APPENDIX TABLE OF CONTENTS

APPENDIX A: ACRES PROTECTED, BY FOREST LAND MANAGEMENT AREA A-1

APPENDIX B: TUSSOCK MOTH INFORMATION B-1
Douglas Fir Tussock Moth Outbreaks B-1
Natural Control B-1
Treatment of previous outbreaks B-3
Effectiveness of treatment in achieving project objectives B-4
Resurgence or Reinvasion Following Treatment B-4
Effects on the natural predators and parasites B-5
Long-Term Resistance of the Insect to Insecticide B-6
No Action Alternative B-6
Proposed Action B-6
Expanded Protection Alternative B-7
TM-BioControl Only Alternative B-7

APPENDIX C: PUBLIC INVOLVEMENT C-1
Introduction C-1
Planning C-1
Scoping C-1
Response Form Questions C-1
Other Means of Communication C-3
Mailings C-3
Response to Comments C-3

APPENDIX D: DFTM SAMPLING AND MONITORING D-1
General D-1
DFTM Early Warning Trapping System D-1
Background D-1
The DFTM Early Warning System D-1
Population Monitoring Process D-1
Ground Surveys D-2
Early Instar Larval Sampling D-2
Cocoon/Egg Mass Sampling D-2
Aerial Detection Survey D-2

APPENDIX E: EFFECTS OF B.T.K ON NON-TARGET MOTHS AND BUTTERFLIES E-1

APPENDIX F: RELEVANT FOREST PLAN STANDARDS AND GUIDELINES F-1

APPENDIX G: PROJECT GUIDELINES G-1
Project Plans G-1
Public Information Plan G-1
Pretreatment Reviews G-1
Operations G-1

Accidents **G-2**
Aerial Observation **G-2**
Spray Standards **G-2**
Mechanical Operations **G-2**
Sensitive Areas and Situations **G-2**
Accident Contingency Plan **G-2**
Spill Management **G-2**
Project Personnel Responsibilities **G-3**
Contractor Responsibilities **G-3**
Spill Control Techniques **G-3**
Protection of Threatened, Endangered, or Sensitive Species **G-3**
Monitoring **G-3**
Protection of Wilderness Values **G-3**

APPENDIX H: HUMAN HEALTH EFFECTS ANALYSIS **H-1**
Affected Environment **H-1**
Environmental Consequences **H-1**
Hazard Identification H-1
Exposure Assessment H-1
Dose-Response Assessment H-2
Risk Characterization H-2
Cumulative Effects H-2
Connected Actions H-2
1. Effects Due to the Douglas-fir Tussock Moth **H-3**
Hazard Identification H-3
Exposure Assessment H-3
Exposure-Response Assessment H-3
Risk Characterization H-3
Cumulative effects H-4
Connected actions H-4
Groups at risk H-4
2. Effects Due to Bacillus thuringiensis var. kurstaki (B.t.k.) **H-4**
Hazard Identification H-4
Exposure Assessment H-5
Dose-Response Assessment H-5
Risk Characterization H-6
Cumulative Effects H-6
Connected Actions H-7
Groups at Special Risk H-7
3. Effects Due to TM-BioControl **H-7**
Hazard Identification H-7
Exposure Assessment H-8
Dose-Response Assessment H-8
Risk Characterization H-8
Cumulative Effects H-8
Connected Actions H-8
Groups at Special Risk H-9
Comparison of Summary and Risk Assessments **H-9**
No Action Alternative H-10

Proposed Action H-10
Expanded Protection Alternative H-10
TM-BioControl Only Alternative H-10

APPENDIX I: MONITORING I-1
General I-1
Application I-1
Treatment effectiveness I-1

APPENDIX J: RESIDENTIAL, ADMINISTRATIVE & RECREATION SITES J-1

APPENDIX K: HAZARD RISK RATING AND MORTALITY RULES K-1
Defoliation Analysis K-1
Defoliation Rules K-2

APPENDIX L: LOCATION OF OLD-GROWTH/LOS L-1

APPENDIX A: ACRES PROTECTED, BY FOREST LAND MANAGEMENT AREA

Table A-1: Colville NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALTERNATIVE ACRES PROTECTED
Old Growth Dependent Species Habitat (MA 1)	21,070	540	19,580
Caribou Habitat (MA 2)	18,380	0	18,380
Recreation (MA 3A)	24,540	1,725	22,240
Recreation/Wildlife (MA 3B)	5,930	0	4,890
Downhill Skiing (MA 3C)	1,340	0	1,340
Research Natural Area (MA 4)	2,400	0	0
Scenic/Timber (MA 5)	120,010	2,680	114,500
Scenic/Winter Range (MA 6)	46,150	1,410	42,800
Wood/Forage (MA 7)	235,080	380	219,940
Winter Range (MA 8)	70,860	525	62,240
Wilderness Management (MA 9)	21,860	0	0
Semi-Primitive, Motorized Recreation (MA 10)	6,520	0	5,690
Semi-Primitive, Non-Motorized Recreation (MA 11)	47,420	0	46,850
TOTAL	**621,560**	**7,260** **1.2%**	**558,450** **89.8%**

Table A-2: Okanogan NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
Semi-Primitive, Non-Motorized Recreation (MA 4)	670	0	660
Visual Quality (MA 5)	34,730	32,110	34,530
Research Natural Areas (MA 8)	3,260	0	0
Bighorn Sheep Habitat (MA 11)	1,530	0	1,240
Lynx Habitat (MA 12)	7,120	0	6,450
Wildlife Habitat (MA 14)	61,220	390	49,250
Wilderness (MA 15, 40,41)	35,960	5,860	5,860
Developed Recreation in a Roaded Setting (MA 17)	1,740	1,740	1,740
Plant Communities (MA 18)	30	0	30
Minerals Exploration (MA 24)	2,580	0	2,270
Timber and Range (MA 25)	116,930	210	96,960
Deer Winter Range (MA 26)	35,150	20	29,410
Northwest Forest Plan (MA 30 - 50, except 40 & 41)	192,250	81,740	155,360
TOTAL	**493,170**	**122,070** **24.7%**	**383,760** **77.8%**

Table A-3: Wenatchee NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
Experimental Forest (EF-1)	150	0	0
Key Deer and Elk Habitat (EW-1)	20,390	8,490	13,000
Key Big Game Habitat/Unroaded (EW-3)	4,000	3,820	3,940
General Forest (GF)	59,240	38,520	46,730
Mather Memorial Parkway (MP-1)	1,100	920	950
Old Growth Management (OG-1)	110	90	90
Developed Recreation (RE-1)	180	0	15
Dispersed Recreation, Unroaded, Motorized (RE-2)	2,450	1,680	2,100
Dispersed Rec., Unroaded Non-Motorized (RE-3)	8,250	5,960	7,070
Dispersed Recreation/Unroaded/ Timber Harvest (RE-4)	670	660	660
Intensive Range Management (RM-1)	670	0	170
Research Natural Areas	230	0	0
Classified Special Areas – Scenic and/or Recreation (SI-1)	6,950	1,410	6,235
Classified Special Area – Other (SI-2)	970	830	890
Scenic Travel – Retention (ST-1)	16,160	10,780	12,330
Scenic Travel – Partial Retention (ST-2)	34,130	17,540	27,640
Wilderness (WI-1)	17,230	0	0
Scenic River (Proposed) (WS-1)	840	550	740
Recreation River (Proposed) (WS-2)	2,290	1,910	1,960
Other	610	170	380
TOTAL	**176,620**	**93,330** **52.89%**	**124,900** **70.7%**

Table A-4: Umatilla NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
Non-Motorized Dispersed Recreation (A 1)	20,590	1,050	17,720
OHV Recreation (A 2)	3,780	3,775	3,775
View shed 1 (A 3)	21,950	21,800	21,850
View shed 2 (A 4)	17,280	17,280	17,280
Roaded Natural (A 5)	4,130	180	2,780
Developed Recreation (A 6)	2,820	2,750	2,810
Wild & Scenic Rivers (A 7)	2,590	1,150	1,150
Scenic Area (A 8)	21,420	21,410	21,410
Special Interest Area (A 9)	2,110	170	1,275
Wenaha-Tucannon Special Management Area (A 10)	2,800	5	2,020
Wilderness (B 1)	236,650	5,890	5,890
Dedicated Old Growth (C 1)	32,140	15,560	27,860
Managed Old Growth (C 2)	1,870	110	690
Big Game Winter Range (C 3)	54,840	1,220	30,490
Wildlife Habitat (C 4)	171,780	8,430	113,950
Riparian (Fish & Wildlife) (C 5)	17,430	2,820	13,140
Special Fish Management Area (C 7)	54,610	800	18,920
Grass-Tree Mosaic (C 8)	46,850	14,660	40,930
Research Natural Area (D 2)	6,200	0	0
Timber & Forage (E 1)	42,250	430	32,280
Timber & Big Game (E 2)	124,600	1,040	65,740
Mill Creek Municipal Watershed (F 2)	6,670	6,590	6,670
High Ridge Evaluation Area (F 3)	590	180	320
Walla Walla River Watershed (F 4)	26,880	1,020	23,430
Other	6,830	1,990	7,460
TOTAL	**931,870**	**130,310** **14.0%**	**479,840** **51.5%**

Table A-5: Wallowa-Whitman NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
Timber Production Emphasis (MA 1,1W)	398,080	46,040	214,510
Wildlife/Timber (MA 3, 3A)	167,460	19,760	89,780
Wilderness (MA 4)	130,380	0	0
Phillips Lake Area (MA 5)	20	0	0
Back Country (MA 6)	30,040	9,030	17,540
Wild & Scenic Rivers (MA 7)	10,670	10,240	10,290
HCNRA, Snake River Corridor (MA 8)	10	0	0
HCNRA, Dispersed Recreation/Native Vegetation (MA 9)	48,100	0	40,210
HCNRA, Forage Production (MA 10)	48,610	1,850	26,930
HCNRA, Dispersed Recreation/Timber Management (MA 11)	44,940	5,240	31,390
Research Natural Areas (MA 12)	1,110	0	0
Homestead Further Planning Area (MA 13)	390	0	180
Starkey Experimental Forest & Range (MA 14)	13,810	0	7,420
Old Growth Preservation (MA 15)	42,770	13,620	28,960
Administrative & Recreation Site Retention (MA 16)	280	70	100
Power Transportation Facility Retention (MA 17)	1,670	10	690
Anadromous Fish Emphasis (MA 18)	21,360	4,660	11,070
TOTAL	**959,700**	**110,520** **11.5%**	**479,070** **49.9%**

Table A-6: Malheur NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
General Forest / Rangeland	357,990	23,200	164,230
Big Game Winter Range Maintenance (MA 4A)	74,390	1,180	31,470
Strawberry Mountain Wilderness (MA 6A)	44,890	0	0
Monument Rock Wilderness (MA 6B)	10,890	0	0
Scenic Area (MA 7)	2,800	70	1,140
Research Natural Areas (MA 9)	560	0	0
Semi-Primitive Non-Motorized Rec. Areas (MA 10)	17,570	1,620	10,840
Semi-Primitive Motorized Recreation Areas (MA 11)	8,390	1,590	4,845
Old Growth (MA 13)	52,690	11,060	36,940
Visual Corridors (MA 14)	96,320	27,030	56,000
Byram Gulch Municipal Supply Watershed (MA 17)	150	150	150
Long Creek Municipal Supply Watershed (MA 18)	230	0	110
Dry Cabin & Utley Butte Wildlife Emphasis Areas (MA 20A&B)	7,430	250	5,240
Wildlife Emphasis Area (MA 21)	23,750	5,260	16,360
Wild and Scenic River (MA 22)	7,220	1,340	5,740
Other	800	160	825
TOTAL	**706,070**	**72,910** **10.3%**	**333,890** **47.3%**

Table A-7: Ochoco NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
Wilderness (F 1)	16,490	0	0
Research Natural Areas (F 5)	1,080	0	0
Old Growth (F 6)	5,760	4,720	4,970
Summit National Historic Trail (F 7)	2,810	2,810	2,810
Rock Creek/Cottonwood Creek Area (F 8)	5,550	5,050	5,190
Silver Creek Roadless Area (F 10)	20	20	20
Lookout Mountain Recreation Area (F 11)	7,480	7,000	7,170
Eagle Roosting Areas (F 12)	5	0	0
Developed Recreation (F 13)	200	200	200
Riparian (F 15)	4,130	2,930	3,130
Bandit Springs Recreation Area (F 16)	270	90	120
Stein's Pillar Recreation Area (F 17)	420	290	310
Hammer Creek Wildlife/Recreation Area (F 18)	110	100	100
Deep Creek Recreation Area (F 19)	110	40	50
Winter Range (F 20)	1,090	610	670
General Forest Winter Range (F 21)	4,740	1,620	1,990
General Forest (F 22)	55,890	35,020	40,200
N. Fork Crooked River Recreation Corridor (F 23)	40	20	20
North Fork Crooked River Scenic Corridor (F 24)	60	40	40
Highway 26 Visual Corridor (F 25)	1,530	1,530	1,530
Visual Management Corridors (F 26)	3,000	2,995	3,000
Round Mountain National Recreation Trail (F 27)	490	490	490
Facilities (F 28)	15	5	10
Other	1,410	1,100	1,240
TOTAL	**112,700**	**66,680** **61.2%**	**73,260** **67.0%**

Table A-8: Winema NF Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
Semi-Primitive Recreation Area (MA 1)	9,750	0	5,190
Developed Recreation (MA 2)	1,570	0	1,200
Scenic Management (MA 3)	30,100	860	6,030
Unique Management Areas (MA 4)	6,940	30	30
Wilderness (MA 6)	22,940	0	0
Old Growth Ecosystems (MA 7)	8,760	3,030	3,040
Riparian Areas (MA 8)	950	0	60
Bald Eagle Habitat (MA 9)	12,430	370	1,750
Big Game Winter Range (MA 10)	2,030	1,290	1,290
Timber Production (MA 12)	89,520	18,030	23440
Research Natural Areas (MA 13)	720	0	0
Upper Williamson (MA 15)	90	0	0
Late Successional Reserves (MA 16)	44,080	0	24,930
Riparian (MA 18)	7,470	1,000	4,240
TOTAL	**237,350**	**24,610** **10.4%**	**71,200** **30.0%**

Table A-9: Fremont NF – Acres in Forest Plan Management Allocations

LAND ALLOCATION (MANAGEMENT AREA #)	ACRES IN HOST TYPE NO ACTION	PROPOSED ACTION & TM-BIOCONTROL ONLY ALT. ACRES PROTECTED	EXPANDED PROTECTION ALT. ACRES PROTECTED
Mule Deer Forage and Cover on Winter Range (MA 1)	1,540	0	30
Old Growth Habitat for Dependent Species above the Management Requirement Level (MA 3)	140	0	0
Scenic Viewsheds (MA 6)	1,320	190	820
Wilderness (MA 10)	710	0	0
TOTAL	**3,710**	**190** **5.4%**	**850** **23.2%**

APPENDIX B: TUSSOCK MOTH INFORMATION

Outbreaks of the Douglas-fir tussock moth occur periodically. Many people who lived in eastern Oregon still remember the tussock moth outbreak in the early 1970's. Others relate their concerns with the Douglas-fir tussock moth in the context of their experience with another major forest defoliator, the western spruce budworm *Choristoneura occidentalis Freeman*. It is important to understand the differences of the biology and life histories of these two insects in order to address some of these concerns.

Some of the questions that arise when talking about potential spray projects are:

- What is the effectiveness of the proposed treatment in achieving the objective;
- Will insect populations come back after treatment;
- What are treatment effects on the natural predators and parasites;
- Will the treatment contribute to the longer-term resistance of the insect to the insecticide?

In order to address these questions, a review of information on such things as past outbreaks and treatments, insect biology, and natural control factors was conducted.

DOUGLAS FIR TUSSOCK MOTH OUTBREAKS

Douglas-fir tussock moth outbreaks occur periodically, approximately every 7-11 years (Mason and Luck, 1978; Swetnam, et.al., 1995; Mason, et.al., 1997). These outbreaks last for 3-4 years and then collapse. The collapse is dramatic, and insects are very rare and difficult to find during non-outbreak periods. Outbreak patterns of DFTM over western North America historically appear to be synchronous, particularly in British Columbia, Washington, Oregon, and northern Idaho. Populations increase to outbreak and collapse in a variable cycle on an average of every 9 years. The dates most outbreaks begin may vary slightly between regions, but most outbreaks end the same year (Shepherd, et.al, 1988).

The Douglas-fir tussock moth belongs to the category of what are referred to as *"fast-cycling"* insects as opposed to the western spruce budworm, which is a *"sustained cycle"* insect (Shepherd, 1994). The difference in these two types of characteristics determines the appropriateness and success of a proposed treatment. Characteristics of a "fast-cycling" insect are that populations are explosive in nature, increasing very quickly, causing severe defoliation and mortality in just one or two years, and then, just as quickly, collapsing. A sustained-cycle insect outbreak builds up more slowly, and lasts for a longer period of time. Severe damage appears only after a number of years of defoliation and impact is related more to duration of defoliation, rather than intensity of defoliation, as occurs in the Douglas-fir tussock moth (Shepherd, 1994). This difference is due, in part, to feeding habits. The western spruce budworm feeds only on the new buds and growth each year, and does not feed on the older needles; thus, it is over a period of several years, after older needles begin to drop naturally, and are not replaced by newer ones, that the tree begins to take on an overall defoliated appearance. Young Douglas-fir tussock moth larvae begin by feeding on the younger, tender new growth, but as they mature, they actively feed on the older needles and can completely defoliate a tree within a couple months. Partial defoliation, at least over a short period of time, is probably not detrimental, and may be somewhat beneficial to the tree. The physiological responses of a tree that receives only partial defoliation (western spruce budworm) versus one that receives severe defoliation would be different (Parks, et.al. 1994). In addition, western spruce budworm outbreaks are speculated to decline from lack of quality food and possibly a weather-related occurrence. It is also likely that because of the longer outbreak cycle, natural parasites and predators are able to develop and catch up with their host population. On the other hand the Douglas-fir tussock moth develops high numbers of individuals at one time causing competition for food and creating an opportunity for a contagion to spread quickly. As a means of comparison, when monitoring insect population numbers, an "outbreak" of western spruce budworm often measures 20-60 larvae per square meter of foliage, but can reach numbers as high as 200. A tussock moth outbreak often measures as many as 150-600 larvae per square meter of foliage.

NATURAL CONTROL

There are a number of fungi and viruses that affect the western spruce budworm, however, because they are individual feeders that remain isolated from each other for much of their life cycle, it is difficult for an epizootic to become established in the population (Fleming, 1985), and viruses do not play a major role in the outbreak cycle.

In contrast, the Douglas-fir tussock moth virus is one of the most virulent viruses known (cited in Hughes, 1978), and its role in the collapse of DFTM outbreak populations is well documented. It has been reported as the reason collapse of outbreaks in Washington, Oregon, Montana, Idaho, California, and British Columbia (cited in Torgersen and Dahlsten, 1978). As early as an outbreak in 1929, in Idaho, Blach (1932) noticed the ground covered with living and dead caterpillars, many of which had died from starvation, or apparently were diseased. Steinhaus first reported a nuclear polyhedrosis virus in tussock moth larvae collected in Washington, Oregon, and Idaho in 1947 (cited in Thompson, 1978). The virus has been reported in association with almost every outbreak since. Apparently, in the absence of extremely high populations and the virus, the outbreak can continue past the normal 3-4 year cycle.

One outbreak in New Mexico persisted for a number of years, slowly spreading from ornamentals in the city of Los Alamos, where it was first noticed in 1968, to trees in the adjacent canyons. This infestation did not exhibit the 3 year outbreak cycle pattern characteristic of outbreaks elsewhere, where populations are brought under control by an epizootic of virus. Tests on the populations found no incidence of virus in 1977 or the spring of 1978 (Hofacker, et al., 1979).

The virus persists in the soil at very low levels between DFTM outbreaks. Thompson and Scott (1979) found that only a very small amount of the virus produced in an epizootic (1%) survived the first year in the soil. However, once it was safely ensconced in the forest duff layer, it was amazingly persistent. They found that 11 years after an epizootic, nearly 1/3 of the active virus surviving the first year in the duff, was still active, and nearly ½ had not become incorporated any deeper than the first inch of mineral soil. In a later study, (Thompson, et al, 1981) sampled the soil in an area where the last DFTM outbreak and epizootic had occurred over 40 years earlier, in 1937-38. In these studies, they found barely detectable (less than 45 polyhedral inclusion bodies/cm3) in 12 of the 15 positive bioassay samples. By comparing the virus survival to other outbreak areas, results suggest that about 50-75% of the active virus in the soil is lost in the first 10 years, and more than 99% in 41 years. Even after 41 years, however, soil samples from sheltered locations still contained enough active virus to infect tussock moth larvae. This suggests that the virus may be a natural component of the forest ecosystem for a long time, but is then reintroduced into the forest canopy during a subsequent outbreak.

Thompson and Scott (1979) also found that virus produced by different age classes varied. The virus produced in the early larval instars was largely inactivated on the foliage, presumably by solar radiation, and never became incorporated in the duff, at least while it was still active. These smaller larvae do not fall from the foliage, but their bodies remained glued to needles where other larvae were likely to encounter the virus. A larger amount of the virus is produced in older larvae and is subsequently incorporated into the duff when they die. As older larvae die from virus infection, they hang; head down, with their posterior abdominal prolegs attached to the foliage. After death, they fall to a lower branch or the forest floor. They usually rupture, and their liquefied body contents splatter into the organic litter on the forest floor or onto an adjacent branch (Thompson, 1978).

Soil samples taken in various places within a previous outbreak demonstrate that different site conditions can affect the survival of the virus. Fifty soil samples from around charred stumps showed no polyhedrosis virus, while a series of samples taken under green timber immediately adjacent to the burned area showed virus in 49 of the 50 samples; a forest fire severe enough to burn down to the mineral soil can completely eliminate the residue of active virus in the forest floor (Thompson and Scott, 1979). In addition, of soil samples taken from young pole thickets, beneath exposed large individual trees, within clusters of large trees, and in disturbed (past salvage/logging activity) soil, and soil covered with a heavy duff layer, only samples from undisturbed soil beneath clusters of large trees in full or nearly full shade, still contained active virus (Thompson, et. al., 1981). In some cases, DFTM outbreaks controlled by the virus occur in areas where there has been no previously recorded outbreak; whether the virus is somehow transported there through air currents, or is residual from an outbreak from years before recording began, or is somehow maintained in the very low DFTM populations indigenous to that area, or a combination of these factors, is less sure.

Two distinct nuclear polyhedrosis viruses (NPV) affect the DFTM and a couple other members of the *Orgyia* genus. Both are in the genus *Baculovirus*, Subgroup A, which includes all nuclear polyhedrosis viruses. The morphological distinction between the two is in the way the virus particles are enveloped. In one, each rod-shaped nucleocapsid is enveloped, individually. This is the unicapsid morphotype designated SV (for single-rod virus). The second is a multicapsid virus with the nucleocapsid occurring in bundles or packets of two or more rods in a single envelope. These are designated BV (or bundled virus). Both are highly infectious, however, the BV appears to be slightly more infectious and was the one selected for development for eventual registration as TM BioControl (Hughes, 1978). BV is one of the most infectious viruses known and only a few polyhedra in the gut of a larva (perhaps fewer than 10) can initiate infection. They are infective to all instars, and pupae frequently die, presumably because they were infected late in the larval life. Adults are not known to have naturally occurring, clinically evident infections (Hughes, 1978). Complete resistance of tussock moth has not been found, either in extensive laboratory rearing or in field populations.

Undoubtedly the virus is the most important natural cause of the frequently observed, dramatic decline of DFTM populations that characteristically terminates a major DFTM outbreak. If the virus were not present in such situations, it is likely that other control factors would take over, although the response would be slower and they would not exert their influence as quickly as the virus. The virus does not appear to be a significant factor in endemic populations or sporadic flare-ups. Other factors, usually a complex of parasites, apparently act significantly on populations during these situations (Wickman, et.al., 1973; Mason, et. al., 1983). The Douglas-fir tussock moth has a number of insect parasites. A solitary egg parasite, *Telenomus californicus* Ashmead, is the most dominant and extremely efficient parasite (Torgersen and Dahlsten, 1978, Torgersen and Mason, 1985). Even when host insects are sparse, over 90% of egg masses may be attacked and 50% of the total egg mass complement may be destroyed (cited in Torgersen and Dahlsten, 1978). It over winters as the adult female and actively searches for and parasitizes eggs both in the fall, and in the spring up

until just prior to egg hatch (Torgersen and Ryan, 1981). The Douglas-fir tussock moth is apparently the only host for this parasite (Torgersen, 1981; Torgersen and Ryan, 1981). A Dipteran parasite, *Agria housei* Shewall, is a significant parasite of cocoons, sometimes causing 64-96% cocoon mortality (Torgersen, 1981). Torgersen (1981) listed about 88 species of parasites of Douglas-fir tussock moth that attack various life stages (eggs, larvae and pupae) of the DFTM. Different parasites can vary as the dominant parasite species in various geographic regions (cited in Torgersen and Dahlsten, 1978).

A variety of arthropods and insects, such as spiders and ants cause varying amounts of predation on DFTM life stages; however, insectivorous birds are a major source of mortality at low host densities. Birds prey on all host stages and estimates of predation range from 3 – 30% on eggs, 19% on late instar larvae, and 19 to 49% on pupae (cited in Torgersen and Dahlsten, 1978; Torgersen, et. al., 1983). This complex of predators and parasites undoubtedly maintains the DFTM populations at low levels during non-outbreak years, and is what continues to keep the populations down once an intervening factor such as starvation, virus, or treatment has brought the high outbreak populations down.

Other factors that have been determined to contribute significantly to mortality are early instar dispersal and starvation, secondary effects from food stress such as reduced fecundity, and sometimes weather factors such as frost damage to new foliage or, in one instance, consecutive days of extreme heat (cited in Torgersen and Dahlsten, 1978).

Insectivorous birds and ants are significant predators of fourth instar larvae through pupae at low population levels of western spruce budworm, but have much less influence at high populations (Torgersen, 1985a). Parasites do serve to keep the populations down, however, studies on parasitoids of various life stages of western spruce budworm suggest that parasites contributed little to variation in survival rates from fourth instar to adults, or the overall generation during outbreaks; and on a broad range of densities parasitism may have a less significant role (cited in Torgersen, 1985b).

