Gypsy Moth Management in the United States: *a cooperative approach*

Final Supplemental Environmental Impact Statement

Volume II of IV

Chapters 1-8 and Appendixes A-E

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Animal and Plant Health
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Gypsy Moth Management in the United States: *a cooperative approach*

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Abstract: The USDA Forest Service and Animal and Plant Health Inspection Service are proposing an addition to the gypsy moth management program that was described in the 1995 Environmental Impact Statement—Gypsy Moth Management in the United States: a cooperative approach—and chosen in the 1996 Record of Decision. The agencies are proposing these new treatment options: adding the insecticide tebufenozide, or adding the insecticide tebufenozide and other new treatment(s) that may become available in the future to manage gypsy moths, provided that the other treatment(s) pose(s) no greater risk to human health and nontarget organisms than are disclosed in this Final Supplemental Environmental Impact Statement for the currently approved treatments and tebufenozide. The addition of tebufenozide or other new treatment(s) to the list of approved treatment options does not change any program or administrative requirements identified in the 1995 EIS. Those requirements include any consultations required and the need to conduct site-specific environmental analyses in accordance with the National Environmental Policy Act and agency regulations.

The complete Final Supplemental Environmental Impact Statement consists of four volumes:

Volume I	Summary
Volume II	Chapter 1. Purpose of and Need for Action
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Volume III	Appendix F. *Bacillus thuringiensis kurstaki* (*B.t.k.*) Risk Assessment
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All volumes can be viewed and downloaded at http://na.fs.fed.us/pubs/detail.cfm?id=5251.

The record of decision is a separate document published and available 30 days or longer after the notice of availability for the Final Supplemental Environmental Impact Statement is published in the Federal Register (40 CFR Part 1506.10).

Volume II

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Gypsy Moth Management in the United States: *a cooperative approach*

Final Supplemental Environmental Impact Statement

Volume II

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Chapter 1

Purpose of and Need for Action

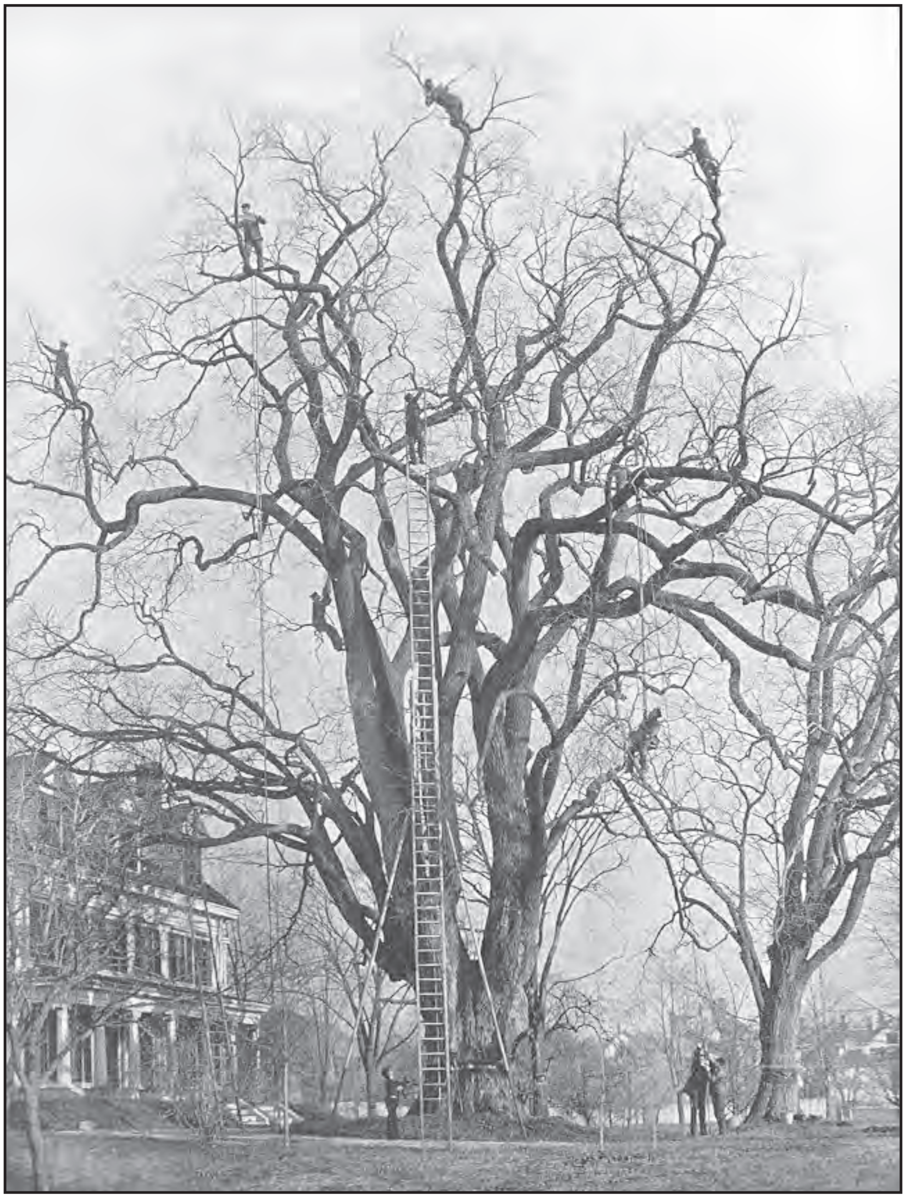

Figure 1-1. In 1892, workers attempted to control gypsy moth by hand picking egg masses.

Chapter 1 Purpose of and Need for Action

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The management of gypsy moth in the United States takes an integrated pest management approach to protecting the forests and trees of the United States from the adverse effects caused by the gypsy moth. This chapter gives brief background on the gypsy moth and the current gypsy moth management program. The chapter also states the proposed changes, rationale, and related issues. It explains the purpose of this supplemental environmental impact statement (SEIS) and how it is to be used.

