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Management Guide for

Gypsy Moth

Lymantria dispar (Linnaeus) (Lepidoptera: Lymatriidae)

Gypsy moth is a polyphagous insect, the host range of the North American strain of gypsy moth consists of over 300 species of trees and shrubs compared to the Asian strain which has a host range that exceeds 500 species.

Perferred Hosts:
- *Quercus* and *Populus*

Riparian habitat hosts:
- *Salix, Alnus* and *Betula*

Other hosts:
- Lodgepole
- Ponderosa pines
- Western larch
- Spruce
- Douglas-fir

Topics

Key Points

- The Asian strain of the gypsy moth is native to Asia.
- Asian gypsy moth female's flight capability and larger host range makes it a serious threat to western forests.
- This insect consumes both old and new needles on conifers which are not able to refoliate.

Overview in the West

Eradication projects have been conducted for European gypsy moth populations throughout the western United States including Utah and Idaho. Early detection, delimitation trapping and the use of a biological insecticide applied when necessary have successfully eliminated introduced populations of this insect in the west. Sporadic introductions of the Asian gypsy moth (AGM) have occurred in the west primarily near west coast cities. However in 2004, an AGM introduction occurred in northern Idaho near Hauser Lake. Environmental consequences associated with the successful establishment of an Asian gypsy moth infestation are more threatening as the female moth is capable of flight. Dispersal distances up to 20 miles could result in an accelerated rate of infestation. AGM presents a more difficult challenge to eradicate because of its broader host range and flight capabilities compared to the North American strain established in the northeast and north central portions of the United States.

Adult female gypsy moth. USDA APHIS PPQ Archives, USDA APHIS PPQ, www.forestryimages.org

History

The European gypsy moth was accidentally introduced into the United States near Boston, Massachusetts during the late 1860's. This introduced defoliator has now expanded its range to include all of the northeastern states, south to North Carolina with outlying infestations found as far west as Minnesota and Iowa. In some forested sites, forest composition has changed too less susceptible species due to periodic heavy defoliation of susceptible hosts.

History

Various chemical insecticides including lead arsenate, DDT, orthene, carbaryl, the insect growth regulator Dimilin®, biological insecticides such as *Bacillus thuringiensis* (Bt) and a natural virus, Gypchek have been used in suppression and eradication efforts.

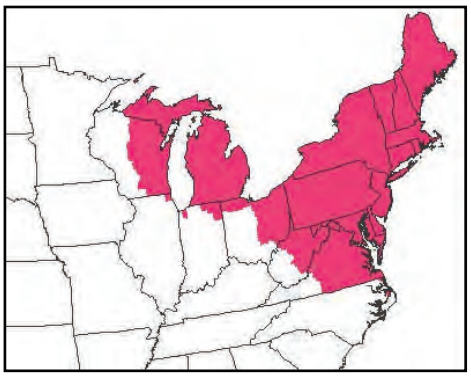
The Asian strain of the gypsy moth is native to Asia. It was first identified in North America in late 1991 near the Port of Vancouver, British Columbia, Canada. Ships infested with egg masses from Pacific ports in eastern Russia introduced the pest while visiting west coast ports when larvae hatched from eggs and were blown ashore. These initial introductions were eradicated using multiple applications of Bt and pheromone traps. In the U.S. it has since been found in California, Washington, Oregon, and most recently in Idaho.

In addition to the female's flight capability the Asian gypsy moth has a larger host range than its European counterpart. Some North American western conifers are hosts for this insect and the insect is better adapted to colder climates. These traits make the Asian strain a more serious threat to our western forests if introduced populations of the insect become established.

Historical Archive Photo

Photo shows use of ropes in climbing trees in treating gypsy moth egg clusters and pruning dead branches from trees when cleaning operations were considered necessary. 1930. USDA Forest Service Archives, USDA Forest Service, www.forestryimages.org

Gypsy Moth Distribution—2005



Damage

Damage by gypsy moth occurs when the leaves or needles of hosts are consumed by developing caterpillars (Figure 1). During severe outbreaks, complete defoliation of susceptible trees or shrubs may result. Defoliated deciduous trees usually refoliate, but this depletes the trees' stored energy reserves, making them more susceptible to pathogens and other insects. Since this insect consumes both old and new needles on conifers and trees are not able to refoliate, severe defoliation may result in tree mortality. Because deciduous trees do refoliate, it generally takes 2-3 consecutive years of complete defoliation before branch and tree mortality occurs.

