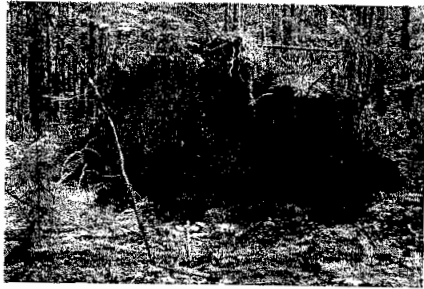
The tree takes in nutrients through the finer roots, which are mostly in the top six inches of soil around the drip line of the tree, but can extend more than two times the distance of the tree canopy. Many varieties of fungi, called *mycorrhizae*, have adapted to extending these fine roots and increasing the uptake of nutrients and water. For this service, the trees supply carbon for the

¹ Ibid. p. 57.

fungi. Recent research indicates that these fungi can connect one tree to another—even trees of different species—and supply carbon from trees growing in sunlight to those growing in shade.¹ Severe soil disturbance, changes in soil chemistry, and lack of dead-woody material on the ground can harm these important tree allies.

The bigger the tree crown, the bigger the root system. Suppressed trees (trees that do not have dominant crowns in the canopy) often have weaker root systems. If the canopy is opened by removing the larger, dominant trees, these suppressed trees will not be windfirm and can blow over. This is one problem with *diameter-limit cuts* (where the logger cuts all trees over a certain diameter) of softwoods.

When large trees blow over, the roots pull up nutrients from lower soil layers, making them available at the surface. The uprooted large trees create a *pit and mound* structure on the forest floor that creates very different microhabitats due to differences in topography, moisture, and nutrients. Pit and mound forest floors are typical of old growth forests.



Tip-up mound from windthrow. Photo by Mitch Lansky

horizon is the *organic pad*, where decomposing organic matter meets the mineral soil and forms humus. This area has the most biological activity, and is where fine roots thrive.

The organic layer is built up by fallen leaves, branches and trunks. Hardwoods tend to have deeper roots than softwoods, and can pull nutrients from deeper soil layers to deposit them on the surface in the form of leaves and branches. The *organic litter* is deepest and breaks down more slowly under softwood stands. Soil under softwoods also tends to be more acidic. Organic matter is broken down by fungi, bacteria, soil invertebrates and other organisms. The organic material is

¹ S.W.Simard, D.A.Perry, M.D.Jones, D.D.Myroid, D.M.Durall & R.Molina. "Net transfer of carbon between ectomycorrhizal tree species in the field." *Nature*. Vol. 388/7 August, 1997, 579-582

thus not just a nutrient source, it is also an important habitat for many species. Organic matter acts as a sponge and retains water, even during dry periods. Because of this, large rotting logs can be an important reliable site for regeneration of some tree species, such as red spruce.

Disturbance of the organic pad impacts nutrient cycling and availability. Approximately half of upper soil volume is made up of pore space filled with air and water. Compaction and rutting can compress these pores between soil particles, preventing air from getting to tree roots and halting much of the biological activity. Water no longer can slowly filter through the soil, but instead forms pools or runs off, taking soil particles and nutrients with it. Soil disturbance is less of a problem when the ground is frozen or dry.

Exposing the soil surface to direct sunlight through large openings can lead to increased temperatures and more rapid breakdown of organic matter, leading to a leaching of nutrients if there is inadequate living vegetation to take it up. This leaching, combined with removal of large amounts of biomass from a heavy cut, can have a major impact on available nutrients. It can also change soil chemistry, making the soil more acidic and less fertile. Whole-tree removals have the most severe impacts since more than half of the nutrients are in the branches, tops, and leaves.¹

An *ecological rotation* is the time it takes for the soil to recover organic matter and available nutrients. This time period depends on site and forest type as well as the intensity of cutting. The more intense the removals, the longer the recovery time. If removals and leaching occur faster than the recovery time, the soil experiences nutrient capital depletion, eventually lowering productivity.