1.1 Proposed Action.

The United States Department of Agriculture (USDA) is responsible for management activities related to the gypsy moth (Lymantria dispar Linnaeus [L.]), for the Federal government. Two USDA agencies, the Forest Service and the Animal and Plant Health Inspection Service (APHIS) share this responsibility. Agency authorities are found in these USDA Delegations of Authority: 7 Code of Federal Regulations (CFR) 2.60(a)(38) by the Under Secretary for Natural Resources and Environment, for the Forest Service; and 7 CFR 2.80(a)(36) by the Under Secretary for Marketing and Regulatory Programs, for APHIS.

The Forest Service and APHIS are proposing an addition to the gypsy moth management program described in the 1995 Environmental Impact Statement (EIS) and chosen in the 1996 Record of Decision (USDA 1995, 1996). The agencies are proposing to add new treatment options: the insecticide tebufenozide and the option of adding other treatments that may become available in the future to manage gypsy moths, provided such treatments pose no greater risks to human health and nontarget organisms than are disclosed in this SEIS for currently approved treatments and tebufenozide.

This SEIS discloses the method of use, effectiveness, and effects of tebufenozide, and outlines the protocol that would be followed in order to add other treatments. Appendix A provides detailed information about the use and effectiveness of tebufenozide and other treatments that are effective for eradicating, suppressing, or slowing the spread of the gypsy moth as represented in this SEIS. Information about treatments and natural control agents that are not used in the USDA National Gypsy Moth Management Program is also presented in Appendix A for the benefit of the reader. Appendix B provides an overview of the National Gypsy Moth Management Program. This SEIS also updates effects of currently approved treatments and of the gypsy moth, with new information that has become available since the 1995 EIS, and about the slow-the-spread strategy, which is now an operational component of the National Gypsy Moth Management Program.

1.2 Public Involvement and Issues.

On April 29, 2004, the Forest Service and APHIS published a Notice of Intent (NOI) to Prepare a Supplement to the Final EIS for Gypsy Moth Management in the United States: a Cooperative Approach (69 Federal Register (FR) 23492-93, April 29, 2004). The public was invited to comment on the proposed supplement. Fourteen comment letters were received from the public on the SEIS. Other NOIs were published on March 13, 2006 (71 FR 12674-75) and on February 7, 2007 (72 FR 5675), revising the dates for filing the draft and final SEIS.

The interdisciplinary team, joined by public affairs specialists and forest pest managers throughout the Forest Service and APHIS (listed in Chapter 5) actively sought public involvement. Two issues were derived from the scoping effort: Issue 1—risk to human health, and Issue 2—risk to nontarget organisms. These issues are described in Chapters 3 and 4 of this SEIS. See Appendix C for details of scoping efforts.

The Forest Service and APHIS mailed 419 hard copies and 765 electronic copies (CDs) of the draft SEIS to a variety of individuals, organizations, and governmental agencies. An additional 146 copies of the summary were mailed to individuals and organizations with the suggestion that they review the complete document if they wished to submit comments. The draft SEIS was also available on the Internet.

The notice of availability of the draft SEIS, published in the Federal Register on September 19, 2008, invited public comments. In response, 41 comment letters were received. A variety of comments was identified in the letters. Specific concerns that were within the scope of the SEIS were examined. Where appropriate, revisions were made in this final SEIS. The responses by the Forest Service and APHIS to all of the comment letters received on the draft SEIS are cataloged and presented in Appendix C, Section C.3.

1.3 Background.

The gypsy moth is a significant nonnative forest pest in the United States. The gypsy moth caterpillar—one of four distinct developmental stages (*Figure 1-2*)—alters ecosystems and disrupts people's lives as it feeds on the foliage of trees, shrubs, and other plants. Excessive feeding causes defoliation, which weakens trees (increasing their vulnerability to other insects and diseases that may kill them), alters wildlife habitat, changes water quality, reduces property and aesthetic values of public and private woodlands, and reduces the recreation value of forested areas. When present in large numbers, gypsy moth caterpillars can pose a nuisance, as well as a hazard to health and safety. Effects due to the gypsy moth are described in Chapter 4.

At least 898 million acres (364 million hectares) of trees susceptible to gypsy moth feeding are at risk in the United States (Morin and others 2005). Also at risk are countless urban and rural forested areas throughout the country where susceptible plants (Appendix D) grow naturally or are planted.

Although both European and Asian strains exist, only the European strain is currently present in the United States (*Figure 1-3*). The European gypsy moth was brought to the United States and accidentally released in eastern Massachusetts around 1869 (Liebhold and others 1989). Since then, it has continued to spread into uninfested areas (Hajek and Tobin 2009, Tobin and others 2007). The Asian strain occasionally has been found in this country, but it has been eliminated whenever it has been found (*Figure 1-4*). Unlike European female gypsy moths, which cannot fly, the Asian moth poses a greater risk of spread because females can fly and deposit egg masses miles from where they fed as caterpillars (*Figure 1-5)*.

Figure 1-2. Feeding by gypsy moth caterpillars (larvae) causes defoliation.

Figure 1-3. European gypsy moths (male on left, female on right) are found in the United States.

Despite many early attempts to halt its spread (McManus 2007), by 2010 the European gypsy moth was established in the District of Columbia and in all or parts of the following States: Connecticut, Delaware,

Figure 1-4. This Asian gypsy moth male (left) and female (right) are from Mongolia. As of this writing, the Asian gypsy moth is not found in the United States.

Figure 1-5. People unknowingly spread gypsy moths by moving objects on which egg masses were deposited.

Illinois, Indiana, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, and Wisconsin (*Figure 1-6)*. Spread continues into uninfested areas because of natural and artificial movement.

The gypsy moth continues to be a problem as it spreads. Historical documentation over the last 100 years reveals gypsy moth outbreaks cause widespread defoliation, tree mortality, environmental and public health risks, and public outcry to control the outbreaks (Williams and Liebhold, 1995a). For more information about the biology, history, and control efforts for the gypsy moth, see Appendix E.

1.4 Purpose of and Need for Action.

In this SEIS the Forest Service and APHIS propose to add additional treatments for use in the USDA National Gypsy Moth Management Program. The proposed treatments are new and were not available when the 1995 EIS was written. Additional treatments would provide gypsy moth managers with more flexibility in conducting suppression, eradication, and slow-the-spread projects. Making new treatments available is also expected to improve the National Gypsy Management Program, because each new treatment developed over the last 30 years has proven safer to human health and the environment, more cost-efficient, easier to apply, and often more effective than older treatments.

