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Douglas-Fir Tussock Moth in Northern Idaho and Western Montana: Current Activity and Historical Patterns

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Introduction

The objective of this report is to describe the current increase in Douglas-fir tussock moth (*Orgyia pseudotsugata* McDunnough) activity in northern Idaho and Montana. The report also relates current conditions to historical and future trends and larger scale increasing tussock moth activity in surrounding western states.

Life History and Population Dynamics

Outbreaks of Douglas-fir tussock moth are cyclical, occurring at 7- to 10-year intervals in the western United States (Mason and Luck 1978). The tussock moth is considered a "fast cycling" insect, where populations are explosive and increase quickly causing severe defoliation and mortality in just 1 to 2 years. Though outbreaks generally only last for 2-3 years, they can result in significant tree damage and mortality. The collapse is dramatic and it is difficult to find any tussock moths during the period between outbreaks. Favored hosts of the tussock moth are grand fir, Douglas-fir, and subalpine fir in northern Idaho and Douglas-fir in western Montana (USDA Forest Service Program Aid 1401 1987).

Defoliated trees turn reddish-brown in July and the first and most significant defoliation occurs on the terminal leader and tips of branches. Defoliation seen from aerial surveys is only apparent during an outbreak. Defoliation prior to

an outbreak is usually only evident from ground surveys the year prior to or during the first year of an outbreak. Hence, an early warning pheromone trapping system is very important for "fast cycling" insects such as the tussock moth. Trap catches usually have to be greater than an average of 25 moths per trap before any ground defoliation is evident.

Tussock moths overwinter in the egg stage and complete one generation per year. Emerging larvae feed on new foliage and disperse by wind. There are six larval instars and most defoliation is caused by feeding of later instars. Full-grown larvae are distinguished by two black tufts of hair behind their head and four dense "tussocks" of hair located along their back. The body hairs of tussock moth larvae can cause a skin irritation for some people. Pupation occurs in late July to early August. Once adults emerge, immobile females emit a strong sex pheromone to attract mobile males.

Predicting Tussock Moth Outbreaks

We have several tools available to help us predict if an outbreak might occur. To predict when an outbreak might occur, we evaluate historical population cycles, annual pheromone trap catches, early larval population estimates, defoliation of ornamental trees in residential areas, and tussock moth activity in surrounding western regions.

Historical Frequency of Outbreaks

Outbreaks of tussock moth usually occur in the same geographical locations (Mason and Luck 1978). Outbreaks have been recorded in northern Idaho from 1944 to 1947, 1963 to 1965, and from 1973 to 1975. A small area between Plummer and Moscow, Idaho experienced an outbreak in 1982. Outbreaks in western Montana have been recorded in the mid-sixties and seventies. A small area near Clearwater Junction, Montana was defoliated in 1983 (Table 1).

Although tussock moth populations are cyclical in the West, not all areas susceptible to tussock moth are defoliated during every outbreak period. Outbreaks in northern Idaho occur at regular intervals and more than 50 percent of the time are synchronized with larger scale western outbreaks. An historical tussock moth area near

Flathead Lake is also synchronized with larger scale western outbreaks more than 50 percent of the time. Many of these historical tussock moth areas (such as those in northern Idaho and western Montana) fail to reach outbreak status for 2-3 decades, but when they do, they should retain synchronization with surrounding regions (Shepherd et al. 1988) (Figures 1 and 2).

Severity of outbreaks also varies across regions. Areas in western Montana are less likely to be severely defoliated than those in northern Idaho and most other regions in the West (Shepherd et al. 1988). Severity and duration of outbreaks is probably associated with weather patterns (Shepherd et al. 1988), soil chemistry, individual tree susceptibility, forest continuity, and the amount and condition of nucleopolyhedrosis virus residing in the soil (Shepherd et al. 1988).

Table 1. Historical Outbreaks of Tussock Moth in Northern Idaho and Western Montana.

