WHITE PAPER

USDA Forest Service Pacific Northwest Region Umatilla National Forest

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Douglas-fir Tussock Moth: A Briefing Paper[1]

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HISTORICAL CONTEXT

Indian Creek portion of Heppner Ranger District (RD) was experiencing an intense outbreak of a defoliating insect called Douglas-fir tussock moth during late 1990s and early 2000s (fig. 1). Other national forests of the Pacific Northwest Region were also experiencing high populations of tussock moth during this era. For this reason, the Pacific Northwest Regional Office completed an environmental impact statement to analyze whether tussock-moth suppression measures were warranted and, if so, how and where they should be implemented to reduce insect populations to non-outbreak levels.

The Blue Mountains have a long history of defoliator outbreaks associated primarily with western spruce budworm and Douglas-fir tussock moth (as described in an Historical Outbreaks section below). In early 2000s, there was concern that tussock moth impacts like those observed on Heppner RD could occur elsewhere on Umatilla National Forest (NF) and, if so, then perhaps they would eventually become as intense, in terms of tree damage and tree mortality, as during a large outbreak affecting Walla Walla RD in early 1970s (1972-74).

In the early 2000s, many questions about tussock moth were being asked by Umatilla NF employees, and by publics using the Forest for hunting or outdoor recreation. This interest related primarily to an ongoing outbreak on Heppner RD (fig. 1), which had affected about 3,500 acres as of May 2001. Information presented in this white paper was compiled in 2001, as a short briefing paper and a 3-page website, in response to tussock-moth questions.

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

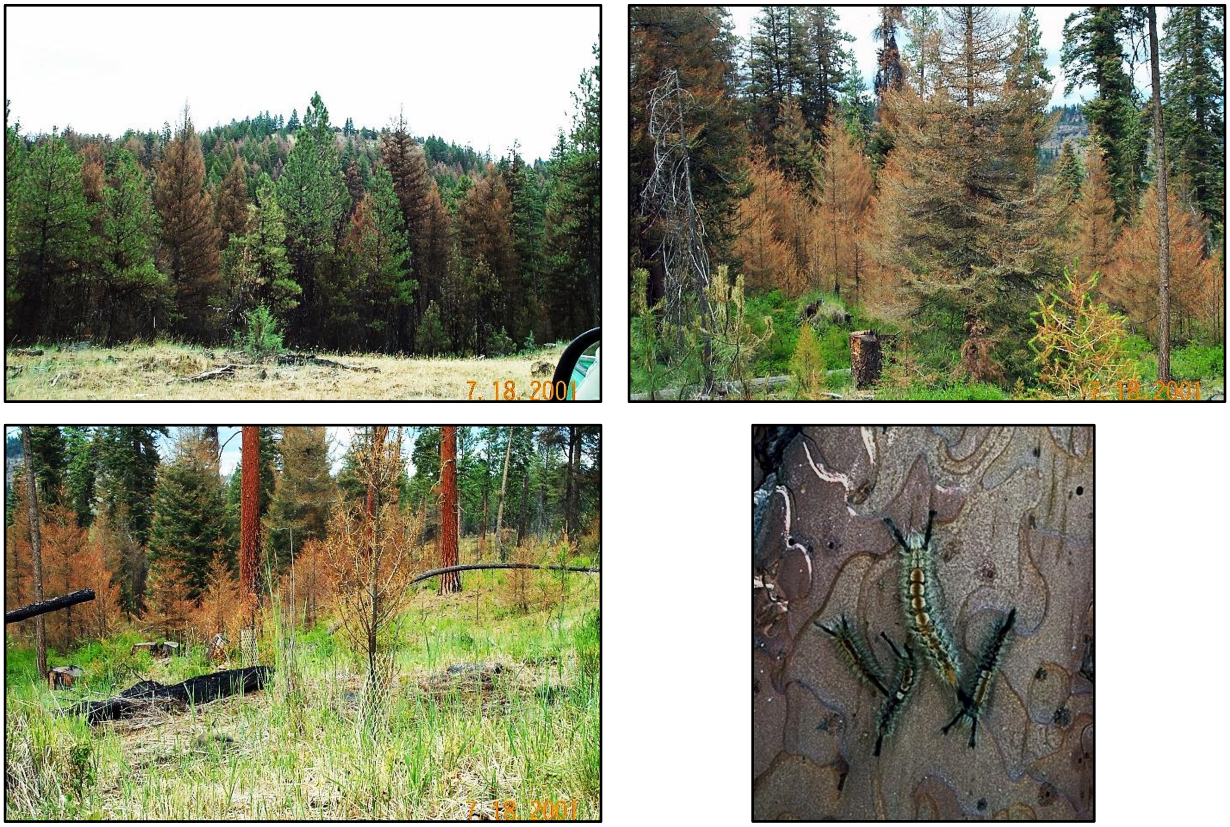
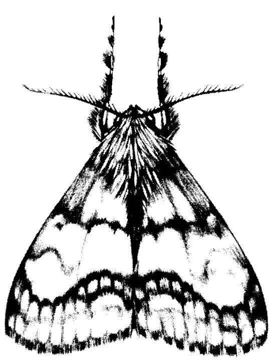