This SEIS also presents new information about currently used treatments. It…

- Introduces hazard quotients for nontarget organisms
- Reinforces that the gypsy moth poses a significant risk hazard to both human health and forest condition
- Provides data showing that slow the spread is very effective in slowing the natural and artificial spread of the gypsy moth
- Determines that disparlure formulations used for mating disruption are of low toxicity to daphnids

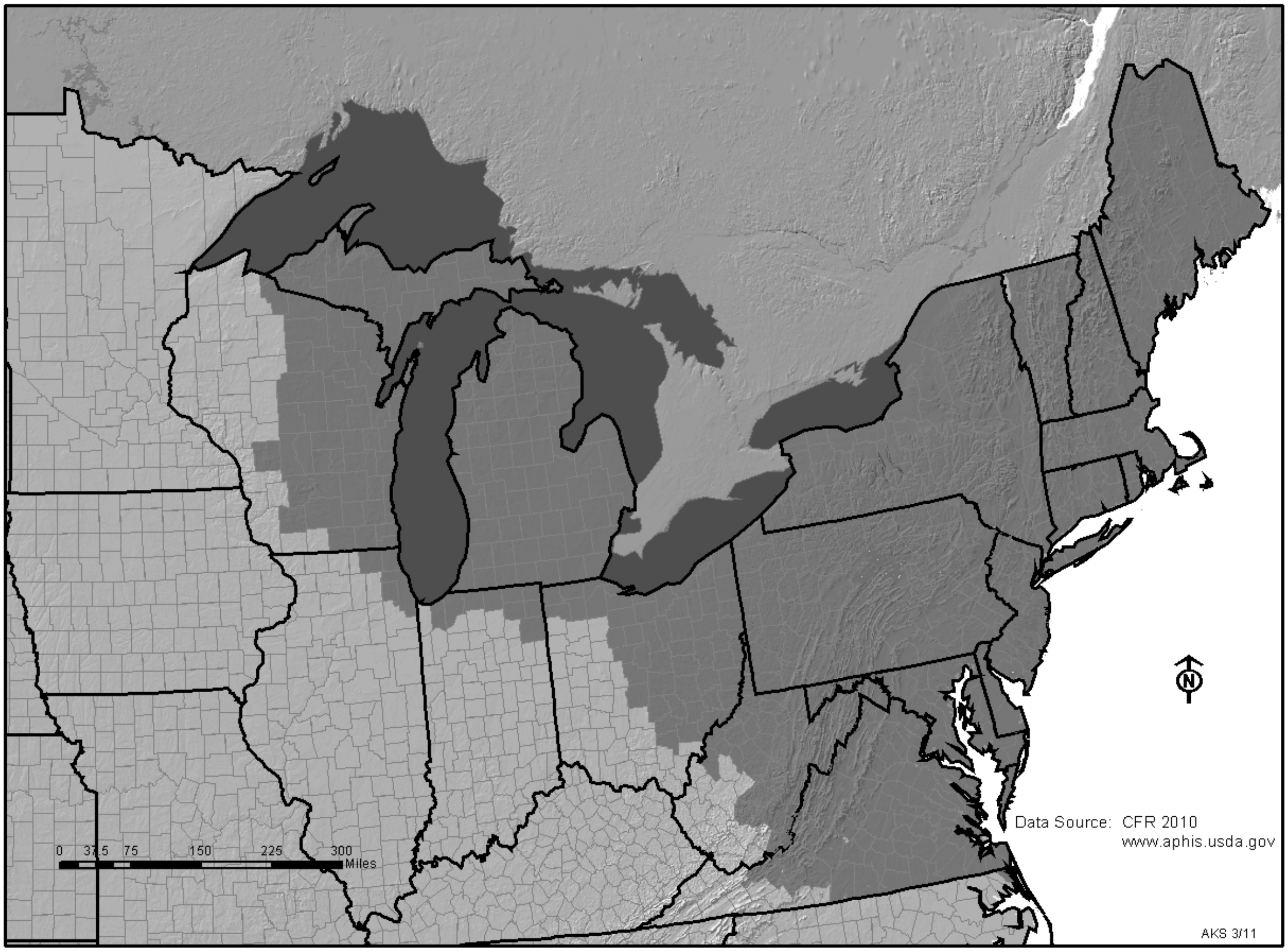

Figure 1-6. In 2010, the European gypsy moth was established in all or part of 19 states and the District of Columbia (shaded in dark gray) (USDA APHIS 2011).

- Confirms that spring-feeding nontarget caterpillars are more at risk from *B.t.k.* applications than are caterpillars that come out later in the year
- Makes available additional epidemiological studies for human health effects associated with *B.t.k.*
- Discloses and discusses the significance of H1N1 flu and exposure to *B.t.k.* on human health.

1.5 Decision Framework.

The 1995 EIS analyzed six alternatives for managing gypsy moth infestations (USDA 1995). With the 1996 Record of Decision (USDA 1996), the agencies selected an integrated pest management (IPM) approach comprised of suppression, eradication, and slow-the-spread strategies to manage the gypsy moth in the United States. The adopted alternative also provides delivery of technical advice and support to State, Tribal, and Federal cooperators by the Forest Service and APHIS. The USDA has carried out its gypsy moth responsibilities under that Record of Decision since 1996.