Area	Size-Outbreak	Outbreak Period
Kalispell, MT	40-399 ac	1963-1964
Hungry Horse, MT	<40 ac	1963-1964
Flathead Lake, MT	40-399 ac	1956
	<40 ac	1965
	400-3999 ac	1974-1975
St. Ignatius, MT	<40 ac	1974-1976
Ravalli, MT	<40 ac	1974-1975
Frenchtown, MT	400-3999 ac	1973-1975
Lolo, MT	400-3999 ac	1973-1974
Bonita, MT	<40 ac	1964
Clearwater Jct., MT	<40 ac	1983
Mica, ID	<40 ac	1963
Plummer, ID	40-399 ac	1956
	<40 ac	1982
Viola, ID	40-399 ac	1945-1947
Benewah Co., ID	>4000 ac	1944-1946
	400-3999 ac	1956
	>4000 ac	1963-1965
	>4000 ac	1972-1974
Latah Co., ID	>4000 ac	1945-1947
	>4000 ac	1963-1965
	>4000 ac	1972-1974
Moscow Mt., ID	40-399 ac	1944-1947
Orofino, ID	>4000 ac	1947
	>4000 ac	1955
	40-399 ac	1973-1974

SD
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M9
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Figure 1. Number of Acres Defoliated during Outbreak Periods between 1947 and 1974 in northern Idaho.

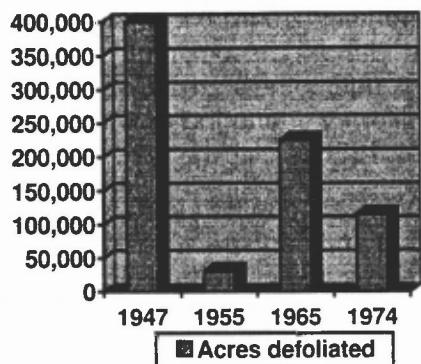
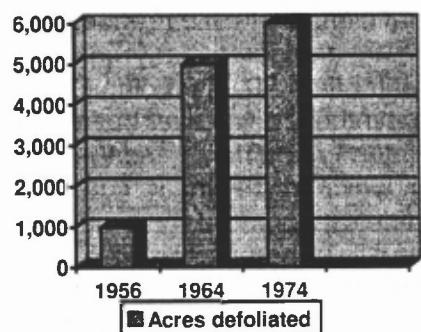


Figure 2. Number of Acres Defoliated during Outbreak Periods between 1956 and 1974 in western Montana.



Pheromone Trapping-An Early Warning System

Low-density populations of tussock moth do not cause visible defoliation that can be detected by aerial surveys. A pheromone trapping system was developed in 1975 to provide an early warning system to predict tussock moth outbreaks. The early warning system is intended to provide land managers advance notice that tussock moth populations are increasing to sub-outbreak levels (Daterman et al. 1979). This provides time for managers to evaluate options and identify areas where treatment may be desirable.

Pheromone trapping has been used to monitor tussock moth populations in northern Idaho and western Montana since 1975 (Figures 3 and 4). Trapping sites were established in areas of historical tussock moth activity. An average trap catch of 25 or more moths indicates that the population may be approaching sub-outbreak levels. An average trap catch of 40 or more moths indicates the need to do more extensive sampling for larvae or pupae to characterize the population in the general vicinity of the early warning plot (Daterman et al. 1999). The use of pheromone trapping as part of an early warning system has not been validated in northern Idaho and western Montana. We have not experienced a large-scale outbreak of tussock moth since the system was established in 1975.

Figure 3. DFTM pheromone trap catch between 1980-1989, average trap catch: (1) north of the Palouse River, (2) south of the Palouse River and (3) western Montana.