Figure 1 – Douglas-fir tussock moth feeding effects at Indian Creek portion of Heppner Ranger District. Tussock moth affected larger trees (upper left), mid-size poles and saplings (upper right), and seedlings (lower left) in Indian Creek, Lovlett Creek, Big Willow Springs Creek, Happy Jack Spring, and The Knob areas of Heppner RD. At one point, tussock moth populations were so high they were swarming on non-host species such as ponderosa pine (lower right, showing tussock-moth larvae on bark of a mature ponderosa pine), and deciduous shrub species were being defoliated as well.

INTRODUCTION (REFLECTS 2001 CONTEXT)

You probably heard that the Blue Mountains might experience a Douglas-fir tussock moth outbreak during the next few years. This prediction was based on an early-warning system utilizing pheromone traps to monitor tussock moth population levels (pheromones are biochemicals whose odor is used to attract insects). The early-warning system was developed during the last major tussock-moth outbreak in the 1970s; it was implemented West-wide in 1980 as one way to help predict future outbreaks.



This briefing paper is intended to provide some background information about Douglas-fir tussock moth, including its history here on the Umatilla NF, and to speculate about what we could expect if an outbreak occurs in the next year or so.

Douglas-fir tussock moth (DFTM) is a native insect of the Blue Mountains; unlike larch casebearer or white pine blister rust, it was not introduced from somewhere else. Tussock moth defoliates true firs (grand fir primarily) and Douglas-fir from the top down, killing trees outright or setting them up for future attack by bark beetles such as Douglas-fir beetle or fir engraver. Unlike western spruce budworm, another major defoliator causing widespread tree damage in the Blues between 1980 and 1992, tussock moth can consume all of a tree's foliage in a hurry – infested trees begin to turn reddish-brown in June and may be entirely defoliated (all of the needles are gone) by mid-July.

Tussock moth, spruce budworm, larch casebearer, and other defoliating insects tend to cause damage in their larval stage (a tussock moth larvae is shown below) rather than an adult stage (an adult tussock moth is shown above, at bottom of previous page).

Tussock moth populations are cyclic, rising on average about every 9 years in the western United States. Not every population peak results in an outbreak – in northeastern Oregon, it appears that an outbreak happens to coincide with every second or third population peak. Outbreaks were recorded for the Blue Mountains in 1928-1929, 1937-1939, 1946-1948, 1963-1965, 1972-1974, and 1992-1993.

Dendrochronology studies found that tussock moth has been active in the Blues for as long as their mixed-conifer forest habitat has been available (note that dendrochronology involves interpretation of tree cores to infer climatic cycles, fire cycles, insect outbreaks, etc.). Dendrochronology analysis indicates that tussock moth might have defoliated mixed-conifer stands in the Drumhill Ridge area (Walla Walla Ranger District) during 1843-1845, 1852-1854, and in 1875.

HISTORICAL OUTBREAKS

There have been two major Douglas-fir tussock moth outbreaks for which we have defoliation or damage maps and written records. The first recorded outbreak was discovered on August 20, 1946 when a pine beetle survey crew was cruising a check plot near Troy, Oregon. After the survey crew reported an outbreak, an entomologist was dispatched from the Forest Insect Laboratory in Portland to examine the situation.