Goals. LIF practitioners strive to cause minimal soil disturbance, and, where damage is unavoidable, to isolate it to the smallest possible area. They pay attention to timing of cut, entering stands when conditions are least vulnerable. They leave plenty of organic matter, including tops, branches, and even trunks, to rot. Where soil has been disturbed or nutrients depleted, the LIF practitioner will allow ample time for recovery.

Water

Principles. The purest water is that which comes from a relatively undisturbed forest. The closed canopy shades the soil, keeping water cooled. The canopy also protects the soil from the impact of direct rain drops and erosion. The organic matter and soil structure act as a filter to keep water clean. Forest vegetation and wetlands help to moderate extreme water level fluctuations. Forest vegetation also takes up nutrients as organic matter rots and breaks down. When there has been extensive removal of forest vegetation, some of these nutrients can leach out of the forest and pollute streams.

Water quality is most impacted by exposed, disturbed, or compacted soils where particles are apt to be washed away with the rain. This happens most often on roads, yards, trails, and stream crossings. States with forest industries all have *Best Management Practices* (BMPs) standards to reduce siltation and other water quality problems from such areas. In Maine, BMPs are voluntary.

Where water meets the forest—the *riparian zones*—some of the richest wildlife habitats are found. These areas are rich in both plants, which take advantage of increased moisture and nutrients, and animals, which appreciate the lush plant life as well as access to water. Riparian zones, if wide enough to be functional habitat, can also be corridors for migrating animals.

¹ James W. Hornbeck and William Kropetin. "Nutrient removal and leaching from a whole-tree harvest of northern hardwoods," *Journal of Environmental Quality*, Vol. 11, No. 2 (1982): 312

The smaller the streams, the more sensitive they are to changes in temperature, siltation, and water-level fluctuations. Opening the canopy by as little as 25% in the zones near sensitive water bodies can impact water quality.¹ Some water bodies, such as *vernal pools* (which can be breeding grounds for amphibians), intermittent streams, or small wetlands, might be wet for only part of the year, but they are important for both wildlife habitat and flood control, and the surrounding forest needs to be managed carefully.

Goals. LIF practitioners carefully control stocking and soil disturbance to maintain quality water from the forest. They pay special attention to riparian zones, especially around the most sensitive streams where these management zones should be wider, not smaller.

Wildlife habitat

Principles. When most people hear the word "wildlife," they think of moose, deer, grouse, and ducks. Occasionally they might include fish, raccoons, or even bald eagles. When biologists say "wildlife" they mean all animals (including insects and spiders), plants, and fungi. The diversity of all wildlife at all levels of organization, from genes to ecosystems and biomes, is called *biodiversity*. The diversity of wildlife helps build resistance to severe disturbances and resilience in recovery from such disturbances. Another word for this resistance and resilience is *stability*.

Forests are not just trees. They are complex ecosystems that include plants and animals. Plants create food from light, water, and minerals. When animals, such as deer, rabbits, or insects, browse intensively they can change plant distribution. Other animals, such as moths, birds, or bats, aid in plant pollination. Many types of birds and mammals help with plant seed dispersal. Some animals, such as spiders, salamanders, foxes, or coyotes, prey on others, preventing over-population and over-grazing. Other creatures, such as insects or fungi, decompose the dead plants and animals, helping them to break down into nutrients usable by plants.

Wildlife cannot survive without acceptable habitats to give them food, shelter, and other necessities. Thus the way to ensure the persistence of all species is to ensure the presence of all required habitats. The habitats must be large enough to support viable populations. A major threat to biodiversity is from habitat *fragmentation*, where the habitat is reduced so that it is too small or too isolated to support breeding, dispersal, or migration. While some species (such as deer or cowbirds) thrive on the *edge* between two habitats, others shun the edge and prefer the *interior* where there may be less predation or competition.

