WHITE PAPER

USDA Forest Service Pacific Northwest Region Umatilla National Forest

WHITE PAPER F14-SO-WP-SILV-27

Mechanized Timber Harvest: Some Ecosystem Management Considerations[1]

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HISTORICAL CONTEXT

On June 4, 1992, Chief F. Dale Robertson issued a memorandum announcing that USDA Forest Service would begin using a new approach called 'ecosystem management' for future management of national forests and national grasslands (Robertson 1992). From that point onward, most Forest Service activities and policies attempted to explicitly adopt an ecosystem approach to natural resources management.

When ecosystem management was formally adopted as a policy, it had a profound influence on agency operations. The Forest Service was emerging from an era (the 1980s) where timber production was primary, and most other programs were secondary. Ecosystem management functioned well to re-center the agency by reinforcing that all resource values were important, as embodied in the Multiple-Use Sustained-Yield Act of 1960.

Prior to advent of ecosystem management, a mechanized timber harvest workshop would likely have focused exclusively on technical aspects of those harvest techniques. After adopting ecosystem management, technical workshops attempted to incorporate considerations addressing a wider spectrum of resource management concerns.

This white paper provides handout material prepared for a mechanized timber-harvest workshop held in Pendleton, Oregon on June 2 and 3, 1993. It describes how mechanized harvest operations could be planned, and implemented, in ways that account for nutrient management considerations, along with provision of habitat for spiders, ants, birds, beetles, and other biotic enemies of western spruce budworm and similar defoliating insects.

INTRODUCTION

Many possible concerns about mechanized timber harvest relate to how the harvest practices could affect site productivity, nutrient cycling, and other ecosystem processes. Some of these concerns will be discussed here.

Needles and branches have a small proportion of a tree's biomass (15%), but contain its highest concentration of nutrients. Stemwood has a high amount of biomass (61%), but relatively little of a tree's nutrients. Woody roots provide a tree's anchorage, but have low nutrient concentrations. The non-woody portion of a root system has high nutrient levels. Roots have 24% of a tree's biomass.

Major nutrients of concern for Blue Mountain forests include nitrogen, potassium, phosphorus, sulfur, calcium, and boron. Many forest sites are nitrogen deficient. For Blue Mountain forests, sulfur is often quite limiting – adding nitrogen without addressing a sulfur deficiency commonly results in little or no growth response and may actually end up killing some trees. Boron can become especially deficient on sites that previously experienced heavy mechanical site preparation treatments (such as a practice referred to as 'potato patching').

	TRUE FIR STAND		PINE STAND	
	Nitrogen	Phosphorus	Nitrogen	Phosphorus
Trees: Aboveground	3%	1%	8%	1%
Trees: Roots	< 1%	< 1%	1%	< 1%
Understory	< 1%	< 1%	< 1%	< 1%
Forest Floor	13%	3%	14%	2%
Soil to 1-meter depth	83%	96%	77%	96%

This table shows that intensive timber harvest leaves at least 77 percent of total nitrogen on site, and usually much more than that, depending on how we handle the forest floor.[2] Does this mean we don't have concerns about possible effects of mechanized harvest, or other timber harvest methods, on site nutrients? Not really, because only a portion of a site's nutrients are available at any one time.

Nutrients that are not available for tree growth may count toward a site's total nutrient capital, but they are largely unaffected by our management practices (unless we mess up bad enough to cause serious soil erosion and off-site soil loss). A significant portion of nutrients found in soil to a 1-meter depth is unavailable for tree growth in the short term. But over a long term, weathering (decomposition) processes will eventually make these nutrients available for plant growth.

Forest floor consists of two major components – larger twigs and branches called debris, and smaller twigs and needles called litter. Forest floor is a major source, a reservoir, of nutrient cycling because relatively rapid turnover (decomposition) occurs there.