When entomologist Walter J. Buckhorn scouted the Troy area on September 18 and 19, 1946, he found that 10,000 to 12,000 acres of mixed-conifer forest had been defoliated by tussock moth, with complete tree mortality occurring on some 500 to 600 acres in patches ranging up to 50 acres. Residents told him that 1946 was the second year of an outbreak. Heavy egg deposits indicated that tussock moth populations were still increasing, and that many trees would probably be killed in 1947.

Buckhorn was particularly interested in the Troy-area infestation because it coincided with a much larger tussock moth outbreak in central Idaho and northeastern Washington. Extensive control operations were already being planned for Washington and Idaho outbreak areas. He decided that the Troy infestation was close enough to a central Idaho outbreak to coordinate a control program involving both areas.

Buckhorn and the Walla Walla District Ranger completed an aerial survey of the Troy outbreak in March of 1947; their sketch map showed 56,065 acres infested to some degree, with heavy defoliation occurring on 1,265 acres, moderate defoliation on 23,890 acres, and light defoliation on the remainder (30,910 acres).

Between June 24 and July 1 of 1947, 14,000 acres of the tussock moth outbreak near Troy were sprayed with a solution of DDT and fuel oil (one pound of DDT in one gallon of fuel oil per acre). An airplane carrying 1,000 gallons of spray solution per trip was used for the project; it operated from the Moscow, Idaho airport located about 65 miles from the Troy area (fig. 2).

Tussock moth control treatments were confined to commercially valuable timber only; unmerchantable and lightly infested stands were excluded because their timber value or defoliation level was too low to economically justify control expenditures.

Another regional tussock moth outbreak affected the Umatilla National Forest in the early 1970s. Initial damage was noticed as 2,400 acres of defoliation in the Okanogan Valley of north-central Washington in 1971. In 1972, over 197,000 acres were defoliated in Oregon and Washington.

Perhaps some of the worst tussock-moth damage in this early-1970s outbreak occurred on the north end of Umatilla National Forest. By 1974, 44% of defoliated acreage in the entire outbreak area (including state, private, and other federal ownerships) was on the Umatilla National Forest – 353,850 acres out of a total outbreak area of 800,000 acres!

How did Umatilla National Forest respond to the early-1970s outbreak? The Forest Service acted quickly and decisively to tussock-moth damage, and political aspects of this story are fascinating.[2]

DDT, a powerful chemical insecticide used in the 1947 spray project near Troy, was found to affect many other organisms in addition to insect defoliators (DDT was also used against western spruce budworm during late 1940s and the 1950s). Due to its environmental persistence and a broad spectrum of organisms affected by it, William Ruckelshaus, director of the Environmental Protection Agency, banned DDT on June 14, 1972.

In the context of the early-1970s tussock moth outbreak, EPA's ban couldn't have come at a worse time. Banning DDT removed the most effective weapon against tussock moth during the first year of what would turn out to be the largest and most severe tussock-moth outbreak ever recorded in North America.

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[2] This historical material was taken from unpublished documents available in Umatilla National Forest's silviculture library archives (http://www.fs.usda.gov/detail/umatilla/learning/history-culture/?cid=stelprdb5200838); from a published report: **Graham, D.A.; Mounts, J.; Almas, D. 1975.** 1974 cooperative Douglas-fir tussock moth control project. Washington, DC: USDA Forest Service. 75 p.; and from a journal article: **Mounts, J. 1976.** 1974 Douglas-fir tussock moth control project. Journal of Forestry. 74(2): 82-86. doi:10.1093/jof/74.2.82

Figure 2 – Budworm spraying in the Blue Mountains. Although this image shows a plane applying insecticide for control of western spruce budworm populations, the same technique was used in early summer of 1947 to help control a tussock moth outbreak near Troy, Oregon.

After DDT was banned, USDA Forest Service immediately began testing other potential insecticides. Testing included Zectran, carbaryl (Sevin), Pyrethroid, and Dylox, all of which were chemical compounds, and two possible biological control agents – *Bacillus thuringiensis* (a bacteria) and a natural virus.