TREATMENT OF PREVIOUS OUTBREAKS

Douglas-fir tussock moth suppression projects have been conducted periodically throughout Idaho, Oregon, Washington, California and British Columbia. From 1947 until 1974, DDT was the primary insecticide used, although tests and pilot projects using alternative chemical insecticides such as mexacarbate, trichlorfon, and carbaryl (Ciesla, 1978), as well as *Bacillus thuringiensis* and the virus were conducted. In almost all cases, treatment during operational projects was applied during the decline phase of the outbreak cycle. Generally, the need to control the outbreak was not recognized until after the first year of heavy defoliation was evident; subsequently, treatments were not applied until the following year. It is doubtful that any benefit was gained from treatment in these circumstances. Most defoliation and tree mortality occurs during the first year of heavy defoliation (Wickman, 1978). An insignificant amount of foliage protection may occur when treating in the year of the population decline, but it is doubtful that it is of any benefit. If foliage protection is an objective for treatment, it must take place prior to significant defoliation.

Although DDT was the primary insecticide used on larger outbreaks, as early as the 1960's projects using TM-BioControl were conducted. Approximately 4,400 acres were treated with TM-BioControl at Wheeler Peak, NV in 1960; and an aerial application of TM-BioControl, which appeared to have effectively reduced populations, was applied to over 12,500 acres on the Boise NF in 1963 (Tunnock, et. al., 1985). In the 1970s, several small studies using TM-BioControl in various formulations were conducted throughout Oregon, British Columbia, and California (Stelzer and Neisess, 1978a). In 1978, TM-BioControl was used in a pilot project near Los Alamos, NM (Hofacker, et. al., 1979) and in 1979; TM-BIOCONTROL was used operationally to control DFTM in Bear Canyon, west of Albuquerque, NM and on the Santa Fe NF near Los Alamos, NM (Hofacker, et. al., 1980). A test using TM-BioControl against the early stage of the outbreak cycle was conducted in B.C. in 1981 (Shepherd, et. al., 1984). In this study, populations were effectively controlled, while populations in the check plots continued to increase the following year until the natural epizootic occurred. It was also tested in Idaho in 1986, and 1991 (Beckwith, et.al. unpublished).

B.t.k. was field tested on various occasions in the early 1970's along with TM-BioControl (Stelzer and Neisess, 1978b). Additionally, it was used operationally in 1989 on 84,000 acres on the Plumas NF. Ninety percent mortality was achieved and severe defoliation was prevented (Hofacker, et. al., tech. coord.1990). In 1991, 116,000 acres were treated with B.t.k. on the Wallowa-Whitman NF (Hofacker, et.al. tech. coordinator. 1992).

Between 1983 and 1993, evaluation and suppression projects using B.t.k. were conducted for western spruce budworm suppression throughout Oregon and Washington, primarily east of the Cascades. These projects varied in size from 800 acres treated for experimental use, to almost 675,000 acres were treated operationally in one year; a total of approximately 1.288 million acres were treated with B.t.k. during a 15-year period. These projects were conducted on a variety of ownerships, including several of the Forests that are being considered for this analysis. Projects were conducted on the Wallowa-Whitman, Umatilla, Malheur, and Wenatchee NF's (Ragenovich, 1988; Sheehan, 1996b). Since Douglas-fir tussock moth and western spruce budworm both use the same host species, Douglas-fir and true fir, it is very possible that many of the areas being considered for protection from Douglas-fir tussock moth have been treated at least once, and in some cases twice with B.t.k. in the past 15 years. Although the target insect in these projects was western spruce budworm, most certainly, any Douglas-fir tussock

moth in the project areas was also exposed to the B.t.k. applications. The last B.t.k. treatment on any of these Forests occurred on parts of the Umatilla and Wallowa-Whitman NF's 7 years ago, in 1992.

EFFECTIVENESS OF TREATMENT IN ACHIEVING PROJECT OBJECTIVES

It is not the intent of the proposed treatment to attempt to control the DFTM outbreak throughout the entire outbreak area. The primary project objective is to provide foliage protection and prevent tree mortality within specific areas of concern. Many areas within the outbreak area would be left untreated. Because DFTM populations build up rapidly, cause significant defoliation in a short period of time, and then quickly collapse, the window for achieving this desired protection is very narrow, and the need to provide foliage protection is limited to one or two years. To prevent damage, populations need to be detected and controlled before tree defoliation occurs. Research indicates that most tree mortality from defoliation occurs during, or is the result of the peak year of defoliation (Wickman, 1978). Although the trees are also defoliated the following year, during the decline phase, when the population is collapsing, little benefit results from preventing this additional defoliation

The proposed insecticides are both biological. B.t.k. causes larvae to cease feeding within a day or two of ingestion. Larvae may continue to feed for slightly longer after ingesting the NPV, and the contagion effect of the virus spreading through the population may take several weeks. As a result, some defoliation can be expected the year of treatment. During a study using both B.t.k. and the virus, treated trees sustained about 15 – 22% defoliation while untreated trees had about 63% defoliation (Stelzer, et al., 1975). In 1981, Shepherd, et.al. (1984) tested a management strategy against very early first instar larvae. In this study, they achieved very little foliage protection the year of treatment, however, trees recovered quickly when populations disappeared due to the virus epizootic caused by the treatment. In another study in 1982, the application of the virus brought about the collapse of the population in the treated plots earlier than if it had been left to the naturally occurring NPV epizootic, and thus prevented tree mortality in these plots (Otvos, et.al. 1987a). Protection of foliage was negligible in year of treatment in plots treated with virus, because the virus is slower acting; however, in the following year treated plots had light tree mortality (4-7%) as compared to untreated plots that had 60-62% tree mortality. Trees sustained defoliation during the year of treatment, however, they recovered quickly when populations disappeared (Shepherd, et. al., 1984).

Treatment with either B.t.k. or TM-BioControl virus, early in the outbreak, prior to peak defoliation would achieve the project objective of protecting trees within the areas of concern until the natural collapse throughout the rest of the outbreak. Varying amounts of defoliation were observed the year of treatment based on the particular application strategy. Some defoliation would occur within the treated areas the year of treatment. However, the quick recovery of those trees and the prevention of subsequent tree mortality would achieve the short-term objective of maintaining the current condition of those sites during the current outbreak.

There has been little work in comparing the effectiveness of B.t.k. and virus on DFTM populations. Similar results in population reductions and foliage protection were achieved in one study (Stelzer, et. al. 1975). Both insecticides appear equally effective in bringing the populations down for the year or two prior to the widespread population collapse; and the parasite and predator complex takes over and is the important factor in low-level populations.

RESURGENCE OR REINVASION FOLLOWING TREATMENT

Concern of effectiveness of treatment is based primarily on the possibility that high insect populations would return one or two years following treatment. Experience with western spruce budworm treatment projects show that large scale projects, for the most part, do not provide more than one or two years of foliage protection (Sheehan, 1996a).

In the past, most operational DFTM projects were conducted during the decline phase of the outbreak cycle of the DFTM. The virus had already established an epizootic and populations were collapsing naturally. Resurgence of the outbreak would not have occurred regardless of whether the area had been treated or not, because natural factors had already come into play. However, there are some examples and instances where treatment did take place earlier in the outbreak cycle (i.e. prior to the decline phase of the outbreak). A field experiment with acephate in 1974 resulted in good foliage protection and only a small portion of the tussock moth populations survived. This resulted in a lower amount of NPV within the treated area. However, the lowered prevalence of the NPV in the treated plots did not result in recovery of the population to outbreak size (Thompson, 1978). A project conducted in 1981 in British Columbia using Virtuss (the registered Canadian DFTM virus insecticide) was aimed at treating in an early stage of the outbreak cycle of Douglas-fir tussock moth. Populations within the treated areas decreased, while populations in the untreated checks continued to increase (Shepherd, et al. 1984). When populations collapsed, they did so throughout the outbreak area, regardless of whether or not it had been treated (Otvos, et. al., 1987b). No resurgence of an outbreak DFTM population after treatment has ever been recorded. The extended DFTM outbreak in New Mexico (Hofacker, et. al., 1979) did not resurge once it had been treated.

Douglas-fir tussock moth population outbreaks and collapses occur regardless of treatment, and, based on the information available, treatment does not prolong an insect outbreak. This is also apparently true of sustained cycle

insects, such as the western spruce budworm, as well, where insect populations collapsed throughout the outbreak area at the same time, regardless of earlier treatments in some areas within the general outbreak (Sheehan, 1996a). Climatic and environmental factors are apparently the driving factors in determining the course of the outbreak (Shepherd, 1994).

The rapidity at which the natural virus can spread throughout the population prevents opportunity for DFTM populations to rebound. Once populations are brought back down to low populations, natural parasites and predator complexes exert a significant influence on the later stages of decline, and endemic DFTM populations (Mason, et.al. 1983; Torgersen, personal communication).

Since the female Douglas-fir tussock moth does not fly, dispersion is limited to movement of the early instar larvae on the wind. However, these larvae do not disperse in high enough numbers to create a new outbreak center before the outbreak collapses (Wickman, et. al., 1973). Therefore, insects do not reinvade treated areas from adjacent untreated areas.

EFFECTS ON THE NATURAL PREDATORS AND PARASITES

Disruptions of non-target organism populations are of concern when evaluating any alternative control method. Parasites of sustained or long cycle insects such as the western spruce budworm respond to their hosts in a delayed manner and would be more unlikely to respond to any rapid changes brought about by man or nature (Hamel, 1977), than parasitoids of a fast cycle insect.

The parasite and predator complexes of DFTM are extremely efficient in locating and maintaining the DFTM populations at low levels. DFTM populations experience a rapid build-up of numbers, and then total collapse of the population within a short period of time, and their parasites simply cannot respond numerically to this type of cycle. Where they are most effective is in maintaining low numbers of the host for long periods of time between outbreaks, and in the collapse phase. The parasites respond somewhat to the increased host densities so they can take advantage of the reduced host numbers brought about by the virus (Torgersen, personal communication). TM BioControl would not directly affect the parasites because it is species specific to the tussock moth. Also, it does not disrupt the parasites to any greater extent than a natural virus event. Treatment with TM BioControl should not affect the natural parasite and predator complex.

The objective of treating with B.t.k. would be the same, to bring DFTM populations back down to low levels. Once these populations are at reduced levels, whether because of natural virus or other means such as weather, or B.t.k., the complex of predators and parasites would exert their influences.

Little work has been done on the effects of B.t.k. on the DFTM parasites and predators. Parasites that would be most likely to be affected by an insecticide application would be those that infect the larval stage. Of eleven species of parasites recovered from western spruce budworm larvae, two species, *Apanteles fumiferanae* and *Glypta fumiferanae*, accounted for over 90% of the parasitism. Only 37 of the 3000 parasites recovered contained Bt spores and crystals. These parasites emerged sufficiently to exit their hosts but were not able to complete development. However, it could not be determined whether the cause was due to microbial infection or insufficient nutrition because of early death of the host (Niwa, 1987). Studies of effects of Bt parasites of western spruce budworm report either alteration in abundance of parasites (i.e. there increases in some parasites and decreases in others) (Hamel, 1977), or there was no significant effect on the overall parasite complex (Buckner, et. al. 1974, cited in the GM EIS, 1995; Niwa, 1987). Effects of B.t.k. on parasites of gypsy moth are reviewed in the Gypsy Moth EIS (1995). Some studies found no change in rates of parasitism by most species due to application of B.t.k. A number of others found increased rates of parasitism and survival of parasites because the B.t.k. prolonged the rate of development of the host caterpillar (cited in Gypsy Moth EIS, 1995).

Pheromone applications aimed at reducing DFTM populations through mating disruption did not result in reduced parasitism of fertile egg masses by *Telenomus californicus* (Sower and Torgersen, 1979).

The primary parasites and predators of DFTM are the egg parasite, *Telenomus californicus*, and avian predators. It is unlikely that treatments with either TM-BIOCONTROL or B.t.k. would affect these, or any of the parasite/predator complexes of DFTM to any significant degree, if at all.

As the virus epizootic runs its course, the infected later instar larvae serve as the primary means for returning the NPV back into the soil in the area. Early instar larvae that die from virus infection remain stuck to the foliage, where the NPV can readily infect other larvae. The greatest effect of applied control, whether with the virus or other insecticides, is to reduce the tussock moth populations so much that the NPV epizootic develops much more slowly or is prevented (Thompson, 1978). This results in reduced amount of virus in the forest ecosystem. The virus produced in early larval instars is largely inactivated on the foliage, presumably, by solar radiation and never becomes incorporated into the soil. A much larger percentage of NPV is produced in the older larvae (Thompson and Scott, 1979). Treatment with the virus or other insecticides, applied before an epizootic has developed, would result in reduced NPV in the forest ecosystem (Thompson, 1978). Whether this reduction is significant, is not known. The virus, once in the soil is extremely persistent; and apparently extremely small amounts are required to initiate an epizootic. The virus appears to be efficiently moved and distributed throughout the forest environment. Outbreaks that occur in areas where there has been no known previous outbreak, still collapse from a virus epizootic. Not all spray drops would impinge on a foliage surface, therefore in TM BioControl applications,

presumably some virus would be returned directly to the forest floor, although not in the concentrations that would occur in a natural epizootic. Insecticide treatments may cause a reduction in the virus in a localized area; but these impacts may not be comparable to those reductions caused by other disturbance factors. Adjacent untreated areas would serve as a reservoir for initiating future virus epizootics, and treatment would not eliminate the virus from the forest system. The No Action Altenative would not result in any impact to the natural virus in the ecosystem; it is likely that there would be some reduction of virus in the forest ecosystem with all three Action Alternatives. It is not believed that this reduction would be significant however additional research or monitoring would be needed in this area.

LONG-TERM RESISTANCE OF THE INSECT TO INSECTICIDE

B.t.k.

There is a question regarding the potential build up of resistance in a population through repeated exposure to an insecticide. Douglas-fir tussock moth, in some of the proposed treated areas would have been exposed to one, and possibly two previous treatments with B.t.k in the last 15 years. Resistance is developed by genetic selection against susceptible individuals in a population. Studies, under field and laboratory conditions, have shown that the diamondback moth, and other agricultural insects, such as the Indian-meal moth and tobacco budworm, can develop significant resistance through repeated exposure to B.t.k (Tabashnik, et. al., 1990; Tabashnik, et. al., 1991); and in laboratory tests 5 of 10 different moth species developed more that 10-fold resistance after selection for 7-23 generations (Tabashnik, 1994). The tests with diamondback moth did show that the resistance was recessive (Tabashnik, et. al., 1992). Tests for resistance in the diamondback moth are rigorous (i.e. repeated exposures; up to 5 treatments 4-5 days apart, and for repeated generations) (Tabashnik, et. al. 1991). Variability in resistance of gypsy moth suggested the potential for resistance development through natural selection (Rossiter, et. al., 1990). Resistance can be slowed, however, by integrating the use of B.t.k with natural parasites and predators Chilcutt and Tabashnik, 1999).

It is very unlikely that resistance to B.t.k would build up in the tussock moth populations based on a variety of reasons. B.t.k has little direct effect on the natural enemies; development of those individuals that do not receive a lethal dose of B.t.k is extended, thereby allowing them more exposure to natural parasites and subsequently being removed from the population. Forest insect populations may be exposed to a B.t.k treatment once every 7 or 8 years, or even longer, on an average. Infrequent applications are not conducive to development of resistance. Genetic mixing with untreated populations during intervening years would result in any expression of resistance remaining in the background. Refuges of untreated areas, or areas treated with virus would allow genetic variability in the populations.

TM-BioControl

This insecticide is comprised of the natural virus of the DFTM. Complete resistance of tussock moth to the virus has not been found, either in extensive laboratory rearing or in field populations, although field populations are generally heterogeneous in susceptibility. No increase in resistance to infection was found in an outbreak occurring after the NP-caused collapse of an outbreak at the same location in Idaho (Thompson, 1978). It has been proposed that resistance to an epizootic in an insect population is not easily established. By the time an epizootic has run it's course, the surviving insects have usually completed their metamorphosis, migrated, or died from other causes, and a new, non-immune population has arisen. The influence of any immune survivors that persisted may fade into insignificance (Steinhaus, cited in Thompson, 1978). The treatment using TM BioControl proposes to introduce higher levels of the virus into the populations, one-two years earlier, than would naturally occur. If there were any resistance or natural selection for resistance against this virus it would occur in response to the natural virus build up as well, if the areas were to be left untreated.

NO ACTION ALTERNATIVE

No treatment would be done under this alternative. Outbreaks would be allowed to continue under natural conditions. Treatment effectiveness, resurgence and reinvasion, and impacts on predators and parasites would not be an issue. The highest amounts of natural virus would return the forest ecosystem to normal levels under this alternative. Development of resistance to the virus, if it did occur, would be natural. There would be no opportunity for developing resistance to *Btk*, and it would continue to increase the amount of time since the last exposure of the insects to this insecticide.

PROPOSED ACTION

This alternative would treat selected areas of concern. All other infested areas would remain untreated. The treatments, either with TM-BioControl or B.t.k would be effective in reducing those populations within the treated areas and providing foliage protection and preventing tree mortality for the duration of the outbreak. Since the outbreak cycle is very short, only one or two years of foliage protection is required. Because of the short outbreak cycle and the fact that the female does not fly, there would be not opportunity for reinvasion into the treated area. There would be no impact on predators and parasites since their role in the DFTM population cycles are to maintain the populations during declining and endemic populations. The natural virus exists in the soil for decades between outbreaks and most virus is returned to the soil through the larger infected larvae. During treatment with either B.t.k or TM-BioControl, most larvae that die would be the younger larvae, and less virus would be returned to the ecosystem. What the very long-term

impact of localized reductions in virus in the forest ecosystem would be is unknown, however, since there would still be untreated areas throughout the forests that would allow development and return of virus to the forest floor, it would still be present in the overall ecosystem. Resistance to TM-BioControl is not likely, or if it occurs it would be no different than would occur under untreated conditions. Resistance to B.t.k is not likely because of extended periods of time between exposure to B.t.k and since there would be refuges of untreated insects in adjacent areas, and areas throughout the forests that would allow for genetic mixing.

Expanded Protection Alternative

In this alternative, the selected areas of concern plus additional areas with 60-100% host type would be treated. As with the Proposed Alternative, treatments, either with TM-BioControl or B.t.k would be effective in reducing those populations within the treated areas and providing foliage protection and preventing tree mortality for the duration of the outbreak. Since the outbreak cycle is very short, only one or two years of foliage protection is required. Because of the short outbreak cycle and the fact that the female does not fly, there would be not opportunity for reinvasion into the treated area. There would be no impact on predators and parasites since their role in the DFTM population cycles are to maintain the populations during declining and endemic populations. The natural virus exists in the soil for decades between outbreaks and most virus is returned to the soil through the larger infected larvae. During treatment with either Btk or TM-BioControl most larvae that die would be the younger larvae, and less virus would be returned to the ecosystem. More areas and acres would be treated in this alternative, so overall; there would be fewer viruses returned to the soil in the treated areas. What the very long-term impact of localized reductions in virus in the forest ecosystem would be is unknown. There would still be untreated areas throughout the forests that would allow development and return of virus to the forest floor, it would still be present in the overall ecosystem, however in less amounts than with the Proposed Alternative. Resistance to TM-BioControl is not likely, or if it occurs it would be no different than would occur under untreated conditions. More acres would be treated with Btk, however, resistance to Btk is not still likely because of extended periods of time between exposure to Btk, and since there would still be refuges of untreated insects in adjacent areas, and areas throughout the forests that would allow for genetic mixing.

TM-BioControl Only Alternative

This alternative would treat selected areas of concern with TM-BioControl only. All other infested areas would remain untreated. It would be effective in reducing those populations within the treated areas and providing foliage protection and preventing tree mortality for the duration of the outbreak. Since the outbreak cycle is very short, only one or two years of foliage protection is required. Because of the short outbreak cycle and the fact that the female does not fly, there would be not opportunity for reinvasion into the treated area. There would be no impact on predators and parasites since their role in the DFTM population cycles are to maintain the populations during declining and endemic populations. The natural virus exists in the soil for decades between outbreaks and most virus is returned to the soil through the larger infected larvae. During treatment with TM-BioControl most larvae that die would be the younger larvae, and less virus would be returned to the ecosystem. What the very long-term impact of localized reductions in virus in the forest ecosystem would be is unknown, however, since there would still be untreated areas throughout the forests that would allow development and return of virus to the forest floor, it would still be present in the overall ecosystem. Resistance to TM-BioControl is not likely, or if it occurs it would be no different than would occur under untreated conditions.

Table B-1: Summary of Treatment Effects on Douglas-fir Tussock Moth

	No Action Alt.	Proposed Action	Expanded Protection Alt.	TM-BioControl Only Alt.
Treatment effectiveness	None	High	High	High
Chance of resurgence or reinvasion	None	None	None	None
Impact on predators and parasites	None	None	None	None
Impact on natural virus	None	Unknown	Unknown	Unknown
Resistance to B.t.k.	None	None	Very Low	None
Resistance to virus	None	None	None	None

APPENDIX C: PUBLIC INVOLVEMENT

INTRODUCTION

The overall goal for public involvement was to provide an "open process" that involved people as early as possible. This meant reaching out to a wide spectrum of the public within two states interested in the management of lands administered by the USDA Forest Service. Additionally, it meant showing how public input was used in the development of this DEIS.

PLANNING

Because of the trapping program of 1998, scientists are anticipating outbreak populations in the spring of the year 2000. Once it was known that on outbreak was imminent, the Forest Supervisors of the affected Forests and the Regional Forester held several meetings to decide a course of action to deal with this pest. The outcome of these meetings was the basis for the scope of this document as well as the basis for the proposed action. Additionally, due to the tight time frame, a decision was made to write an EIS considering only Forest Service lands and not adjacent lands. Another outcome of these meetings was the decision to complete one document for the Region rather than attempting to complete nine separate documents, one for each Forest.

SCOPING

Scoping is a process required in the early stages of preparing an EIS (*40 CFR 1501.7*). This process is used to determine the scope of the issues to be addressed and for identifying the significant issues related to the proposed action. The significant issues are then used to generate a full range of alternatives based on the proposed action. As part of the scoping process, a Notice of Intent was published in the Federal Register on June 18, 1999. This notice described the intention of the Forest Service to manage the anticipated tussock moth outbreak in Oregon and Washington. A 30-day comment period ended in July. No comments were received by the Forests or the Regional Office.

Meanwhile, an Interdisciplinary Team developed a "scoping" package that contained a letter of introduction describing the pending problem and a description of the proposed action. A self-addressed letter asked four questions to which interested participants were asked to respond. Each Forest was asked to attach specific information about the tussock moth outbreak. Packages were mailed July 1999. The team accepted comment letters until September 1, 1999. This deadline was necessary to finalize the significant issues and concerns, and to develop alternatives. Nine additional comment forms and letters were received after the September deadline.

ALL comments were analyzed as to whether it contained significant issues, concerns, or general comments. If more than one letter contained a comment with the same theme, the comments were combined to form a specific issue/concern. The Regional Office does not keep a record of individual mailing lists maintained by each Forest. Interested parties should contact the specific Forest(s) for that information.

Table C-1: Comments Received

Forest	Letters	Internet	Phone
Colville	6		
Fremont	2		
Malheur	18		
Ochoco	30		
Okanogan	5		
Umatilla	10		
Wallowa-Whitman	12		
Wenatchee	23		
Winema	4		
Unknown Forest	28		
Total	138 + 9 late = 147	1	6

Table C-2: Comments by Affiliation

Affiliation[1]	Comments
No affiliation noted	73
Adjacent landowner/permittee/rancher/farmer	20
Timber industry/forestry consultant	17
Environmental organization	12
Chamber of Commerce or municipality	5
Federal or State agency	5
Recreation user group/organization	4
Organized camp/recreation retreat	2
Retired Forest Service employee	2
Miner	1

RESPONSE FORM QUESTIONS

1. What are the resource (wildlife, recreation, and other) values/issues that you think should be considered in the EIS?

- (39 respondents): The Forest Service should consider "timber values and forest health" with most respondents favoring a spray project to protect these values.
- (15 respondents): The Forest Service should consider "multiple uses and multiple resources" in the EIS.

[1] A few respondents wrote letters concerning separate Forests or wrote on behalf of someone else.

- (4 respondents): The Forest Service should consider "scenic" resource values in the EIS. One respondent was concerned about effects to scenery in Wilderness areas.
- (35 respondents): The Forest Service needs to consider "wildlife values" and expressed specific concerns for both the initial and residual effects of this project on non-target species and their habitat including T & E species and late successional habitat.
- (18 respondents): Impacts on recreation should be considered in the EIS.
- (5 respondents): The EIS should consider "fire hazard" caused by mortality of infested trees.
- (5 respondents): The EIS should consider "water quality" including the effects to domestic water supplies.
- (4 respondents): The EIS should consider "additional research" relative to the treatment agents proposed for use.
- (3 respondents): The EIS should consider the effects of spraying in Wilderness areas.
- (1 respondent): Concern over the Little Pend Oreille National Wildlife Refuge and the effects created by the tussock moth. Interested in controlling the tussock moth if it is a threat in the refuge.

2. Are there sites of particular concern to be treated? Not treated? Why?

- (33 respondents): Support for treating infested areas identified in the National Forest mailings.
- (30 respondents): These respondents listed specific areas on National Forests that should or should not be sprayed.
- (18 respondents): Noted adjacent ownerships where treatment should or should not occur. Note: Of the 18, one respondent opposed spraying adjacent to their land and garden areas. Another respondent who represented Crater Lake National Park felt their participation was unnecessary due to low risks of outbreak.
- (8 respondents): Concerns for treatment within "old growth" areas and near "fisheries". Two wanted the Forest Service to show restraint in treatment "tread softly" while most favored treatment to avoid defoliation.
- (7 respondents commented): Spraying should be done in areas important to timber production.
- (3 respondents): Concerned about spraying near populated areas such as nearby villages, organized camps, and domestic water supplies.
- (4 respondents): Concern about spraying in Wilderness. Reference was made to the fact that the moth is a natural part of wilderness. Additionally, Hell's Canyon National Recreation Area is a unique ecosystem and should be handled with a stricter standard.
- (1 respondent): Opposed to spraying in any areas particularly around this person's residence on the Umatilla National Forest.
- (1 respondent): All areas on the Malheur should be treated.
- (1 respondent): Challenged the viability of the spray project on the Malheur, Umatilla, Wallowa-Whitman, and Ochoco on concerns of efficacy of the treatment, tree mortality impacts on the environment, or the unknown cost/benefit ration of the project.