The 1996 decision provides for the use of several insecticides and other treatments in suppression (*Table 1-1*), eradication (*Table 1-2*), and slow-the-spread projects (*Table 1-3*). These include *Bacillus thuringiensis* var. *kurstaki* (*B.t.k.*), the insect growth regulator diflubenzuron, the gypsy moth nucleopolyhedrovirus product Gypchek, a pheromone attractant disparlure used in mating disruption and mass trapping, the killing agent dichlorvos used

*Table 1-1. Acres treated in suppression projects, by treatment, 2001–2010**

Year	***B.t.k.***	**Gypchek**	**Diflubenzuron**	**Total**
2001	274,057	2,280	187,784	464,121
2002	149,772	4,794	131,601	286,167
2003	67,895	10,015	25,124	103,034
2004	73,493	6,078	0	79,571
2005	7,292	0	0	7,292
2006	145,053	602	18,000	163,655
2007	161,887	1,389	28,424	191,700
2008	450,528	2,268	90,155	542,951
2009	291,508	3,478	26,586	321,572
2010	5,668	401	0	6,069
Total	1,627,153	31,305	507,674	2,166,132

*Table 1-2. Acres treated in eradication projects, by treatment, 2001–2010**

Year	***B.t.k.***	**Gypchek**	**Diflubenzuron**	**Mating disruption**	**Total**
2001	1,440	0	0	0	1,440
2002	9,961	0	0	650	10,611
2003	16,540	0	0	0	16,540
2004	10,855	0	0	250	11,105
2005	36,778	0	0	0	36,778
2006	19,960	0	0	0	19,960
2007	5,189	0	0	0	5,189
2008	883	0	567	1,850	3,300
2009	1,578	0	0	0	1,578
2010	537	399	0	360	1296
Total	103,721	399	567	3,110	107,797

*Table 1-3. Acres treated in slow-the-spread projects, by treatment, 2001–2010**

Year	***B.t.k.***	**Gypchek**	**Diflubenzuron**	**Mating disruption**	**Total**
2001	62,398	0	650	212,925	277,974
2002	28,705	0	3,938	542,600	575,243
2003	70,470	6,819	0	647,618	720,907
2004	131,282	8,230	0	588,256	727,728
2005	108,611	17,075	790	287,890	414,366
2006	95,860	7,003	12,292	426,138	541,293
2007	57,521	3,789	96	364,902	426,308
2008	43,513	112	0	368,157	411,782
2009	36,165	303	0	382,670	419,138
2010	59,008	4,655	0	468,489	534,162
Total	693,533	47,986	17,766	4,289,645	5,048,901

*Source: USDA Forest Service 2011

in large-capacity pheromone traps, and the sterile insect technique. Human health and ecological risk assessments (HHERA) were prepared for each of these insecticides and for the proposed insecticide tebufenozide, and can be found in Appendixes F-K of this SEIS.

Like the 1996 Record of Decision, the decision to be made will be programmatic. No site-specific suppression, eradication, or slow-the-spread projects will be implemented as a direct result of the decision that will follow this SEIS. The decision to implement any treatment project will be made after site-specific environmental analyses are conducted and documented in accordance with agency NEPA implementing procedures. Analyses will address unique local issues, beyond the scope of this document, for site-specific management projects for the gypsy moth. Site-specific environmental analyses are more detailed and precise as to geographical locations, individual treatments to be used, and timing of treatments.

The decision on this SEIS will serve as the primary guide for management of the gypsy moth on Forest Service lands; treatments and strategies allowed by the 1996 decision will continue to be available for use. The USDA is not reconsidering the suppression, eradication, and slow-the-spread strategies, or the treatments made available by the 1996 Record of Decision. The decision whether to plan and implement a gypsy moth project on National Forest System lands rests with the responsible official in that particular forest.

1.6 Scope of This Document and NEPA Requirements.

This SEIS concerns only the USDA gypsy moth management program carried out by the Forest Service or APHIS, directly or in conjunction with others (States, other Federal agencies, and Tribal governments). Actions of other Federal or local agencies or private citizens to manage the gypsy moth on their own, are not affected or in any way constrained by the USDA program. Such actions are affected or constrained only by applicable Federal and State laws, local ordinances, insecticide label instructions, and any self-imposed constraints.

The information and analysis contained in this SEIS can be incorporated by reference, into environmental documents prepared for proposed gypsy moth management projects, in accordance with the National Environmental Policy Act (NEPA) (42 United States Code (U.S.C.) 4332) and agency NEPA procedures. Future environmental documentation for specific projects would tier to the final SEIS and to the 1995 EIS (40 CFR 1508.28). Proposed treatment projects will be evaluated on an individual basis to determine if they are biologically sound, environmentally acceptable, and economically efficient.

Some gypsy moth related activities, such as treatment of regulated articles infested with gypsy moths, the boarding and inspection of ships entering U.S. seaports, and research and methods-development activities, are outside the scope of this document and were not examined. More information about these activities can be found in Appendix B.

1.7 Consultations.

As they had done on the 1995 EIS, for this SEIS the Forest Service and APHIS also consulted with the U.S. Fish and Wildlife Service on the proposed action (Alternative 3) under the Endangered Species Act. The Forest Service and APHIS requested concurrence from the Fish and Wildlife Service based on the determination that USDA management of gypsy moth in the United States is not likely to adversely affect endangered and threatened species or critical habitat under the jurisdiction of the Fish and Wildlife Service, outside the Karner blue butterfly (*Lycaeides melissa samuelis*) habitat in Wisconsin.

The Fish and Wildlife Service concurred with this determination and indicated, "[e]ffective coordination with the Service's field organization will be a key element in ensuring the avoidance of adverse effects to listed species and their habitats." Such coordination with the Fish and Wildlife Service at a local level will ensure that each proposed gypsy moth project will have no effect or is not likely to adversely affect federally listed species or designated critical habitat. The Forest Service and APHIS will ensure the implementation of any protection measures for threatened and endangered species or critical habitat that result from such coordination. If incidental adverse effects to listed species or critical habitat are likely to occur, then the Forest Service and APHIS will reinitiate consultation with the Fish and Wildlife Service. Where formal consultations currently take place for USDA-sponsored gypsy moth treatments that may adversely affect Karner blue butterfly in Wisconsin, the established consultation process will be continued. This process has been developed and agreed to locally by the Fish and Wildlife Service's Green Bay Ecological Services Office.

In addition, the Forest Service and APHIS will ensure that site-specific consultations will be done as necessary at the project level under the National Historic Preservation Act and any other laws, regulations, executive orders, and agency policies that apply to site-specific projects.

Chapter 2
Alternatives Including the Preferred Alternative

Figure 2-1. Early spray operations for gypsy moths used horse-drawn equipment.

Chapter 2 Alternatives Including the Preferred Alternative

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This chapter defines the three alternatives that are being considered. It compares the alternatives based on their ability to provide flexibility for managing gypsy moth populations and their relation to the identified issues. The preferred alternative is identified. This chapter also describes mitigation measures that can be used to protect human health and nontarget organisms.