Fragmentation can make a habitat so small that it is all edge, and thus not be able to support interior species. In Maine, the Land Use Regulation Commission requires a minimum of 75-foot buffers (that provide "shade") around small streams that drain more than 300 acres. When these buffers are surrounded by clearcuts, they are too narrow to support viable populations of forest interior song birds, such as bay-breasted warblers.² Fragmentation is most severe in populated areas where species such as cats, raccoons, or cowbirds can harm nesting interior birds.

To have all habitats requires having all the successional stages for each forest type. Due to disturbance and growth, forest habitats are always changing, both on site and over the landscape. Early-successional habitats transform over decades. Late-successional habitats can persist for centuries--though changed with small gaps. A deficit of early-successional habitat in the

¹ Steve Kahl. *A Review of the Effects of Forest Practices on Water Quality in Maine*. Water Research Institute, University of Maine, Orono. 1989: 16

² Brad Meikeljohn. *The value of buffer strips as riparian habitat in northern forests*. M.S. Thesis. University of Vermont. Burlington. 1994

landscape can be remedied in a matter of days with a chainsaw. It might take a century to remedy a deficit of late-successional habitat. Therefore, planning for late-successional habitat is a higher priority.

While early-successional species tend to be aggressive recolonizers of disturbed areas, late-successional species tend not to be as good at rapid dispersal and recolonization.¹ Recolonization of disturbed areas by these slower-responding species is best assured if there are species sources within (*biological legacies*, the species and habitats that survive a disturbance), adjacent to, or near the developing stand. In Maine's presettlement forest, late-successional forests made up the majority of the landscape, and there was enough time between severe disturbances to ensure recolonization and thus the survival of all species.²

Goals. LIF practitioners strive to provide habitats adequate to support viable populations of all native species and to assure the presence of these habitats in the landscape over time. This means having representation of all successional stages. In the Acadian forest type, late succession should be the landscape context, not a minor content. Habitats of rare or sensitive species require a higher level of protection.

III. LIF Logging Guidelines and Standards

How does one get the generalizations of the principles and goals turned into more specific practices? Who is responsible for their implementation?

Responsibility

Low-impact forestry is a partnership between the landowner, the forester, and the logger. It starts with the landowner, who has to know what LIF is and has to make the decision to do it. For LIF to happen, however, the landowners (if they do not do the work themselves) must be able to contact qualified foresters and loggers who have to agree to work within LIF standards. Otherwise the cut may not turn out as the landowners wish.

Low-impact forestry is not just a single cut--it involves long-term planning. The forester needs to incorporate LIF goals and principles into the management plan as well as ensure that loggers meet performance standards. To the extent that the forester (or logger) can locate the highest paying markets, LIF becomes more viable for all participants.

Without the logger, LIF could not happen, despite the best long-term plans. The logger must understand the techniques and have the appropriate equipment to perform LIF. Before cutting a stick of wood, the logger must know the best markets to ensure that the wood is cut to the optimal lengths considering diameter and grade.

For low-impact forestry to work, therefore, the landowners, foresters, and loggers involved must all understand the goals and principles of LIF. And they must all agree to abide by those goals and principles. And the foresters and loggers must follow basic guidelines and standards.

Forester guidelines

¹ Cathy Elliot, ed., 1999. Grow Flatebo, Carol Foss, and Steven Pelletier, *Biodiversity in the Forests of Maine: Guidelines for Land Management*, University of Maine Cooperative Extension Bulletin #7147: p. 103

² Lorimer, p. 147.

Stand Assessment. Before coming up with a management plan, the forester must assess and map the stand, taking into consideration such factors as stand types, species, volume, quality, watersheds, and wildlife habitat.