3. What are other issues (social, economic, and other) that you would like to see addressed in the analysis?

- (50 respondents): There is a need to address social and economic issues in the EIS. The majority was specific to the economic benefits to local communities resulting from protection of valuable timber resources from defoliation as well as salvage activities of mortality.
- (13 respondents): The need to address the issue of "humans". Specifically, health issues associated with spraying.
- (8 respondents): Concern over adjacent land ownership, specifically being able to participate, and the concern that pests and noxious weeds from public lands have invaded their property. One was response was specific about summer homes.
- (5 respondents): The timber and resource values should be protected for future generations.
- (4 respondents): The EIS should analyze the impacts of "not spraying". Consider past outbreaks.
- (1 respondent): Wanted local participation in whatever is done.
- (1 respondent): A concern about public access to National Forests and mineral rights.
- (1 respondent): Concerned about being informed when spraying would happen and where it would happen.

4. Other Comments or concerns?

- (37 respondents): These participants chose this space to express their support for implementation of a spray project to protect forest resources.
- (13 respondents): These participants asked specific questions about treatment method and availability of control substances.
- (12 respondents): Made comments on administrative aspects of the projects or asked for additional information.

- (10 respondents): Three management schemes were suggested: a) Institute an aggressive salvage program of timber killed by the moth, b) Thin infested stands as a means to improve forest health and provide resistance to future outbreaks, and c) Use under-burning as a tool.
- (8 respondents): Wanted to be informed of when and where spraying was to take place.
- (8 respondents): Voiced their perceptions about past management practices contributed to this outbreak and the present unsustainable condition of the forests.
- (6 respondents): On the value of the tussock moth as a natural, native species.
- (6 respondents): Gave suggestions on other alternatives to be explored.
- (4 respondents): Chose to use this space to share thoughts on resource issues no necessarily related to spraying.
- (2 respondents): Requested additional scientific information relating to the "early warning" system and the life cycle of the moth.
- (3 respondents): Expressed concern related to the large area to be treated. One suggested quick action in the years 2000 and 2001. Another wanted to know how the effectiveness would be determined and the EIS should have a comprehensive monitoring plan.
- (2 respondents): Made comments relative to "dry site" management. These were in regards to spending money to spray versus not spraying. The other was an assessment of using fire instead of spraying to control the insect populations much like the Wenatchee National Forest "dry site" management plan.
- (1 respondent): Voiced a concern that insects would gain a resistance to insecticides of enough of it is used over time.

OTHER MEANS OF COMMUNICATION

From the beginning, newspaper articles have appeared in different regions of Oregon. These papers included *The Blue Mountain Eagle* (John Day, Oregon, June 30 and July 27, 1999), *The Bend Bulletin* (Bend, Oregon, August 3, 1999), *The Baker City Herald* (Baker City, Oregon, August 10, 1999), *The Walla Walla Union Bulletin* (Walla Walla, Washington, August 16, 1999), *The Oregonian* (Portland, Oregon, August 11, 1999), and *The LaGrande Observer* (LaGrande, Oregon, August 5 and 11, 1999). Readers were informed of the potential tussock moth outbreak and the potential for defoliation over a wide area. They were informed of the availability of the Notice of Intent and whom to contact. The *Walla Walla Bulletin* interviewed a Forest Service entomologist on the tussock moth interdisciplinary team.

This Forest Service entomologist was also interviewed by *Oregon Public Broadcasting* and *KPLU*, Seattle Washington.

An article on the possible tussock moth outbreak appeared in the *Weekly Member Update* published and distributed by the Prineville-Crook County Chamber of Commerce on August 2, 1999.

The Forest Service maintains an Internet site where users can view information on various projects and items of interest. The Regional Office also offers a web page specific to the tussock moth: www.fs.fed.us/r6/nr/fid/eisweb/dftm_eis.htm. This site features regular updates on the progress of the analysis and other general information.

MAILINGS

The DEIS has been mailed to numerous agencies, organizations, and individuals. Please refer to Chapter V for a list of interested respondents.

RESPONSE TO COMMENTS

A table summarizing comments on the Draft Environmental Impact Statement follows. The table also contains references to how these comments are addressed in the Final EIS.

Table C-3: Response to Comments

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Do research results exist from the last DFTM spray project(s)? (1)		No research was conducted in conjunction with the 1991 DFTM outbreak. Although not necessarily in conjunction with the suppression project, a significant amount of research was done on DFTM during the 1972-74 outbreak and after. This information is reported in numerous publication and articles – many are referenced throughout this EIS
Show effects of the 1972 outbreak and show maps (1)		Effects of the 1972-74 outbreak are not displayed, but information from that outbreak was used and referenced throughout the document – such as acres of defoliation, estimated mortality by defoliation class, and subsequent bark beetle mortality.
Address Economics / cost benefit analysis (3)	Ch. IV, Cost of Operations	
Discuss funding availability (1)		Funding for potential large scale insect suppression projects are outside of the USFS base budget and requested annually as a separate request from the Sec. of Agriculture and/or Congress.
What is the cause of the outbreak of tussock moth (1)	Ch. III, Douglas-fir Tussock Moth	
Should wait to treat until it's known if the tussock moth population collapses (1)	Ch. III, Douglas-fir Tussock Moth; Appendix D	Douglas-fir tussock moth outbreaks typically build fast and then they collapse within 2-3 years. However, by the time the population collapses, the damage is done – this project is intended to prevent the damage (defoliation) before the collapse. That means the population needs to be checked before it has a chance to incur damage.
Discuss native predators and parasites of the Doug-fir tussock moth (1)	Ch. III, Douglas-fir Tussock Moth; Ch. IV, Lepidoptera: Douglas-fir Tussock Moth Appendix D	
Will the Doug-fir tussock moth rebound to even higher population levels after treatment (4)	Ch. IV, Lepidoptera: Douglas-fir Tussock Moth Appendix D	
Will the tussock moth outbreak spread between federal lands and other ownerships (1)	Ch. IV, Other Concerns: Effects on Adjacent lands; Ch. IV, Lepidoptera: Douglas-fir Tussock Moth Appendix D	
Need discussion of the beneficial aspects of an outbreak (12)	Ch. III, Forest Health Ch. IV, Forest Health Ch. III, Douglas-fir Tussock Moth	Incorporated references to Wickman et al 1986 & Wickman & Starr 1990
Need to prevent large scale damage – forests are now far from healthy (10)	Ch. IV, Forest Health	

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Need info about species composition of protected areas to evaluate beneficial effects of the No Action alternative (1)	Ch. III, Forest Health	Describes plant assn. series, % host type, structure
Discuss the relationship to bark beetle attack. [One comment specific to Tiger Canyon] – then linkage to fire (3)	Ch. III, Areas Currently Protected from Bark Beetles Ch. III, Fire Ch. IV, Issue 11- Secondary Mortality from Bark Beetles Ch. IV, Fire Ch. IV, Human Environment: Municipal Watersheds	
Role of moth in maintaining a healthy pine forest. One commenter felt that the tussock moth defoliation would help convert to pine forests, the other felt it would not (2)	Ch. III, Forest Health Ch. III, Fire Ch. IV, Forest Health Ch. IV, Fire	Incorporated references to Wickman et al 1986 & Wickman & Starr 1990
If the intent is to convert to pine, this needs a forest plan amendment (1)	Ch. III, Forest Health Ch. III, Forest Environment: OG/LOS Ch. IV, Forest Health Ch. IV, Forest Environment: OG/LOS	See Wickman et al 1986. Pine is native to these sites. All alternatives allow the outbreak to take its natural course in some areas in host type. This may result in some transition to a different plant/tree composition in stands. A forest plan amendment is not required in this case.
Need better definitions and location information on OG (1)	Ch. III, Forest Environment: OG/LOS	
Disclose effects of fuel buildup and fire risk (2)	Ch. III, Fire Ch. IV, Fire	
Check snag fall rate accuracy (1)	Analysis file, Fire	Incorporate by reference
Address changes in fire/flood cycles (3)	Ch. IV, Fire	Discussion on effects and fire are included. Effects of this outbreak on 100-500 year floods are beyond the scope of this analysis
Address human health effects from the spray (2)	Ch. IV, Human Environment: Health; Appendix H	
Should there be a concern of human health effects from tussockosis (1)	Ch. IV, Human Environment: Health Appendix H	
Obtain approval from the WA Dept of Health (1)		An approval is not required in this case, but it is our intent to work with state agencies on projects of this nature. They have submitted an opinion saying that they expect no adverse public health impact from the proposed methods of controlling tussock moth.
Non-target Species. Concerned about B.t.k. wiping out other Lepidoptera species. (Include Dr. Miller study on topic in LaGrande) (20)	Ch. III, Lepidoptera Ch. IV, Lepidoptera: Non-Target Analysis file: Non-Target Lepidoptera;	Dr. Miller has not done work in LaGrande (pers. com.). However, all three of Dr. Millers studies on non-targets, in addition to other non-target Lepidoptera studies by Grimble, Sample, Peacock, Wagner, and Hall were cited and used extensively in the analysis

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Concern about non-target invertebrates (2)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Sensitive Species Ch. IV, Fish & Wildlife: Other Species	
Concern about the sufficiency of research of B.t.k. on other than non-target Lepidoptera such as DFTM predators and parasites (2)	Ch. IV, Lepidoptera; Douglas-fir tussock moth Appendix B Appendix E	
Why are non-target lepidoptera populations expected to recover in a couple of years and not the tussock moth (1)	Ch. IV, Lepidoptera: Douglas-fir Tussock Moth Appendix B Appendix E	Both the non-target Lepidoptera and the tussock moth do recover. The treatment will bring the extremely high Douglas-fir tussock moth outbreak levels back down to endemic levels. The tussock moth is not eliminated, and it does recover to normal population levels. Its normal level is very low. It will just not return to outbreak levels.
B.t.k. may drive fragile T&E moths and butterflies to extinction (4)	Ch. III, Lepidoptera; Ch. IV, Lepidoptera: Non-Target Analysis file: Non-Target Lepidoptera	
EPA data shows that side effect using B.t.k. is large reduction of animal biomass (2)	Analysis file: Non-Target Lepidoptera	The EPA study is not referenced, but Dr. Miller's work is referenced. It presents similar results regarding reductions of biomass.
Should not conclude that uncertain effects of TM-BioControl on non-target Lepidoptera is equivalent to no effect (1)	Ch. IV, Lepidoptera: Non-Target Ch. IV, Issue 3: Effects on Non-Target Lepidoptera	TM-BioControl is specific to Douglas-fir tussock moth and 3 other species of tussock moths.
Concern about 9 rare Lepidoptera species (1)	Ch. III, Lepidoptera Ch. IV, Lepidoptera: Non-Targets Analysis file: Non-Target Lepidoptera	
Address effect of spray on reducing food source for birds and other species (7)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Sensitive Species Ch. IV, Fish & Wildlife: Other Species	
Discuss Army cutworm as food source to bears, wolverines and other predators (3)	Ch. III, Fish & Wildlife Ch. IV: Fish & Wildlife: Other T&E Species Ch. IV, Fish & Wildlife: Sensitive Species Ch. IV, Fish & Wildlife: Other Species	
Describe cumulative impacts from spraying on croplands, other forestlands (2)	Ch. IV, Other Concerns: Cumulative Effects of Treatment	
Address indicator butterflies in ICBEMP (1)		There are no plans to use butterflies as indicator species in ICBEMP
Avoid spraying meadows, marshes and forest edges (1)	Ch. II, Mitigation Measures Appendix G: Operations Guidelines	

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Address Johnson's Hairstreak (1)	Ch. III, Lepidoptera Analysis file: Non-Target Lepidoptera	
Conduct surveys for 159 rare lepidopteron species and 114 species of uncommon lepidopteron species (1)	Ch III Lepidoptera Ch. IV, Lepidoptera: Non-Targets Analysis file: Non-Target Lepidoptera	The analysis addresses threatened & endangered listed species & candidates for listing, and Forest Service sensitive species list. State lists and other reports and lists of species were examined and addressed where appropriate. The analysis addresses risks to these species. With that and additional mitigation measures, surveys are not necessary.
Should take a baseline survey before/after treatment	Ch III Lepidoptera Ch. IV, Lepidoptera: Non-Targets Analysis file: Non-Target Lepidoptera	See the response above. In addition, studies were referenced that tracked Lepidoptera populations before and after previous spray applications.
Do surveys exist on T&E or sensitive lepidoptera, or predators (1)	Ch. III, Lepidoptera Ch. IV, Non-Target Lepidoptera	Since no T&E Lepidoptera species occur on the Forests in the analysis; no surveys have been conducted; mitigation measures will favor sensitive species.
Address Lepidoptera species in riparian habitat (2)	Ch. III, Lepidoptera Ch. IV, Lepidoptera: Non-target	Riparian species were not addressed, per se. Rather, non-target Lepidoptera in various habitats were addressed as a whole.
Utilize information from the Rare Butterfly study by Paul Hammond and others including works by Grimble, Beckwith, Hammond (1)	Ch. III, Lepidoptera Ch. IV, Lepidoptera: Non-target	Hammond's Rare Butterfly Study was not used. Other sources were used and referenced, including the original report by Grimble, on which the Grimble, Beckwith, and Hammond study is based.
Address concerns of insecticides on culturally significant plants - impacts on humans. (1)	Ch. IV, Human Environment: Health; Appendix H	
Discuss the mardon skipper (3)	Ch. III, Lepidoptera Ch. IV, Lepidoptera: Non-targets Analysis file: Non-Target Lepidoptera	
Need well-designed monitoring program to determine after effects of intervention [by spraying]. Document effects on non-target species (3)	Appendix I	The reference provides guidelines for monitoring. Monitoring will be done to determine effectiveness in meeting objectives
Include a control area to compare with a spray area (2)	Ch. IV, Forest Health	Note that all alternatives would leave some untreated areas.
Will treatment be decided locally within protected areas (1)		The Record of Decision (ROS) will describe selected alternative to be implemented
Use TM-BioControl versus B.t.k. (5)	Ch. II, Alternatives	A TM-BioControl Only Alternative was added and considered in the analysis as a result of public comments
Analyze a bull trout and high use recreation only alternative (1)	Ch. I, Purpose and Need Ch. I Decisions to be Made	The EIS analysis addressed objectives described in the purpose and need. However, the deciding official can modify an action alternative in the decision.

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Protect fish streams only (1)	Ch. I, Purpose and Need Ch. I Decisions to be Made	See the above response
Allow for multiple treatments – logging and thinning – other (2)	Ch. II, Alts. Considered but Eliminated…	
Are successive treatments necessary (1)	Ch. III, Douglas-fir Tussock Moth. Ch. IV, Lepidoptera: Douglas-fir Tussock Moth	Successive treatments in the same area will not be necessary.
Need statement should be rewritten to look at pro's & con's of treating (4)	Ch. IV, Effects Analysis	This is analyzed in effects; not part of purpose & need
Discuss need to spray wilderness and roadless areas (1)	Ch. II, Proposed Action Ch. IV, Other Concerns: Wilderness	Roadless was not an area of concern of itself. Wilderness is addressed separately.
What "elements" were used to make up "high value" areas (1)	Ch. I Purpose and Need	
The Proposed Action does not minimize threats from bark beetle & fire from adjacent ownerships (1)	Ch. IV, Issue 11: Secondary Mortality from Bark Beetles	Areas of Concern plus high-risk areas are included in the action alternatives. Treatment will not minimize threats from adjacent lands, but will keep trees from being stressed from defoliation, so they will not be as susceptible to bark beetle attack.
Include wilderness for protection (1)	Ch. II, Proposed Action	Lake Chelan/Sawtooth for fire risk & NF Umatilla for fish habitat
Do not treat in Research Natural areas (1)	Ch. II, Mitigation Measures	These are excluded
Do not treat anadromous fish areas (1)	Ch. I Decisions to be Made	The deciding official may elect to exclude areas of concern from protection
Are seed orchards covered under an Orchard EIS? (1)	Ch. IV, Seed Orchards	There is no Seed Orchard EIS
Discuss the need to treat in viewsheds (2)	Ch. IV, Human Environment: Municipal Watersheds	
Include deer and elk habitat (2)	Ch III – Fish & Wildlife	Deer & elk habitat would be included in the Expanded Protection alternative.
Include areas available for timber harvest (2)	Ch. II, Expanded Protection Alternative	The Expanded Protection Alt. Was developed after initial Public Scoping in part to address this concern.
Set traps to control the tussock moth in infested areas (1)	Ch. II, Alts. Considered but Eliminated…	The trap-out method has never been tested or used on Douglas-fir tussock moth, and the success of such a method is unlikely. Mating disruption, another method using pheromones to manipulate populations has been tested-
Select areas to treat based on risks for damage (1)	Ch I, Purpose and Need Ch. III, Forest Health Ch. IV, Forest Health Appendix K	Risk is an important component in the EIS analysis, however, it was not the primary factor in identifying areas of concern that are described in the action alternatives. The latter were selected to meet objectives described in the purpose and need.
TM-BioControl is made from genetically engineered virus (3)	Ch. I, Ch. III, Appendix B	TM-BioControl is processed from a native virus – it is not a genetically engineered product.

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Drift of spray [near wilderness] (3)	Ch. IV, Lepidoptera: Non-target Appendix G	
Operation plans should be part of the EIS (1)	Appendix G	Operations Plans are very extensive detailed documentation specific to particular areas. However, operations guidelines are established in the EIS.
Discuss spraying operation and information on confining to irregular polygons (1)	Appendix G	
Address methods for determining outbreak levels and when need to spray (5)	Ch. III, Douglas-fir Tussock Moth Appendix D	
With the early warning system, why the need for the "emergency" exemption (2)	Analysis file, letter of justification	The "Early Warning System" only provides 9 months' notice of population increase and if the decision is one of the action alternatives, the project must be implemented this season if defoliation from the tussock moth is to be prevented.
Should display the information from the early warning system (1)	Ch. III, Douglas-fir Tussock Moth	The Douglas-fir tussock moth early warning system report is not included as part of the EIS, but is available.
Post spray areas or provide other public notification (2)	Appendix G	
Address impact on pollinators and sensitive plants (3)	Ch. IV, Plants	
Address effects on the Showy Stickseed – should there be a no spray mitigation around the plant (2)	Ch. II, Mitigation Measures Ch. IV, Plants: Threatened & Endangered Species	
Discuss coordination with private landowners (2)	Ch. I, Special Mgt Considerations, Ch. II, Features Common to All Action Alts. Ch. IV Other Concerns: Effects on Adjacent Lands.	
Why the high residential & administrative site count for the Wenatchee NF (1)	Appendix J Analysis File	Wenatchee has 7 res./admin sites. The site at Fish Lake is very large (8,000 ac)
Discuss the effects to Coleoptera, Orthoptera, & Diptera species from B.t.k.		The specificity of B.t.k. to Lepidoptera is well documented. Studies on Hymenoptera, Diptera, Neuroptera, Orthoptera, Coleoptera, Hemiptera, and Araneae have shown no adverse toxic effects to these species. Incorporate by Reference – Gypsy EIS, Ecological Risk assessment
What is the impact to DFTM parasites and predators (2)	Ch. IV, Lepidoptera: Douglas-fir Tussock Moth Appendix B	
What is the B.t.k. [spray] effect on water quality for fish (2)	Ch. IV, Issue 6: Effects of Spraying on Fish and Wildlife	

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
What is the B.t.k. [spray] effect on water quality and human consumption (2)	Ch. IV, Water Quality: Insecticide Effects Ch. IV, Human Environment: Health Ch. IV Issue 7: Water Quality Appendix H	
What is the impact of the spray carrier (4)	Ch. IV, Human Health Appendix H	
Is this project to use up old insecticides – what are the expiration dates for TM-BioControl and B.t.k. Are there any purchase agreements (1)		There are no expiration dates for TM-BioControl. The FS does not have any B.t.k. on hand and there are no purchase agreements in place.
Discuss diflubenzuron (Dimilin) as an effective insecticide (1)	Ch. II, Alts. Considered but Eliminated…	
Discuss spray effects to water quality for irrigation uses – effect of spray in the water on Lepidopterans in crop fields (3)	Ch. IV, Water Quality: Insecticide Effects	B.t.k. survives for a limited time in the water. Concentrations that would reach the water through aerial application, and subsequent dilution makes impacts on Lepidoptera in crop fields highly unlikely.
Avoid direct application to streams (1)		Where operationally feasible, direct application to open bodies of water will be avoided; however, one of the objectives of the purpose and need is to protect host trees that are critical to maintaining the riparian condition or habitat, and this may require treatment adjacent to and over some streams.
Address species resistance development to B.t.k. (5)	Ch. IV, Lepidoptera: Douglas-fir Tussock Moth Appendix B	
Address the persistence of TM-BioControl and B.t.k. – especially in the soil (2)	Ch. IV, Lepidoptera: Douglas-fir Tussock Moth	Natural virus from which TM-BioControl is made has been documented to persist up to 40 years in the soil. B.t.k. is also found naturally in the soil, and can persist for several months; however, insecticidal activity is greatly reduced. Repeated applications of B.t. did not result in an increased concentration of B.t. in natural soils in the field. Gypsy Moth EIS, 1995. Appendix G, Ecological Risk Assessment
Address the effect of insecticide to other wildlife (1)	Ch. III, IV, Fish Wildlife Ch. IV, Issue 6: Effects of Spraying on Fish & Wildlife	
Disclose the forest plans desired future condition in managed forest areas (1)	Ch. III, Timber Management.	Incorporate Forest Plans by reference

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Discuss the potential for salvage logging, or post outbreak management on affected lands (4)	Ch. IV, Forest Health	No plans currently in place. Salvage logging plans could only occur after an outbreak and specifics about the location and extent of mortality is known. There are strategies and plans for projects for long term restoration of elements of the forest ecosystem such as the Blue Mt. Demonstration Project, and the Interior Columbia Basin Ecosystem Management Project draft EIS.
If timber areas are protected, will timber production increase (1)	Ch. IV Issue 2: Protection of Timber Values	Expanded Alternative addresses protecting trees to prevent volume loss
Snag fall predictions need to account for size class (1)	Analysis File-Fire	Snag fall rates not included in EIS
Address mortality predicted by size class (1)	Ch. IV, Forest Health Ch. IV, Issue2: Protection of Timber Values Analysis file: Timber	The mortality analysis of timber available for harvest does take into account broad size classes in developing an estimate of mortality.
Address loss of timber volume (1)	Ch. IV, Issue2: Protection of Timber Values.	
Address timber values the same as recreation values	Ch. III, Recreation Ch. IV, Human Environment: Recreation Ch. IV, Issue 2: Protection of Timber Values	Analysis looks only at potential volume (not value) of potential timber lost.
Identify forest plan areas where wood production allowed (1)	Ch. III, Timber Management Appendix A	
The eastside screens was short-term, interim direction (1)	Ch. III, Timber Management.	Eastside Screen are still mgt. direction
Discuss effects on 303[d] listed streams and impacts on future improvements (1)	Ch. III, Water Quality Ch. IV, Water Quality	
Discuss municipal watersheds – link to water quality – Specific mention was made of the Mill Creek watershed (3)	Ch. III, Human Environment: Municipal Watersheds Ch. IV, Human Environment: Municipal Watersheds	
Discuss effects of spraying in intermittent streams during dry periods (1)	Ch. IV, Water Quality: Tussock Moth and Insecticide Effects.	No effects on water quality are expected. As a result, it is not anticipated that there would be effects on intermittent streams.
What is the impact to reptiles and amphibians (4)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Sensitive Species Ch. IV, Fish & Wildlife: Other Species	
Discuss impact to Bald Eagles (2) – include .5 mile no spray zone (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other T&E Species	
Fully discuss effects to federally listed species (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: T&E Species (all)	
Need analysis of nesting Spotted Owls [include noise effects, critical habitat units] (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: T&E Species Incl. in Project Obj.	

COMMENT (# RECEIVED)	REFERENCE	RESPONSE
Address effects on the Canada lynx (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other T&E Species	
Address effects on the gray wolf (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other T&E Species	
Address effects on the Grizzly Bear (6)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other T&E Species	
Address effects on raptors (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Sensitive Species Ch. IV, Fish & Wildlife: Other Species	
Address effects on bats (2) - Townsend Big Eared bat (2)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Sensitive Species	
Address effects on neo-tropical birds (1); - insectivores birds (5)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other Species	
Address Survey and Manage species (1)	Ch. III, Fish & Wildlife Ch. III Plants Ch. IV Fish & Wildlife: Other Species	
Consult for sensitive and endangered species (1)		In process for listed, not required for sensitive
Impacts on non-endangered species – deer or elk, others (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other T&E Species Ch. IV, Fish & Wildlife: Sensitive Species Ch. IV, Fish & Wildlife: Other Species	
Address flammulated owls (2)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other Species	
Address impacts to shrews that feed on moths (2)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other Species	
Consider effects to woodpeckers, pigmy nuthatch (1)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: Other Species	
Consider effects to micro fauna and flora (2)	Ch. IV, Issue 6, Effects of spraying on fish and wildlife.	None were identified
Discuss each Bull Trout waterway proposed for spraying (2)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: T&E Species Incl. in Project Obj.	
Analyze areas where negative effect would occur [from defoliation] for salmon, steelhead, and bull trout (3)	Ch. III, Fish & Wildlife Ch. IV, Fish & Wildlife: T&E Species Incl. in Project Obj Ch. IV, Fish & Wildlife: Sensitive Species	

APPENDIX D: DFTM SAMPLING AND MONITORING

GENERAL

Proposed actions and locations of where these actions take place are based on monitoring the Douglas-fir tussock moth populations. Population monitoring takes place at several levels, and it is a combination of these levels that helps us determine whether an outbreak is potentially imminent, and where it will occur. Population monitoring consists of three levels of monitoring: the Douglas-fir tussock moth early warning system, early larval and cocoon/egg mass ground sampling, and the aerial detection survey.

DFTM EARLY WARNING TRAPPING SYSTEM

BACKGROUND

Douglas-fir tussock moth, *Orgyia pseudotsugata* (McCunnough) (Lepidoptera: Lymantriidae), outbreaks in the western United States and Canada tend to be cyclic, occurring about every 9 years (Shepherd et al. 1988). In the Pacific Northwest, a Douglas-fir tussock moth population increase typically consists of four phases or years. During the first phase, the population begins to increase but remains at sub-outbreak levels. In phase II populations continue to increase above the outbreak level threshold and some defoliation is apparent. In phase III, populations are extremely high and can result in complete tree defoliation. Populations remain very high during phase IV; however population pressure and insect pathogens cause the population to collapse during this phase. Additional defoliation will be incurred during this phase prior to the collapse of the population.

Generally, land managers do not recognize the significance or the severity of a DFTM outbreak until Phase III when the first year of complete defoliation occurs. Once significant defoliation occurs it is too late to implement any management options.

The last widespread outbreak of Douglas-fir tussock moth (DFTM) in Oregon and Washington occurred in eastern and central Washington and northeastern Oregon during 1971-1974. Since that time, populations have fluctuated twice without reaching outbreak status, except in more localized areas.