To summarize: "When appropriately applied, intensive utilization should maintain adequate organic reserves. With moderate treatment of productive sites, more intensive use than currently practiced should be possible with minimal or no adverse impacts on new forests."[3]

Our slash disposal and site preparation treatments can have a big impact on site nutrients. Severe or extreme burns have been shown to cause nitrogen losses of 92 percent or more; light burns have shown no effect or slight increases in available (mineralizable) nitrogen, ranging up to an increase of 28% (see note 4).

Prescribed fire also affects soil fauna. Density of soil fauna in an undisturbed forest soil is usually quite large. In a study of soil fauna present in organic and upper soil layers under a ponderosa pine forest near Grass Valley, California, it was found that there was a population density of about 200,000 arthropods per square meter of forest floor area. About 150 species were represented, dominated by mites and springtails.[4]

Soil compaction has often been associated with timber harvest, but it can easily occur in conjunction with mechanical site preparation treatments too. Machine piling is one treatment with a high potential for compaction.

Compaction affects aeration and infiltration capacity of a soil, which in turn affects mycorrhizal abundance and activity. (Mycorrhizae are fungi forming a mutually beneficial association with tree roots.) Without mycorrhizae, tree growth usually suffers. Since compaction may be very persistent without some sort of remedial treatment (it is not uncommon for compaction to persist for 40 years or more), compaction can have a serious impact on long-term productivity.

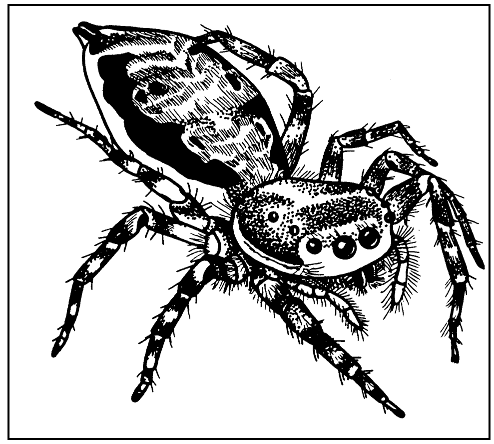
On nutrient-poor sites (how many eastside sites aren't?), these considerations can be helpful for maintaining site productivity:

1. Use longer rotations (allows longer periods of nutrient cycling between stressful ecosystem events such as regeneration timber harvest or site preparation).
2. Lessen harvest intensity, especially in relation to its potential for causing persistent soil compaction.
3. Limb trees where they fall, thereby retaining most nutrient-rich foliage and small twigs or branches on-site.
4. Minimize use of high-intensity prescribed fire as a site preparation treatment or when reducing natural fuel accumulations.

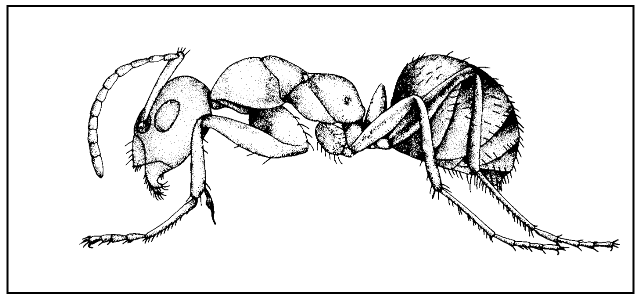
In 1993, when this mechanized timber harvest workshop was convened, we've just emerged from the most impactful spruce budworm outbreak ever experienced for the Blue Mountains (the 1980-1992 outbreak). As land managers, we can influence future outbreaks by how we affect natural enemies of our primary defoliating insects – western spruce budworm and Douglas-fir tussock moth. Ants, birds, yellowjackets, beetles, jumping spiders, and other native predators of defoliating insects can be affected by insecticide applications, prescribed fire, silvicultural practices, and timber harvest methods.