Landscape planning. Watersheds, ecosystems, wildlife ranges, and disturbance patterns do not normally coincide with property boundaries. For landowners who own thousands of acres, landscape planning starts to become possible. With smaller ownerships, the foresters and landowners should try to cooperate on a community basis to ensure that wildlife needs (such as effective corridors for migration and dispersal) are met. Cooperation of this sort, involving government, industry, and small landowners, is now being done, for example, in New Brunswick's Greater Fundy Ecosystem.¹

Where landscape planning is possible, foresters should ensure that a representation of ecosystem types and sensitive habitats are protected in reserves. Reserves can serve many functions, from baseline "controls" for the long-term experiment of forest management, to *refugia* (source areas for future recolonization of disturbed forests). Maine currently has less than 2% of its forest in reserves. A number of organizations, such as the Forest Stewardship Council, have called for at least "representative samples of existing ecosystems."² In general, the bigger the landscape planning unit, the bigger the reserve system. Bigger reserves can survive the largest expected disturbances without losing essential habitats, and habitats are more apt to support viable populations of species needing larger ranges. Large reserves in the landscape, generally, are publicly owned, but small baseline reserves (to serve as an uncut control to the forestry experiments) on private land can be important as well.

Allowable cut. A number of methods can be used to calculate allowable cut. In doing these calculations, the forester must account for areas where there will be no cutting or less cutting because: 1) the site has such low productivity that sustainable management is not economically viable; 2) the site is environmentally sensitive (riparian zones, deer yards, slopes, species of special concern); or 3) the site is in a baseline reserve.

Because the degree of tree crown closure (and thus residual stocking) is so important for both productivity and wildlife, one favored method is to classify stands as "operable" when they have more than a minimum above a recommended stocking level to allow a commercial cut. The quantity above the minimum stocking is the allowable cut.³ Another method is to ensure that cut is less than growth. Over a rolling 10-year period (for larger management units), cut might average less than 70% of growth, allowing some growth to be reinvested into the ecosystem. This calculation is normally not done at a stand or woodlot level. The area is too small and the harvest too infrequent to use 10 years as the base. Often harvests occur at intervals of 20 or more years, so a longer time frame can be used. On large ownerships with balanced age classes and

¹ Greater Fundy Ecosystem Research Group. *Forest Management Guidelines to Protect Biodiversity in the Fundy Model Forest*. New Brunswick Cooperative Fish and Wildlife Research Unit, University of New Brunswick, 1997.

² Forest Stewardship Council Principles and Criteria for Forest Management, February, 1996, Principle #6.4

³ Menominee Tribal Enterprises. *Forest Management Plan 1983-1997*, pp 1-16 in R. Simeone, M. Krones, L. Nesper, *Sustainable Management of Temperate Hardwood Forests: A Review of the Forest Management Practices of Menominee Tribal Enterprises, Inc.* Submitted to Green Cross Certification Company, Feb. 14, 1992.

logging occurring annually, the 10-year time frame can be used. Cut can, of course, exceed growth for *species* that are over-represented (such as balsam fir or red maple) and less desired for long-term stability. There are also periods of heavy mortality (such as from spruce budworm) where the cut/growth ratio over 10 years will be inadequate as a guideline for some species.

Because the majority of land should eventually be classified as sawtimber (to ensure that relatively closed-canopy mature and late-successional stands are the landscape context, not just a small content), *even-aged* management (where a cut is made that reduces the stand to seedlings and saplings, leading to a single age class) should be done only if uneven-aged management will not work for the stand. Priority for even-aged management should first go to *irregular shelterwood* (where some of the overstory is retained), and only go to regular *shelterwood* (where regeneration is well-established before cutting the overstory) if retention of residuals is not possible. *Rotation* (the interval between stand establishment and the final cut) for even-aged stands should be based on stand type and should allow enough time for soil recovery and habitat recovery, including tall, large diameter trees.

Cutting cycle. More frequent, light cutting (every 5 years, for example) creates the potential for increased residual damage. Less-frequent (every 20 or 25 years), heavier cuts create potential for more drastic stand changes. The forester can reach a compromise between these two possibilities. Low-impact logging creates an opportunity to more successfully do lighter cutting and still minimize damage on 10- to 15-year cutting cycles.