THE DFTM EARLY WARNING SYSTEM

DFTM population level trends are monitored annually throughout Oregon and Washington using a plot network of approximately 405 pheromone traps. This on-going Douglas-fir Tussock Moth Early Warning System is a cooperative effort that includes the USDA Forest Service, USDI Bureau of Land Management, USDI Bureau of Indian Affairs, Oregon Department of Forestry and the Washington Department of Natural Resources. Other western Regions and States also participate in this west wide survey. The objective of the Early Warning System is to detect incipient DFTM outbreaks. When trap catches increase to predetermined levels, additional sampling activities are initiated to further quantify population levels (Sheehan et al. 1993). The DFTM Early Warning System is intended to provide an advance warning of population changes that would indicate a potential outbreak one to two years prior to the outbreak occurring. This would allow land managers an opportunity to evaluate and implement management options before high levels of defoliation occurred.

The pheromone traps are deployed according to standardized procedures (Daterman et al. 1979) in specified trap sites in July and retrieved following moth flight in the fall. The pheromone lures contain a very low pheromone dose and are calibrated specifically to detect low populations. There are five traps per plot. The average number of moths per trap is calculated for each plot. Male DFTM are sampled annually on these permanent locations throughout eastern Oregon and Washington.

POPULATION MONITORING PROCESS

Plot trap catch averages, trends in trap catches on plots from year to year, and trap catch density patterns over larger geographic areas, are the factors considered when determining future sampling intensity and methodology. The following sequence of sampling actions is initiated when plot averages exceed predetermined threshold levels, and when the trend of trap catches is increasing.

1. Additional pheromone trap plots are established the following year in the area surrounding plots averaging 25 or more, but less than 40 moths per trap. Establishment of additional pheromone trap plots serves to increase confidence in the accuracy of pheromone trap data for detecting incipient outbreaks in a specific area.

2. Cocoon and/or larval surveys utilizing methods developed by Mason (1979) are conducted in the fall of the same year or spring of the following year in the vicinity of plots with trap catch averages exceeding 40 moths per trap, and in areas of concern. Cocoon and larval survey data provide estimates of population densities and give more accurate indications of outbreak potential and population trends than the pheromone trap data. The traps are intended to be used **only** as an early warning indicator.

The DFTM Early Warning System is **not designed or intended** to predict exactly where the defoliation will occur; areas to be sampled on the ground should be selected on the basis of the impact of DFTM defoliation on management objectives. DFTM Early Warning System traps are **not** calibrated for use during DFTM outbreaks, or to determine population levels once an outbreak has begun. As populations increase, a decline in trap catches will

typically be noted. Larval and cocoon/egg mass surveys are used to determine what the populations are doing in a particular area, once the traps have signaled a population increase.

GROUND SURVEYS

Two types of ground surveys are done, once the Early Warning System indicates an increase in populations - early instar larval sampling in the spring, and cocoon/egg mass surveys in the fall. These samples are used to verify the presence and levels of the populations.

EARLY INSTAR LARVAL SAMPLING

The procedures for the early larval sampling are slightly modified from those described by Mason (1978) and Mason and Paul (1994). These sampling procedures are used in areas where Early Warning System trap counts are high and in the areas currently being analyzed in the EIS. It is also the sampling system that will be used in the early spring to verify that suboutbreak and outbreak populations before any treatment would occur. If appropriate levels were not evident, an area would not be treated.

Lower crown beating (LCB) is a simple method of obtaining counts of Douglas-fir tussock moth. These counts can be used to index the populations that occur in the midcrown of a host tree, or they may be used to simply express population levels directly in the lower crown. The counts which are obtained by LCB may be use to calculate population densities, and can be expressed in various different units of measurement (e.g. mean number of larvae per 3-branch sample; lower crown density per 1000 sq. in. of foliage; midcrown density per 18-in. branch tip; and midcrown density per sq. meter of foliage).

Measurements of insect densities are important information for determining current population levels and trends over time, and for providing a biological basis for management decisions regarding need for suppression, monitoring, or other follow-up actions for a stand or forest.

Lower crown beating, when timed properly will normally occur sometime between mid June and mid July. Timing will depend upon elevation and current weather conditions. Thus, sampling will likely be done over several days, or perhaps over a couple of weeks, where large areas of varying elevations and aspects are to be sampled. It is important to monitor development of host and/or insect over the area to be sampled, for this reason.

At each location, 50 tussock moth host trees (white or grand fir, and Douglas-fir) with new shoots that can easily be reached from the ground, are selected. To sample the larvae, a beating cloth is held under the apical 45-cm (18-inches) of each of three branches, and each branch is rapped about a dozen times with the beating stick to dislodge the larvae from the branch. After all three branches have been ``rapped," the total number of larvae is counted, and totals are recorded. This procedure is repeated on all 50 trees on the plot. A number of plots are established throughout a sample area. This number varies on the size of the area; in larger areas it will average about 1 plot per square mile. The sampling results are summarized by consolidating the data. The mean number of larvae is then calculated to reflect number of larvae per 1000 sq. in. of a mid-crown branch. This is then used to determine the status of the mean tussock moth population for the area. The following table is used to determine population status of an area and predicted defoliation (Mason, 1978):

> Average less than 3.0 larvae per 1000 sq. in = low-level: population at least 2 years away from outbreak;
>
> Average 3.0 - 20.0 larvae per 1000 sq. in = suboutbreak; potentially one year away from outbreak;
>
> Average 20.0 or more larvae per 1000 sq. in. = outbreak level

Another sequential sampling method for sub-outbreak populations is also sometimes used. It also involves lower crown beating and numbers of trees sampled is determined by the population densities; this sampling method categorizes the sampling area into L= Low; S = Sub-outbreak; and I = Indeterminate (Mason, 1978).

COCOON/EGG MASS SAMPLING

Populations are also monitored through cocoon/egg mass sampling in conducted in the fall after the adult flight. The frequency of the cocoons and egg masses can also predict the population and defoliation levels that can be expected the following spring and are based on lower crown cocoon samples (Mason, et. al., 1993). The number of sample plots per sample area is determined by the size of the sample area. Twenty-five to fifty host trees are randomly selected per plot. The undersides of three 18-inch branch tips are examined for the presence or absence of cocoons and egg masses and the total number for the three branches is recorded. The proportion of the samples infested calculated to reflect mid-crown densities, which are in turn used to estimate population levels and predicted defoliation for the following year. These densities are:

> Low density; no defoliation = Less than 0.01 cocoons per 1000 sq. inches in the lower crown
>
> Sub-outbreak, little or no visible defoliation = 0.3 cocoons per 1000 sq. inches in the lower crown
>
> Moderate outbreak, defoliation visible on most trees = 0.31-0.70 cocoons per 1000 sq. inches in the lower crown
>
> Severe outbreak, defoliation intense in upper crowns of many host trees with some trees completely defoliated = greater than 0.70 cocoons per 1000 sq. inches in the lower crown

AERIAL DETECTION SURVEY

In addition to the pheromone trapping and insect population monitoring on the ground Douglas-fir tussock

moth defoliation can be detected from the air. An annual aerial detection survey is conducted over all forested lands in Washington and Oregon and tree mortality and defoliation are recorded. This is also one way to monitor the progress and outcome of a Douglas-fir tussock moth outbreak. However, once defoliation is visible from the air, the populations have moved from suboutbreak to moderate outbreak levels. Generally, defoliation is expressed in a few areas one year, and then encompasses much larger areas the following year. Information from the first year when some visible defoliation is apparent can help determine where to focus additional sampling. However, the ultimate use of the aerial survey will be to record the location, extent and severity of the outbreak as it progresses, and monitor secondary mortality from bark beetles in the area following the decline of the outbreak. The defoliation is recorded as light, moderate, and heavy defoliation and mortality in acres.

APPENDIX E: EFFECTS OF B.T.K ON NON-TARGET MOTHS AND BUTTERFLIES

SPECIES	APPLICATION RATE	SITE DESCRIPTION	RESULTS AND CONCLUSIONS	STUDY R[2]	DESIGN C	STUDY
Target = spruce budworm (*Choristoneur fumiferana*)	Thuricide 16B Dipel WP, with and without chitinase. 2 & 4 lbs. /acre	Algonquin Park, Ontario, & Spruce Woods, Manitoba. Spruce-Fir forests.	Numbers of hand-picked larvae from aspen, alder, and maple were not different on control and treated plots.	No	Yes	Buckner and Others, 1974
32 species of Lepidoptera on tobacco brush, *Ceanothus velutinus*	20 BIU/ha	Estacada, Clackamas Co., Oregon Program to control spruce budworm *(Choristoneura occidentalis*)	Number of larvae on shrubs in treated site decreased 80% between pre- and post-treatment surveys compared to control site where number of larvae increased 6% in same time period, 2 weeks post-spray. 2 months post-spray there were no differences between spray and control sites. One year after spray and 1st post-spray sample, larval abundance was lower than pre-treatment the previous year and lower than control site. Late-season sample in 2nd year was again no different between control and treated sites. Species richness and diversity not statistically different between control and treated site; *B.t.k.* tended to even-out the proportion of species.	No	Yes	Miller, 1990a
35 spp. Lepidoptera in 10 families. ll in Garry oak (*Quercus garryana*)	40 BIU/ha 3 times	Elmira, Lane Co., Oregon Program to manage gypsy moth	3 post-spray samples. Significant differences in caterpillar density between treated and control plots for each post-spray sample; remained significant by day 68, not by day 90. Species richness significantly lower on treated plots. Species richness and larval abundance significantly lower 1 year after spray, but not 2 years after spray. Results expected of univoltine species.	No	Yes	Miller, 1990b
Forest Lepidoptera on 30 ha plots	Thuricide 32LV 3.5 L/ha	White Mtns., NH Northern hardwoods: maple, beech, birch	Spraying in 1983 significantly reduced caterpillars relative to unsprayed plots. No differences in 1984 & 1985, because numbers were naturally low on control plots those years.	No	Yes	Rondenhouse and Holmes, 1992
Non-target moths in Asian strain of the gypsy moth eradication program area	60 BIU/ha (24 BIU/acre)	Pierce and King Counties, WA	Full-spectrum lights. 49-97% lower catches at treated sites in 1993 v. same sites in 1992; stat. significant drop. Three species (*Orthosia hibisci, Protorthodes rufula, Perizoma curvilinear*) eliminated from site? Overall, moth diversity	Yes	No	Crawford and others, 1993 Wood,1994 (pers. comm..)

[2] The R column indicates whether the study design included replicates, and the C indicates controls.

SPECIES	APPLICATION RATE	SITE DESCRIPTION	RESULTS AND CONCLUSIONS	STUDY R^2	DESIGN C	STUDY
			unaffected. Spring in 1993 was significantly cooler and wetter, Untreated sites monitored in 1993 also experienced a significant decline in populations. Author attributes this decline to effects of Btk in treated areas located 1 and 3 miles away from untreated sites. Author assumes no variables, such as weather, other than *Btk*.			
Cinnabar moth	Dipel hg (0, 2, 8, 25, and 250 BIUs/ha	Laboratory study on tansy ragwort	*B.t.k* has little effect on early (1-3) instar survival, but 4th and 5th instars were susceptible.	Yes	Yes	James and others, 1993.
Lepidoptera on 24 20ha plots treated with *Btk*	Foray 48B 36BIU/ha (15BIU/ac)	Ridge and Valley region of eastern West Virginia	B.t.k *reduced richness and abundance of non-target Lepidoptera. Both larval and light trap sampling for adults moths conducted. Species with early season larvae experienced greatest impact. Impacts on larvae evident year of treatment; impacts on adults not observed until one year later.* Monitored impacts of gypsy moth and defoliation on non-targets. Both *B.t.k* and forest defoliation by gypsy moth larvae reduce richness and abundance of native lepidopteran.	Yes	Yes	Sample and others, 1993.
Micro- and macro-lepidoptera	89 BIU/ha (36 BIU/acre) Sprayed in 1992	Rockbridge Co., VA Oak woodland, 50 acre plots	Sampled in 1992 and 1993. Pre- and post (day 6 and 12) foliage samples from canopy, subcanopy, and shrub-layer show reductions in the relative abundance of 16/19 most common taxa. 12/16 were microlepidopterans. In 1992 larval abundance reduced on 3/5 *B.t.k*. sites in canopy and subcanopy. Uneven application accounted for variable effects. 2 plots consistently showed the greatest effects. Total numbers of lepidopterans on foliage were no different on treated and control sites in 1993. Microlepidoptera accounted for 95% of the individuals collected from foliage in 1992 and about 85% in 1993. 6 of 8 most common macrolepidopteran species trapped under burlap bands were reduced by treatment. 3 of these spp. were nearly absent in treated plots (*Satyrium calanus, Malacosoma disstria, Orthosia rubescens*). Other less common spp. appeared to be significantly less on treated plots. *Dasychira obliquata* was not affected apparently. Noctuidae also lower in 1993.	Yes	Yes	Peacock and others, 1994.

SPECIES	APPLICATION RATE	SITE DESCRIPTION	RESULTS AND CONCLUSIONS	STUDY R^2	DESIGN C	STUDY
Lepidoptera Sampled in 1990-1992	14.4 BIU/ha Sprayed in 1991	Grant and Pendleton Counties, WV 50 ha plots in Oak-hickory with pine; blueberry shrub layer.	4 treatments: control; bt-sprayed without gypsy moth (GM); bt with GM; GM alone (defoliated). Foliage and blacklight (b-1) samples. Total larval abundance reduced following *B.t.k*. applications in 1991. No effects of *B.t.k.* and GM on several microlepidopterans noted. Total spp. richness (SR), SR of Noctuidae, and of Geometridae reduced in *B.t.k*. plots in 1991. Residual effects noted in 1992 on Noctuidae. B-1 sampling found reductions in 1991 in abundance of total Lepidopterans, microleps., and Geometridae. Total lepidop., microleps. and noctuids were reduced in 1992. Few differences in adult Lepidoptera richness between sprayed and control plots.	Yes	Yes	Sample and others, 1995; Butler, 1995.
Lepidoptera 458 species on 4 – 16ha (40ac) plots	Thuricide 16 BIU/ac	Wallowa-Whitman and Umatilla NF-northeastern Oregon – riparian areas	Monitored treated and untreated areas for 3 years (1992-1994) with black lights to monitor adult moths for 22 weeks. Conducted larval samples for 2 years, and conducted net samples of day-flying species. A large number of species (458 samples) are resident. Most species were noctuids and geometrids. Late season fliers were more abundant on the Umatilla NF than the Wallowa-Whitman NF. There were no differences between trap catch means on sprayed vs. un-sprayed plots. No evidence in ULV data that *B.t.k* has a measurable lasting impact on nocturnal lepidopterans. Confounding effects of weather and uneven distribution of food plants may mask differences caused by spray.	Yes	Yes	Grimble, 1995.
3 Lepidoptera 2-tree feeding swallowtail butterflies, and promethia moth	Foray 48B 40 BIU/ha (16 BIU/ac.) ground application	Applications to individual trees of 7 host tree species. 4 sites in Michigan	*B.t.k* was toxic to early and later (4th) instar larvae regardless of host. Long-term persistence was monitored for 40 days. Toxicity for one species persisted for 30 days after treatment.	Yes	Yes	Johnson and others, 1995.
Approx. 498 species of Lepidoptera larvae	Bt at 24 BIU/ac	Warm Springs, Or east slope of central Cascade Mt. On ocean spray, snowbush and	Larval sampling and black light trapping of adult moths in treated and untreated areas. There were significant reductions in larvae species richness and abundance and biomass following treatment in 1993, with recovery of some species richness and	Yes	Yes	Miller, 1995

SPECIES	APPLICATION RATE	SITE DESCRIPTION	RESULTS AND CONCLUSIONS	STUDY R^2	DESIGN C	STUDY
		greenleaf manzanita in coniferous forests	some abundance and biomass in 1994, and no significant difference in richness, abundance and biomass by 1995. Adult trapping had a significant reduction in the numbers of adult moths trapped the fall following treatment. In 1994 the treated plot had a significantly higher number of adults trapped than untreated; and in 1995 there was no difference.			
Native non-target Lepidoptera	90 BIU/ha Single application	Goshan wildlife Mgmt. Area, Rockbridge Co. west central Virginia Various hardwoods – scarlet, red, white and chestnut oaks, tulip poplar	Overall caterpillar abundance was lower on foliage from sprayed plots, but differences were modest and mostly non-significant. Greatest impacts were in macrolepidoptera fauna beneath burlap bands. 95% of lepidoptera were shelter-forming microleps (leaf rollers, etc.) that could avoid the treated foliage. Caterpillar numbers rebounded in the first post-spray year, with only 2 species remaining significantly less common on treatment plots; reduced abundance of these two species remained through the 2nd post-year samples.	Yes	Yes	Wagner and others, 1996
42 species of native Lepidoptera	Foray 48B and Dipel AF	Laboratory bioassay	Effect of two formulations of *B.t.k* was evaluated on 42 species on instars that would be present in the field at the time of treatment. Mortality was significant for 57-64% (Dipel and Foray, respectively) of species tested. All butterfly species were highly sensitive versus 10 of 38 moth species. Late instars of 7 of 8 species of xylenini noctuids were insensitive to *B.t.k.*	Yes	Yes	Peacock and others, 1998
668 nontarget native Lepidoptera species	2-3 applications of Foray 48B @ 24BIU/ac each application; Gypchek in sensivtive areas	Lower Cape Fear region; flatwoods and savannahs of southeastern North Carolina	Black light trapping of adult moths compared *B.t.k* treatment to Gypchek treated plots. A major depression of macromoth abundance occurred independently of treatment effects (possibly weather-related). Moth abundance in *B.t.k* treated plots was lower than in Gypchek treated plots the fall of the year of treatment and for univoltine moths the following spring. Increases in moth numbers occurred between 1994 and 1995. 668 sopecies were sampled of which 79% were Geometridae and Noctuidae. Found little evidence that any species was extirpated; and several rare species either survived	Yes	Yes	Hall and others, 1999

SPECIES	APPLICATION RATE	SITE DESCRIPTION	RESULTS AND CONCLUSIONS	STUDY R^2	DESIGN C	STUDY
			or quickly recolonized the *B.t.k* blocks. Nonetheless, recommend using Gypchek to protect core natural areas. Protection of at least large blocks of high quality habitat may play a role in re-colonization of depleted areas.			

APPENDIX F: RELEVANT FOREST PLAN STANDARDS AND GUIDELINES

Colville (LRMP 1988)

Suppress insect and disease outbreaks that threaten the wildlife habitat objective (LRMP, p. 4-72).
Prevent or suppress insect and disease outbreaks that are an imminent threat to caribou habitat, in a manner consistent with habitat management objectives (LRMP, p. 4-76).
Prevent or suppress insect and disease outbreaks that threaten the recreation objective (LRMP, p. 4-79).
Prevent or suppress insect and disease outbreaks that threaten the recreation or wildlife objectives (LRMP, p. 4-83).
Prevent or suppress insect and disease outbreaks that threaten the recreational visual objective (LRMP, p. 4-87).
Insect and disease control is appropriate to protect the uniqueness of the Research Natural Area (LRMP, p. 4-91).
Prevent and suppress insect and disease outbreaks that threaten visual resources (LRMP, p. 4-96 and 4-100).
Prevent or suppress insect and disease outbreaks that threaten the timber values (LRMP, p. 4-104).
Prevent or suppress insect and disease outbreaks that threaten the winter range objective (LRMP, p. 4-108).
Insect and disease characteristics will be monitored and evaluated. If conditions pose a significant threat to lands outside the wilderness or caribou habitat inside, control measures may be taken with biological controls to be given preference (LRMP, p. 4-113).
Prevent or suppress insect and disease outbreaks that threaten the semi-primitive objective (LRMP, p. 4-117).
Prevent or suppress insect and disease outbreaks that threaten the Semi-Primitive, Non-Motorized objective or that are an imminent threat to caribou habitat (LRMP, p. 4-122).

Okanogan (LRMP 1990)

(The following are management directions for land both in and outside the Northwest Forest Plan)

Integrated Pest Management strategies shall be used to manage pests in conformance with the resources goals of the management areas (LRMP, p. 4-53, Forest Wide Standards and Guidelines).
Insects and diseases may be suppressed when necessary to protect the recreation and the scenic values in the area or in adjacent Management Areas, or when necessary to prevent the spread of insects and disease to adjacent Management Areas where timber production is a primary emphasis and when projected volume losses would be substantial. Pest populations shall be monitored to assure that there is not an insect buildup that could spread to adjacent Management Areas (LRMP, p. 4-64). *Applies to lands outside the NWFP and lands in LSRs.*
Insects and diseases shall be suppressed when outbreaks threaten managed resources and/or users. Suppression methods that minimize site disturbance should be used. Stands shall be managed to control insect and disease problems and to control outbreaks, to the extent practicable (LRMP, p. 4-69). *Applies to lands outside the NWFP and lands in Matrix and in Administratively Withdrawn Lands.*
Suppression may be allowed where insects and diseases would adversely affect achieving the resource goals in the [North Cascades Highway] area (LRMP, p. 4-72). *Applies to lands under and outside the NWFP.*
Where pest management activities are prescribed [in Research Natural Areas], they shall be specific against the target organism and induce minimal impact to other components of the ecosystem (LRMP, pg, 4-75). *Applies to lands under and outside the NWFP.*
Insects and diseases may be suppressed when necessary to protect the wildlife habitat values in [Mountain Goat Habitat] area, or when necessary to prevent the spread of insects and diseases to adjacent management areas where timber production is a primary emphasis and when projected volume losses would be substantial (LRMP, pg, 4-77). *Applies to lands inside and outside LSR's and to lands outside the NWFP.*
Suppress insects and diseases when adversely affecting vegetation essential for maintaining [Bighorn Sheep] habitat and unacceptable damage to resources would occur if no controls are applied (LRMP, pg, 4-80). *Applies to lands within LSR's and outside the NWFP.*
Suppress insects and diseases when adversely affecting vegetation essential for maintaining wildlife habitat and/or unacceptable damage to resources would occur if no controls are applied (LRMP, pg, 4-85). *Applies to lands outside of the NWFP and to Matrix lands and to Administratively Withdrawn Lands.*
Insect and disease outbreaks [in Wilderness without trails] shall not be artificially controlled unless it is necessary to prevent unacceptable resource damage to resources on adjacent lands or an unnatural loss to the wilderness resource. If control becomes necessary, it shall be carried out by measures that have the least adverse impact on the wilderness resource and are compatible with wilderness objectives (LRMP, pg, 4-90). *Applies to lands under and outside the NWFP.*
Insect and disease outbreaks [in Wilderness with trails] shall not be artificially controlled unless it is necessary to prevent unacceptable resource damage to resources on adjacent lands or an unnatural loss to the wilderness resource. If control becomes necessary, it shall be carried out by measures that have the least adverse impact on the wilderness resource and are compatible with wilderness objectives (LRMP, pg, 4-97). *Applies to lands under and outside the NWFP.*

[At Developed Recreation Sites], control insect and disease infestations to provide a safe environment for recreation users, to protect facilities, and to prevent the spread of introduced pests to the surrounding management areas (LRMP, pg, 4-99). *Applies to lands inside LSRs and Matrix lands and within Administratively Withdrawn Lands and lands outside the NWFP.*

No action should be taken against insects and diseases unless an outbreak threatens the plants being protected or is inconsistent with the management goals for the adjacent areas (LRMP, pg, 4-100). *Forest wide direction and ROD direction would apply*.

Aggressively suppress insects and diseases when outbreaks significantly threaten [Timber and Range] resource management. Use principles of integrated pest management to select suppression strategies (LRMP, pg, 4-106). *Applies to lands inside LSR's and Matrix lands and lands outside the NWFP*.

Suppress insects and diseases when adversely affecting vegetation essential for maintaining [Deer Winter Range] and unacceptable damage to resources would occur if no controls are applied (LRMP, pg, 4-109). *Applies to lands inside LSR's, Matrix lands, and Administratively Withdrawn Lands and lands outside the NWFP*.

Wenatchee (LRMP 1990)

Survey stands for early detection of pest problems. Coordinate with the Regional Forest Pest Management Unit for technical assistance. Pesticide application will conform to EPA regulations and label restrictions, and will [occur] only after site-specific evaluations have been made. Utilize integrated pest management strategy to prevent unacceptable resource damage and to meet resource objectives in an economically efficient manner (LRMP, p. IV-103).

Insect and disease outbreaks should be suppressed when studies are threatened and/or unacceptable damage to [Experimental Forest] resources would occur if no controls were applied. Research should develop and/or follow sound integrated pest management principles. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives. Coordinate all activities with the Experimental Station Project Leader during planning and implementation of project (LRMP, p. IV-111).

Suppress insects and diseases when necessary to protect [Key Deer and Elk Habitat] resource values. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-120).

Suppress Forest pests when they adversely affect the vegetation component essential for maintaining the [Riparian-Aquatic Habitat Protection] zone and/or when unacceptable damage to resources would occur if no controls were applied (LRMP, p. IV-127).

Suppress insects and diseases when adversely affecting vegetation essential for maintaining [Key Big Game Habitat/Unroaded] and/or unacceptable damage to resources would occur if no controls were applied. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-134).

Aggressively suppress insects and diseases when outbreaks threaten resource management. Utilize high intensity prevention with sound IPM principles (LRMP, p. IV-139).

[Along the Mather Memorial Parkway], suppress insects and diseases when outbreaks threaten managed resources and/or users. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-145).

Suppress insect and disease outbreaks to ensure protection of old-growth trees and other resources. Insects and disease are important components of old-growth. Survey insects and diseases common to old-growth that may threaten immediate and adjacent areas (LRMP, p. IV-152).

Suppress insect and disease outbreaks to ensure protection of old-growth timber and other resources. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives. Survey insects and diseases common to old-growth that may threaten immediate and adjacent areas (LRMP, p. IV-158).

Suppress insect and disease outbreaks with a minimum of resource disturbance to protect [Developed Recreation sites] and/or users. Favor biological and silvicultural treatments over pesticides when possible. Utilize high intensity preventive efforts featuring Integrated Pest Management (LRMP, p. IV-164).

Suppress insects and diseases when outbreaks threaten [Dispersed Recreation, Unroaded, Motorized] resources and/or users. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-169).

[At Dispersed Recreation, Unroaded, Non-Motorized sites], suppress insects and diseases when outbreaks threaten managed resources and/or users where possible. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-175).

[In Dispersed Recreation/Unroaded/Timber Harvest areas], suppress insects and diseases when outbreaks threaten managed resources and/or users. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-181).