After a Forest Service petition requesting emergency use of DDT was denied by EPA in June 1973, 32,000 acres of the Walla Walla watershed was immediately sprayed with Zectran during a test project.

On Thursday, August 16, 1973, when United States Senator Bob Packwood was reviewing tussock moth damage near La Grande, Oregon, a forest fire broke out near Perry and burned nearly 6,000 acres in a short period of time, including an area damaged by tussock moth. This Rooster Peak fire directly threatened La Grande, burning several homes at its edge and coming within yards of others.

Over 1,500 people fought the Rooster Peak fire, and many of them were local residents of La Grande. The National Guard was activated to help evacuate homeowners from foothill areas. Shortly after this fire event, an area-wide fire closure was implemented because of high fire danger from tussock moth damage and an on-going drought.

Initially, Senator Bob Packwood had no official position regarding EPA's ban on the use of DDT. Following the Rooster Peak fire and after examining thousands of acres of tussock-moth damage from both the air and the ground, Senator Packwood eventually expressed this opinion regarding a DDT ban: "But, now I'm convinced their decision was wrong" (in reference to EPA's decision not to authorize use of DDT for tussock moth control).

Following Packwood's visit and the Rooster Peak fire, petitions began circulating in northeastern Oregon requesting that an EPA ban on DDT be lifted so it could be used against tussock moth. On August 31st of 1973, Secretary of Agriculture Earl Butz visited the Blues to view tussock moth damage first hand.

In January 1974, EPA held hearings in Portland to consider possible DDT use against tussock moth. On January 30, 1974, a Tussock Moth Control Association of La Grande, Oregon presented petitions containing 57,000 signatures to Vice President Gerald Ford; petitions requested that DDT be allowed for emergency use against tussock moth. On February 26, 1974, EPA director Russell Train authorized emergency use of DDT against tussock moth only.

After a Johnny Appleseed clean-up weekend in early June 1974, when 2,000 four-wheel drive club volunteers performed clean-up work in tussock moth damaged areas, a tri-Region, tri-State DDT spray project began on June 9, 1974 on the Colville Indian Reservation. By June 22, DDT spraying was underway in the Blue Mountains, eventually concluding on July 25, 1974.

A total of 426,559 acres were sprayed to reduce tussock moth population levels in 1974, including 32,706 acres on the Umatilla NF and 72,717 acres on the Wallowa-Whitman NF.

Although applying an insecticide was a primary Forest Service response to tussock moth defoliation, salvage sales to harvest damaged and dead timber were also completed. The first Umatilla NF tussock-moth salvage sale was sold on November 28, 1972. The last of 40 tussock-moth salvage sales sold on September 3, 1974.

Some old harvest units in places like Ruckel Ridge, Phillips Creek, and upper Tiger Canyon date from a tussock-moth salvage program during the early 1970s.

The following notes were prepared by Paul Bouchard, a long-term employee and forester assigned to Pendleton Ranger District of the Umatilla NF. They describe well how the Pendleton RD responded to the tussock moth outbreak.

"The 1973 aerial sketch map showing tussock moth defoliation became the planning map for the salvage timber harvest program. The heavy infestation and damage areas were used to rough out potential timber sale area boundaries. By estimating the potential treatment area and timber volume by damage classes, a rough estimate of total sale acreage and salvage volume was then available for program management purposes (personnel, supplies, funding needs, etc.).

It was estimated that the tussock moth salvage program could involve as much as 210 million board feet of timber volume from a gross analysis-area acreage of 66,000 acres, of which 38,000 was forested. All of the potential treatment areas were reconnoitered from the air and sale area boundaries then established on 4" to the mile aerial photographs enlarged from a

1970 high-altitude reconnaissance flight. Areas more than 800 feet below the ridgelines and areas with small-diameter, dead white fir (usually in the headwaters of intermittent drainages) were eliminated from timber sale consideration.