Residual stocking. The forester will consult silvicultural guides appropriate to the stand type. To ensure relatively closed canopy areas in large blocks (for adequate interior species habitat), minimum stocking should be at least 65% of crown closure, increasing to 75% of full crown closure for riparian areas. Near riparian areas, to prevent changes to water quality and flow, cuts should not exceed 25% of standing volume.¹

Crop trees. The forester will identify crop trees and potential crop trees--trees that have good form and quality. These are the trees to leave after harvest and should be given special attention to avoid any injury that would diminish value. The normal target is around 50 to 75 per acre. Common terminology calls trees acceptable growing stock (AGS) and unacceptable growing stock (UGS). Using this approach of AGS and UGS, a harvest can be designed to improve stands and focus on the future crop trees.²

Pecking order. The forester should mark trees to be cut based on a "pecking order" that would prevent highgrading and thus stand degeneration. First to be cut should be high risk (trees that would not survive to the next cut), low vigor, and poor quality trees (UGS).³ With a pecking order, the logger would be more likely to cut short-lived, poor quality medium-sized suppressed trees than long-lived, high quality, large-diameter dominant trees that are still growing well.

¹ Steve Kahl, p. 16

² Si Balch, personal communication

³ Menominee

Mast trees. Mast trees are those that produce edible nuts, seeds, and fruits that are important for wildlife. If no high-quality (for lumber) trees are suitable for mast, some low-quality mast-producing trees (such as beech) should be retained.

Dead wood. The forester will consult recommendations from forest wildlife guides to determine a minimum of snags, dead trees, and dead-downed trees.¹ Preference will be given for larger-diameter (over 18 inches) *leave trees* (trees left behind), and allowance will be made to develop *recruitment trees* (trees that will be allowed to develop eventually into large-dead trees), since current dead-standing trees eventually fall over. The additional factor of safety must be considered since dead snags and branches have a higher potential for injuring loggers.

Logger guidelines

Felling and limbing. LIF loggers will use directional felling to avoid damaging residual trees. Limbs will be left in the woods to provide wildlife habitat and to rot and supply nutrients.

Getting trees to trails. LIF loggers will move single large stems or a few small stems (but not winch whole trees) to the trail. If winching, the logger will, if necessary, use snatch blocks to avoid damaging valuable crop trees. The logger will avoid digging up the soil during winching and use such items as grapples or cones when needed.

Wood trails. Wood trails will not exceed 10 feet wide (to give several feet clearance to machinery) unless dealing with very large trees requiring large equipment. The goal is to encourage crown closure over the trails, rather than have a series of openings large enough to allow shade-intolerant plants to proliferate. Machinery wider than 7.5 ft. should be avoided, unless trees are very large and smaller equipment will not do the job.

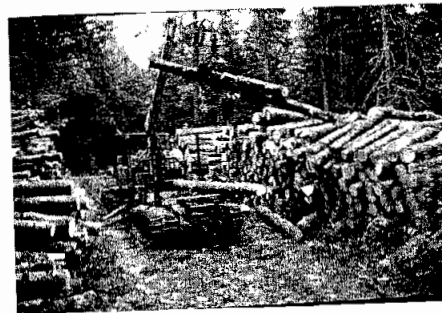
LIF practitioners should strive to distribute trails more than 100 feet apart to minimize damage to soil and roots. Some low-impact practitioners with radio-controlled winches distribute trails 150 feet apart. With horses yarding to forwarders, trails can be up to 300 ft. apart. With widely-spaced trails, use of larger forwarders may be appropriate.

Getting trees to yards. The LIF preference is to carry rather than drag bunches of logs. A forwarder is thus preferred over a skidder. Use of short logs, rather than tree-length logs, minimizes damage when going around curves. The more passes over a given area, the more likely the damage. So, LIF practitioners try to keep heavier equipment on permanent, widely-spaced trails to confine the worst damage to the smallest area possible.

The result, however, is more important than the method used. If a logger can use a small skidder and do minimal damage, then the skidder is acceptable. It is possible to make a single pass on a temporary trail with a narrow machine working on dry or frozen soils and do minimum damage. Whole-tree removal with a grapple skidder, especially of hardwoods, violates too many LIF principles and has the potential to cause too much residual damage to be acceptable in most cases.