Suppress insect and diseases when adversely affecting vegetation essential for maintaining livestock and/or when unacceptable damage to resources would occur if no controls were applied. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-188).

Suppress insect and disease outbreaks to meet Research Natural Area objectives. Use these areas to observe insects and diseases in undisturbed areas. Survey pest populations as a management strategy for adjacent resource areas (LRMP, p. IV-192).

Suppress insects and diseases when outbreaks threaten managed [Classified Special Area] resources and/or users (LRMP, p. IV-197). Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-204).

Suppress insects and diseases when outbreaks threaten [Scenic Travel-Retention] managed resources and/or users. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-213).

Suppress insects and diseases when outbreaks threaten managed [Scenic Travel-Partial Retention] resources and/or users. Use suppression methods that minimize site disturbance. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-222).

Suppress insects and diseases when outbreaks threaten managed [Utility Corridors] and integrity of structures. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-226).

Suppress insects and diseases when outbreaks threaten [Wilderness] resources in adjacent areas. Favor biological controls when available. Survey pest populations as a management strategy for adjacent resource areas (LRMP, p. IV-232).

Suppress insect and disease outbreaks to preserve recreational character and adjacent resources. Avoid degradation of water quality. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-239).

Suppress insect and disease outbreaks when necessary to protect [Wild River] character or adjacent resources. Utilize IPM strategies to prevent unacceptable pest damage and meet resource objectives (LRMP, p. IV-245).

Umatilla (LRMP 1990)

Protect forest and range resources and values from unacceptable losses due to destructive forest pests through the practice of integrated resource management (LRMP, p. 4-3).

Integrated pest management prevention, and suppression strategies will be utilized to manage pests within the constraints of laws and regulations and to meet Forest-wide management objectives. Methods may include management practices (cultural or silvicultural); biological, mechanical, manual, prescribed fire, or chemical treatments; or regulatory measures. All pest management suppression project proposals will be analyzed through the NEPA process to select an appropriate suppression response. Individual project plans will specify licensing approval and public notification requirements for pesticide use on a case-by-case basis (LRMP, p. 4-89).

Use integrated pest management principles and strategies in meeting [Non-motorized Dispersed Recreation] management area objectives. Suppress pests when outbreaks threaten recreation objectives or resources in adjacent areas. Favor biological methods when available (LRMP, p. 4-96).

Use integrated pest management principles and strategies in meeting OHV Recreation management area objectives. Suppress pests when outbreaks threaten dispersed recreation objectives or resources in adjacent areas. Favor biological methods when available (LRMP, p. 4-98).

Use integrated pest management principles and strategies to manage insect and disease pests in meeting Viewshed 1 objectives. All treatment strategies may be utilized. Emphasize strategies that improve visual quality, aesthetics, and safety (LRMP, p. 4-104).

Use integrated pest management principles and strategies to manage insect and disease pests in meeting Viewshed 2 objectives. All treatment strategies may be utilized. Emphasize strategies that improve visual quality, aesthetics, and safety (LRMP, p. 4-110).

Use integrated pest management principles to manage insect and diseases in meeting Roaded Natural management area objectives. All treatment strategies may be utilized. Emphasize strategies that improve visual quality, aesthetics, and safety. Suppress pests when outbreaks threaten users and/or managed resources. Use suppression methods that minimize site disturbance (LRMP, p. 4-116).

[At Developed Recreation sites], use integrated pest management principles and strategies to prevent or control unacceptable vegetative losses due to insects and diseases. Emphasize prevention and early detection measures. Prevent, control, or suppress pest outbreaks with a minimum of disturbance to protect users and/or developments. Favor biological and silvicultural treatments where possible (LRMP, p. 4-120).

[Along Wild and Scenic Rivers], use integrated pest management principles and methods. Prescribed fire may be used to help reduce stocking and conditions favorable for bark beetle and other insects and diseases (LRMP, p. 4-127).

Use integrated pest management principles to manage insects and diseases in meeting scenic area objectives. Suppress pests when outbreaks threaten scenic area objectives or resources in adjacent areas. Favor biological methods when available. Control of defoliators may be accomplished by spraying following approval of an environmental analysis (LRMP, p. 4-130).

[In Special Interest Areas], utilize integrated pest management principles and strategies to prevent unacceptable vegetative losses due to pests. Emphasize prevention and early detection measures. Suppress pest outbreaks with a minimum of disturbance to protect users and/or resources. Favor biological and silvicultural treatments where possible (LRMP, p. 4-133).

[In the Wenaha-Tucannon Special Management Area], use integrated pest management principles and strategies in meeting management area objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments can be prescribed early (LRMP, p. 4-137).

Monitor the levels and activities of pests normally associated with Wilderness and old-growth ecosystems. Most insect and disease agents do not normally pose threats to adjacent lands; effects of endemic levels will be accepted as naturally occurring phenomena (LRMP, p. 4-143).

Monitor the levels and activities of pests normally associated with old-growth ecosystems. Effects of endemic levels will be accepted as naturally occurring phenomena. No special management practices will be utilized to control losses from insects and diseases at endemic levels. Suppress or control pests when outbreaks reach epidemic levels and threaten catastrophic loss of dedicated old-growth resources or other resources on adjacent lands. Favor biological treatment methods or prescribed burning. Integrated pest management methods will not conflict with wildlife objectives (LRMP, p. 4-146).

Use integrated pest management principles to meet [Managed Old-Growth] area objectives. Emphasis will be on the prevention of stand and fuels conditions that increase pest populations above epidemic levels. Natural or endemic levels are acceptable and no special management practices will be employed to control losses from insects or diseases at these levels. Suppress or control pests when outbreaks threaten managed old-growth resources, the ability of stands to become old-growth, or other resources on adjacent lands. IPM methods will not conflict with wildlife objectives (LRMP, p. 4-150).

Use integrated pest management principles and strategies in managing insects and disease to meet [Big Game Winter Range] management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments, consistent with resource objectives, can be prescribed early. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives (LRMP, p. 4-154).

Use integrated pest management principles and strategies in managing insects and disease to meet [Sensitive Big Game Winter Range] management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives (LRMP, p. 4-157).

Use integrated pest management principles and strategies in managing insects and disease to meet [Wildlife Habitat] management objectives. Detection and monitoring of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives (LRMP, p. 4-162).

Use integrated pest management principles and strategies in managing insects and disease to meet [Riparian] management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. The use of pesticides must not conflict with riparian/wildlife management objectives (LRMP, p. 4-166).

Use integrated pest management principles and strategies in managing insects and disease to meet [Special Fish Management Area] management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives. The use of pesticides must not conflict with riparian, fish, and water management objectives (LRMP, p. 4-170).

Use integrated pest management principles and strategies in meeting [Grass-Tree Mosaic] management area objectives. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives or resources on other lands. Favor biological methods in meeting protection and suppression requirements. Control of defoliators may also be accomplished by spraying following approval of an environmental analysis (LRMP, p. 4-174).

Action to control insects or diseases [in a Research Natural Area] will not be taken unless an outbreak will drastically alter the natural processes with the RNA, or if it poses an unacceptable threat to resources adjacent to the RNA. Treatment to control insects and diseases within RNA will support and promote the basic objective and purposes of establishing the area (*FSM 4063.3(8))*. Biological methods are preferred (LRMP, p. 4-177).

Use integrated pest management principles and strategies in managing insects and disease to meet [Timber and Forage] management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives. Use a variety of methods in meeting protection and suppression requirements (LRMP, p. 4-181).

Use integrated pest management principles and strategies in managing insects and disease to meet [Timber and Big Game] management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. Protect growing stock consistent with the level of investment by practicing high intensity prevention activities. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives. Use a variety of methods in meeting protection and suppression requirements (LRMP, p. 4-186).

[In the Mill Creek Municipal Watershed-Undeveloped], use integrated pest management principles and strategies in managing insects and diseases to meet management objectives. Management of insects and diseases (including suppression activities) is permitted. In coordination with the City of Walla Walla, prevent unacceptable damage in the watershed. The preferred method is use of biological controls (LRMP, p. 4-188).

[In the High Ridge Evaluation Area], use integrated pest management principles and strategies in managing insects and disease to meet management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. Protect growing stock consistent with the level of investment by practicing high intensity prevention activities. Aggressively suppress insects and disease using cost efficient strategies when outbreaks threaten resource objectives. Use a variety of methods in meeting protection and suppression requirements (LRMP, p. 4-190).

[In the Walla Walla River Watershed], use integrated pest management principles and strategies in managing insects and disease to meet management objectives. Monitoring and detection of pest conditions and populations will be done so that corrective treatments consistent with resource objectives can be prescribed at the earliest opportunity. Suppress pests using cost efficient strategies when outbreaks threaten dispersed recreation, water and/or wildlife habitat objectives or resources in adjacent areas. Favor biological methods when available. The use of pesticides will not conflict with water and habitat objectives (LRMP, p. 4-195).

Wallowa-Whitman (LRMP 1990)

All projects or activities (including but not limited to pesticide application,) with the potential to adversely affect surface or ground waters will include constraints and/or mitigation measures designed to prevent contamination (LRMP, p. 4-24, 4-62).

Use fertilizers and pesticides (chemical or biological) within the watersheds only in emergencies, and then only following close coordination with the city (LRMP, p. 4-26).

Use integrated pest management strategies for early detection, suppression, and prevention of Forest pests and to manage pests within the constraints of laws and regulations (LRMP, p. 4-55).

Prevent and/or suppress insects and diseases using integrated pest management techniques when outbreaks threaten [Timber Production Emphasis] resource management objectives. Activities might include… application of pesticides for defoliators and cone insects (LRMP, p. 4-58).

Monitor the levels and activities of pests normally associated with Wilderness and old-growth ecosystems. Most insect and disease agents do not normally pose threats to adjacent lands; effects of endemic levels will be accepted as naturally occurring phenomena (LRMP, p. 4-65).

[In the Philips Lake Area], apply Forest-Wide standards and guidelines for insects and disease (LRMP, p. 4-68).

Insect or disease outbreaks affecting trees will not be artificially controlled unless it is necessary to protect [Back Country] resources in adjacent management areas (LRMP, p. 4-70).

[Along Wild and Scenic Rivers], control forest pests in a manner compatible with the intent of the act and management objectives of contiguous National Forest System lands (*FSM 3400*, LRMP, p. 4-72).

[In the HCNRA Snake River Corridor], apply Forest-Wide standards and guidelines for insects and disease (LRMP, p. 4-76).

[In HCNRA Dispersed Recreation/Native Vegetation areas], emphasize biological methods when necessary to control insects or noxious weeds, although abiotic methods are not prohibited (LRMP, p. 4-78).

Apply Forest-Wide standards and guidelines for insects and disease [in HCNRA Forage Production areas] (LRMP, p. 4-80).

[In HCNRA Dispersed Recreation/Timber Management areas], apply Forest-Wide standards and guidelines for insects and disease (LRMP, p. 4-82).

The decision on treatment of Forest pests [in Research Natural Areas] will be made on a case-by-case basis. Where pest management activities are prescribed, they shall be as specific as possible against target organisms and induce minimal impact to other components of the ecosystem (LRMP, p. 4-85).

[In the Homestead Further Planning Area], permit artificial control of Forest pests only to protect values outside the further planning area (LRMP, p. 4-86)

[In the Starky Experimental Forest and Range area], apply Forest-wide standards and guidelines provided preventive and suppressive techniques are consistent with research purposes (LRMP, p. 4-88).

Control of pests is encouraged where pests threaten destruction of an old-growth stand. Where destruction of the old-growth is not likely, artificial control of pests will occur only when this can be accomplished without adverse effects on old-growth values (LRMP, p. 4-91).

Prevent insect and disease outbreaks [at Administrative and Recreation Sites] including noxious weeds, with a minimum of disturbance to developments or users. Favor biological and silvicultural treatments (LRMP, p. 4-93)

[At Power Transportation Facilities], apply Forest-wide standards and guidelines for insects and disease (LRMP, p. 4-94).

[In Anadromous Fish Emphasis areas], practice high intensity prevention activities such as monitoring pest populations to be forewarned of outbreaks. Use pesticide only where this use can occur without adversely affecting fish habitat (LRMP, p. 4-98).

Malheur (LRMP 1990)

Determine the effects of management practices on the incidence and severity of pathogens and insects as they affect long-term timber productivity. Evaluate the effects of insects and pathogens on forest composition and the influence of forest composition on the population dynamics of insects and pathogens (LRMP, p. II-9).

Site-specific project analysis will address both short-term and long-term effects, particularly in the case of cover where short-term options to treat stands for insects and disease will improve forest health in the long term (LRMP, p. III-8).

Apply integrated pest management principles to minimize the impacts of the mountain pine beetle, western spruce budworm, tussock moth, and other insect and disease infestations to the extent necessary to achieve the overall goals and objectives of this Forest Plan (LRMP, p. IV-45).

Continually monitor pest populations and implement activities to prevent population buildups to epidemic levels. Aggressively suppress insects and diseases when outbreaks threaten timber management objectives (LRMP, p. IV-51).

Apply integrated pest management principles to minimize losses and protect riparian area values (LRMP, p. IV-61).

Apply integrated pest management principles to minimize losses and protect [anadromous] riparian area values (LRMP, p. IV-68).

Allow endemic levels of infestation to occur [in Big-Game Winter Range]. Treat epidemic levels that threaten eagle roost values or adjacent lands (LRMP, p. IV-75).

Allow endemic levels of infestations [in the Strawberry Mountain Wilderness]. Treat epidemic levels that severely threaten adjacent lands (LRMP, p. IV-78).

Allow endemic levels of infestations [in the Monument Rock Wilderness]. Treat epidemic levels that severely threaten adjacent lands (LRMP, p. IV-87).

[In the Monument Rock Wilderness – Primitive Areas], manage to allow natural ecological successions, including infestation of insects, unless they endanger significant resources outside the wilderness (LRMP, p. IV-88).

Allow endemic levels to occur [in Scenic Areas]. Treat epidemics that threaten scenic values or adjacent lands (LRMP, p. IV-92).

Allow endemic infestations to occur [in Special Interest Areas]. Treat epidemics that threaten special interest areas or adjacent lands (LRMP, p. IV-94).

Take action against endemic or epidemic levels of insects or diseases in accordance with the direction given in the [Research Natural Area] establishment report (LRMP, p. IV-96).

Allow endemic infestations to occur [in Semi-Primitive, Non-Motorized Recreation Areas]. Treat epidemics that threaten semi-primitive, non-motorized recreation values or adjacent lands (LRMP, p. IV-98).

Allow endemic infestation to occur [in Semi-Primitive, Motorized Recreation Areas]. Treat epidemics that threaten semi-primitive motorized values or adjacent lands (LRMP, p. IV-100).

Allow endemic levels of infestation to occur [in Old-Growth]. Favor biological methods of control if at an epidemic level (LRMP, p. IV-107).

Control insect and disease epidemics if necessary to protect other resource values or to prevent spread to adjacent, suitable forestlands (LRMP, p. IV-114).

[In the Byram Gulch Municipal Supply Watershed], protect water quality and quantity when applying integrated pest management practices (LRMP, p. IV-116).

[In the Long Creek Municipal Supply Watershed], protect water quality and quantity when applying integrated pest management practices (LRMP, p. IV-118).

Allow endemic infestations to occur [in Wild and Scenic River areas]. Epidemics that threaten scenic values or adjacent lands may be treated (LRMP, p. IV-137).

Ochoco (LRMP 1989)

Utilize Integrated Pest Management strategies to maintain forest health. Resource activities to control pests will depend on site-specific analysis and may vary greatly from year to year. Emphasis will be on prevention rather than control. When control is necessary, the method with the least impact on the environment will be used (LRMP, p. 4-12).

Utilize Integrated Pest Management strategies to manage pests within the constraints of laws and regulations, and meet Forest management objectives. IPM strategies include manual, mechanical, cultural, biological, chemical, prescribed fire, and regulatory means. Select strategy through the environmental process, and in compliance with the Regional Vegetation Management Environmental Impact Statement, 1988. Coordinate strategies with the Agricultural Pest Health Inspection Service (APHIS) when proposing major Forest-wide control projects. Pesticide application, if used, will conform to EPA regulations, label restrictions, and the Regional Environmental Impact Statement on chemical applications. Use the integrated pest management strategies on forested types, as displayed in Table 4-32. Exceptions for individual management areas are discussed in management area standards and guidelines for Forest health. (Table 4-32: Short Term Strategy – treat infested fir stands with biological or chemical insecticides).

[In Wilderness], insect and disease outbreaks will not be controlled unless treatment is necessary to prevent unacceptable damage to resources on adjacent lands or an unnatural loss to wilderness resource due to exotic pests. Management of insects and diseases in wilderness will follow direction in *FSM 2324.1* (LRMP, Table 4-33, p. 4-152).

[In Research Natural Areas (RNA's)], take no action to control insects or diseases, unless an outbreak will drastically alter the natural processes within the RNA. Treatment to control insects and diseases within RNA must support and promote the basic objectives and purposes of establishing the area. (*FSM 4063.3(8)*, LRMP, Table 4-33, p. 4-152).

[In Old-growth], generally, insects and diseases will not be controlled or suppressed. Exceptions may occur when treatment is necessary to prevent unacceptable damage to resources on adjacent lands or to the old-growth resource. Acceptable treatments are prescribed burning and use of synthetic or biological chemicals, based on site-specific environmental analysis (LRMP, Table 4-33, p. 4-152).

All treatment strategies may be utilized to manage insects and diseases to meet [Visuals] management area objectives. Emphasize strategies that improve aesthetics and safety (LRMP, Table 4-33, p. 4-152).

[In Roadless Areas], control of defoliators may also be done by spraying following environmental analysis (LRMP, Table 4-33, p. 4-152).

[In Recreation/Wildlife Emphasis Areas], generally, treatment of insect and disease conditions will not be in high priority, except when the ability of the forest resource to meet the area objectives is threatened. Treatment of pest conditions will also be considered when damage is catastrophic and threatening to the surrounding area. There are no constraints for selection of control strategy (LRMP, Table 4-33, p. 4-152).

[In Eagle Roosting Areas], utilize all strategies to meet the area objectives for providing roosting habitat for bald eagles. All treatments must meet seasonal restriction (Dec. 1 to May 1) (LRMP, Table 4-33, p. 4-153).

[At Recreation Sites and Facilities], utilize all methods to prevent or suppress insect and disease outbreaks. Control of defoliators in the mixed conifer type is also emphasized to meet visual objectives (LRMP, Table 4-33, p. 4-153).

[In Riparian Areas], utilize all methods, except chemical spraying, to prevent or suppress insect and disease outbreaks. Pest management activities must consider the effects on the stands ability to provide shade, bank stability, and large woody material to the stream (LRMP, Table 4-33, p. 4-153).

[In Winter Range], take aggressive action to suppress insect or disease caused mortality, where action could prevent loss of winter thermal cover and is cost effective (LRMP, Table 4-33, p. 4-153).

[In General Forest Winter Range], utilize all methods to prevent or suppress insect and disease outbreaks (LRMP, Table 4-33, p. 4-153).

[Throughout the Forest], utilize an integrated pest management approach to managing insect and disease conditions. Aggressive monitoring and detection of pest conditions and populations will be done so corrective treatments can be prescribed early (LRMP, Table 4-33, p. 4-153).

Winema (LRMP 1990)

Control endemic levels of Forest pests, and provide controls that are compatible with resource objectives. The Forest will rely on integrated pest management principles to avoid creation of forest pest problems and to suppress existing forest pest problems (LRMP, p. 4-10).

All planned activities shall include integrated pest management practices. All insect and disease control projects shall be carried out in ways that meet management area objectives. If normal insect surveillance indicates the threat of an epidemic, project-level detection and control operations, including coordination with other land ownership's, shall be accomplished on a forest wide basis (LRMP, p. 4-59).

No effort will be made to control insect and disease outbreaks [in Semi-Primitive Recreation areas], except when pest or pathogen populations are a threat to adjacent lands. The need for control actions will be evaluated on a case-by-case basis through the environmental analysis process (LRMP, p. 4-89).

[In Unique Management Areas], insect and disease outbreaks shall be managed with a minimum of resource disturbance. Biological and silvicultural treatments should be emphasized (LRMP, p. 4-114).

[In the Saddle Mountain Cultural Resource Area], insect or disease outbreaks shall not be artificially controlled unless it is necessary to prevent unacceptable resource damage to resources on adjacent lands or an unnatural loss to the management area's resources. If control becomes necessary, it shall be carried out by measures that have the least adverse impacts on the management area's resources and that are compatible with the management area's objectives (LRMP, p. 4-117).

[Along the Sycan National Wild and Scenic River], insect and disease outbreaks shall be suppressed with a minimum of resource disturbance (LRMP, p. 4-119).

Insect or disease outbreaks shall not be artificially controlled unless it is necessary to prevent unacceptable [Wilderness] resource damage to resources on adjacent lands or an unnatural loss to Wilderness resource. If control becomes necessary, it shall be carried out by measures that have the least adverse impact on the Wilderness resource and that are compatible with Wilderness objectives (LRMP, p. 4-123).

Insect and disease outbreaks will be managed with a minimum of [Bald Eagle Habitat] resource disturbance. Biological and silvicultural treatments will be emphasized (LRMP, p. 4-145).

Insect and disease outbreaks shall not be suppressed [in Research Natural Areas] (LRMP, p. 4-158).

Fremont (LRMP 1989)

Long-term sight productivity will be considered in all silvicultural prescriptions. Items to be integrated into the prescription will include, but are not limited to, and effect of frequency of harvest entries on insect and disease and occurrence (LRMP, p. 73).

Integrated pest management strategies will be utilized to manage pests within the constraints of laws and regulations and to meet Forest management objectives. Prescribed fire and manual, mechanical, cultural, biological, and chemical strategies will be used (LRMP, p. 74).

Stands may require protection from biological agents in order to meet stocking and growth standards (LRMP, p. 74).

Protect RNA's from fire, insect, disease, and animal damage primarily by management practices outside the area such as under-burning, thinning, etc. (LRMP, p. 95).

Integrated pest management strategies will be utilized to manage pests within the constraints of laws and regulations and to meet Forest management objectives. IPM strategies include manual, mechanical, cultural, biological, chemical, prescribed fire, and regulatory means (LRMP, p. 101).

Stand treatments will include controlling stocking levels and species mix; improving growth rates; protecting stands from insects, disease, and other damage; and regenerating old stands no longer showing optimum growth rates (LRMP, p. 125, second paragraph).

Salvage operations will take place only when catastrophic events occur (such as wildlife, insect infestations, wind throw, etc.) and the affected old-growth stand is no longer considered suitable old-growth habitat. A new old-growth stand should be delineated to replace the original habitat (LRMP, p. 139).

Stand treatments will include controlling stocking levels and species mix; improving growth rates; protecting stands from insects, disease, and other damage; (LRMP, p. 145).

Stands should not be salvage logged at other than the prescribed entry cycle except where wildfire, bark beetles, disease, or other conditions have created catastrophic mortality (LRMP, p. 151).

Temporary departure from assigned VQOs may be necessary in areas highly susceptible to insect or disease epidemics in order to protect long-term values. Suppress pests when outbreaks threaten managed resources and/or users. Use methods that minimize site disturbance. Utilize integrated pest management strategies to prevent unacceptable damage in visual corridors (LRMP, p. 155).

Temporary departure from the Partial Retention VQO may be necessary in areas highly susceptible to insect or disease epidemics, in order to protect long-term values (LRMP, p. 157).

Suppress pests when outbreaks threaten wilderness objectives or resources in adjacent areas. Such action shall occur only when authorization is granted per FSM 2320. Favor biological methods when available. Monitor pest populations within the Wilderness as a management strategy for adjacent resource areas (LRMP, p. 179).

Suppress pest outbreaks with a minimum of disturbance to protect developments and/or users. Favor biological and silvicultural treatments where possible (LRMP, p. 192).

APPENDIX G: PROJECT GUIDELINES

PROJECT PLANS

Prior to implementation of the preferred alternative, each affected Forest will develop a project plan specific to their Forest and situations. Forests can combine operations and prepare one plan for several Forests. This plan will describe the logistics of the proposed operations in depth. In addition, the plan will address how the public is to be notified of spray operations, what specific safety concerns exist or are expected, how project operations will be monitored, and how accidents and spills may be prevented. Contingency plans will be included that describe procedures that would be followed in the event there are accidents or spills.

PUBLIC INFORMATION PLAN

Prior to implementation, a public information plan will be developed. Timely notification will be given to anyone who may be near the project area during operations. If requested, individuals may be notified in advance of spray dates and times. For example, a range permittee may request notification so he/she can move animals prior to project implementation. Warning and informational signs will be placed along the perimeter of treatment areas.

PRETREATMENT REVIEWS

This document does not imply that blanket spraying will occur over all acres on an affected Forest. Treatment will only occur when defoliation is eminent. The proposed treatment areas will be grouped into Entomological Units (EU's) that would be similar in location and characteristics. Insect population monitoring plots will be placed throughout the Entomological Units. Prior to beginning operations, population levels of the tussock moth will be verified to ensure insect populations are present and at or near suboutbreak or outbreak levels. This will be done according to an entomological sampling plan for early instar sampling, although cocoon/egg mass sampling may also be done in the early spring before egg hatch. Early instar levels will determine if adequate populations are present at levels to warrant treatment (see DFTM Population Sampling Appendix). If populations are not at suboutbreak or outbreak levels, the area will not be treated. If, when these units are sampled, there are mixed population levels in the EU, it will be further subdivided and additional population measurements taken to quantify them as separate areas. Those areas with low populations will be dropped from treatment. It is possible that in some cases, high populations will occur in only a limited area within the larger Entomological Unit with low population levels. In this case, it may be logistically or operationally difficult to treat only this limited area. The decision to drop the isolated area or continue to keep it in the treatment schedule will depend on the resource at risk for that particular site and be made in conjunction with the appropriate Forest Supervisor or designated representative.

Once population levels have been verified, Project and Public Information Plans will be followed.

OPERATIONS

Treatment area boundaries, heliports, and airstrips will be mapped prior to beginning operations and will available upon request. Treatment area boundaries will be described (when possible) by topographical or other physical features. Proposed treatment areas will be evaluated and large meadows and areas of non-host will be mapped for exclusion from treatment. Heliports and airstrips will be located close to or in the project area. Landings will be away from sensitive areas, such as streams, meadows, floodplains, etc.

Each Forest will assign a project manager to oversee all aspects of the project. Forests can combine operations and assign one project manager for several Forests. The project manager will ensure that all personnel are fully qualified to perform their duties. Project managers will notify military bases when project aircraft may be within or near training routes.