2.1 Background.

The gypsy moth is destructive to vegetative resources, and the human health and environmental effects from exposure to the pest are substantial (Chapter 4 and Appendix L). The strategies of suppression, eradication, and slow the spread and the currently approved treatments (*Table 2-1*) have proven successful in reducing damage caused by gypsy moth outbreaks in the generally infested area, eliminating new isolated infestations of the gypsy moth introduced outside the generally infested area, and slowing the short-range natural and artificial spread of this insect. For a description of the strategies, see Section B-5 in Appendix B.

These strategies form the basis for the alternatives that were considered in the 1995 Environmental Impact statement (EIS) and for the alternatives in this supplemental EIS (SEIS).

2.2 Alternative Chosen From the 1995 Gypsy Moth EIS.

A program consisting of the strategies of suppression, eradication, and slow the spread--the preferred alternative in the 1995 EIS--was chosen in the 1996 Record of Decision. The following insecticide and noninsecticide treatments were approved for use in the strategies:

- *Bacillus thuringiensis* var. *kurstaki* (*B.t.k.*) (a microbial insecticide)
- Diflubenzuron (an insect growth regulator)
- Gypchek (gypsy moth nucleopolyhedrosis virus product)
- Mass trapping (using traps baited with the gypsy moth attracting pheromone disparlure and sometimes containing the killing agent dichlorvos)
- Mating disruption (aerially dispensed medium impregnated with the gypsy moth attractant disparlure)
- Sterile insect technique (release of sterile or partly sterile gypsy moth pupae or eggs)

Table 2-1 shows which treatments may be used in each strategy.

This alternative was adopted because it fully met the USDA goal of reducing the adverse effects of the gypsy moth on the Nation's forests and trees. The alternative addresses the major issues associated with the gypsy moth and treatments, while incorporating flexible options for managing ecosystems affected by the gypsy moth. The issues influencing the discussion in the 1995 Gypsy Moth EIS focused on the effects of the gypsy moth and gypsy moth treatments on human health, nontarget organisms, and forest conditions.

2.3 Alternatives in This SEIS.

Like the 1996 Record of Decision, the decision to be made as a result of this SEIS will be programmatic. No site-specific suppression, eradication, or slow-the-spread projects will be implemented as a direct result of the decision on this SEIS. The decision to implement any treatment project will be made after site-specific environmental analyses are conducted and documented in accordance with agency NEPA implementing procedures.

The following three alternatives are examined in this SEIS:

Alternative 1—No action

Alternative 2—Add tebufenozide

Alternative 3—Add tebufenozide, and add other new treatments through the application of the protocol (preferred alternative).

Table 2-1. Treatments that have been approved for use in gypsy moth projects since the 1995 gypsy moth EIS.

Strategy	*B.t.k.*	Diflubenzuron	Gypchek	Mass Trapping (Dichlorvos plus disparlure)	Mating Disruption (Disparlure)	Sterile Insect Technique
Suppression	●	●	●			
Eradication	●	●	●	●	●	●
Slow the Spread	●	●	●	●	●	●

Alternative 1—No Action.

Alternative 1 is the same as the alternative selected in the 1996 Record of Decision. It is the current gypsy moth management program of suppression, eradication, and slow the spread, using currently approved treatments. Alternative 1 would make no change to the 1996 Record of Decision, and it would add no treatment options to those approved by that decision.

Alternative 2—Add Tebufenozide.

Alternative 2 would add the insecticide tebufenozide to currently approved treatments. Information on the use and effectiveness of tebufenozide is provided in Appendix A. The human health and ecological risk assessments for tebufenozide are in Appendix J.

Alternative 3—Add Tebufenozide, and Add Other New Treatments Through the Application of the Protocol (Preferred Alternative).

Alternative 3 would add the insecticide tebufenozide and add other treatment(s) that may become available in the future for managing gypsy moth, to currently approved treatments. A new treatment would be available for use upon the agencies' finding that the treatment is registered by the U.S. EPA for use on gypsy moth and poses no greater risks to human health and nontarget organisms than are disclosed in this SEIS for the currently approved treatments and tebufenozide.

The protocol for making the necessary finding that a treatment is authorized by this Alternative is as follows:

1. Conduct a human health and ecological risk assessment (HHERA). In this risk assessment review all scientific studies available for toxicological and environmental fate information relevant to effects on human health and nontarget organisms. Use this information to estimate risk to human health and nontarget organisms. Include these four elements in the HHERA: (a) hazard evaluation, (b) exposure assessment, (c) dose-response assessment, and (d) risk characterization. The HHERA will do the following:

- Identify potential use patterns, including formulation, application methods, application rate, and anticipated frequency of application.
- Review hazards relevant to the human health risk assessment, including systemic and reproductive effects, skin and eye irritation, dermal absorption, allergic hypersensitivity, carcinogenicity, neurotoxicity, immunotoxicity, and endocrine disruption.
- Estimate exposure of workers applying the chemical.
- Estimate exposure of members of the public.
- Characterize environmental fate and transport, including drift, leaching to groundwater, and runoff to surface streams and ponds.
- Review available ecotoxicity data including

hazards to mammals, birds, reptiles, amphibians, fish, and aquatic invertebrates.

- Estimate exposure of terrestrial and aquatic wildlife species.
- Characterize risk to human health and wildlife.

2. Conduct a risk comparison of the human health and ecological risks of a new treatment with the risks identified for the currently authorized treatments and tebufenozide. This risk comparison will evaluate quantitative expressions of risk (such as hazard quotients) and qualitative expressions of risk that put the overall risk characterizations into perspective. Qualitative factors include scope, severity, and intensity of potential effects, as well as temporal relationships such as reversibility and recovery.

3. If the risks posed by a new treatment fall within the range of risks posed by the currently approved treatments and tebufenozide, publish a notice in the Federal Register of the agencies' preliminary findings that the treatment meets the requirements of Alternative 3. The notice must provide a 30-day public review and comment period and must advise the public that the HHERA and the risk comparison are available upon request.

4. If consideration of public comment leads to the conclusion that the preliminary finding is correct, publish a notice in the Federal Register that the treatment meets the requirements of Alternative 3 and, therefore, is authorized by that Alternative for use in the USDA gypsy moth management program. The Forest Service and APHIS will make available to anyone, upon request, a copy of the comments received and the agencies' responses.