Potential effects of mechanized timber harvest on natural enemies include:

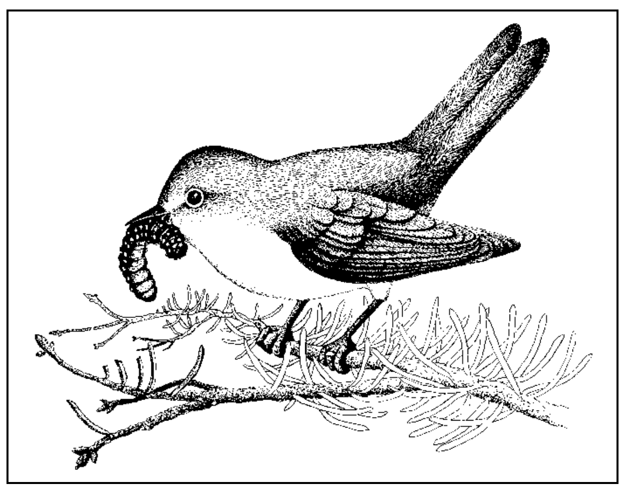
1. Whole-tree yarding removes fine branches and foliage that is important cover for spiders and other insects that prey on western spruce budworm larvae. Jumping spider, shown here, is a common budworm predator. Home gardening provides an example of this concept: to encourage spiders as a predator of aphids, mites, and other damaging garden insects, spread grass clippings in garden beds to provide cover and habitat for spiders.



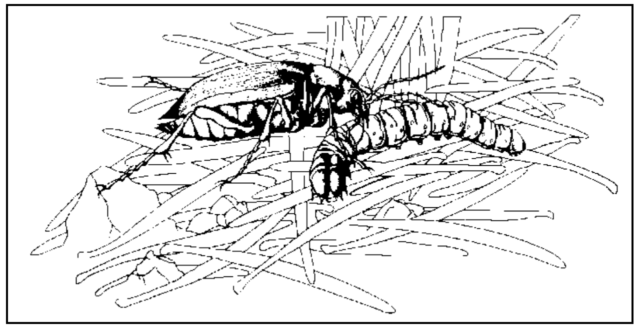
2. Down logs and standing snags provide important habitat for carpenter ants and thatch ants, two important predators of budworm larvae. It's important to retain enough of these 'biological legacies' to ensure that ant populations will remain viable following treatment. *Skidders and yarders should avoid thatch ant nests!*



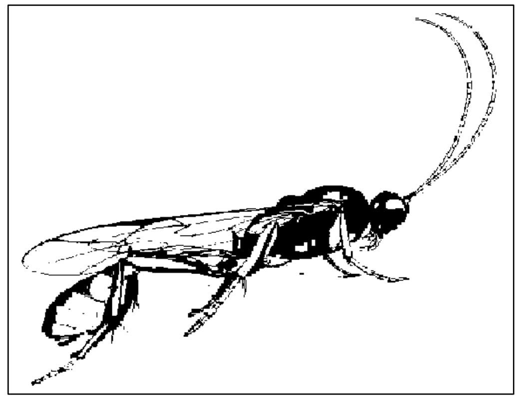
3. Birds are important predators of western spruce budworm. Our management practices should maintain a variety of habitat conditions to assure their long-term viability (particularly by maintaining or promoting shrub-dominated under-growths). As we continue to see constraints placed on our use of insecticides, the viability of natural budworm predators should be a primary concern. Ruby-crowned kinglets (shown here), mountain chickadees, and nuthatches are very effective as avian budworm predators. In a study where birds and ants were excluded from host trees (by using cages and sticky barriers), those trees had 10 times more budworm larvae than normal trees.[5]



4. Clerid beetles and true bugs are two other important predators that feed on western spruce budworm larvae, especially those that fall to the forest floor. A clerid beetle feeding on a budworm larva is shown here.



5. Many species of wasps and flies are known to parasitize insect larvae. Parasitic insects find budworm larvae, pupae, or eggs, where they lay their own eggs. After their eggs hatch, developing parasites feed on the budworm host, eventually killing it. The wasp shown here is a common Blue Mountain species *(Hyposoter masoni* Torgersen).



Why worry about birds, beetles, and ants?

