



Biological Evaluation R2-24-03, December 2023

Douglas-fir Tussock Moth Population Status and Potential for a Front Range Outbreak

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1. Introduction and History

Douglas-fir tussock moth (DFTM) is a native defoliator in the western United States and Canada that impacts Douglas-fir, true firs, and spruce in the Rocky Mountain Region. DFTM can be one of the most damaging western defoliators. Host damage is caused as larvae feed on the current year's foliage causing it to shrivel and turn brown. As larvae mature, they consume older, whole needles. Defoliation occurs first at the tops of trees and outer branches and then, as the season progresses, on lower crowns and inner branches of the host tree. DFTM can completely defoliate trees in one season. Defoliation can result in top and branch kill, reduced vigor, growth loss, and increased susceptibility to attack by other insects and diseases, particularly Douglas-fir beetle, that can move in and kill stressed trees within 3-5 years post-outbreak of DFTM. Photographic documentation of life history can be seen in Figure 1.

DFTM outbreaks tend to be cyclic in nature and reach outbreak levels every 7-14 years throughout its range (10-12 years in Colorado) and typically last for 2-4 years. Several natural population regulators, including predators, parasitoids, and nuclear polyhedrosis virus (NPV), cause collapse in outbreak populations. Outbreaks have been documented in the Rocky Mountain Region since the late 1930s.

A large-scale, wildland forest epidemic of DFTM in the central Rocky Mountains, predominately in the South Platte River drainage of the Pike National Forest, occurred from 1993-1996 with significant mortality of Douglas-fir on 30-40% of the approximately 18,000 acres affected. The next DFTM outbreak occurred from 2004-2008 along the Rampart Range, causing small, isolated pockets of tree mortality. The most recent past outbreak occurred from 2014-2016, also along the Rampart Range, defoliating 24,000 acres on private property in the Perry Park area and adjacent Pike National Forest lands, and about 1,600 additional acres on/adjacent to Cheyenne Mountain, southwest of Colorado Springs (Figs 2-3).