Wind speed and direction, turbulence, air temperature, relative humidity, temperature inversions, rain, visibility, and the presence of moisture on vegetation will be considered prior to spraying. Tolerance guidelines for each of these environmental parameters will be included in the application contract. Contractors are required to meet all Federal and State requirements concerning pesticides and the application of pesticides.

Unlike previous projects, the proposed action identifies protecting only areas of concern. This creates a project that may have a number of small, irregularly shaped, and widely separated treatment areas. As a result, the project logistics will be very complex. It will require using aircraft (such as helicopters) that can negotiate close turns, and turning booms off during some times to avoid application to areas not within the treatment boundaries. It may also require setting up more small temporary helispots, or ferrying longer distances to treat isolated areas. Operation feasibility and safety are a primary concern.

The project manager will place special emphasis on reducing or eliminating the following concerns:

1) Spraying outside designated areas.
2) Treating designated areas more than once.
3) Spraying outside of designated weather parameters.
4) Non-uniform coverage of the target area.
5) Spraying prior to notification of people recreating or camping, or conducting other activities.

6) Fuel and pesticide spills.

7) Where operationally feasible, direct application to large forest openings and forest edges will be avoided.

ACCIDENTS

The potential for accidents exist. In general, there are four common causes of accidents during pesticide treatment:

Mechanical Failure
Human Error
Environmental Conditions
Transport and mixing of pesticides

There is always the potential for accidents to occur on this and future suppression projects. The standards and mitigation measures mentioned in this report are designed to prevent or lessen the impact of any future incidents.

AERIAL OBSERVATION

In order to monitor and control pesticide application, treatment aircraft will be accompanied by an observation aircraft staffed with a fully qualified aerial observer. Observation aircraft are integral parts of ensuring areas are treated with pesticides in an effective manner. It is anticipated that GPS guidance systems will be used to control swathing and the proper placement of pesticide. Aerial observers monitor spray behavior, calibration, and serve as a backup to the spray aircraft to aid in locating hazards, avoidance of sensitive areas, and to aid in search and rescue if needed. Inefficiencies exist when observation aircraft are paired with more than one spray aircraft.

SPRAY STANDARDS

Application will be made at 50 –75 feet above the tops of the trees. Average application speed will be about 85 miles per hour and average swath will be 65 to 120 feet; although speed and swath width will vary with application types of application aircraft.

The maximum allowable wind speed for spraying is 8 miles per hour. No spraying will be attempted, and all spraying will cease, if wind speeds are in excess of this standard in the spray block. If the application aircraft is unable to compensate for spray drift caused by wind speeds less than 8 miles per hour, or if wind will cause drift into non-target areas, spraying will be stopped or operations moved to areas with more favorable conditions.

Spraying will not occur when fog or low clouds cover the spray area. Spraying may occur when vegetation is moist but not dripping wet. No spraying will take place when it is raining or if rain is predicted within six hours of spray application.

When humidity drops below 50%, spray drops evaporate before they can reach the target area. To prevent this, no spraying will be conducted when relative humidity is less than 50%.

Treatment will not occur when the air temperature at application altitude is 35°F. or less, or above 70°F. Application altitude is defined as the height of the aircraft above the general forest canopy. If the temperature at application altitude is warmer than the surface temperature (even if less than 70°), the spray tends to “hang” (an inversion has developed). Spraying will stop if this condition occurs. Inversions are not a problem if the application aircraft can work within the cooler air.

In certain instances, updrafts can cause the pesticide to rise. When this condition exists, treatment will stop. This can be a localized phenomena; spraying may continue other, affected another portion of the treatment area.

MECHANICAL OPERATIONS

Application operations will be suspended if any of the following conditions exist:

- Mechanical problems with the aircraft.
- Malfunctioning spray system.
- Communication problems.
- Pilot is not in a functional condition.
- Nonfunctioning meters or equipment on batch truck.
- Leaking or faulty systems on aircraft or trucks.
- Lack of qualified personnel (truck driver(s), observation pilot, aerial observer, ground crews, etc.).

SENSITIVE AREAS AND SITUATIONS

Spraying will be suspended when weather conditions could cause drift into no-spray areas. As much as possible, spraying will be avoided over livestock and areas containing large numbers of people.

The Pacific Northwest Forest and Range Experiment Station will be contacted to determine if long-term research projects are located in proposed treatment areas. If so, the project manager will attempt to satisfy the requests of the experiment station.

ACCIDENT CONTINGENCY PLAN

The project manager will ensure that contingency plans for accidents exist prior to operations. Plans will specify the list of authorities and responsibilities of each agency, participants and contractors, notification procedures, and provisions for search and rescues, spills, and cleanup.

SPILL MANAGEMENT

The objective of spill management is to minimize the possibility of spills by planning and monitoring any operations where pesticides, diesel, jet fuel, or other petroleum-based products are being used. In the event of a spill, contract personnel will take immediate action to correct the problem. These protective efforts will be continuous and progressive; actions are dependent upon the product and the nature of the spill.

PROJECT PERSONNEL RESPONSIBILITIES

Spill plans developed by the contractor will be reviewed by project managers. The project manager, or personnel designated by the project manager, will assist the contractor to meet project objectives. Project personnel will secure an accident area until the contractor completes appropriate control and cleanup actions to protect the environment and to meet Federal and state laws and regulations.

CONTRACTOR RESPONSIBILITIES

Cleanup and disposal of leaks or spills will be the responsibility of the contractor. Cleanup and disposal shall be in accordance with any applicable State laws and regulations. The Forest Service may assist the contractor, but will not assume any contractor responsibilities.

Prior to beginning, the contractor will submit a spill plan, with procedures for cleanup to protect the environment and the safety of workers. The spill plan will indicate that the contractor has the knowledge and ability to minimize the effects of any accidents that might occur. The spill plan must be approved by the appropriate officials before operations begin.

SPILL CONTROL TECHNIQUES

At a minimum, dirt berms may be used to stop the spread of a spill or divert it to less sensitive areas. Spills may be absorbed by dirt, sawdust, newspaper, sweeping compounds, or other suitable material. If an incident occurs, a thorough investigation will be conducted.

PROTECTION OF THREATENED, ENDANGERED, OR SENSITIVE SPECIES

A biological evaluation ("BE") will be completed for all Forest Service actions that could affect threatened, endangered, or sensitive species or their habitat. The BE will determine whether a species or habitat is present in the project area and any potential effects. Mitigation measures or project modification may be necessary to ensure the proposed activity will not adversely affect the recovery of threatened, endangered, or sensitive species.

MONITORING

Spray projects will have a written monitoring plan. The purpose of monitoring is to:

- Measure project accomplishment, specifically the post-treatment insect populations and foliage protection.
- Provide timely feedback about the conduct of the operation.
- Monitor spray deposit in the target areas.
- Monitor overall treatment effectiveness.

In the event of a pesticide spill into a body of water, water samples and visual observations will be used to monitor pesticide distribution and environmental effects.

PROTECTION OF WILDERNESS VALUES

Several Forest Land and Resource Management Plans contain specific standards and guidelines for management of Wilderness areas. Some of these objectives are:

- To allow indigenous insect and plant diseases to fulfill, as nearly as possible, their natural ecological role.
- To protect the scientific value of observing the effect of insects and diseases on ecosystems and to identify resistant plant species.
- To control insect and plant disease epidemics that threaten adjacent lands or resources.

Generally, Wilderness areas across Washington and Oregon will not be treated to control tussock moth. This is because the moth life cycle suggests that the lack of treatment in Wilderness does not pose a threat to non-Wilderness lands. Therefore, most natural processes will be allowed to continue. However, Forest Plan standards and guidelines do allow treatment in Wilderness areas under certain circumstances. Treatment in Wilderness areas would be allowed if tussock moth infestation threatens municipal watersheds. Additionally, treatment would be allowed where unique ecosystems exist. Each Forest will evaluate their situation to see if treatment is appropriate.

APPENDIX H: HUMAN HEALTH EFFECTS ANALYSIS

AFFECTED ENVIRONMENT

The health and safety of people are influenced by many factors including diet, climate, diseases, contaminants in the soil and water, emotional well-being, and access to medical facilities. This analysis concerns itself with the potential or perceived health effects associated with the Douglas-fir tussock moth and proposed actions. Human health effects include those effects related to the exposure and potential effects of treatment with insecticides, and the effects related to exposure to the Douglas-fir tussock moth.

There are interspersed private lands within the administrative boundaries of the nine National Forests. Recreation sites, special use sites, and general recreation areas are within the analysis area. In addition there are small communities scattered throughout that are in close proximity to National Forests. Forest Service employees often live or work on administrative sites within the National Forest boundaries. People who live in or near areas where there is host type (Douglas-fir and true fir trees) could be affected by the Douglas-fir tussock moth; and people who live near proposed treatment areas could be exposed to treatments. Included could be individuals with allergic reactions, respiratory ailments, or chemical sensitivities; immunocompromised individuals; pregnant women; children; and the elderly. Individuals who work in the forest environment or with trees, who mix or apply the pesticides, or recreate within the forest could be exposed to the Douglas-fir tussock moth or the treatments.

ENVIRONMENTAL CONSEQUENCES

The human health consequences of Douglas-fir tussock moth, *Bacillus thuringiensis* var. *kurstaki*, and TM-BioControl are discussed in this section. An in-depth risk assessment was done for *Bacillus thuringiensis* var. *kurstaki* for the Programmatic Gypsy Moth Environmental Impact Statement (USDA FS and APHIS, 1995), and we incorporate information from that document for this analysis. An in-depth risk assessment has been done for TM-BioControl and this information is used in this analysis. The Gypsy Moth EIS also includes an analysis of Gypchek, which is the gypsy moth nucleopolyhedrosis virus equivalent to TM-BioControl. Some of the analyses for Gypchek used in the Gypsy Moth EIS will be inferred for TM BioControl, as needed. In addition, the Gypsy Moth EIS discusses effects due to the gypsy moth. The gypsy moth (*Lymantria dispar* L.) is closely related to the Douglas-fir tussock moth. Since the gypsy moth often occurs in urban areas and areas where higher populations occur and work, the risk assessments for the Gypsy Moth EIS will take into consideration opportunities for more exposure by a higher number of people than will likely occur with Douglas-fir tussock moth and it's proposed treatments.

In the Gypsy Moth EIS, procedures used to assess risks to human health were similar to those recommended by the National Research Council of the National Academy of Sciences. The Gypsy Moth EIS contains analyses of: Hazard Identification, Exposure Assessment, Dose-Response Assessment, and Risk Characterization. We rely on these assessments and adapt the descriptions to better describe the Douglas-fir tussock moth situation as needed, and where additional information is available. The following is a description of the methods used in the Gypsy Moth EIS:

HAZARD IDENTIFICATION

Hazard identification determines whether a particular treatment or the Douglas-fir tussock moth can be associated with adverse health effects and identify the effects that it is likely to induce in those exposed to it. In other words, the hazard identification process for the human health risk assessment involves determining what endpoints an agent is likely to induce in humans for such reproductive and teratogenic effects, carcinogenicity, and irritant effects. The hazard of each treatment and the Douglas-fir tussock moth was examined by reviewing relevant toxicological and pharmacokinetics data from published literature, manufacturer's information, specific information from knowledgeable experts in the field and reliable published anecdotal information on exposed populations. The hazard of inert ingredients or possible contaminants in the insecticides was also considered.

EXPOSURE ASSESSMENT

The exposure assessments determine the dose of an agent to which humans may be exposed, including the magnitude, duration, schedule, and route of exposure; the size, nature and types of populations exposed; and the uncertainties involved in deriving all estimates. Three steps were involved in assessing the population exposures:

1. Describing exposure scenarios
2. Estimating levels in the environmental media, such as soils, water, air, and vegetation
3. Calculating dose rates.

The exposure scenarios selected were based on how the insecticides are applied and the biological, physical, and toxicological properties of both the insecticides and the insect. Depending on the insecticide properties and application method, the following were considered: oral, dermal, inhalation, or combined exposure to the insecticide or gypsy moth (i.e. Douglas-fir tussock moth); exposure of people living in or visiting treated areas and by project workers; and acute, subchronic, or chronic durations of exposure.

Three types of exposure scenarios were considered: routine, extreme, and accidental. For routine exposures,

assumptions were made that the recommended application rates are used, that recommended safety precautions are followed, and that the estimated model values, such as food or water consumption rates and skin surface area, are based on the most likely activities and circumstances that increased the estimate of exposure. For extreme exposures, assumptions were that recommended procedures and precautions were not followed and that exposure parameters were based on different activities and circumstances that increased the estimate of exposure. For accidental exposures, the assumption was some form of equipment failure or gross human error occurred. Not all scenarios were used in each analysis. The decision to use a particular scenario was based on its applicability to the agent being assessed and the need to encompass uncertainties in the exposure.

The Human Health Risk Assessment (Appendix F of the Gypsy Moth EIS) also considered potential exposed or absorbed doses for individuals of different age groups, such as adults, young children, and toddlers. Values such as body weights and food consumption weights were taken from standard sources (U.S. EPA 1988c, 1989b cited in USDA FS and APHIS GM EIS, 1995).

Dose-Response Assessment

A dose-response assessment, which is only done in connection with human health, is the response of characterizing the relationship between a known dose response of an agent, and the incidence of an adverse effect in an exposed population. It involves estimating the incidence and severity of an effect as a function of dose or exposure to the specific agent, the intensity of exposure, the age range during exposure, and other variables that might affect the response, such as sex and lifestyle. Extrapolation from low to high dose and from animals to humans is often required (NRC 1983, cited in the Gypsy Moth EIS).

Two general types of dose-response assessments were conducted in the human health risk assessment. For the most part, a no-observed-adverse-effects-level (NOAEL) and an uncertainty factor were used for the non-carcinogenic effects. For cancer risks, a dose-response model was used.

Quantitative toxicological assessments involve deriving an estimate of the dose level that is unlikely to cause adverse health effects in humans. This dose estimate is called the risk reference value (RRV). It is derived by taking the experimental no effect (or equivalent) dose associated with the most sensitive effect and applying a series of uncertainty factors to adjust for differences between the experimental design and the conditions for which the RRV is being derived.

Risk Characterization

Risk characterization is the process of estimating the incidence of human health effect in a human population under different conditions of exposure represented in the exposure risk assessment (NRC, 1983, cited in USDA FS and APHIS, 1995). It involved comparing the dose to which humans may be exposed, with the RRV. This comparison produces a hazard quotient, which indicates a level of concern regarding one or more exposure scenarios. Because the RRV represents an exposure that is not expected to cause adverse effects, a hazard quotient of 1 or less would not be cause for concern.

All relevant routes for exposure (mouth, skin, respiratory tract) were considered in deriving a composite hazard quotient. A hazard quotient greater than 1 (dose exceeds the RRV) indicated that an adverse effect might be observed after exposure. In some cases, however, uncertainties associated with the hazard identification and exposure assessment required a qualitative judgment to characterize the risk involved.

Cumulative Effects

Some exposures, especially in workers, may last for several days to several months. In addition, some program activities may be repeated for several consecutive years. Such exposures are referred to as cumulative exposures.

Depending on the specific exposure scenario and the nature of the available data, the consequences of cumulative exposures are assessed in a variety of ways. For carcinogenic effects, total dose is assumed to be related directly to risk. Thus, the consequences of two applications at a given rate would be twice those of a single application.

For toxic effects, concern is triggered by exposures that exceed the RRV. Only a limited amount of most control agents may be applied in a given year. Consequently most exposure scenarios assume maximum application rates. If the RRV is not exceeded by multiple applications at maximum rates, it will not be exceeded by multiple applications at lower rates. The Gypsy Moth EIS considered multiple applications because in cases of eradication, areas are often treated twice or three times. Douglas-fir tussock moth suppression would only involve one treatment on an area, and therefore, the Gypsy Moth EIS assessment will be addressing a more rigorous application than is proposed for the Douglas-fir tussock moth.

Connected Actions

Some individuals may be exposed to several treatment types, either in their job as applicators or because more than one type of treatment or exposure will be used in adjacent areas. Such exposures are considered connected actions, that is, one or more actions that an individual may take that could affect the individual's risk to the agents used to control the Douglas-fir tussock moth. In addition, individuals are exposed to a multitude of chemicals and biological organisms every day in foods, medicines, household products, and other environmental chemicals.

Exposure to multiple chemical or biological agents could lead to interactions. For most of the agents under review, relatively little information pertaining to this issue is

available. Available information is included in the risk characterization.

1. Effects Due to the Douglas-fir Tussock Moth

Hazard Identification

Douglas-fir tussock moth outbreaks are associated with an adverse human health effects called "Tussockosis". The urticating hairs of the Douglas-fir tussock moth cause an allergic reaction characterized by skin irritation, eye irritation, and respiratory tract irritation. Individuals who work in the woods, such as loggers had significantly higher reactions (83%); two other worker groups, forester and forester assistants studying and working in the woods, and mill workers also had significant reaction (44% and 41% reactions, respectively). Individuals who have sensitivities and allergies to other insects are more sensitive than others are to DFTM (Perlman, et. al, 1976). Studies indicate that DFTM hairs are at least as potent, and possibly more potent irritants that gypsy moth (SERA, 1999). Therefore, the hazard risk for the assessment of gypsy moth on human health represents similar, if not slightly less direct effect on people that the Douglas-fir tussock moth.

The DFTM may also be a nuisance, although this issue may not constitute an easily measured health effect. Fewer people would be exposed than occur in urban areas. In 1998, many people were inconvenienced by the presence of millions of larvae feeding on trees within the developed sites and raining fecal material onto visitors and their property during the outbreak in Kings Canyon National Park in California (USDI, 1999).

Exposure Assessment

During non-outbreak years the Douglas-fir tussock moth does not represent a hazard because it occurs at very low levels. During outbreaks, the combinations of insect frass, loss of shade, and the large numbers of caterpillars may become a major nuisance in those areas where people are living, working or recreating. The localized variability of the outbreaks makes the potential for human exposure difficult to quantify. If people live or are in an area with an outbreak however, their chances of coming in contact with larvae are greatly increased. Estimates for exposure analysis are approximately 300,000 larvae/acre for an outbreak (SERA, 1999). These estimates were based on Douglas-fir tussock moth population levels (rated at an average of 50 larvae per 1000 sq. inches of foliage) during the outbreak in Sequioa/Kings Canyon National Park in 1997. As the density of the caterpillar populations within an area increases, the risk of exposure to the insects in that area is likely to increase. This analysis focuses on sites on National Forest lands, so people most likely to be exposed to DFTM in the analysis areas are those who are working, visiting or recreating, or otherwise temporarily located within an infested area. Except for a few exceptions, most people will not be living within the analysis sites.

Exposure-Response Assessment

In the Gypsy Moth EIS, two kinds of exposure-response assessments were possible. The one most similar to an assessment for DFTM is the approach based on the standard RRV, or exposure level associated with no adverse effects in an exposed population. For the RRV, the NOAEL (no-observed-adverse-level) was considered to be the incidence of skin reactions in a community that had low exposure, when compared to that of a community with high exposure. Severe gypsy moth infestations may be associated with 20%-30% of the incidences of skin rashes that are sufficiently severe to cause members of the general public to seek medical attention. Perlman, et. al. (1976) examined 227 workers with the primary signs and symptoms of Douglas-fir tussock moth. The extra risk for mill workers, forestry workers, and loggers was 24%, 28%, and 78%, respectively. For mill workers and forestry workers, these rates are similar to those reported for gypsy moth. For loggers, the 78% is substantially higher that the other two groups, or rates in the general public from gypsy moth (SERA, 1999). Loggers represent the extreme opportunity for contact with high amounts of insect hairs. The forestry workers probably represent the more likely level of opportunity for reaction from individuals recreating or working in an infested area. Based on these results, the exposure-response assessment for gypsy moth developed in the Gypsy Moth EIS can be used as representative of the exposure-response for the Douglas-fir tussock moth.

Risk Characterization

Exposure to DFTM caterpillars is associated with skin, eye, and respiratory effects in humans. The presences of larvae and defoliation may cause stress, especially to individuals in recreation areas, or whose job requires them to work in an infested area. Skin reactions may be considered to be the most sensitive of all health effects, that is, if skin irritation is not observed, other health effects are not likely.

Risk of human exposure is associated with the probability of coming in contact with the larvae or cocoons and eggs masses of the Douglas-fir tussock moth. Because caterpillar density and human behavior are related to exposure, two types of probabilities are of concern: 1) the chance that an individual will have an adverse response if they come in contact with DFTM, and 2) for a given level of insect population, the proportion of the population likely to be affected. The Gypsy Moth EIS characterizes four gypsy moth population levels – sparse, moderate, heavy and extreme. For Douglas-fir tussock moth, outbreak levels are most likely comparable to the heavy and extreme scenarios. The gypsy moth, hazard quotients for exposure to the four population densities were all greater than 1, indicating that exposed individuals would likely have some adverse response; and the more likely the exposure, the greater was the chance of having a reaction, and the likelihood of exposure increased with higher insect population densities.

A different risk estimate represented the proportion of workers and similarly exposed individuals who would likely have adverse health reactions after a significantly high exposure. An estimate of 25% approximates the groups of individuals who developed skin rashes after confirmed contact with the gypsy moth. Perlman, et. al. (1976) reported 41% -83% reaction to DFTM with and adjusted rate of extra risks of 24% for forestry workers.

Cumulative effects

Two types of cumulative effects were considered in assessing the consequences of gypsy moth exposure. Of those, repeated exposures in one season are most appropriate for Douglas-fir tussock moth. Cumulative affects over more successive years is less likely because of the rapid increase and decline of the tussock moth population and the length of time between outbreaks. Some individuals may become more sensitive to the tussock moth over repeated exposures during the course of a season, but not over exposure over several seasons.

Connected actions

There are no known data that can be used to assess the consequences of connected actions involving the various activities for the proposed projects. TM-BioControl contains Douglas-fir tussock moth larvae parts and may cause irritant effects similar to those caused by the DFTM caterpillars. Exposure to both the DFTM caterpillars and TM BioControl may be additive, although there are no data showing that this occurs.

Groups at risk

Young children appear to exhibit more reactions than adults do to gypsy moth. Whether this was because they are more sensitive, or because they spend more time outdoors is not known. If it is because they are more sensitive, then it is assumed that reactions would be similar for DFTM. If they are more sensitive than adults are because they spend more time out of doors, then for DFTM the reactions should be similar for adults and children in most cases, since children would be accompanying and recreating with adults visiting National Forest sites.

2. Effects Due to Bacillus thuringiensis var. kurstaki (B.t.k.)

The Gypsy Moth Environmental Impact Statement provides an in depth risk assessment for *Bacillus thuringiensis* var. *kurstaki*, which we incorporate and adapt as needed for the Douglas-fir tussock moth.

Hazard Identification

Human exposure to B.t.k. provides little cause for concern about health effects. For example, in its review of technical information submitted by manufacturers if B.t.k. formulations, the U.S. EPA concluded that B.t.k. is not a human pathogen, but can cause irritation or inflammation. More recently, the British Columbia Ministry of Health concluded that B.t.k. is specific to Lepidopteran caterpillars and does not pose a threat to humans.

Under usual conditions, B.t.k. formulations do not pose a substantial risk to workers of the public. In drawing this conclusion, a clear distinction must be maintained between the microorganism B.t.k., and commercial preparations of it. As with any preparation containing microorganisms, potential concerns include pathogenicity, persistence of the microorganism in the human body, the genetic stability of the microorganism in the environment, and the ability of the microbial agent to interact with other microorganisms. As a complex mixture of chemicals, formulations may have toxic properties that are unrelated to the presence of B.t.k. For example the available data regarding human exposure to B.t.k. formulations suggest that they cause eye, skin, and respiratory tract irritation. It is not clear, however, if these effects are caused by the microorganism itself or other parts of the formulations.

To ensure that no formulations contain pathogenic contaminants, the U.S. EPA requires that manufacturers implement quality control measures to detect either contamination with other microorganisms or changes from the characteristics of the parent B.t. strain. For example, batches are tested and rejected if potentially hazardous bacteria exceed established levels that have been reviewed and accepted by the U.S. EPA.

The most common effects from exposure to B.t.k. are eye, skin, and respiratory tract irritation, which have been seen in experimental animals and in exposed workers.

Additional recent accounts report similar eye and skin irritations and hypersensitivity (cited in Anonymous, 1999) similar to reports cited in the Gypsy Moth EIS. In one report, a doctor in France reported isolating a strain of B.t.k. from a severe wound in a soldier in Bosnia. This was later identified as a strain of B.t. known as HD-34, and when an automated medical analysis was conducted, it seemed to show the bacterium was *B. cerus*, that produces a toxin, which ruptures cell membranes (McKenzie, 1999). Human health factors were monitored during and following multiple applications of B.t.k. in New Zealand in 1997, and an in-depth human health monitoring program was conducted in British Columbia in 1999. Both studies concluded that in cases where B.t.k. isolates were recovered, on no occasion were the B.t.k. isolates associated with disease, and no change in health status could be linked to the spray program (Public Health Care Service, 1997; Capital Health Region Office, 1999). In all cases where B.t.k. was isolated, it was determined to be a contaminant (Public Health Care Service, 1997). These findings do not refute other research and findings, that B.t.k. is not a human pathogen. These references are generally similar to those cited by the Gypsy Moth Human Health Assessment and we conclude that they would not alter anticipated impacts or consequences.

Despite the large volumes of B.t. based products that have been used for a number of years, and in some instances, directly over urban and highly populated areas, there are

very few case reports of human illness due to B.t.k. or other *Bacillus thuringiensis* subspecies. Even in these isolated cases, the precise role fo the B.t.k. was unclear. Previous surveillance in Oregon, Washington, Vancouver, and New Zealand either found no clinical cases associated with B.t.k. or found no cases where B.t.k. could neither be confirmed nor refuted as a contributing factor to a persons disease (Capital Health Report, 1999).

Concern that B.t. would mutate into *B. anthacis* (the cause of anthrax in animals and man) initiated several studies that showed that there was no indication of mutation (Saik, et.al., 1989). B.t.k. has been used extensively for almost 40 years, and to our knowledge there has been no reported case where B.t.k. has mutated into another organism.