1. More and more, people don't seem as supportive of timber harvest, even though this viewpoint is globally irresponsible.[6]
2. Often, these same people don't like spraying, and whether or not an insecticide is a chemical substance doesn't seem to make much difference anymore. Applying a biological insecticide, such as *Bacillus thuringiensis* (B.t.), is likely to generate as much criticism from environmental groups as using a chemical insecticide such as carbaryl (Sevin).
3. Therefore, natural enemies will only increase in importance if we can't use thinning harvests to maintain forest resilience, or spray insecticides to combat insects.

To summarize the main points from this presentation, here are a few ideas for maintaining site productivity and promoting nutrient cycling:

1. Prevention is the best prescription – leave as many resources on site as possible because they are a source for future decomposition and nutrient cycling, and they function as habitat for birds, ants, wasps, spiders, and other natural enemies of defoliating tree insects.
2. Manage with a light hand, and when thinking about what qualifies as a light hand, don't just think about residual tree damage and maintenance of advance regeneration – consider soil impacts as well!
3. Try to keep heavy equipment off the soil as much as possible.

4. Limit scarification treatments to keep nutrients and organic matter on site.
5. Keep burns cool (200° to 400° F.; 2- to 4-foot flame lengths) so that more nutrients present in slash (and natural surface fuels) are retained on site – nitrogen and sulfur are highly vulnerable to being lost (volatized) during hot burns.
6. Be especially careful on harsh sites because nutrient cycling is slow for these areas (including hot dry sites where ponderosa pine is climax, and cold dry sites dominated by subalpine fir).
7. During timber harvest, leave as many tree tops and branches on site as possible to replenish the forest floor and encourage nutrient cycling.
8. Manage forest floor resources (litter and duff) as carefully as possible because this is an area of rapid cycling and high nutrient availability.

Timber harvest is fully compatible with maintaining birds, ants, and other natural enemies of defoliating insects.

NOTES

[1] White papers are internal reports; they receive only limited review. Viewpoints expressed in this paper are those of the author – they may not represent positions of USDA Forest Service.

[2] Data for this table came from: Powers, R.F. 1989. *Maintaining long-term forest productivity in the Pacific Northwest: defining the issues*. In: Perry, D.A.; Meurisse, R.; Thomas, B.; Miller, R.; Boyle, J.; Means, J.; Perry, C.R.; Powers, R.F., eds. Maintaining the long-term productivity of Pacific Northwest forest ecosystems. Portland, OR: Timber Press: 3-16. isbn:0-88192-144-0

[3] Harvey, A.E.; Meurisse, R.T.; Geist, J.M.; Jurgensen, M.F.; McDonald, G.I.; Graham, R.T.; Stark, N. 1989. *Managing productivity processes in the inland northwest – mixed conifers and pines*. In: Perry, D.A.; Meurisse, R.; Thomas, B.; Miller, R.; Boyle, J.; Means, J.; Perry, C.R.; Powers, R.F., eds. Maintaining the long-term productivity of Pacific Northwest forest ecosystems. Portland, OR: Timber Press: 164-184. isbn:0-88192-144-0

[4] Mitchell, R.G.; Martin, R.E. 1980. Fire and insects in pine culture of the Pacific Northwest. In: Martin, R.E.; Edmonds, R.L.; Faulkner, D.A.; Harrington, J.B.; Fuquay, D.M.; Stocks, B.J.; Barr, S., eds. Proceedings: sixth conference on fire and forest meteorology. Washington, DC: Society of American Foresters: 182-190.

[5] See: Torgersen, T.R.; Mason, R.R.; Campbell, R.W. 1990. Predation by birds and ants on two forest insect pests in the Pacific Northwest. Studies in Avian Biology. 13: 14-19. Predation%20by%20Birds%20and%20Ants%20on%20Two%20Forest%20Insect%20Pests%20in%20the%20Pacific%20Northwest