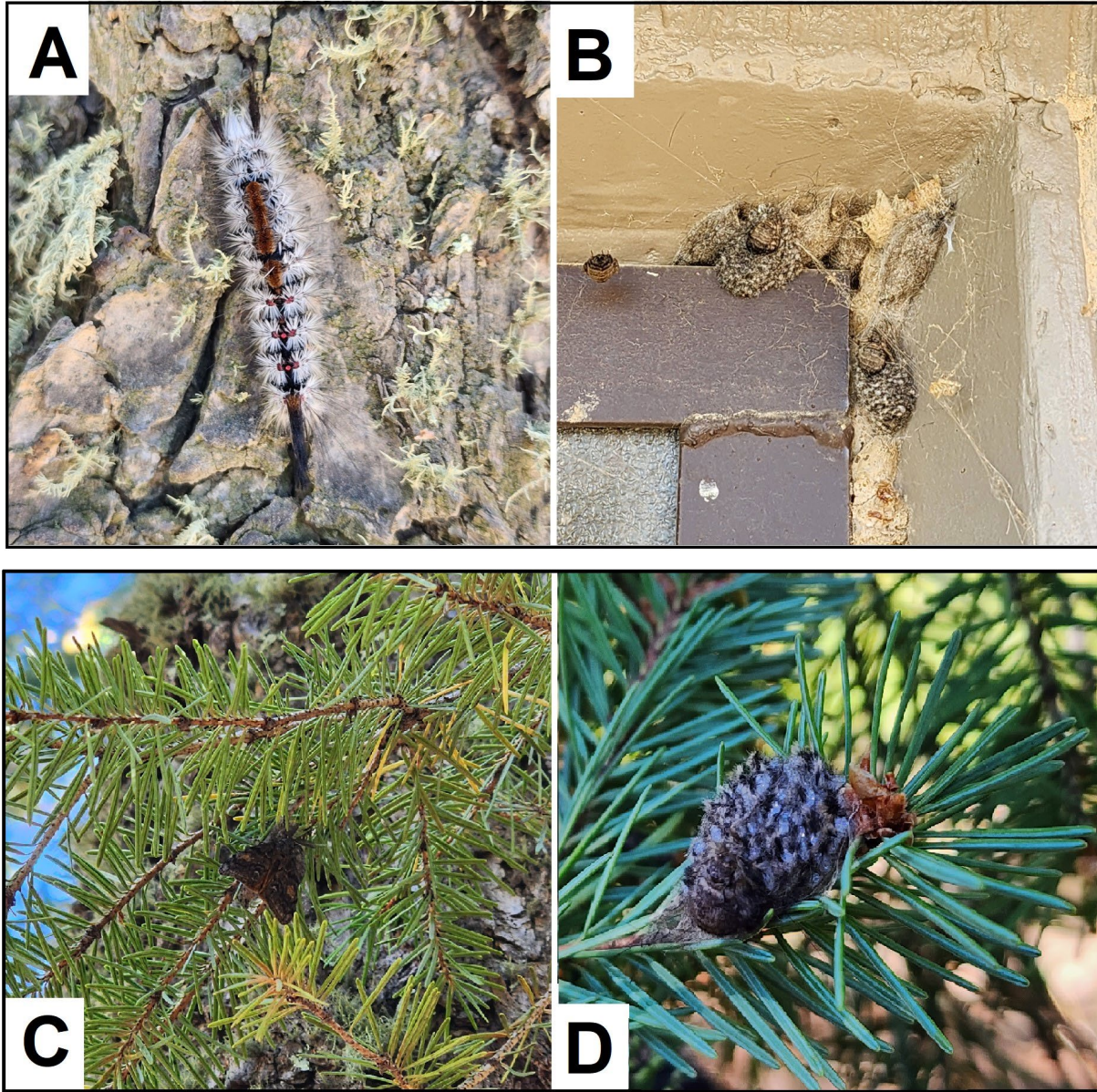


Figure 1. **A.** DFTM larva. **B.** Cocoons and egg masses with wingless female moths present on a building (pit toilet). **C.** Adult male moth. **D.** Fresh egg mass laid on top of cocoon by female.



Figure 2. DFTM defoliation (circled) on Cheyenne Mountain, 2014.



Figure 3. View of DFTM defoliation from Gold Camp Road north of Helen Hunt Falls, 2016.

The pattern of 2014-2016 outbreak was similar to the one in 1993-1995 where the population collapsed dramatically in its third year, 1995, with less than 1,500 acres impacted. Ground observations on DFTM in 2016 were consistent with those made during 1995 including levels of defoliations and NPV in larval populations. Crashes in populations due to NPV in both outbreaks shortened the effects of repeated defoliation, and therefore resulted in only small pockets of tree mortality.

The Lakewood Service Center participates in the DFTM Early Warning System (EWS), that uses a series of permanent pheromone trap sites to identify increasing populations prior to undesirable tree defoliation (system adapted from Daterman et al. 1979). Pheromone lures that mimic female moths are placed in sticky traps before the DFTM flight period and the number of adult males caught throughout the flight period is recorded each year. Sharp increases in trap catches provide land managers advance warning of an impending outbreak. In the late fall of 2013, DFTM traps caught more than 25 male moths per trap. This number typically indicates that an outbreak is likely to occur.

In mid-July of 2014, the first areas of aerially detected DFTM defoliation were observed. The most notable area was on Cheyenne Mountain on both State Park and NORAD properties. Other smaller patches of defoliation were observed along the Rampart Range (Pikes Peak Ranger District). In 2015, DFTM activity continued in areas impacted in 2014 and was observed in more northerly portions of the Pike National Forest (South Platte Ranger District) on private, state, and federal properties. Lakewood Service Center staff have been monitoring DFTM activities at Cheyenne Mountain and the Pike National Forest throughout the last outbreak as well as the impending current outbreak.

In August 2023, Lakewood Service Center entomologists investigated two reports of DFTM larvae on the Pike National Forest. We visited these locations and looked for larvae on other sites, surveying standing mature trees as well as regenerating Douglas-fir. We found late instar larvae, including molting 4th and growing/mature 5th instars and cocoons. We were surprised at how many larvae could be found given the lack of defoliation. Findings were relayed to reporting parties. We conducted an egg mass/cocoon survey during the fall on the Pike National Forest where the 2014-2016 outbreak occurred to gauge population levels for the coming year.

2. Methods

The study area extended across the Front Range of southcentral Colorado.