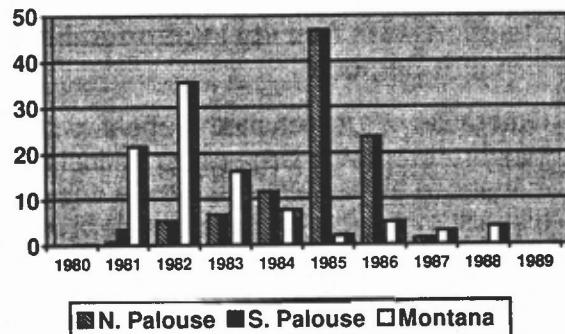
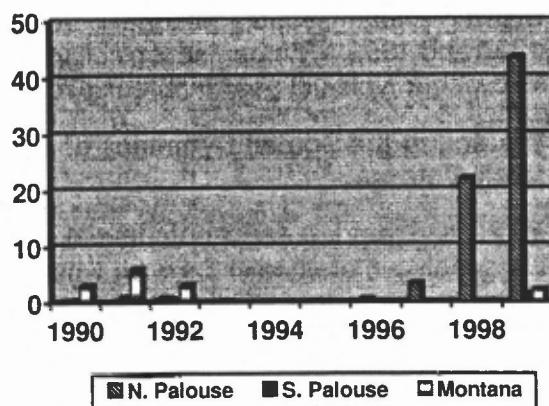


Figure 4. DFTM pheromone trap catch between 1990-1999, average trap catch: (1) north of the Palouse River, (2) south of the Palouse River and (3) western Montana.



Larval Population Estimation

Differences in numbers between early and late instar larvae can be used to predict if a population will continue to increase to outbreak levels or decline to low densities. Outbreaks of tussock moth are usually preceded by a generation in which a high proportion of larvae survive. Larval population estimates are useful in estimating present density and survival rate of larvae in the next generation (Mason and Torgersen 1983). Larval growth and survival is very dependent upon weather conditions (Shepherd et al. 1988). Larval sampling can usually predict an outbreak 1 to 2 years before tree defoliation is observed.

Defoliation of Ornamental Trees in Residential Areas

Defoliation of ornamental trees and shrubs by tussock moth in areas around Coeur D'Alene, Moscow, and other urban areas in Idaho and Montana has been observed prior to outbreaks in forested stands.

Tussock Moth Activity in Surrounding Western Regions

Outbreaks of tussock moth appear to be synchronized over large geographical areas as evidenced by historical outbreaks and by current tussock moth activity across western regions. In the Pacific Northwest, tussock moth trap catches have been increasing since 1996. Limited defoliation was seen in 1999. In 2000, 39,392 acres were treated with TM-Biocontrol (a naturally occurring virus that affects only Douglas-fir tussock moth and two other species of western tussock moths in Oregon and Washington). In California, pheromone trap catches began to rise in 1995. In 1998, 72 percent of traps averaged less than 25 moths per trap and 28 percent averaged 25 or more moths per trap (Wenz 1998). Defoliation was recorded in the southern Sierra Nevada (Sequoia National Forest) between 1997 and 1999. The population collapsed in 1999 following a typical 3-year outbreak cycle.

Predicting the Spatial Dynamics of a Tussock Moth Outbreak

In addition to predicting if an outbreak may occur, we are also interested in knowing where an outbreak may occur. Outbreaks often reoccur in the same general geographical area.

Localized weather patterns may be key in determining where tussock moth activity will occur in a given year within susceptible forests. In northern Idaho and western Montana, the areas most at risk to significant defoliation and tree damage and mortality are from Lewiston north to Coeur d Alene, Idaho. Tussock moth populations continue to expand into new areas, as in the case in southern California during the recent 1997-99 outbreak (Wenz 1998).