Like the 1996 Record of Decision, the decision to be made as a result of this SEIS will be programmatic. Decisions to use specific treatments in projects, including new treatments authorized under the protocol in Alternative 3, will be made after site-specific environmental analyses are conducted and documented in accordance with agency NEPA implementing procedures.

2.4 Evaluation and Comparison of Alternatives.

Different treatments could be used under the different alternatives, as shown in *Table 2-2*. The more treatments that are available, the more flexibility the project managers have in choosing the right treatment for a given set of specific conditions and the greater likelihood of meeting the project objectives. The Alternatives provide increasing flexibility from Alternative 1 to Alternative 3. With the addition of tebufenozide and other treatments that may become available, Alternative 3—the preferred alternative—would provide project managers the greatest flexibility. This flexibility for Alternative 3 includes reducing the cost, streamlining the process, and greater efficiency in adding new treatments for gypsy moth management. Cost, availability, efficacy, and site-specific environmental effects are examples of considerations regarding which treatment to use for a specific project.

The effects of the different treatments are summarized by the issues in *Table 2-3*.

Table 2-2. Treatments available under each alternative in this SEIS

Alternative	**Currently approved treatments***	**Tebufenozide**	**Other treatments that may become available**
1	●		
2	●	●	
3	●	●	●

*Currently approved treatments:

Bacillus thuringiensis var. *kurstaki*
Diflubenzuron
Mass trapping (dichlorvos and disparlure)
Mating disruption (disparlure)
Gypchek
Sterile insect technique

2.5 Mitigation Measures.

Given the variety of places and circumstances where gypsy moth projects could be implemented, it will be necessary to develop and implement specific mitigation measures for each project. Mitigation measures will be developed and implemented on a site-specific basis for each project based on local conditions and concerns.

The site-specific mitigation measures developed and employed in gypsy moth projects since the 1996 Record of Decision have been shown to be effective in addressing human health and safety concerns, adverse effects on nontarget organisms and potential impacts on economic resources such as organic farms. At the same time the objectives of gypsy moth projects have been met. Site-specific mitigation measures will continue to be developed and implemented. The following are examples of project level mitigation measures that have been employed in the past and could be implemented for future projects.

Human Health.

- Ensure workers handling insecticides wear appropriate personal protective gear and protective clothing.
- Prepare a project safety plan, disseminate it to project workers, and conduct safety briefings.
- Ensure workers handling dichlorvos insecticide strips wear gloves and assemble the gypsy moth traps outdoors, preferably at the trap site, and transport traps and trapping supplies in an air-tight plastic bag.
- Use gypsy moth traps that do not contain dichlorvos, when possible, in residential areas.
- Encourage public involvement to identify human health issues, including concerns of people sensitive to insecticides. Public notification is an important part of the program, enabling those living in treatment areas to plan their activities and avoid exposure.
- Consider social and cultural factors. Take steps to ensure all groups of the affected population understand the project and are invited to provide input during project development, such as the distribution of information pamphlets in languages relevant to the affected population.
- Give notice to hospitals, schools, public health facilities and local law-enforcement agencies of treatments, the types of insecticides used and risks to humans.
- Give notice of pesticide treatment projects to organizations, groups and agencies that consist of, or work with, people who are chemically sensitive.
- Give notice to the public when treatments are scheduled, including the insecticides planned for use, potential health effects and other characteristics of the project, such as the use of low-flying aircraft.
- Give notice of treatments to people living in the project area sufficiently in advance to allow them to plan their activities and avoid exposure.
- Establish safety and protection measures for workers known to be sensitive to insecticides.
- Establish buffer zones as needed (for example, tebufenozide would not be sprayed over water or areas where surface water is present, and buffers will be maintained around these areas). Certain actions like using the latest advances in application technology as outlined in section A.5 of Appendix A would minimize the risk of insecticides drifting into bodies of water or sites such as organic farms.
- Mix, load, and unload insecticides in areas where an accidental spill will not enter and contaminate bodies of water.

Nontarget Organisms.

- Use public involvement to identify any site-specific issues with potential for effects on nontarget organisms (including threatened and endangered species), and to design appropriate means to mitigate these effects.
- Select treatments taking into consideration maximum project efficiency, potential effects on nontarget organisms (including threatened and endangered species), and the potential for these organisms to recolonize areas if they are displaced or die after treatment.

- Establish buffer zones where necessary to minimize or eliminate insecticide drift to areas of special concern, such as wilderness areas or sensitive species habitats (for example, tebufenozide would not be sprayed over water or areas where surface water is present, and buffers will be maintained around these areas).
- Review maps and conduct ground inspections or other actions as part of the site-specific analysis to identify small brooks, wetlands, estuarine waters, areas where threatened and endangered species are found, bat caves and other roosts or other sensitive areas, and to determine actions needed to minimize adverse outcomes.
- Mix, load, and unload insecticides in areas where an accidental spill will not enter and contaminate bodies of water.

Mitigation Efficacy.

The mitigation measures developed and employed in site-specific gypsy moth projects have proven to be effective in protecting human health and non-target organisms. At the same time, the objectives of gypsy moth suppression, eradication, and slow-the-spread projects have been successfully met since 1996.

Table 2-3. Effects of treatments approved and proposed for use, by alternatives and identified issues. (Unless otherwise noted, the effects are based on the maximum registered usage rate allowed by the insecticide label.)