Pheromone Traps

The U.S. Forest Service Rocky Mountain Region manages EWS DFTM monitoring sites throughout the central part of the state. Lakewood Service Center entomologists maintain nine trap sites along the Front Range as far south as the U.S. Air Force Academy. Each year, five pheromone-baited sticky traps are installed along a transect at each trap site, with approximately 75 feet between traps. Traps are placed in young, open-grown host trees (typically Douglas-fir) by late July to coincide with DFTM flight timing. Traps are collected in late September or October and the number of male moths captured in each trap is recorded. The common threshold used to predict defoliation the following years is an average of 25 moths/trap at a site, but we have learned over time that even 15 males on average indicates a potential outbreak, but more surveys are recommended. EWS pheromone trapping is not designed to predict the exact location of future defoliation.

Egg Mass Sampling

When DFTM larvae become obvious in the forest and/or pheromone trap captures are high (near the 25 average moths/trap threshold), egg mass sampling in the fall may be used to estimate the potential for defoliation in a specific area the following year. The egg mass sampling methods used in Colorado are those described in Shepherd et al., 1985 and Mason et al. 1993. This method works well with crews of 2-4 people and involves sampling three branches on each of 50 trees. The mean number of egg masses per tree is then calculated. Areas where high numbers or densities of egg masses are observed during sampling are likely locations of defoliation the following year. However, it is important to note that egg masses are exposed to winter injury, predation, and parasitism prior to hatching the following spring, and first instar larvae may be susceptible to starvation if many egg masses are observed in areas that have already been heavily defoliated.

3. Results

Pheromone Trapping

A total of nine sites (42 traps, 3 lost) were monitored in central Colorado during 2023 (Table 1). The overall mean trap capture for the EWS traps in 2023 was 2.33 moths/trap with one trap on the Air Force Academy containing 8 moths. Increasing trap catch numbers in DFTM traps suggest an upcoming outbreak in Colorado. In 2015, the second year of defoliation in the previous outbreak, average trap catches approached 25 moths/trap, and outbreaks usually last three years. Continued high trap captures is not unusual during outbreak or outbreak collapse, since male DFTMs (the sex targeted in traps) develop faster than females and therefore are exposed to fewer natural enemies. Despite the survival of some males, however, high mortality in female moths nonetheless results in a population crash.

Larval Surveys

Informal larval sampling was conducted at several easily accessible sites with historical DFTM defoliation activity. While no defoliation was observed or reported in forest settings, two Foresters reported DFTM larvae on trees on the S. Platte Ranger District, and a separate report in a landscaped setting was confirmed by Forest Health Protection Entomologists. Late-instar larvae were observed at all locations, sometimes crawling on the ground presumably seeking pupation sites. Cocoons were visible on trees, rocks, and buildings in the areas where larvae were observed.

Egg Mass Sampling

Egg mass sampling was formally conducted at 15 sites along the southern portion of Colorado's Front Range. Although many old egg masses from previous years were observed, particularly on buildings, there were very few to moderate numbers of current, viable egg masses found. At the 15 sites surveyed, no current egg masses were observed at three sites, and seven sites had fewer than five current egg masses each. Five sites had 11-13 current egg masses, and one site had 22 current egg masses (Table 2, Figure 4).

Table 1. Adult DFTM trapping results in Front Range locations in 2023.

Trap Name	Area	DFTM count
Topaz Point-5	Rampart Range	0
Topaz Point-4	Rampart Range	0
Topaz Point-3	Rampart Range	0
Topaz Point-2	Rampart Range	0
Topaz Point-1	Rampart Range	0
Log Jumper-5	Rampart Range	0
Log Jumper-4	Rampart Range	0
Log Jumper-3	Rampart Range	0
Log Jumper-2	Rampart Range	0
Log Jumper-1	Rampart Range	0
Flat Rocks-5	Rampart Range	2
Flat Rocks-4	Rampart Range	0
Flat Rocks-3	Rampart Range	0
Flat Rocks-2	Rampart Range	0
Flat Rocks-1	Rampart Range	0
Forest Boundry-5	Rampart Range	3
Forest Boundry-4	Rampart Range	0
Forest Boundry-3	Rampart Range	0
Forest Boundry-1	Rampart Range	2
Devils Head-5	Rampart Range	0
Devils Head-4	Rampart Range	0
Devils Head-3	Rampart Range	1
Devils Head-2	Rampart Range	1
Devils Head-1	Rampart Range	0
Cabin Ridge-5	Rampart Range	0
Cabin Ridge-4	Rampart Range	0
Cabin Ridge-3	Rampart Range	0
Cabin Ridge-2	Rampart Range	0
Cabin Ridge-1	Rampart Range	0
AFA Medical Ctr-5	Air Force Academy	0
AFA Medical Ctr-4	Air Force Academy	0
AFA Medical Ctr-3	Air Force Academy	0
AFA Medical Ctr-2	Air Force Academy	0
AFA Medical Ctr-1	Air Force Academy	0
AFA Golf Course-5	Air Force Academy	0
AFA Golf Course-4	Air Force Academy	0
AFA Golf Course-3	Air Force Academy	0
AFA Golf Course-2	Air Force Academy	0
AFA Golf Course-1	Air Force Academy	0
AFA Drive-5	Air Force Academy	1
AFA Drive-4	Air Force Academy	0
AFA Drive-3	Air Force Academy	8