The composition of inert (inactive) ingredients in the commercial formulations of B.t.k., and their significance to public health is a matter of concern for the general population. These were evaluated in both the Gypsy Moth EIS and the Human Health Surveillance Report in British Columbia. These intentionally added inert ingredients, also known as formulants. They serve a variety of purposes and include stickers and binders to help the spray remain on the vegetation, and products to reduce contamination by other yeasts and bacteria. Although the identities and quantities of the inert ingredients are proprietary information, all of the inert ingredients in Foray formulations produced by Abbott Laboratories are on the U.S. EPA Lists 3 and 4. Inclusion in list 4 indicates that the inerts are generally recognized as safe (the GRAS list), and inclusion in list 3, indicates that there is insufficient information to classify them. One document on Foray 48B does provide some specific information that can be disclosed. Foray 48B is a mixture of B.t.k. and fermentation materials, which comprise almost 90% of the product. The added inerts (that is, those that are incidental to the fermentation process) include materials to inhibit bacterial or fungal contaminants. Compounds could include residues of leftover bacteria food such as starches, glucose or sucrose, proteins, water and a sticking agent. Other food grade materials such as sodium hydroxide or potassium phosphate may also be found in basic ingredients (Capital Health Region Office, 1999). These additives are approved for use in foods both in the U.S. and Canada. No volatile solvents are used in Foray 48B. All inerts have been reviewed by both the U.S. EPA and by various agencies in Canada (USDA FS and APHIS, 1995; Capital Health Region Office, 1999). In addition, the Oregon Department of Human Resources reviewed the complete formulation of Foray 48B and determined that "…. exposure to the ingredients in the Foray 48B formulation are unlikely to pose a public health treat to populations exposed to spray in eradication programs" (Flemming, 1993, cited in the Gypsy Moth EIS, 1995). In preparation of the risk assessment for the Gypsy Moth EIS, U.S. EPA files on product chemistry were reviewed for all B.t.k. formulations and the individual components do not appear to be highly toxic agents. Some components are complex mixtures of nutrients that have not been fully characterized.

Exposure Assessment

The aerial and ground methods of spraying B.t.k. suggest that the likeliest routes of exposure by the general public are by mouth, skin, and respiratory tract. Accidental exposures through the eyes may occur in workers.

Data were collected on exposure of workers and the public to B.t.k. from aerial sprays. Worker exposures to B.t.k. were substantially the same for pilots, aerial observers, a safety officer, or a security guard. Exposures for all but one card checker were in the general range of other aerial applicators. It is possible for weather observers or card checkers to have direct contact with the spray in the field.

Exposure of card checkers to B.t.k. varied considerably between studies. Substantial differences may be due to work practices, although the studies used different B.t.k. formulations and batches, and different analytical methods. The levels of viable B.t.k. spores in batches from the same manufacturer may vary by a factor of at least 50. Thus, the levels of exposure between studies are not necessarily comparable.

During ground spraying workers can be exposed to high levels of B.t.k., with concentrations ranging from 0.2 to 15.8 million colony-forming units per cubic meter of air (Cook, 1994, cited in Gypsy Moth EIS, 1995). The maximum cumulative exposure for these workers was 720 million colony-forming units and the lowest cumulative exposure was 5.4 million colony-forming units. Variables that influence actual exposure rates are concentration of the B.t.k., specific application methods, duration of exposure, and the type of job.

In an extensive human health exposure study conducted in British Columbia, air, nasal, fruits and vegetables in local markets, and clinical isolates from bad infections were sampled, both before and after spray and within and outside of the treatment areas. The frequency of B.t.k. HD-1 increased significantly, but no health effects were observed to be associated with this increase (Capital Health Region Office, 1999).

Dose-Response Assessment

For workers, skin contact with B.t.k. suspended in air is the primary exposure concern. It is the likeliest exposure for ground workers. Reported responses in exposed workers were characterized as irritation to the skin, eyes, and respiratory tract. Low level cumulative exposure (ranging from 5.4 million to 100 million colony form units) resulted in each worker reporting 1.5 symptoms – about twice the response rate of 0.8 symptoms per person) in the control group. Using this information and standard methods and uncertainty factors to calculate risk reference values, the RRV derived for workers was determined to be 0.2 million colony units.

The effects covered by this dose-response assessment are of minor clinical significance. The number of workdays lost by ground workers was no greater than that of the control group (Cook, 1994 cited in the Gypsy Moth EIS).

No dose response relationship could be proposed for workers on aerial application projects. In monitoring studies, however, exposure of aerial workers to B.t.k. was only slightly higher than that of the general public (Elliott and others, 1986, 1988 cited in the Gypsy Moth EIS, 1995).

Two detailed epidemiology studies were available on exposure of the public to B.t.k. One study in Oregon involved the aerial application of Dipel at a rate of 16 billion international units (BIU) per acre (39.5 BIU/ha) over about a quarter of a million acres with a human population of about 40,000. One study in British Columbia involved the aerial application of Foray 48B at a rate of about 20 BIU/acre (49 BIU/ha). Neither study detected any adverse effects in the exposed populations. In addition, a surveillance program by a group of family physicians noted no substantial difference in the reports of symptoms that might be associated with B.t.k. exposure within and outside of the spray area (cited in the Gypsy Moth EIS, 1995).

The doses in both of these studies were regarded as no-observable-effect levels (NOEL), since neither study detected any effects in exposed populations. Since both studies covered large numbers of individuals in the general population, an uncertainty factor was not used. The higher NOEL of 20 BIU/acre was taken directly as the RRV for the general public. On the basis of both the available epidemiology studies as well as the long history of use, no hazard has been identified for members of the general public exposed to B.t.k. formulations. Some individuals are likely to be considered part of a sensitive subgroup, which may not have been represented in the studies.

Risk Characterization

Commercial formulations of B.t.k. would be applied both aerially and by ground sprays in areas where people may recreate and work, and to a lesser extent live, and exposure of both workers and the general public are a concern. A large and compelling body of human experience, as well as many toxicity studies on experimental mammals, indicate that neither B.t.k. nor its commercial formulations are highly toxic or infectious.

Aerial Sprays

For aerial application crews and the general public, the hazard identification is essentially negative, that is, no adverse effects can be attributed to B.t.k. exposures during aerial application. Epidemiology studies indicate that application rates of up to 20 BIU/acre have not been associated with adverse effects in humans: consequently this value was adopted as the RRV. The hazard quotient is 1 for exposure to 20 BIU/acre: however the risks associated with exceeding the RRV cannot be directly characterized. No epidemiology studies have been conducted at the maximum application rate of 40 BIU/acre. Thus, the hazard quotient is 2 for this application rate. Application rates for B.t.k. for the Douglas-fir tussock moth will be between 16 and 24 BIU/acre.

Ground Sprays

Exposure of workers to commercial formulations of B.t.k. during ground application is likely to cause transient and relatively minor irritation of the skin and respiratory tract. Dose-response relationships of these effects have been demonstrated (Cook, 1994 cited in the Gypsy moth EIS, 1995). Hazard quotients ranged from 30 to 3600, depending on the specific exposure levels: low, medium, or high. Hazard quotients greater than 1 do not necessarily indicate severe health effects are anticipated for ground workers. The health effects to ground workers associated with the very large hazard quotients, based on exposures reported (Cook, 1994 cited in the Gypsy Moth EIS, 1995), can be classified as relatively mild and transient. Exposure of the public to ground sprays is similar to aerial sprays, therefore, the hazard quotients are the same.

Uncertainties

Uncertainties in the risk characterization for B.t.k. include these: (1) the complex and variable nature of B.t.k. and its formulations; (2) the toxic agent or agents associated with the irritant effects to the eyes, skin, and respiratory tract have not been clearly identified; (3) the dose-response assessment for ground workers is based on only one formulation of B.t.k.; and (4) the most meaningful measure of human exposure to B.t.k. formulations cannot be determined. That is, is it more meaningful to look for a threshold level below which no effects occur or to take a conservative approach and use the cumulative exposure per person? The risk assessment used the more conservative approach.

The inability to identify clearly the ingredient or ingredients in B.t.k. formulations associated with potential adverse effects complicates the analysis. In addition, because the dose-response assessment is specific to monitoring data from a specific study, the data (in terms of the colony forming units) from one study may not be directly analogous to the data from other studies. This imposes substantial limitations on the characterization of risk. These uncertainties notwithstanding, the overall quality of the data on B.t.k. can be categorized as being moderate to good.

Cumulative Effects

The cumulative effects associated with the application of B.t.k. formulations must consider both the residual exposure to B.t.k. and formulation products after a single application as well as the effects of multiple applications in a single season and over several years. Monitoring data from the Oregon study (Elliott and others cited in the Gypsy Moth EIS, 1995) demonstrate that levels of B.t.k. in the air can be detected several days after spraying. Because the dose-response assessment is based on epidemiological studies, it implicitly considers this type of cumulative effect. The effects of multiple exposures over several years, however, cannot be directly assessed.

Agrichemical and Environmental News (Anonymous, 1999) cited one study that indicated a greater prevalence of hypersensitivity to B.t. among the most highly exposed workers. Most individuals do not fall into the category of "most highly exposed", and, for the most part, as indicated by a study in British Columbia, effects that may occur are likely to be transient (Cook, 1994; Nobel and others, 1992 cited in the Gypsy Moth EIS, 1995). In this respect, cumulative effects from spray programs conducted over several years would not be anticipated. In the Douglas-fir tussock moth project, the only group likely to be exposed to successive years of exposure to B.t.k. would be workers who happened to work on successive projects in different areas.

Connected Actions

Workers or members of the public who are exposed to either aerial or ground sprays of B.t.k. will also be exposed to the Douglas-fir tussock moth and may be exposed to TM-BioControl as well. No data were available to suggest that risks posed by these other agents will affect the response, if any, to B.t.k. formulations. Similarly, exposure to chemicals in the environment may affect the sensitivity of individuals to B.t.k. Again, no data were available to permit an assessment of such interactions.

Groups at Special Risk

B.t.k. formulations contain viable microorganisms; therefore, it is reasonable to suggest that immunocompromised individuals may be at special risk. A study in British Columbia, however, did not find immunocompromised individuals to be at special risk due to a gypsy moth spray program (Nobel and others, 1992 cited in Gypsy Moth EIS, 1995). Immunocompromised mice cleared injected B.t.k. from their systems without illness, as did immunocompetent mice (Siegel and others, 1987 cited in Gypsy Moth EIS, 1995).

Little information is available on groups with special sensitivities such as allergies or chemical sensitivities to B.t.k. formulations. In British Columbia, only a weakly positive relationship was noted in the incidence of irritant effects between ground workers with and without a history of asthma, seasonal allergies, or eczema (Cook, 1994, cited in Gypsy Moth EIS, 1995). Asthmatic children both within and outside of the spray zone were monitored before, during and following aerial applications of B.t.k. People with asthmatic children in the spray zone did not have any more symptoms than did those outside of the spray zone, either before or after treatment. One five year old boy experienced increased problems, however, this could not be directly linked to the spray (Capital Health Region Office, 1999).

3. Effects Due to TM-BioControl

A separate risk assessment was conducted for TM-BioControl (SERA, 1999). The Gypsy Moth Environmental Impact Statement provides a risk analysis of Gypchek, the nucleopolyhedrosis virus (LdNPV) specific to gypsy moth. The same format is used, and much of the information for these two products is similar.

Douglas-fir tussock moth nucleopolyhedrosis virus (OpNPV) occurs naturally and is responsible for the collapse of most of the DFTM outbreaks. There are two similar nucleopolyhedrosis viruses that occur: one, the multicapsid virus, appears to be the most virulent, and it was this virus that was used in the development of TM-BioControl. TM-BioControl is a powdered formulation of the virus, and was developed and registered by the USDA Forest Service for control of Douglas-fir tussock moth. The powdered formulation of TM-BioControl is produced by the *in vivo* culture of infected DFTM larvae. As a result, the major portion of the formulations consists of ground tussock moth caterpillar parts (about 89%). The powdered TM-BioControl is mixed with water, molasses, and a whitening agent (to protect the virus from the effects of solar radiation) and applied at the rate of 1-2 gallons per acre. In some instances, TM-BioControl may be mixed with Carrier 038, which is a premixed carrier. All of the components of Carrier 038 are on the EPA list 4 (GRAS – Generally Recognized As Safe) and all are exempt from residue tolerances under Chapter 40 of the Code of Federal Regulations, Section 180.1001. Most of the components are natural products, many of which are complex and not chemically defined.

Hazard Identification

This assessment is based on human data, as well as data on experimental mammals. The typical endpoints were addresses. In addition, for biological control agents, additional endpoints of particular concern are infectivity (the ability to survive in an organism) and pathogenicity (the ability to grow in and damage and organism). For TM-BioControl, another area of concern is the potential impact of insect parts of the Douglas-fir tussock moth, which are known irritants, and allergens in humans. Several moth larvae, including Douglas-fir tussock moth have hairs that can cause skin, eye, and respiratory irritation in humans. Studies of humans exposed to DFTM infestations indicate that the prevalence of these effects may range from approximately 25% to 75%.

Most of the available mammalian toxicity data on TM-BioControl was generated in the mid-1970's as part of the registration process and involved only assays for acute toxicity and infectivity/pathogenicity. Most of these studies involved relatively small numbers of animals and assay for only a limited number of effects. Single oral (gavage) doses of 3160 and 10,000 mg/kg caused no mortality, overt signs of toxicity, or gross pathological changes in rats. Injections of 500 mg/kg of TM-BioControl into the abdomen of mice were fatal within 4 hours of dosing. No effects were seen after injections of 5 or 50 mg/kg. The relatively rapid death of the mice suggests that the mortality was not attributable to infectious bacterial contamination.

TM-BioControl is known to cause skin, eye, and respiratory tract irritation. The available human data

regarding the effects of exposure due to DFTM larvae suggest that the irritant effects are probably due to the occurrence of insect parts in the TM-BioControl formulation. In a standard assay for eye irritation – 0.1g or 100mg in the eyes of rabbits – moderate eye irritation was noted over a 28 day post-exposure period. At a much lower dose, 3.0mg per eye, slight and transient conjunctival irritation was noted with full recovery after 48 hours. A comparison of exposure studies involving undiluted formulations of TM-BioControl and Gypchek indicates that of the two biological control agents, TM-BioControl is a stronger eye irritant.

Exposure Assessment

In the re-registration of both TM-BioControl and Gypchek, the U.S. EPA determined that formal exposure assessments for the general public and workers were not required because of the lack of any apparent hazard of systemic toxic effects and because the use of TM-BioControl will not substantially increase ambient levels of both NPV and insect larval parts. Based on calculations presented in the TM-BioControl Risk Assessment, it appears the treatment of a severe Douglas-fir tussock moth infestation with TM-BioControl would increase the environmental levels of NPV by about 3% or less. In addition, the use of TM-BioControl to prevent a severe infestation would reduce eventual exposures to both the virus and the insect larvae.

The application rate for TM-BioControl is 6.84×10^{12} PIB's (poly inclusion bodies) per acre. In the production of TM BioControl, the average yield is 6.7×10^{8} PIB's per larvae. Thus the number of larval equivalents at the nominal application rate is about 10,0000 larvae/acre. This is an overestimate since it does not consider the removal of insect parts during the production of TM-BioControl. By comparison, the number of larvae during an infestation averaging 50 larvae per 1000 square inches of foliage would correspond to about 300,000 larvae per acre. Thus treatment during a severe infestation would increase exposure to the larvae by only about 3%. Treatment of an area with a lower infestation rate would reduce exposure by inhibiting the increase in the larval population by a substantial amount with a subsequent reduction in OpNPV exposure.

Dose-Response Assessment

As with the exposure assessment, there is no basis for conducting a dose-response assessment for systemic toxic effects because there no systemic toxic effects can be qualitatively identified for plausible routes of exposure (i.e. dermal, oral, or respiratory). TM-BioControl may cause skin and eye irritation and these endpoints are of concern, at least, for occupational workers.

In the re-registration of TM-BioControl, the U.S. EPA used data on Gypchek to assess some of the possible risks of exposure to TM-BioControl. Based on an eye irritation study using Gypchek at twice the concentration of a typical field application solution (2X), the U.S. EPA judged that both Gypchek and TM-BioControl would not cause eye irritation at the field dilutions (1X). Available data on the technical grade formulations (i.e. undiluted formulations) suggest that of the two biological agents, TM-BioControl is a somewhat stronger eye irritant.

Risk Characterization

There is no basis for asserting that workers are subject to any risk of systemic adverse effects in the use of TM-BioControl. Nonetheless, workers involved in the mixing of TM-BioControl will be exposed to the undiluted formulation and there is potential for skin, eye, and perhaps respiratory tract irritation. Even in the application of field dilutions of TM-BioControl, it would be prudent for workers to take reasonable measures and use personal protective equipment to limit the potential for introducing either undiluted formulation, or field dilutions into the eyes.

Infestations of the Douglas-fir tussock moth tend to occur in relatively remote areas and members of the general public are not likely to be exposed to TM- BioControl in the treatment of such infestations. If members of the public were exposed to a spray of TM-BioControl, the primary concern would be the insect parts in the formulation. Because application of TM-BioControl will not substantially increase ambient exposures to either OpNPV or the insect parts, and because TM-BioControl will, over the longer term, reduce exposures to OpNPV and the Douglas-fir tussock moth, the use of TM-BioControl may be judged as beneficial rather than potentially detrimental to members of the public.

Cumulative Effects

There is a low apparent risk associated with one application of TM-BioControl. Because of the fast acting nature of the virus, the same area would not be treated more than once either during the same year or in successive years, and repeated exposure over one or more spray seasons is not expected. Because TM-BioControl contains Douglas-fir tussock moth parts, and individuals may have repeated exposures to tussock moths themselves during one season, there may be a cumulative effect, however, it is very likely insignificant in the context of any cumulative effect that may occur from repeated exposures to the caterpillars themselves.

Connected Actions

Workers or members of the public who are exposed to either aerial or ground sprays of TM-BioControl will also be exposed to the Douglas-fir tussock moth and may be exposed to B.t.k., as well. No data were available to suggest that risks posed by these other agents will affect the response, if any, to TM-BioControl formulations. Again, because TM-BioControl may cause irritant effects similar to those caused by the Douglas-fir tussock moth, exposure to both caterpillars and TM-BioControl may have a very slight additive effect. However, this assessment is speculative.

Groups at Special Risk

The available data suggest that immunocompromised animals were not at increased risk from Gypchek, and it is assumed that this applies to TM-BioControl as well. By analogy to the human health effects from exposure to tussock moth caterpillars, individuals with pre-existing allergies may be at greater risk of effects from TM-BioControl.

Comparison of Summary and Risk Assessments

The 1995 Gypsy Moth EIS compares the assessments for Gypsy Moth, B.t.k., and the gypsy moth virus. The comparison generally holds true for Douglas-fir tussock moth as well. The assessment addresses the risks to workers and the general public to the treatment options. In addition, the risk assessment considered the potential adverse human health effects from exposure to Douglas-fir tussock moth, because the tussock moth causes adverse health effects and these must be considered in the assessment of any treatment strategy.

In this comparison, the Douglas-fir tussock moth, B.t.k., and TM-BioControl all cause the same general types of effects: skin, eye, or respiratory tract irritations. These effects are not life threatening or debilitating and are reversible.

In a quantitative comparison, the Gypsy Moth EIS developed a hazard quotient for each treatment as well as the caterpillar itself. On a scale from .0001 to 10,000, the value of 1 or less indicates no effect and a value greater than 1 indicates some level of effect. Based on similarities, it is assumed that the same values developed for the gypsy moth virus and the gypsy moth itself are similar to those that could be expected from the Douglas-fir tussock moth and it's virus, and are applied accordingly.

Under routine conditions of exposure, the only agent likely to cause a substantial number of adverse health effects is the Douglas-fir tussock moth. Under extreme conditions, the use of B.t.k. may be associated with some irritant effects in some members of the public.

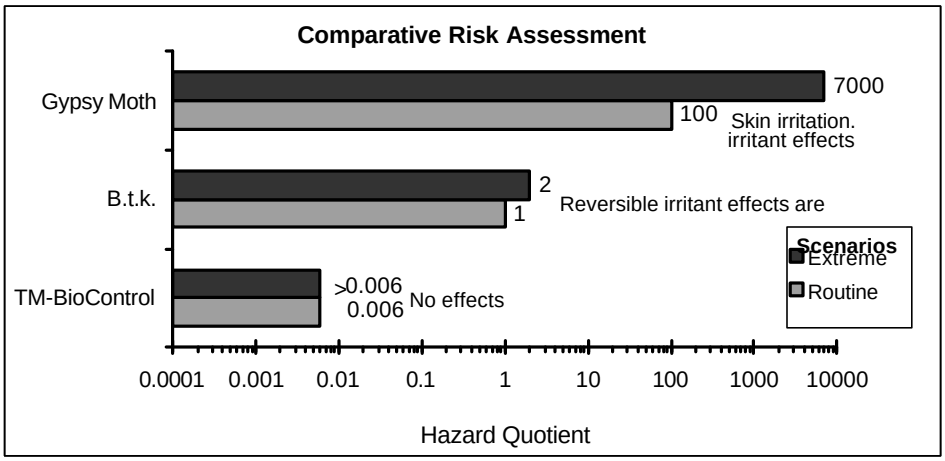

Table H-1: Qualitative Comparison of Risk Assessments

Agent	Public	Workers
Douglas-fir tussock moth	In moderate or severe infestations, rashes or other adverse skin reactions will be prevalent, most likely in children, and those spending time out of doors near an infestation. Approximately 25% to 40% of the public could have reactions to DFTM.	Approximately 41% to 75% of the workers, working either within the infested areas, or on a project, will exhibit reactions such as skin, eye, and respiratory irritations.
B.t.k.	If exposed to the direct spray, some individuals are likely to have minor irritation of the skin, eyes, or respiratory tract. Pathogenic effects are not likely, even in immunocompromised individuals. Allergic responses are conceivable.	Ground workers may have transient irritation to the eyes, skin, and respiratory tract unless methods are developed to reduce exposures. Aerial workers may develop such effects during prolonged periods of spraying.
TM-BioControl	Irritation of the eyes, skin, and respiratory tract are possible but the likely-hood of such effects cannot be assessed because of limitations in the availability of toxicity and exposure data.	Irritation of the eyes, skin, and respiratory tract are more likely in workers than in the general public because exposure will be higher. As with the public, the likelihood of such effects cannot be assessed.

No Action Alternative

In this alternative, no areas would be treated; and no individuals would be exposed to the effects of B.t.k. or TM-BioControl. Individuals recreating and working in infested areas would be exposed to the irritant effects of the Douglas-fir tussock moth. Based on previous data, approximately 25%-40% of the public and 41% to 75% of the workers will experience reactions to the tussock moth larvae.

Proposed Action

This alternative identifies treating specific areas of concern. Some areas would be treated with TM-BioControl and some would be treated with B.t.k. Many of the proposed treatment areas are fairly remote and removed from the general public, and for the most part, the general public would not be exposed to the treatment. Some areas such as campgrounds and administrative sites are included, and should individuals from the general public be in these areas during direct aerial application of either of the treatments, some may experience transient skin, eye, or respiratory tract irritations. Workers and employees living within the treatment area will have a higher level of exposure.

Because this alternative does not propose to treat all of the potentially infested areas, and none of the adjacent state or private lands which may be infested, individuals, either general public or workers within these untreated infested areas will be exposed to the effects of the Douglas-fir tussock moth.

Expanded Protection Alternative

This alternative proposes to treat the areas of concern in the Preferred Alternative plus more of the infested general forest areas. More areas will likely be treated with B.t.k. As with Preferred Alternative, many of the proposed treatment areas are fairly remote and removed from the general public, and for the most part, the general public would not be exposed to the treatment. Some areas such as campgrounds and administrative sites are included, and should individuals from the general public be in these areas during direct aerial application of either of the treatments, some may experience transient skin, eye, or respiratory tract irritations. Workers will have a higher level of exposure.

This alternative proposes to treat more, but not all of the potentially infested areas, and none of the adjacent state or private lands which may be infested. Individuals, either general public or workers, within these untreated infested areas will be exposed to the effects of the Douglas-fir tussock moth.

TM-BioControl Only Alternative

This alternative proposes to treat the same areas as the Preferred alternative, but with TM-BioControl only. Many of the proposed treatment areas are fairly remote and removed from the general public, and for the most part, the general public would not be exposed to the treatment. Some areas such as campgrounds and administrative sites are included, and should individuals from the general public be in these areas during direct aerial application of TM-BioControl, some may experience transient skin, eye, or respiratory tract irritations. Workers and employees living within the treatment area will have a higher level of exposure. Since the amount of TM-BioControl is limited, it is possible that some infested areas may not be treated. Individuals in these areas would be exposed to effects of the Douglas-fir tussock moth.

APPENDIX I: MONITORING

GENERAL

The Land and Resource Management Plans of each of the Forests affected by this document require monitoring of specific items within various program areas. The involved Forests produce an annual monitoring report that describes compliance with standards and guidelines, Forest direction, progress in moving lands to a more desired condition, and accomplishments. The various monitoring categories for each of the Forests are not repeated in this document however; interested parties may be able to receive these monitoring reports through the Forest(s) of interest. The monitoring items listed below are additional items because of site-specific analysis contained in this document.

Monitoring for the Douglas-fir tussock moth suppression project will have two objectives:

1) Monitor the application and conduct of the project itself.
2) Monitor the effectiveness of the treatment in achieving the objectives of the project.

APPLICATION

To a significant degree, the success of a project is based on the appropriate application of the insecticide - both in timing and in getting the spray to the target area. Timing is critical because TM-BioControl and B.t.k. have to be ingested by the caterpillars in order to be effective. The following aspects will be monitored to assure correct timing:

- ✓ Bud development – Newly emerged Douglas-fir tussock moth larvae feed first on the tender foliage of the new growth. Therefore, it is important to ensure that as many of the new needles are exposed as possible. Trees will be monitored to assure that bud caps have dropped and new needles are fully exposed.
- ✓ Insect development - The insect must be out and actively feeding on the foliage at the time of application. The ideal stage of the insect for treatment is when the majority of the insects are in the 2nd and 3rd instars. Older instars are actively feeding, but they consume significant amounts of foliage very quickly and the objective of foliage protection would not be achieved. Sample trees will be established throughout the treatment areas and insect development will be monitored on a daily basis.
- ✓ The following aspects will be monitored to assure correct spray deposit:
- ✓ Weather – The one factor that influences spray deposits the most is weather. There are very specific weather parameters that define the spray window. Treating outside of these parameters will jeopardize optimum application and result in drift off-site. Wind, humidity, and temperature are all factors that will be monitored both through weather forecasts and by weather observers placed in the spray blocks collecting this information on about 15 minute intervals, starting early in the morning before application is to begin and during the time of application.
- ✓ Application – Aerial observers will be flying in aircraft above the spray aircraft. These observers will be monitoring the location and swath characteristics of the spray aircraft as well as height and application. Observers will also monitor the spray characteristics that may be affected by localized weather conditions such as spray drift or rising due to thermal uplifts. They will also be able to monitor for mechanical problems such as clogged spray nozzles that will affect spray deposit. If possible, spray aircraft will be equipped with GPS guidance systems that will assist proper swath widths and spray block boundaries.