Treatments and alternatives	**Issue 1.** **Risk to Human Health**	**Issue 2.** **Risk to Nontarget Organisms**
B.t.k. Alternatives 1, 2, 3 (See Appendix F for Human Health and Ecological Risk Assessment (HHERA))	May irritate the eyes, skin, and respiratory tract. Reduces human health effects caused by gypsy moth hairs.	May reduce populations of some spring feeding caterpillars. Reduces effects of gypsy moths on nontarget organisms.
Diflubenzuron Alternatives 1, 2, 3 (See Appendix I for HHERA)	May slightly increase methemoglobin in sensitive individuals. Reduces human health effects caused by gypsy moth hairs.	Potentially affects arthropod species that produce chitin (hard exoskeleton) and are immature at time of treatment. Can temporarily increase algae due to reduction of algae-feeding aquatic invertebrates. (This has not been observed in the field.) Reduces effects of gypsy moths on nontarget organisms.
Gypchek Alternatives 1, 2, 3 (See Appendix G for HHERA)	Not likely to affect human health. Reduces human health effects caused by gypsy moth hairs.	Has no effect on nontarget organisms. Reduces effects of gypsy moths on nontarget organisms.
Dichlorvos plus disparlure (Mass Trapping) Alternatives 1, 2, 3 (See Appendixes H and K for HHERA)	Used in intact traps, not likely to affect human health. Could impair the nervous system if someone disassembles a milk carton trap and tampers with the dichlorvos-impregnated strip, resulting in skin contact or ingestion.	Not likely to affect nontarget organisms.

(continued)

*Table 2-3 (continued)***.**

Treatments and alternatives	**Issue 1.** **Risk to Human Health**	**Issue 2.** **Risk to Nontarget Organisms**
Disparlure (Mating Disruption) Alternatives 1, 2, 3 (See Appendix H for HHERA)	Not likely to affect human health.	Has no effect on nontarget organisms.
Sterile Insect Technique Alternatives 1, 2, 3	Has no effect on human health	Has no effect on nontarget organisms.
Tebufenozide Alternatives 2, 3 (See Appendix J for HHERA)	May slightly increase methemoglobin in sensitive individuals. Reduces human health effects caused by gypsy moth hairs.	May affect some Lepidoptera species. Reduces effects of gypsy moths on nontarget organisms.
Other treatment Alternative 3	Has effects no more severe than those described in this SEIS for currently approved treatments and tebufenozide. Reduces human health effects caused by gypsy moth hairs.	Has effects no more severe than those described in this SEIS for currently approved treatments and tebufenozide Reduces effects of gypsy moths on nontarget organisms.

Chapter 3
Affected Environment

Figure 3-1. Undated historical image of workers involved in a gypsy moth management program.

Chapter 3 Affected Environment

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Table

This chapter describes the environment that is or could be affected by the gypsy moth and the USDA gypsy moth management program.

3.1 General Affected Environment.

Because this is a programmatic document, the description of the affected environment contained in this chapter is, by necessity, general. The potentially affected environment in the United States is anywhere vegetation susceptible to gypsy moth feeding is found. Given the known worldwide distribution of the gypsy moth, it is probably capable of surviving anywhere in the United States where suitable host plants and climatic conditions are available (McFadden and McManus 1991, Gray 2007).

3.2 Affected Forest.

Affected Plants.

Field and laboratory studies of numerous tree species enabled determination of the gypsy moth's feeding preferences (Liebhold and others 1995; and see Appendix D for a list of susceptible plants). Forest trees grow either in pure stands comprised of a single species or in mixed stands as an aggregation of different species. Plant species composition is an important factor in determining the degree of susceptibility of a forest to the gypsy moth (McFadden and McManus 1991). Other factors include total density (basal area per acre) of preferred tree species and proportion of area covered by susceptible stands (*Figure 3-2*). Stands with basal area of preferred species greater than 20 percent are particularly at risk (Gansner and Herrick 1984, Herrick and Ganser 1987, Morin and others 2005).

Table 3-1 lists the total basal area of the 20 most common and important gypsy moth hosts in the United States. The more hardwoods, particularly oaks, in a forest, the more vulnerable it is to the gypsy moth. Higher numbers of susceptible species result in increased intensity, duration, and frequency of defoliation episodes (Davidson and others 1999).

The Forest Service classifies forested areas by combining forest cover types into "forest type groups" for inventory, mapping, and other purposes. Although forest cover types are based on and named after the

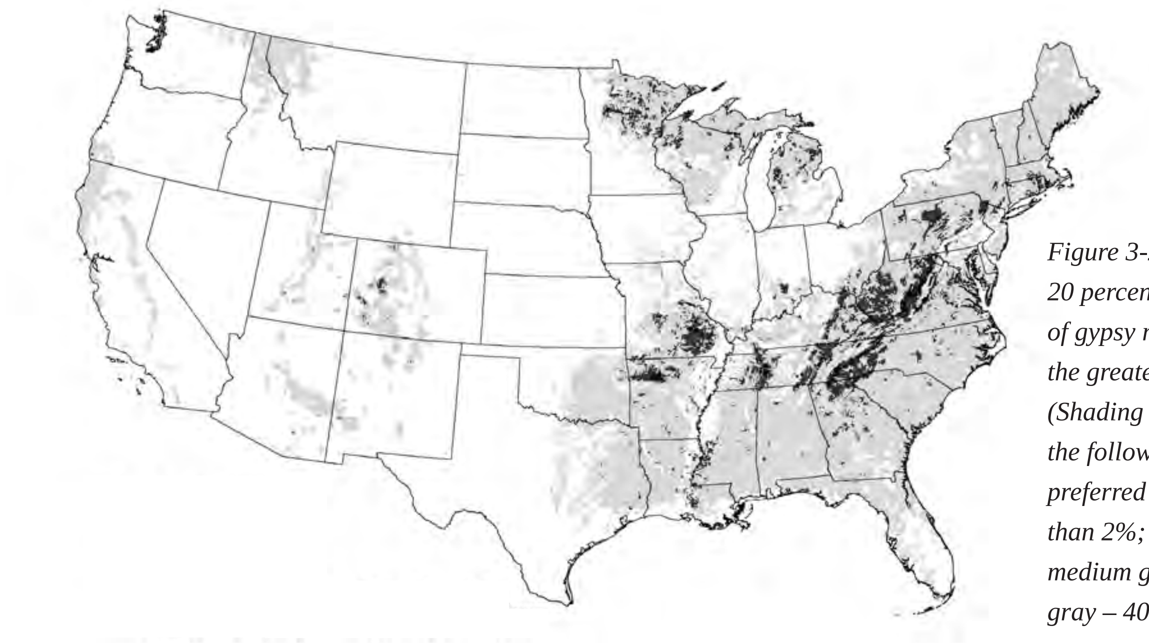

Figure 3-2. Forest stands with 20 percent basal area or more of gypsy moth host trees are at the greatest risk of defoliation. (Shading on the map represents the following basal areas of preferred hosts: white – less than 2%; light gray – 2-20%; medium gray – 21-39%; dark gray – 40-79%.)