Table 2. Results of egg mass surveys in Front Range locations in 2023 (follows Shephard et al. 1985 and Mason et al. 1993).

Sampling Site	Number of Egg Masses	Number of Cocoons	Rating	Latitude	Longitude
Indian Creek	22	38	intense	39.386242	-105.093775
Sunset Point	13	24	moderate	39.344370	-105.084384
Little Scraggy TH	12	29	moderate	39.346939	-105.260090
Shinglemill TH	11	9	moderate	39.346396	-105.282996
Kelsey CG	12	11	moderate	39.308899	-105.263736
Pine Valley Ranch	4	0	light	39.410726	-105.346171
Willow Bend	2	3	light	39.343641	-105.181551
Forest Road 368	5	2	light	38.749892	-104.891345
Helen Hunt Falls	5	15	light	38.791314	-104.904411
Buffalo Creek	1	2	light	39.342744	-105.320479
South Platt TH	1	0	light	39.402069	-105.172030
Forest Rds 368-371	0	0	light	38.735576	-104.902882
Cabin Ridge	0	0	light	39.277856	-105.110368
Topaz Point	0	0	light	39.259440	-105.121660
Dakan TH	1	0	light	39.303748	-105.033973



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2023 Douglas-fir Tussock Moth Egg Mass Survey