TREATMENT EFFECTIVENESS

The primary objective of the project is to prevent defoliation and subsequent tree mortality that will cause significant change in the stand structure or the treated areas. Short-term treatment effectiveness can be monitored by the direct impacts on the insecticide on the insect populations (thus preventing defoliation) and by monitoring the amount of protected foliage. Longer-term effectiveness can be determined by continued monitoring of the foliage and stand conditions the following year.

The following aspects will be monitored:

- ✓ Pre-spray insect populations - Beginning early in the spring, several weeks prior to anticipated spray dates, entomologists will begin monitoring the proposed treatment areas to determine the status of insect populations. Spray blocks will be dropped and boundaries adjusted based on the local insect populations. In addition, insect-sampling plots will be established to determine the actual insect population levels, and insect development. An estimate of the defoliation that may have already occurred from feeding of very young larvae will also be made. Plots will also be established in untreated areas in order to compare effects of treatment versus no treatment.
- ✓ Post-treatment monitoring – Insect populations and foliage will continue to be monitored during periodic intervals (such as 7, 14, and 21 days) following treatment to assure continued larval mortality.
- ✓ The following aspects will be monitored for foliage protection and tree mortality:

- ✓ Foliage protection – estimates of tree defoliation will be made on specific plot trees just prior to treatment and at periodic intervals following treatment. Because of the nature of the biological insecticides, some additional feeding and loss of foliage can be expected. Defoliation will also be monitored through the annual aerial detection survey conducted during late summer and any defoliation occurring on the treated areas will be classified according to intensity.
- ✓ Long-term foliage protection – Plots and sample trees will be revisited during the fall of the following year to measure any defoliation and tree mortality that may have occurred. Defoliation will also be monitored for a second year though the annual aerial detection survey during late summer.

APPENDIX J: RESIDENTIAL, ADMINISTRATIVE & RECREATION SITES

Tables J-1: Colville National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Bead Lake	810
Canyon Creek Campground	55
Ione City Campground	2,900
Lake Ellen Campground	210
Marshall Lake	290
Panhandle Campground	55
Pierre Lake Campground	110
Pioneer Campground	10
Sullivan Lake	1,020
Swan Lake Recreation Area	1,380
Trout Lake Campground	200
Wolfe Addition	60
TOTAL	7,100

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
none	0

Tables J-2: Okanogan National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Andrews Creek Trailhead	2
Antoine Trailhead	10
Ballard Campground	10
Beaver Lake Campground	2
Beth Lake Campground	20
Big Tree Botanical Area	10
Billygoat Trailhead	5
Black Canyon Snowpark	1
Blackpine Lake Campground	35
Bonaparte Lake Campground	20
Buck Lake Campground	10
Camp 4 Campground	2
Cedar Creek Trailhead	10
Chewuch Campground	3
Chickadee Trailhead	5
Cottonwood Campground	3
Crater Creek Trailhead	3
Crawfish Lake Campground	15
Cutthroat Trailhead	2
Eagle Creek Trailhead	10
Early Winters Ski Allocation	1,070
Falls Creek Campground	2
Farewell Creek Trailhead	2
Flat Creek Campground	10
Foggy Dew Campground	2
Foggy Dew Trailhead	2
Fourteen Mile Trailhead	5
Gilbert Trailhead	10
Goat Creek Snopark	10

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
Bonaparte Lake Recreation Residence	20
Boy Scout Camp	65
Kiwanis Organization Site	10
Lutheran Organization Camp	10
North Fork Salmon Recreation Residence	5
Salmon Meadows Lodge	5
Washington Pass Visitor Information Center	5
Total	**120**

Highlands Snopark	3
Honeymoon Campground	10
JR Campground	20
Kerr Campground/Snopark	10
Klipchuck Campground	20
Lake Creek Corral Trailhead	15
Lone Fir Campground	10
Longswamp Campground/Trailhead	1
Lost Lake Campground	20
Loup Loup Campground	30
Loup Loup Ski Bowl	315
Lyman Lake Campground	3
Monument Creek Trailhead	3
Myers Creek Trailhead	10
Mystery Campground	1
North Fork Salmon Trailhead	2
Nice Campground	5
North Summit Snopark	1
Oriole Campground	5
Poplar Flat Campground	10
Riverbend Campground	10
Road's End Campground	5
Robinson Lake Trailhead	15
Ruffed Grouse Campground	5
Salmon Meadows Campground	5
Scatter Creek Trailhead	10
South Creek Campground	5
South Fork Gold Creek Snopark	1
South Summit Snopark	15
Sugarloaf Campground	5
Sweat Creek Campground	40
Thirtymile Trailhead	10
Twisp River Horsecamp	2
Twisp River Snopark	1
War Creek Campground	5
War Creek Trailhead	5
West Fork Buttermilk Trailhead	10
Williams Creek Trailhead	10
Wolf Creek Trailhead	1
Yellowjacket Snopark	5
Total	**1,950**

Tables J-3: Wenatchee National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Alder Creek Horse Camp	1
Beverly	10
Bonanza	10
Clear Lake North	1
Clear Lake South	2
Cottonwood	1
Deep Creek	2
Domke Lake	5
Eightmile	2
Fox Creek	4
Goose Creek	10
Goose Egg Mountain	5
Grouse Mountain	1
Hatchery	5
Hause Creek	2
Horseshoe Cove	2
Ice Water	1
Lake Creek	5
Mineral Springs	1
Peninsula	5
South Fork	2
South Fork Meadow	5
Swift Water	5
Taneum	10
Tronsen	10
Tumwater	2
Willows	1
Total	**110**

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
Cliffdell	80
Entiat Summer Homes	290
Holden	90
Liberty	120
Plain Fish Lake	7,960
Rimrock	100
Valley Hi	10
Total	**8,650**

Tables J-4: Umatilla National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Alder Thicket Campground	45
Big Spring Campground	10
Bluewood Ski Area	890
Bone Springs Campground	80
Bull Prairie	150
Corral	80
Dale	15
Drift Fence Campground	3
Frazier Campground	30
Goodman Spring Campground	75
Howard Creek Trailhead	65
Jubilee Lake Campground	600
Lane Creek Campground	70
Mottet	84
Olive Lake Campground	80
Rose Springs	1
Spillway	1
Spout Springs	380
Squaw Spring Campground	65
Stentz Spring	40
Target Meadows	1
Teal Spring Campground	20
Tucannon Campground	15
Tucannon Spring	30
Twin Buttes	20
Umatilla Forks Campground	120
Wallow Creek Campground	10
Welch Creek Camp	60
Wickiup Campground	60
Woodland Park Campground	70
Woodward Forest Camp	60
Total	**3,230**

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
Clearwater Guard Station	80
Corporation Guard Station	60
Dale Compound	50
Desolation Guard Station	25
Ditch Creek	95
Frazier	60
Fremont Powerhouse	120
Little Turkey Recreation Residence	50
Long Meadows Guard Station	45
Summit Guard Station	65
Tamarack Mountain Lookout	50
Tollgate	35
Tucannon Guard Station	55
Tupper Guard Station	75
Wenatchee Guard Station	75
Total	**940**

Tables J-5: Wallowa-Whitman National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Eagle Creek Wild & Scenic River	4,100
Grande Ronde Wild & Scenic River	970
Imnaha Wild & Scenic River	4,210
Joseph Creek Wild & Scenic River	10
Losting Wild & Scenic River	1,060
North Fork John Day Wild & Scenic River	230
North Powder Wild & Scenic River	360
TOTAL	10,950

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
none	0

Tables J-6: Malheur National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Buckhorn Meadow Trailhead	10
Canyon Meadows Campground	10
Canyon Mountain Trailhead	10
Crescent Campground	10
Elk Creek Campground	10
Fields Peak Trailhead	10
Lake Creek Trailhead	10
Magone Lake Campground	10
Meadow Fork Trailhead	10
Murray Campground	10
North Fork Trailhead	10
Sheep Creek Trailhead	5
Starr Campground	10
Starr Ridge Trailhead	5
Table Mountain Trailhead	5
Wickiup Campground	5
Total	**140**

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
County Road 65 Corridor	60
Total	**60**

Tables J-7: Ochoco National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Barnhouse Campground	10
Cottonwood Camp	25
Delintment Lake Campground	5
Independence Mine Trail	2,730
Little Summit Prairie Campground	2
Mud Springs Campground	5
Ochoco Divide Camp	20
Ochoco Forest Camp	1
Round Mountain Trail	1,010
Scotts Campground	1
Steins Pillar Trail	255
Walton Lake Campground	100
Whistler Campground	10
White Rock Campground	1
Wildcat Campground	15
Wildwood Campground	10
Total	**4,200**

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
Allison Guard Station	5
Crystal Springs Camp	12
Ochoco Ranger Station	43
Private Homes on Highway 26	180
Total	**240**

Tables J-8: Winema National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
Odessa Campground	20
Total	**20**

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
Lake of the Woods Summer Home Tract	75
Rocky Point Community	75
Total	**150**

Tables J-9: Fremont National Forest

RECREATION SITE NAME	ACRES IN HOST TYPE
None	0

RESIDENTIAL/ADMIN. SITE NAME	ACRES IN HOST TYPE
none	0

APPENDIX K: HAZARD RISK RATING AND MORTALITY RULES

Based on previous research, it is known that there are some areas where Douglas-fir tussock moth outbreaks are more likely to occur, and that there would be varying amounts of damage within these areas. Research has been able to characterize these areas based on certain vegetation and geographical features. Rather than assume that the same infestation levels, damage, and mortality would occur across the entire analysis area (and thus overestimate the extent and amount of damage), the Forest Service has developed general hazard/risk rating rules. These rules were designed to distinguish between high, moderate, and low risk areas. They are used to provide a percentage of the analysis areas in each category, and are intended to be used as aides in developing more realistic analyses scenarios. Distinction needs to be made between an estimate of how much area is likely to incur damage and where that damage might actually occur. It cannot be assumed that DFTM infestation would occur in, and cause significant damage, only to high or even moderate risk areas, and decisions for treatment cannot be made on the basis of these rules.

High Risk Areas in Washington

- Aspect 135 degrees to 270 degrees or slope < 10% and
- Elevation <= 4,500 feet and
- Host type 60-100% and
- Small to Large trees and
- Crown Closure > 60%

High Risk Areas in Oregon

- Aspect 90 to 270 degrees or slope <10% and
- Elevations <= 8,000 feet and
- Host type 60-100% and
- Small to Large trees and
- Crown Closure > 70%

Moderate Risk In Washington

- Any Aspect and
- Elevation <=4,500 feet and
- Host 20-60% or 60-100% and
- Small to Large trees and
- Crown Closure >30%

Moderate Risk in Oregon

- Any Aspect and
- Elevation <= 8,000 feet and
- Host 20-60% or 60-100% and
- Small to Large trees and
- Crown Closure >30%

Low Risk in Washington and Oregon

All host type not in above 2 categories. This would include saplings and smaller stands, elevations above 4,500 feet in Washington or 8,000 feet in Oregon, and low density stands.

The Umatilla and Wallowa-Whitman NF's had already developed DFTM Risk areas in previous analyses and these were used rather than the above rules for those Forests.

DEFOLIATION ANALYSIS

Varying degrees of defoliation and subsequent mortality would occur throughout the potential DFTM outbreak area. There would be 100% defoliation and mortality on just a percentage of the area. Other parts of the outbreak area will receive moderate defoliation and some mortality, and other areas will have light defoliation and no mortality. In order to assign a reasonable measure or percentage of the analysis area that would receive various levels of defoliation and mortality, biologists developed analysis guidelines.

First, an estimate was made as to how much of the analysis area would fall into the light, moderate and heavy defoliation categories. The hazard/risk map divides the potential outbreak area into areas of high, moderate, and low risk; and to some extent, although it was not the intended use of this map, the severity of the defoliation in those areas can be inferred. It is possible that a low risk area could in fact receive heavy mortality, or visa versa. This map helps establish a reasonable estimate of actual mortality across the potentially affected area. Since it is not known exactly where the DFTM outbreaks would occur, over four million acres is analyzed under the No Action alternative in this document. Using the 1972 – 1974 outbreak as a reference, it is likely that a new outbreak will occur on 16% (approximately 700,000 acres) of the affected areas. Based on site characteristics such as slope, aspect, and percent of host type, the analysis area has been classified into high, moderate, and low risk to DFTM outbreak and damage. Within the 700,000 acres, it is estimated that 65% would be designated as high risk, 30% would be medium risk, and 5% would be low risk.

The categories for the risk map are high, moderate, and low. For the development of the risk map it was assumed the following defoliation levels would occur in the following risk categories:

Low = Light defoliation; less than 40%,

Moderate = Moderate defoliation is 40-60%

High = Heavy defoliation is over 60%

Wickman (1979) developed a table to predict mortality for Douglas-fir and true fir based on defoliation class. This rating system was intended for predicting individual tree mortality; however, it is used here a guide for estimating the amount of average mortality to be expected within each defoliation category.

For Light Defoliation, the estimated mortality based on defoliation of less than 40% (defoliation classes 1 and 2) is

less than .5% for grand fir and less than 2.25% for Douglas-fir; the average of less than 1.25% mortality is so low that for Light Defoliation areas, it is assumed there would be no 0% or mortaility from DFTM.

For Moderate Defoliation: the estimated mortality based on defoliation of 50% (defoliation class 3) for grand fir is 2% and for Douglas-fir is 8%, with an average of 5% mortality to be expected.

For Heavy Defoliation the estimated mortality based on an average of classes 4-7 (75% or greater defoliation) for each species. The average mortality for grand fir was 53% and for Douglas-fir, 43%, to obtain an overall average of 48% mortality.

The above represents expected mortality from DFTM defoliation alone. The risk of secondary mortality from bark beetles is based, to some extent, on the same factors.

The following table is developed to provide a guide in determining mortality by size class from defoliation alone, a combination of defoliation and bark beetles, with no bark beetles in the vicinity, and mortality from defoliation and bark beetles with a currently existing bark beetle population in the area.

DEFOLIATION RULES

To aid in the analysis, the 1997/1998 bark beetle layers from the annual aerial detection survey have been overlaid on the alternatives for each Forest. This resulted in a recommendation for identifying which of the mortality rules apply based on occurrence of bark beetles. Some Forests have two distinct parts and in some cases, there were differences with regard to the presence of bark beetles.

Table K-1: Mortality Estimates

Tree Size	Low Risk <40% Defoliation	Moderate Risk 40-60% Defoliation	High Risk > 60% Defoliation
Trees over 21” DBH	Estimated mortality from defoliation alone = 0%	Estimated mortality from defoliation alone = 5%	Estimated mortality from defoliation alone = 48%
	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 3%	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 12%	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 61%
	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 6%	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 25%	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 70%
Trees 14 – 24” DBH	Estimated mortality from defoliation alone = 0%	Estimated mortality from defoliation alone = 5%	Estimated mortality from defoliation alone = 48%
	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 3%	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 12%	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 61%
	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 6%	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 25%	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 70%
Trees 9 – 14” DBH	Estimated mortality from defoliation alone = 0%	Estimated mortality from defoliation alone = 5%	Estimated mortality from defoliation alone = 32%
	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 2%	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 5%	Estimated mortality from defoliation and bark beetles if bark beetles are not currently in the area = 34%
	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 4%	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 7%	Estimated mortality from defoliation and bark beetles if bark beetles are in the area = 37%

Table K-2: Colville NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with no bark beetles in the area
East half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area
West half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with no bark beetles in the area

Table K-3: Okanogan NF Mortality Rules

Forest-wide Basis	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with bark beetles in the area
No Action	Use mortality from defoliation with no bark beetles in the area
East half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation only
Expanded Protection Action	Use mortality from defoliation only
No Action	Use mortality from defoliation only
West half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area

Table K-4: Wenatchee NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area

Table K-5: Umatilla NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area
North half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area
South half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area

Table K-6: Wallowa-Whitman NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area
East half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area
West half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with no bark beetles in the area

Table K-7: Malheur NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with no bark beetles in the area
North half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with bark beetles in the area
South half only	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation only
Expanded Protection Action	Use mortality from defoliation only
No Action	Use mortality from defoliation only

Table K-8: Ochoco NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation with no bark beetles in the area
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with no bark beetles in the area

Table K-9: Winema NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation only
Expanded Protection Action	Use mortality from defoliation with no bark beetles in the area
No Action	Use mortality from defoliation with no bark beetles in the area

Table K-10: Fremont NF Mortality Rules

Forest-wide	
Proposed Action and TM-BioControl Only Action	Use mortality from defoliation only
Expanded Protection Action	Use mortality from defoliation only
No Action	Use mortality from defoliation only

APPENDIX L: LOCATION OF OLD-GROWTH/LOS

The following identifies where old-growth and late/old structures are located.

Colville National Forest

Host type areas have not been identified.

Okanogan National Forest

Old growth and late/old structure stands are concentrated in the following areas:

Jakita Ridge, in the Pasayten Wilderness: 7,400 acres of host type; 9,000 acres of non-host.
North Cascades Scenic Highway Corridor: 8,600 acres of host type; 10,000 acres of non-host. This includes spotted owl nesting habitat.
Yellowjacket: 3,800 acres of host type; 3,700 acres of non-host. This includes spotted owl nesting habitat.
Chewuch River Basin: 9,800 acres of host type; 8,800 acres of non-host. The West Chewuch Road, a scenic corridor, runs through this area.
Fawn Creek Basin: 7,400 acres of host type; 8,000 acres of non-host. Parts of this area are in the Highway 20 scenic corridor.
Early Winters Creek: 7,400 acres of host type; 4,000 acres of non-host. This includes spotted owl habitat and the Highway 20 scenic corridor.
Upper Twisp River: 8,600 acres of host type; 3,500 acres of non-host. This includes some spotted owl nesting habitat, and the Twisp River Road scenic corridor.
Virginian Ridge: 8,800 acres of host type; 8,500 acres of non-host.
Gold Creek: 5,000 acres of host type; 3,200 acres of non-host.
Salmon Creek: 5,000 acres of host type; 3,200 acres of non-host. This includes the State Road 38 scenic corridor.
Mount Hull: 8,600 acres of host type; 1,100 acres of non-host.
Big Tree Botanical Area: 8,600 acres of host type.
Dugout: 6,200 acres of host type; 2,200 acres of non-host.
Cedar Creek: 6,000 acres of host type.
Buck Mountain: 5,200 acres of host type; 2,800 acres of non-host.
Another 2,000 acres of host type and 2,700 acres of non-host are scattered throughout the Forest.
Wenatchee National Forest

Old growth that includes host type stands is concentrated in the following areas:

Lake Chelan Recreation Area (North Cascades National Park): 5,000 acres of host type; 6,500 acres of non-host.
Bear Creek to Little Big Creek, along Lake Chelan: 4,500 acres of host type; 6,600 acres of non-host.
Mad River: 3,00 acres of host type; 15,000 acres of non-host.
Baldy: 2,000 acres of host type; 8,000 acres of non-host.
Chumstick Mountain: 3,000 acres of host type; 3,500 acres of non-host.
Dinkelman Ridge: 500 acres of host type; 8,000 acres of non-host.
Tronsen Creek: 3,000 acres of host type; 3,000 acres of non-host.
Mission Ridge: 4,000 acres of host type; 7,500 acres of non-host.
Cougar Gulch: 5,000 acres of host type; 2,000 acres of non-host.
William O. Douglas Wilderness: 500 acres of host type; 150,000 acres of non-host.
The following areas have old growth with no host type:

Glacier Peak Wilderness: 20,000 acres.
Chiwawa River: 40,000 acres.
Henry Jackson Wilderness: 135,000 acres.
Alpine Lakes Wilderness: 23,500 acres.
Cle Elum Lake: 16,000 acres.
Teanaway Ridge: 20,000 acres.
Manashtash Creek: 20,000 acres.
Umatilla National Forest

Late/old structure stands are concentrated in the following areas:

The largest continuous block of old growth, 2,050 acres, is in the Wenaha-Tuscannon Wilderness. It includes about 500 acres of host type.
The head of Jug Creek includes a 1,800-acre block, which is 50% host type.
There are scattered patches totaling about 2,000 acres in the Vinegar Hill area, on the other side of the ridge from old growth on the Malheur National Forest. These patches are about 60% host type.
There is a 500-acre patch near the Ruby Creek Mines, along the boundary with the Wallowa-Whitman National Forest. It is about 50% host type.
Between the Wenaha-Tuscannon Wilderness and Highway 84 there are about 20 patches of old growth totaling 11,000 acres. These are 95% host type.
There are 6 old growth patches along the Grande Ronde River, on the boundary with the Wallowa-Whitman National Forest. They total 1,000 acres, and are primarily host type.
North of the Wenaha-Tuscannon Wilderness are 10 patches of old growth totaling 1,400 acres. These are about 50% host type.
West of the North Fork John Day Wilderness are 20 patches of old growth totaling 4,250 acres. These are primarily host type.
Wallowa-Whitman National Forest

The only extensive areas on the Wallowa-Whitman where late/old structure stands are not found are along the Snake River, and at high elevations near Eagle Cap.

Malheur National Forest

On the Malheur National Forest, late/old structure stands are concentrated in the following areas:

A unique stand of Alaska yellow cedar on the Bear Valley District is part of a 5,000-acre area of late/old structure. This area is about 80% host type. About 10% is considered to be at high risk for defoliation; the rest is moderate risk.

There is a 400-acre stand of late/old structure in the head of the Canyon City watershed, which is entirely host type at moderate risk.

About 4,000 acres of late/old structure is found on the boundary between the Bear Valley and Prairie City Ranger Districts. This is west of the Snowshoe Fire, along the visual corridor to Indian Creek Trailhead. Several dedicated old growth stands are included in this area. About 80% of the late/old structure is dominated by host type at moderate risk.

About 3,000 acres of late/old structure, including three small areas of dedicated old growth, are part of the visual corridor into the east side of Bear Valley Ranger District. About 60% of this area is dominated by host type, with non-host late/old structure mostly on the west end. About 10% of host type is high risk, and the rest is moderate risk.

The Upper Deer Creek Sub watershed contains about 6,400 acres of late/old structure, which is about 60% host type at moderate risk.

The Magone Lake area contains about 500 acres of late/old structure. About half of this is host type at moderate risk.

There is about 200 acres scattered late/old structure in Vinegar Creek, about half of which is host type at moderate risk.

The Middle Fork of the John Day River Headwaters contains about 6,000 acres of late/old structure, including several stands of dedicated old growth. It is about 60% host type. About 20% of the host type is high risk; the rest is moderate risk.

The Genesis Project Area old growth stands total about 1,000 acres, and is almost entirely host type at moderate risk.

The Reynolds area includes about 6,000 acres of late/old structure. Some of these areas are dedicated old growth. It is about 80% host type at moderate risk.

The Phink/Elk area includes about 6,000 acres of late/old structure, including several dedicated old growth stands. It is about 90% host type at moderate risk.

The John Day Headwaters contains about 5,000 acres of late/old structure that is almost entirely host type. About 5% is high risk; the rest is moderate risk.

The Wickiup area contains about 7,300 acres of late/old structure, including several dedicated old growth stands. These stands are about 70% host type at moderate risk.

Ochoco National Forest

On the Ochoco National Forest, late/old structure stands are concentrated in the following areas:

The Lookout Mountain Management Area, including the Ochoco Ranger Station, has about 79,000 acres: 64,000 acres of host type, and 15,000 acres of non-host. It includes 2 stands of designated old growth in host type, totaling 500 acres.

The Black Canyon Wilderness Area has 47,500 acres: 35,000 acres of host type, and 12,500 acres of non-host.

The Bridge Creek Wilderness Area has 22,500 acres: 17,500 host type, and 5,000 acres of non-host. It includes one stand of designated old growth, about 700 acres, in host type. This includes the Mitchell Municipal Watershed.

The Mill Creek Wilderness Area has 20,000 acres, about 10,000 acres of host type and 10,000 non-host types.

The Highway 26 corridor has 10,000 acres, about evenly divided between host and non-host.

The north half of the Paulina Ranger District has about 57,250 acres: 52,250 of host type, and 5,000 acres of non-host. It includes 21 stands of designated old growth, about 2,000 acres, mostly in host type.

The south half of the Paulina Ranger District has about 25,000 acres, primarily non-host. It includes 6 stands of designated old growth, totaling about 500 acres. One of these stands is in host type, about 100 acres.

The north end of the Big Summit Ranger District has about 40,000 acres: 30,000 acres of host type, and 10,000 acres of non-host. It includes 14 stands of designated old growth, about 1,500 acres, primarily in host type.

Ochoco Divide RNA has about 10,000 acres, almost entirely host.

The Silver Creek RNA has about 40,000 acres, almost entirely non-host.

Allison Spring has about 10,000 acres, almost entirely non-host.

The Snow Mountain District outside of Allison Spring and the Silver Creek RNA has about 54,250 acres, primarily non-host. It includes 24 stands of designated old growth, about 1,200 acres. One of these stands, about 500 acres, is in host type.

About 10,000 acres of other scattered late/old stands can be found throughout the Forest. These are about evenly divided between host and non-host.

Winema National Forest

Old growth stands are concentrated in the following areas:

Jackson Creek area: 15,500 acres of host-type; 50,000 acres of non-host.

The area bordered by Klamath Marsh, the Williamson River, and the Sprague River: 10,000 acres of host-type; 60,000 acres of non-host.

Chiloquin Ridge and vicinity: 20,200 acres of host-type; 3,500 acres of non-host. Host type stands include habitat for spotted owl. Tussock moth has been observed in this area.

The area between Sun Mountain Road and Crater Lake: 4,500 acres of host-type; 4,000 acres of non-host.

Sky Lakes Wilderness: 15,000 acres of host-type; 23,000 acres of non-host.

Lake of the Woods Resort: 18,500 acres of host-type; 0 non-host.

From Sevenmile Creek south to Mountain Lakes Wilderness, east of Sky Lakes Wilderness: 11,000 acres of host-type, 1,500 acres of non-host. Host-type includes about 8,700 acres around rare algae in Mare's Egg Spring and an isolated bull trout reach in Threemile Creek. Tussock moth has been observed in this area.

Other clumps of old growth scattered throughout the Forest: about 1,500 acres, primarily non-host.

Fremont National Forest

Old growth stands are concentrated in the following areas:

Cabin Lake/Fort Rock Wildlife Area: 20,000 acres.

Yamsay Mountain Recreation Area: 15,000 acres.

Between Summer Lake and the Sycan River: 20,300 acres.

Crane Mountain Recreation Area: 3,000 acres.

Other clumps of old growth scattered throughout the Forest: 4,000 acres.