[6] The concept of social irresponsibility with respect to timber harvest focuses on the fact that America's appetite for wood products is largely disconnected from our country's capacity to meet its own wood product demand. In other words, when United States wood production declines, for whatever reason, it has historically been replaced with wood imports from the tropics, Canada, or other regions of the World, and many wood-exporting countries have environmental laws and regulations that are less stringent than those governing harvests in the U.S. When we import wood, we are, in effect, 'exporting our harvest impacts' (clearcuts, in some instances) to countries that may be ill-prepared to deal with them in an environmentally responsible manner. Two articles describe this situation well: (1) "Is the northern spotted owl worth more than the orangutan?" (Dekker-Robinson, D. 1997. Pages 19-28 In: USDA Forest Service. Communicating the role of silviculture in managing the national forests: Proceedings of the National Silviculture Workshop. Gen. Tech. Rep. NE-238. Radnor, PA: USDA Forest Service, Northeastern Forest Experiment Station. https://www.fs.usda.gov/treesearch/pubs/14988); and (2) Dekker-Robinson, D.L.; Libby, W.L. 1998. American forest policy – global ethical tradeoffs. BioScience. 48(6): 471-477. doi:10.2307/1313245

APPENDIX: SILVICULTURE WHITE PAPERS

White papers are internal reports, and they are produced with a consistent formatting and numbering scheme – all papers dealing with Silviculture, for example, are placed in a silviculture series (Silv) and numbered sequentially. Generally, white papers receive only limited review and, in some instances pertaining to highly technical or narrowly focused topics, the papers may receive no technical peer review at all. For papers that receive no review, the viewpoints and perspectives expressed in the paper are those of the author only, and do not necessarily represent agency positions of the Umatilla National Forest or the USDA Forest Service.

Large or important papers, such as two papers discussing active management considerations for dry and moist forests (white papers Silv-4 and Silv-7, respectively), receive extensive review comparable to what would occur for a research station general technical report (but they don't receive blind peer review, a process often used for journal articles).

White papers are designed to address a variety of objectives:

(1) They guide how a methodology, model, or procedure is used by practitioners on the Umatilla National Forest (to ensure consistency from one unit, or project, to another).

(2) Papers are often prepared to address ongoing and recurring needs; some papers have existed for more than 20 years and still receive high use, indicating that the need (or issue) has long standing – an example is white paper #1 describing the Forest's big-tree program, which has operated continuously for 25 years.

(3) Papers are sometimes prepared to address emerging or controversial issues, such as management of moist forests, elk thermal cover, or aspen forest in the Blue Mountains. These papers help establish a foundation of relevant literature, concepts, and principles that continuously evolve as an issue matures, and hence they may experience many iterations through time. [But also note that some papers have not changed since their initial development, in which case they reflect historical concepts or procedures.]

(4) Papers synthesize science viewed as particularly relevant to geographical and management contexts for the Umatilla National Forest. This is considered to be the Forest's self-selected 'best available science' (BAS), realizing that non-agency commenters would generally have a different conception of what constitutes BAS – like beauty, BAS is in the eye of the beholder.

(5) The objective of some papers is to locate and summarize the science germane to a particular topic or issue, including obscure sources such as master's theses or Ph.D. dissertations. In other instances, a paper may be designed to wade through an overwhelming amount of published science (dry-forest management), and then synthesize sources viewed as being most relevant to a local context.

(6) White papers function as a citable literature source for methodologies, models, and procedures used during environmental analysis – by citing a white paper, specialist reports can include less verbiage describing analytical databases, techniques, and so forth, some of which change little (if at all) from one planning effort to another.

(7) White papers are often used to describe how a map, database, or other product was developed. In this situation, the white paper functions as a 'user's guide' for the new product. Examples include papers dealing with historical products: (a) historical fire extents for the Tucannon watershed (WP

Silv-21); (b) an 1880s map developed from General Land Office survey notes (WP Silv-41); and (c) a description of historical mapping sources (24 separate items) available from the Forest's history website (WP Silv-23).