¹ For example, *Good Forestry in the Granite State* recommends 6 trees to the acre with 1 exceeding 18 inches and 3 exceeding 12 inches in diameter. The FSC Acadian Working Group recommends 10 snag trees per acre or leaving behind the tallest tree with each cut. *Biodiversity in the Forests of Maine* has a chart (p. 146) of the snag requirements of primary cavity excavators in Maine.

Residual damage. For long-term forestry, the residual, or "crop" trees must not be damaged. During cutting, winching, and transporting trees, every attempt will be made to avoid such damage. While damage to tops and branches is of concern, it is even more important to avoid damage to trunks and roots.



Low-impact yarding area with small forwarder. Photo by Mitch Lansky

Some LIF practitioners in New England guarantee that they will damage less than 5% of crop trees. This figure is also a goal in Sweden, where any opening in the bark bigger than a matchbook is counted as "damage."¹ William Ostrofsky has developed a method for measuring damage levels for the American Pulpwood Association.²

Yarding. LIF yarding areas can be kept to a minimum in size with minimum damage to soil if short logs are piled with a loader, rather than pushed with the dozer blade of a skidder. LIF practitioners normally need less than 1500 square feet for yards on average. Whole-tree yarding with grapple skidders and delimiting in the yard require too much space, are too damaging to residuals and soil, and remove and damage too much organic matter to be suitable for LIF.

Truck Roads. Road width and densities should be minimized. Road rights-of-way widths should be kept between 15-30 feet with a maximum of 33 feet.³ Generally the running surface would be 12 feet with added width if ditching, turnouts or space for snowplowing are needed. Outsloping, dips, and waterbars can reduce need for ditching.⁴ Road density becomes an issue in bigger blocks of non-settled forest. Managers in the Greater Fundy Ecosystem recommended keeping road density to less than 0.9 miles per square mile due to impacts on large predators and other sensitive animal.⁵ For narrow truck roads that are used infrequently, the density can be more than 2 miles per square mile.

Landscape conversion. Loggers and managers should strive to keep the percent of forest taken out for permanent trails, yards and roads to less than 15%.

¹ Thomas Beier, Swedish forester, personal communication

² American Pulpwood Association. *Professional Mechanical Harvesting Practices*. Rockville, Md. 1997, pp. 24-29

³ Herb Hammond. *Pacific Certification Council Standards for Ecologically Responsible Timber Management*. Slocan Park, BC. 1996, p. 36.

⁴ For a more thorough treatment on forest roads, see *A Landowner's Guide to Building Forest Access Roads* by Richard L. Wiest, USDA Forest Service, Northeastern Area, NA-TP-06-98, Radnor, PA, 1998. 45 pgs.

⁵ Greater Fundy, p. 12

Water quality. LIF loggers will follow state BMPs to prevent soil damage that leads to siltation of waters. In addition, foresters will take into account soil type, watershed characteristics, and season of cut to further advise loggers as to when logging standards should be even stricter than BMPs.¹ Preference for LIF practitioners is to log when the soil is frozen or dry.

Conclusion

One low-impact cut does not qualify as long-term forestry--but that one cut should keep the possibility of long-term forestry open. After that cut, managers can still work with a well-stocked forest. After a heavy high-grade operation, they can't.

These guidelines are not strict rules. Following them increases the chance of meeting the goals, but common sense and experience may find other or better ways in a given situation. This document is also not the final word--the author hopes that feedback from those working on the ground will lead to improvements and refinements.

Getting low-impact forestry to work on the ground will depend on issues covered in later chapters such as: technologies, logger payment systems, contracts, assessments, and economics. Understanding the basic principles and goals of low-impact forestry is the starting place if forestry is going to act as if the future mattered.

Pesti- Side Bar: Chemical Pesticides and Low-Impact Forestry

Aerial spraying of chemical insecticides or herbicides hardly qualifies as "low-impact." Pesticides do not always hit or stay on their target, and even when they do, they can cause ecological harm. Aerially-applied chemicals can drift or run off into ground water, causing health and environmental problems.² For those concerned about retaining the "little things that run the forest," broad-spectrum pesticides should be shunned.