Three potential silvicultural treatments were mapped from the aerial reconnaissance: clearcutting (completely dead areas); shelterwood cutting (mostly dead areas); and partial cutting (areas with intermixed mortality). Nearly pure inclusions of non-host tree species and light damage of host species were also mapped. Due to time and personnel limitations, a very extensive and limited ground check and plot cruise was made (plot locations were noted on aerial photographs). The cruise amounted to about a 2/10 of a 1% sample.

By correlating plot data with experienced estimates, a salvage timber harvest program was developed for 128 million board feet covering 55,000 gross acres and 23,000 net acres. Approximately 137 million board feet was cut and removed under 13 timber sale contracts (which was 105% of the appraised amount)."

TREATMENT OPTIONS

Before discussing possible treatment options, how do we know when an outbreak may occur? As a result of the 1970s outbreak, an early warning system was developed to monitor tussock moth population levels. As part of the early warning system, pheromone traps are strategically placed throughout eastern Oregon and Washington. These traps attract the adult male moth.

By trapping adult moths, resource specialists can determine if populations are stable or increasing. If average trap count exceeds 40 moths/trap, ground sampling is initiated to determine actual population levels. In recent years, the Umatilla NF has seen an overall increase in trap counts, with some counts exceeding a 40 moth/trap threshold, so ground sampling was initiated – it indicated that sub-outbreak to outbreak levels were present in some areas.

Now, how would the Umatilla National Forest respond to a tussock moth outbreak in the near future? The answer to this question is that "it all depends." The response could involve application of an insecticide but, if it did, the area treated would be much smaller and more focused than was done in the early 1970s.

The impetus for early 1970s spray projects was protection of high-value timber, but impetus for an early 2000s project would be protection of values related to fisheries, visual quality, recreation, and so forth.

Unlike the early 1970s, it is highly unlikely that chemical insecticides would be considered for a contemporary spray project; a polyhedrosis virus has been produced and stockpiled at a Forest Service lab in Corvallis, Oregon and would be available for application, in addition to *Bacillus thuringiensis* and other biological insecticides.

In 1999, a team of resource specialist began to address an anticipated outbreak (as indicated by the early warning system) of tussock moth on nine National Forest in Oregon and

Washington. This included the Colville, Okanogan, Wenatchee, Umatilla, Wallowa-Whitman, Malheur, Ochoco, Winema, and Fremont national forests.

In preparation for possible treatments, the team began a process of formulating an Environmental Impact Statement (EIS) to identify key issues and formulate a proposed action. In April 2000, a final EIS was published and released. In May, a Record of Decision (ROD) was signed by Pacific Northwest Region Regional Forester to allow use of an insecticide, TM-BioControl, to treat areas (of concern) identified in the EIS.

TM-BioControl is based on a natural virus of the tussock moth (similar to what was produced and stockpiled at Corvallis). This virus is specific to Douglas-fir tussock moth and other species of western tussock moths. The virus is the primary reason that tussock moth populations collapse naturally after a few years.

In June of 2000, 6,125 acres were treated with TM-BioControl on Pomeroy and Walla Walla ranger districts, Umatilla National Forest. Since the Regional EIS did not authorize the entire Umatilla NF to be treated with TM-BioControl, other actions may be needed if an outbreak was to occur in areas beyond those included in the EIS.

If no direct action was taken to suppress tussock-moth populations and mixed-conifer forests then suffered partial or complete tree mortality, it is possible that salvage timber sales would be completed to remove some of the dead trees. Timber salvage would only be considered for situations where tree removal was compatible with other resource values (and where it was permitted by standards and guidelines from the Umatilla NF Forest Plan).

Since tussock moth can kill entire stands of susceptible host type, and do it quickly, future risk of wildfires would also need to be considered. Damaged areas in a wildland-urban interface zone might pose a particularly high wildfire risk, so any salvage operations would probably be considered there first.

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
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

Paper #	Title
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

November 2014: First version of this white paper (4 p.) was prepared in May 2001 to help answer questions and address concerns about whether a tussock moth outbreak was imminent for Umatilla NF. This 2014 revision implemented minor editing changes.

December 2016: This update reformatted the original white paper into a contemporary style by adding a first page 'white paper' header, assigning a white paper number, and adding an appendix describing the silviculture white paper system.