The following papers are available from the Forest's website: Silviculture White Papers

Paper #	Title
1	Big tree program
2	Description of composite vegetation database
3	Range of variation recommendations for dry, moist, and cold forests
4	Active management of Blue Mountains dry forests: Silvicultural considerations
5	Site productivity estimates for upland forest plant associations of Blue and Ochoco Mountains
6	Blue Mountains fire regimes
7	Active management of Blue Mountains moist forests: Silvicultural considerations
8	Keys for identifying forest series and plant associations of Blue and Ochoco Mountains
9	Is elk thermal cover ecologically sustainable?
10	A stage is a stage is a stage…or is it? Successional stages, structural stages, seral stages
11	Blue Mountains vegetation chronology
12	Calculated values of basal area and board-foot timber volume for existing (known) values of canopy cover
13	Created opening, minimum stocking, and reforestation standards from Umatilla National Forest Land and Resource Management Plan
14	Description of EVG-PI database
15	Determining green-tree replacements for snags: A process paper
16	Douglas-fir tussock moth: A briefing paper
17	Fact sheet: Forest Service trust funds
18	Fire regime condition class queries
19	Forest health notes for an Interior Columbia Basin Ecosystem Management Project field trip on July 30, 1998 (handout)
20	Height-diameter equations for tree species of Blue and Wallowa Mountains
21	Historical fires in headwaters portion of Tucannon River watershed
22	Range of variation recommendations for insect and disease susceptibility
23	Historical vegetation mapping
24	How to measure a big tree
25	Important Blue Mountains insects and diseases
26	Is this stand overstocked? An environmental education activity
27	Mechanized timber harvest: Some ecosystem management considerations
28	Common plants of south-central Blue Mountains (Malheur National Forest)
29	Potential natural vegetation of Umatilla National Forest
30	Potential vegetation mapping chronology
31	Probability of tree mortality as related to fire-caused crown scorch

Paper #	Title
32	Review of "Integrated scientific assessment for ecosystem management in the interior Columbia basin, and portions of the Klamath and Great basins" – Forest vegetation
33	Silviculture facts
34	Silvicultural activities: Description and terminology
35	Site potential tree height estimates for Pomeroy and Walla Walla Ranger Districts
36	Stand density protocol for mid-scale assessments
37	Stand density thresholds as related to crown-fire susceptibility
38	Umatilla National Forest Land and Resource Management Plan: Forestry direction
39	Updates of maximum stand density index and site index for Blue Mountains variant of Forest Vegetation Simulator
40	Competing vegetation analysis for southern portion of Tower Fire area
41	Using General Land Office survey notes to characterize historical vegetation conditions for Umatilla National Forest
42	Life history traits for common Blue Mountains conifer trees
43	Timber volume reductions associated with green-tree snag replacements
44	Density management field exercise
45	Climate change and carbon sequestration: Vegetation management considerations
46	Knutson-Vandenberg (K-V) program
47	Active management of quaking aspen plant communities in northern Blue Mountains: Regeneration ecology and silvicultural considerations
48	Tower Fire…then and now. Using camera points to monitor postfire recovery
49	How to prepare a silvicultural prescription for uneven-aged management
50	Stand density conditions for Umatilla National Forest: A range of variation analysis
51	Restoration opportunities for upland forest environments of Umatilla National Forest
52	New perspectives in riparian management: Why might we want to consider active management for certain portions of riparian habitat conservation areas?
53	Eastside Screens chronology
54	Using mathematics in forestry: An environmental education activity
55	Silviculture certification: Tips, tools, and trip-ups
56	Vegetation polygon mapping and classification standards: Malheur, Umatilla, and Wallowa-Whitman National Forests
57	State of vegetation databases for Malheur, Umatilla, and Wallowa-Whitman National Forests
58	Seral status for tree species of Blue and Ochoco Mountains

REVISION HISTORY

June 1993: First version of this white paper (5 p.) was prepared in June 1993 as handout material for a mechanized timber harvest workshop held in Pendleton, Oregon.

January 2017: Minor formatting and editing changes were made, including adding a white-paper header and assigning a white-paper number. An appendix was added describing a silviculture white paper system, including a list of available white papers. A short Historical Context section was added.