Broad-spectrum chemical insecticides (such as those used to combat the spruce budworm) kill more than just the "target" species. They also tend to kill predators and parasites (or decimate the food supply for these species), pollinators, and aquatic invertebrates. While in some cases the affected species may rebound within a year, this is not always the case. Researchers could find no recovery in stoneflies, for example, three years after they had been sprayed with carbaryl during spruce budworm spray programs. Not all of the "target" species get killed. Given that their food supply is still intact and their predators may be reduced, "pest" populations can rebound to be a continued problem.

The guiding philosophy for dealing with "pests" in low-impact forestry is Integrated Forest Management, rather than Integrated Pest Management. The focus is on the whole forest, rather than just one element of the forest. Low-impact practitioners strive to manage the stand and landscape to be resistant to and resilient from disturbance. Part of encouraging such stability is to encourage a natural diversity of species and structure. Old-growth spruce forests, for example, have weathered numerous budworm outbreaks over the last few centuries. Part of the reason for their success is adequate habitat for predators and parasites of potential pests.

¹ See Janet Cormier, *Review and Discussion of Forestry BMPs*. MDEP and USEPA. 1996. And Steve Kahl's *A review of the effects...*

² For more detail and full documentation on impacts of forestry pesticides on the environment and human health, see *Beyond the Beauty Strip: Saving What's Left of Our Forests*, by Mitch Lansky, published by Tilbury House Publishers, 1992.

Low-impact practitioners manage away from shorter-lived, more vulnerable species toward less vulnerable species.

If ecosystems are threatened by a pest outbreak (especially exotic species that may have few natural controls), the low-impact practitioner would favor physical (removal of breeding sites, for example), cultural (managing to favor less vulnerable species and encouraging more diverse habitat), and biological approaches (such as release of predators, parasites, or diseases) over the use of broad-spectrum pesticides.

Landowners use herbicides in response to proliferation of "brush," pioneer hardwoods, and hardwood "competition," after heavy cutting. While landowners may call these unwanted plants "weeds," these weeds are often native plants that are adapted to the very habitat the landowners are creating with heavy cutting. Some companies *plan* for herbicides to follow clearcuts and plantation establishment. This is adding an insult to an injury.

Heavy cutting not only removes large volumes of wood (with all the nutrients within), it also leaves bare ground that is exposed to sunlight and the direct impacts of rain. The increased temperatures promote more rapid breakdown of residual organic matter, leading to accelerated leaching of more nutrients from the forest ecosystem. Pioneer plants slow the leaching, protect the soil with shade, and act as "nurse crops" for the more shade-tolerant species that follow. Herbicide spraying leads to: renewed nutrient leaching; damage of broad-leaved trees that have both ecological and economic value; and even, in some circumstances, some damage to the "crop" species. It is quite probable that the herbicides also affect soil microflora, either directly (through toxicity) or indirectly (through killing plants that have important interactions with soil microorganisms). To the extent that the knock-down of vulnerable plants opens up bare soil again, plants more resistant to the herbicide can fill the gaps, sometimes leading to a "need" to spray again.

Early-successional habitat (the major target of herbicides) can be avoided by avoiding unnecessary heavy cutting that creates large openings. Where overstory removal is unavoidable, it is best done in an irregular-shelterwood system, where advanced regeneration is established first and some windfirm overstory trees (or clumps of trees) are retained. Retention of some live and dead large trees creates biological legacies that help the forest recover more quickly. More targeted vegetation control, with chainsaws or clearing saws, can encourage quality trees of favored species. Having some early-successional habitat, however, is an important part of landscape management. Many species prefer such habitat for food and nesting. Wind, fire, and other natural disturbances will create such openings in the landscape. Humans are not needed to do what nature will do anyway. It is best to work with, not against, the species that are best adapted to the habitats created by such forces.

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