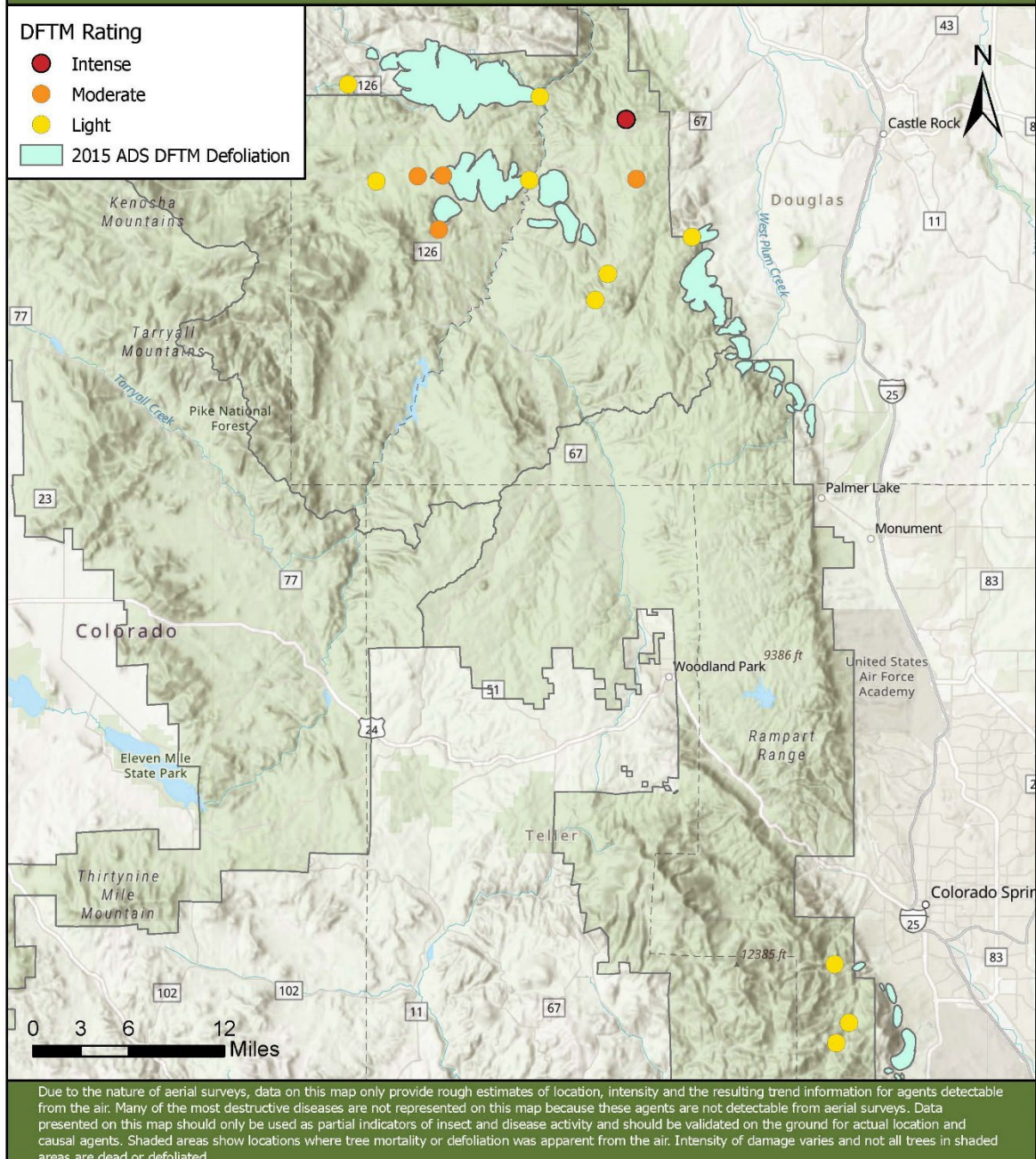


Figure 4. DFTM egg mass sampling sites with rating results for the 2023 egg mass survey (as described in Table 2). Blue-green polygons represent DFTM defoliated acreage flown and mapped by Aerial Detection Survey program at the peak of the last outbreak in 2015.

4. Discussion

The DFTM-EWS has been generally effective at predicting outbreaks in Washington, Oregon, and Idaho, but less obviously effective - but predictive of trends in the southern Rocky Mountains. If DFTM populations behave according to past trends, populations can be expected to increase to damaging levels in eastern Colorado in 2024 or 2025. EWS trapping, observations of larvae, cocoons and egg masses all suggest an outbreak is on the horizon. The Indian Creek area, where high numbers of DFTM egg masses and cocoons were observed in surveys this fall, may experience significant defoliation in 2024.

FHP expects to see increased activity and a greater number of caterpillars in the spring and summer of 2024. Caterpillars of the DFTM are very hairy. The hairs on the caterpillars as well as their egg mass and cocoons may cause allergic reaction to some people, called “tussockosis”. Itching is the most common complaint, but adverse health effects can include rashes (with welts or blisters), watery eyes, runny nose, cough, and less commonly, shortness of breath, wheezing, and chest tightness. With Douglas-fir tussock moth activity documented this year in PSICC National Forest campgrounds, campground hosts and campers should be warned not to touch these caterpillars when they are active next year.

During the last outbreak, defoliation was observed in the 2014 Aerial Detection Survey. We anticipate that in 2023, we are one year ahead of aerial detection surveys documenting defoliation, and two years from severe defoliation across the Front Range of Colorado. We have a good opportunity to share information and recommendations ahead of this impending outbreak. The Lakewood Service Center has worked with numerous clients and partners to facilitate response to DFTM issues along the Front Range. Partners include Cheyenne Mountain Air Force Station (DOD), Air Force Academy (DOD), Fort Carson (DOD), Cheyenne Mountain State Park (CPW), Colorado State Forest Service, City of Colorado Springs, Broadmoor Estate, and private property owners in Douglas, Jefferson, and Boulder counties.

Lakewood Service Center staff and partners are committed to a continued joint response to DFTM and have outlined the following activities for 2024.

- Egg mass sampling on impacted properties (Federal, State, and private lands).
- Continued monitoring for signs of NPV in larvae.
- Effectiveness of control treatments (if conducted).
- Survival/mortality rates of DFTM impacted trees.
- Annual aerial detection survey flights.
- Public outreach on the potential health impacts of DFTM.