Hazard rating systems can be used to predict where defoliation and damage will likely occur based on site and stand characteristics. Several stand and site characteristics have been identified and linked to high tussock moth activity in the West. In northern Idaho, high-hazard stands are usually characterized by: (1) Ridge top or upper slope sites. These sites often have poorer soils, greater radiation, and stronger air currents than lower slope sites, which may directly affect tussock moth and its natural enemies. (2) Low volcanic ash. Soils with high volcanic ash have greater water holding capacities and, therefore, trees on these sites are less stressed by events such as defoliation. (3) Low site occupancy. As the ratio of total biomass to site productivity increases, defoliation decreases. (4) Average age of stand is greater than 50 years old. Older trees are less photosynthetically active, have a higher demand for water and nutrients and thus have reduced vigor, which makes them more susceptible to defoliation. (5) High proportion of grand fir. Grand fir is more susceptible to defoliation and damage than Douglas-fir (Stoszek and Mika 1978). Very limited validation of this hazard rating system has been done in northern Idaho and western Montana.

Current Tussock Moth Activity

Numbers of adult male tussock moths caught in pheromone traps in northern Idaho and western Montana have been increasing since 1998. At approximately 95 trapping sites in northern Idaho, about 12,000 moths were caught in 1999, compared to 6,500 moths in 1998. The Montana trap catch from 33 sites, totaled 371 moths in 1999, up from 17 in 1998. In 1999, many trapping sites north of the Palouse River in Idaho averaged greater than 40 moths per trap. Trap catch averages south of Palouse River and in western Montana were much lower. The exception was an area near St. Ignatius, Montana where the average was 64 moths per trap. In 1999, some

minor defoliation was observed on ornamental trees in residential areas, but none was seen in forested stands. In addition, larvae were found at most pheromone trapping sites.

In the spring of 2000, we detected both low and sub-outbreak tussock moth populations in areas of 1999 high trap catches via a larval sequential sampling scheme. Most of the populations in western Montana and south of the Palouse River were at low levels, which at the maximum rate of increase, is 2 years away from causing visible tree defoliation. Eighty percent of early warning sites sampled north of the Palouse River were at the sub-outbreak level, which has the potential of increasing to an outbreak level in 1 year (Mason 1978). We will continue to monitor adult populations with pheromone traps that were deployed in late July. In July 2000, the Idaho Department of State Lands treated 300 acres with *Bacillus thuringiensis* in the Mary Mineira McCroskey State Park.

In late July, we recorded approximately 35 acres of predominantly Douglas-fir defoliated by the Douglas-fir tussock moth on the Flathead Indian Reservation northeast of Ravalli, Montana. We will continue to monitor this population throughout the summer of 2000. If Douglas-fir tussock moth populations continue to build in this and other areas across the Region, management alternatives could be considered in 2001.

Predicting Future Tussock Moth Activity

The pheromone trapping system in northern Idaho and western Montana indicates that tussock moth populations are increasing in susceptible forested areas. This increasing tussock moth population trend is synchronized with increasing populations across other parts of the West. Susceptible forested stands in our Region have not been part of larger west-wide outbreak periods for the past 20 years.

Lack of fire or management could result in stand conditions that are likely to experience a tussock moth outbreak in the future because of increasing forest susceptibility. A recent Forest Health Analysis (Byler and Hagle 2000) of stands on the Clearwater and Nez Perce National Forests (encompassing historic tussock moth areas) between 1935-1975 showed an increase toward late seral cover types and larger tree structural classes and greater stand diversity. Based on

these results, they predicted that there should also be an increase in grand fir, Douglas-fir, and cedar/grand fir cover types and in larger tree-closed canopies and larger tree-broken canopies over the next 15 years; some of this will be in historic tussock moth areas. Successional changes toward these conditions will result in an increase in forest susceptibility to tussock moth. Stands with dense crown closure and larger trees have a higher likelihood of damage if a tussock moth outbreak occurs. Tussock moth defoliation can also predispose trees to bark beetle attacks.

How we view the results of an outbreak is largely dependent upon management objectives. The Forest Health Analysis highlights the importance of focusing on the outcomes of insects and diseases versus the insects and diseases themselves. Tussock moth outbreaks may result in mortality of larger grand fir and Douglas-fir, thus creating openings for more desirable early seral species such as larch and pines on some habitat types. However, for habitat types where grand fir and Douglas-fir are climax species, mortality of larger trees may result in reduced habitat for many important birds and animals.

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