Caterpillar silk strands, droppings, destroyed leaves and dead moths are a nuisance in homes, yards and recreation areas. Caterpillar hairs can result in an allergic reaction in some people when exposed to larvae.

Photo of gypsy moth defoliation. Mark Robinson, USDA Forest Service, www.forestryimages.org

Figure 1. Late instars feeding on oak foliage. Photo by: Tim Tigner, Virginia Department of Forestry, www.forestryimages.org

Life Cycle

First instar larvae will drop on silken threads and disperse by the wind called "ballooning"

The gypsy moth life cycle has four stages: egg, larvae, pupa and adult moth. Eggs of the North American strain are laid on the bark of trees (Figure 2), female moths lay egg clusters in virtually any sheltered location including homes, vehicles, firewood, and on outdoor items. For the Asian strain egg masses can be deposited on the same substrates but egg laying behavior varies greatly throughout its native range.

In the Russian Far East, eggs are deposited on leaves, in Mongolia eggs are laid near the forest floor and in Japan the females select trees with light colored bark (primarily Betula) for egg deposition.

Figure 2. Egg mass on bark of tree. Photo by Daniela Lupastean, Faculty of Forestry, University of Suceava, Romania, www.forestryimages.org

Figure 3. Photo of older larvae displaying the bright red spots along dorsal side. Photo by: Cooperative Extension University of California

Gypsy moth eggs hatch and larvae emerge in the spring after overwintering in protected egg masses consisting of 100-1000 individual eggs. In most cases larvae hatch in synchronization with bud break of preferred hosts. However, egg hatch is predominantly determined by temperature. After hatching first instar larvae spend from 3 –5 days on or near the egg mass, eventually the larvae climb vertically in response to sunlight. Depending on crowding and the suitability of the host, a percentage of the first instar larvae will drop on silken threads and disperse to a new location propelled by wind. This dispersal behavior is known as "ballooning:" Distances of dispersal usually average less than ½ mile (0.80 km), but can be as great as 12 miles (19.3 km) or more.

Once finding a suitable host, the larvae begin to feed. As larvae feed they go through a series of molts and increase in size with each consecutive molt. Instars are the larval stage between molts. Male larvae normally have five instars and females six before entering the pupal stage. Older larvae have five pairs of raised blue spots and six pairs of raised brick-red spots along their dorsal (back) side (Figure 3). If populations are sparse, larvae move up and down the tree depending on light intensity. Larvae in the later instars feed in the top of the tree at night and crawl down the truck to rest during the day. When populations are high, larvae feed continuously day and night until all the foliage is consumed.

McManus (1987) reports the time interval of individual instars can range between 4 to 10 days depending on temperature. The caterpillar stage can last from 8-12 weeks depending on temperature, food quality, and population levels. Caterpillars feed from early May to mid-July in the western U.S depending on elevation and the factors affecting growth mentioned previously. Late instar larvae can reach approximately 2 inches in length.

Life Cycle

Photo shows a gypsy moth trap in the late 40's. USDA Forest Service Archives, USDA Forest Service, www.forestryimages.org

A caterpillar may consume up to one square foot of foliage during its development. Once feeding is completed, the caterpillars are ready to pupate which can occur from late June to early August. Following pupation, which usually lasts from 10 to 14 days, adult moths emerge and mate.

Adult moths of the North American strain are slightly smaller (male wingspan about 1 inch, female wingspan up to 2 inches) compared to the Asian strain (male wingspan 1 ½ inches and female wingspan 3 ½ inches). Adult coloration is similar for both strains. Males are light tan to dark brown with blackish wavy bands across their forewings and arrowhead markings near the leading edge (Figure 4). Female moths are nearly white with faint, dark wavy bands on the forewings (Figure 4).

The North American strain generally deposits her eggs near her pupation site. Female moths of the Asian strain have flight capabilities up to 20 miles (32 km). Eggs are deposited in a single mass and then covered with dense layer of brown hair from the female's body. The cycle is completed when the fully developed embryos hatch in the spring.