Predicted DFTM effects on the forest:

- Short term (1-2 yrs): Douglas-fir will suffer significant mortality where damage is most severe (entire trees stripped of foliage). Pine trees in the defoliated areas will not be affected.
- Long term (2-4 yrs): Virus in caterpillars (harmless to humans) will provide a natural control that will collapse outbreaks in the third or fourth year.
- Ultimately, active forest management can increase the resilience and health of the forest by encouraging diversity of trees species and increasing tree vigor to minimize tree losses.

6. Management Recommendations

Douglas-fir tussock moth management should be tailored to site conditions, level of insect activity and management objectives. Previous DFTM events in the area have resulted in as much as 30-40% tree mortality after severe defoliation. Based on how easy it was to find caterpillars in 2023, with no sign virus, spring 2024 may be the most opportune time to knock down populations over the larger area. Being that the properties visited are of differing ownerships, sizes, stand compositions, management objectives and DFTM impacts, no single management recommendation is appropriate. Some basic guidelines for decision making are:

Considerations with minimal defoliation

- Landowners may be able to assess future defoliation likelihood by looking for egg masses on their property.
- Low to moderate impacts by DFTM are likely to be tolerated by most hosts. In these areas, direct control of DFTM is likely unwarranted. However, in high value viewsheds, aerial application of insecticide may be warranted to reduce defoliation effects.

Considerations with moderate to severe defoliation

- Moderate to severe impacts by DFTM may warrant more aggressive control.
- Damaged trees should be monitored. Trees with light or moderate defoliation may recover, but stress resulting from DFTM-caused defoliation can result in increased bark beetle activity, leading to further tree mortality in the area.
- Trees with severe defoliation that have green, pre-emergent buds may recover from the defoliation event. Trees that do not have green pre-emergent buds should be considered for removal.
- Ideally, spray operations should be conducted from aircraft. However, individual, high-value tree protection can be accomplished by topical applications of chemicals that disrupt DFTM feeding or development.

Long term management activities

- Stands of hosts can be made more resilient through manipulation of stand composition, favoring non-host trees, and reducing understory host component.
- Community groups can explore landscape level treatments by joining efforts for larger combined parcels.
- Management of DFTM may be incorporated into long-term forest management plans, including forest health and fire reduction activities.

Natural Controls

Douglas-fir tussock moths are controlled by several natural agents, helping to maintain tussock moth populations at endemic levels. Overwintering eggs masses, larvae, and pupae can all be affected by parasitic insects, predacious insects, and some bird species. These natural controls are most effective at endemic levels and do not control outbreak populations. A naturally occurring nuclear polyhedrosis virus (NPV) can significantly impact larvae and pupae populations and can result in a precipitous drop in populations after 3-4 years. That timeline and potential damage to trees may be unacceptable to some property owners who may wish to take direct action (chemical applications).

Chemical Applications

Protection of sections of forest stands as well as individual high value trees early in the season may be appropriate on high value sites or for private property owners. Once natural occurring virus is detected in current populations, direct control is not warranted on National Forest lands. There are registered insecticides that have been utilized with various results to reduce DFTM populations and reduce defoliation impacts. A natural pesticide that can be used is *Bacillus thuringiensis* or B.t. There are also growth regulator pesticides that disrupt growth and ultimately kill larvae. Other chemicals have been labeled for direct control of feeding on host foliage. Aerial application is the most effective method. All chemical applications must be done in accordance to labeling.

For additional information (including data, maps, reports, photos, or videos) please contact the U.S.D.A. Forest Service, Forest Health Protection, Lakewood Service Center: James Kruse james.kruse@usda.gov 303-236-9541 or Marianne Davenport marianne.davenport@usda.gov 303-590-4915.

7. Acknowledgements

We appreciate the contributions of Corinne Casper, Isaac Dell, and Andrew Neisess for assistance with field work.

8. Key Reference Documents

- Technical Report R2-67 The History of Douglas-fir Tussock Moth in Colorado and Wyoming
- LSC-14-17 Evaluation of Douglas-fir Tussock Moth on Cheyenne Mountain

- LSC-15-2 Evaluation of Douglas-fir Tussock Moth Activity on the Air Force Academy
- LCS-15-13 Douglas-Fir Tussock Moth Evaluation on Cheyenne Mountain Area
- LSC-16-2 Assessment of Western Spruce Budworm and Douglas-Fir Tussock Moth and Other Forest Health Issues at the Air Force Academy
- LSC-16-7 Douglas-fir Tussock Moth-Impacted Private Property Visits with Colorado State Forest Service

9. Literature Cited

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