Figure 4 male(left) and female (right) Asian gypsy moths - shown for comparison . USDA APHIS PPQ Archives, USDA APHIS PPQ, www.forestryimages.org

Management

Figure 5. Photo shows today's pheromone delta traps being deployed in wooded area near high risk waterway USDA APHIS PPQ Archives, USDA APHIS PPQ, www.forestryimages.org

The risk of introduced North American strain populations becoming established in the west increases as more people move from the generally infested areas in the east to the uninfested west. As trade increases with Asian countries, the risk of introducing the Asian strain to North America also increases.

Gypsy moth detection programs in the west rely on pheromone baited delta traps to locate introduced populations (Figure 5). If a single male moth is caught in the detection grid, the trapping grid is refined the following year. This delimitation trapping grid is used to locate developing populations. Occasionally egg mass and larval surveys are also conducted near a positive catch site if a suspected introduction has occurred.

Detection and delimiting programs are conducted jointly by State and Federal agencies placing pheromone traps in areas of risk. High-risk areas include cities, towns, National and State Parks, and campgrounds where susceptible hosts occur and people are likely to arrive from the generally infested areas. Most of the North American strain introductions occur in the west as the result of humans moving articles with egg masses from the generally infested area in the east.

Management

Spraying DDT in the 1930's. USDA Forest Service Archives, USDA Forest Service, www.forestryimages.org

Eradication programs are initiated in the west if multiple male moth catches of the North American strain occur within detection or delimitation trapping grids or other life stages of the insect is found. If a single Asian gypsy moth adult is captured, current APHIS (Animal, Health Plant Inspection Service) policy is multiple applications of Bt within a one mile radius of the positive catch site.

Historically, conventional pesticides such as DDT, carbaryl, and acephate were used in the northeastern states in gypsy moth suppression/eradication programs. Non-target impacts and human health concerns resulted in discontinuing these products as suppression/eradication strategies for gypsy moth. Suppression/ eradication programs for gypsy moth typically involve an integrated pest management (IPM) approach.

Applying a barrier band used to capture migrating caterpillars. (Village of Hartland, 2001)

Integrated Pest Management

The following products or methods are often considered in developing an IPM program for gypsy moth in the west:

- Mass trapping with pheromone baited traps.
- Release of sterile male gypsy moths.
- Mating disruption with a registered synthetic version of the pheromone disparlure in products such as Disrupt®II, Luretape Gypsy Moth®, and Luretape Plus®.
- Diflubenzuron (Dimilin®), an insect growth regulator.
- Nucleopolyhedrosis virus (NPV), a natural disease agent in gypsy moth caterpillars. Gypchek® is a registered NPV product that is available for use.
- *Bacillus thuringiensis* kurstaki (Btk), a microbe that is a natural disease agent of caterpillars. Several registered Btk products are available for use.

Pesticide registrations change frequently; please contact County, State, or Federal pesticide coordinators for a list of registered insecticides.

Management

During severe outbreaks, complete defoliation of susceptible trees or shrubs may result.

Natural enemies play an important role in gypsy moth control during years of light infestations. Wasps, flies, ground beetles, spiders, and ants are common predators. Birds such as chickadees, bluejays, nuthatches, towhees, and robins serve as control agents. Several woodland mammals including mice, shrews, chipmunks, and squirrels are also predators. Over ten foreign biological control agents that includes parasites, predators, and disease organisms specific to gypsy moths, have been introduced for control purposes in North America.

Biocontol for gypsy moth - parastic wasp laying eggs on gyspy moth pupal case. Eggs will hatch into wasp larvae which will feed and kill host. USDA APHIS PPQ Archives, USDA APHIS PPQ, www.forestryimages.org

Other Reading

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http://www.aphis.usda.gov/plant_health/plant_pest_info/gypsy_moth/index.shtml

Forest Health Protection and State Forestry Organizations

Assistance on State And Private Lands	Assistance on Federal Lands
Montana: (406) 542-4300	US Forest Service Region One Missoula: (406) 329-3605 Coeur d'Alene: (208) 765-7342
Idaho: (208) 769-1525	
Utah: (801) 538-5211	
Nevada: (775) 684-2513	US Forest Service Region Four Ogden: (801) 476-9720 Boise: (208) 373-4227
Wyoming: (307) 777-5659	