Table 3-1. Top 20 tree species in the United States preferred by gypsy moths, ranked by total basal area (BA).

Common Name	Species	Total BA ($100,000,000 \ ft^2$)
White oak	*Quercus alba*	14.30
Sweetgum	*Liquidambar styraciflua*	11.60
Quaking aspen	*Populus tremuloides*	10.10
Northern red oak	*Quercus rubra*	9.62
Black oak	*Quercus velutina*	7.31
Chestnut oak	*Quercus prinus*	6.84
Post oak	*Quercus stellata*	5.47
Water oak	*Quercus nigra*	4.34
Paper birch	*Betula papyrifera*	3.81
Southern red oak	*Quercus falcata*	3.75
Scarlet oak	*Quercus coccinea*	3.31
American basswood	*Tilia americana*	2.41
Western larch	*Larix occidentalis*	2.40
Laurel oak	*Quercus laurifolia*	1.94
Bigtooth aspen	*Populus grandidentata*	1.90
Tan oak	*Lithocarpus densiflorus*	1.64
Willow oak	*Quercus phellos*	1.49
California red oak	*Quercus kelloggii*	1.45
Eastern hophornbeam	*Ostrya virginiana*	1.26
Canyon live oak	*Quercus chrysolepis*	1.14

tree species dominating the stand, other tree species may be present. These associated tree species may be susceptible to the gypsy moth as well.

Oak-hickory is the largest and most diverse susceptible forest type group, extending from the Great Plains to the eastern seaboard. Oak-pine types are found in the South. Oak-gum-cypress types are bottomland forests, typically found in the South and Southeast, especially within the Mississippi Delta and Piedmont. Aspen-birch forests are located in the North Central States. All of these forest types are susceptible to the gypsy moth.

Much of south-central and southeastern Alaska has climate and trees (paper birch, willow and alders) suitable for the gypsy moth. Aspen types are the most abundant hardwood in the intermountain area, while oak types predominate in California and red alder in the Pacific Northwest.

Compared with the European strain, the Asian strain of the gypsy moth feeds on more plants (Baranchikov 1989, USDA 1992). In addition to feeding on the same plant species as the European strain, the Asian strain of the gypsy moth will feed on larch and tamarack (*Larix* spp.) in Siberia, eastern Asia, and Japan (USDA 1992), and on both eastern (*L. laricina*) and western larch (*L. occidentalis*) in the United States.

Affected Areas.

Uninhabited Forest.

Land use in uninhabited forest areas is dependent on the individual landowner's management objectives (e.g., timber, wildlife, esthetics, recreation). This classification of forest has no or few residences and few if any paved roads. Uninhabited forest areas exhibit nearly complete forest canopy coverage, typically with three layers composed of subcanopy vegetation, ground layer vegetation, and a layer of organic debris at the soil level. The layers of vegetation serve to reduce the impact of raindrops and the subsequent chance of erosion due to overland runoff.

Forest Recreation Areas.

Recreation sites typical of rural settings include municipal, county, and state parks, national parks, monuments, forests and grasslands, public and private campgrounds, hiking trails, winter sports complexes, vacation cabins, forest lands for backpacking, and lakes and rivers used for hunting, fishing, and boating. Rural roads and scenic vistas provide attractive and tranquil settings, drawing many visiting tourists from populous, developed areas. All of these areas may be subject to gypsy moth outbreaks.

Forest Residential Areas.

Suppression projects are often conducted in areas where forests and people meet. Examples are forested residential areas that contain single- and multiple-family housing, parks, cemeteries, schools, churches, and small businesses; and woodlots in farm areas that offer the potential for gypsy moth movement. These areas are typically occupied year-round, with landowners directly experiencing the impact of gypsy moth defoliation. Homeowners generally place a high value on their trees for shade, esthetics, privacy, investment, and wildlife habitat, and are consequently concerned when this resource is threatened. Several studies reveal that trees increase property values 5 to 15 percent (Dwyer and others 1992). The presence of defoliated, dying or dead trees can decrease property value and marketability. The cost to remove a dead tree and stump is potentially hundreds of dollars.

Developed Areas.

Natural plant communities in developed areas tend to be fragmented and small, as native plants are frequently replaced with nonnative species.

Forest Condition.

Indicators of forest condition include tree mortality rates, tree growth rates, degree of insect damage (defoliation by gypsy moths), and species composition in the understory and canopy. Gypsy moth defoliation can not only cause mortality of trees, but can also affect the composition of forest communities.

The gypsy moth is not the only introduced pest that can adversely affect the Nation’s forest resources. Chestnut blight and Dutch elm disease in the past, and more recently beech bark disease, dogwood anthracnose, emerald ash borer, hemlock woolly adelgid, Asian longhorned beetle, Sirex woodwasp, butternut canker, and others threaten both natural and urban forests. As the gypsy moth and other introduced insects and pathogens spread, they all add stress to forest areas. This stress may be responsible, in part, for documented cases of widespread mortality where no single agent appears to be responsible (Weiss and Rizzo 1987).

Water Quality.

Lakes, streams, rivers and other surface waters in areas with plants susceptible to feeding by gypsy moth caterpillars may be part of the affected environment. Indicators of water quality include flow rate and water chemistry.

Microclimate.

Microclimates created by moisture and temperature conditions found in forests vary by the amount of annual precipitation, elevation, and forest type group. Microclimates may potentially be affected in areas with trees susceptible to gypsy moth feeding.

Soil.

Soil types capable of supporting vegetation susceptible to gypsy moth feeding are potentially part of the affected environment. Soil supports a great diversity of organisms, such as earthworms, arthropods, and microorganisms, which may live in the surface layer, beneath leaf litter, or throughout several soil layers.

Soil structural differences support a wide range of soil-dependent organisms; for example, ground-dwelling arthropods in urban settings are less diverse than those commonly found in undeveloped areas (Gilbert 1989). Impervious surfaces in developed areas prevent air and water from penetrating the soil, which is often more disturbed and compacted than in undeveloped areas. These conditions contribute to a general reduction of plant vigor, root penetration, nitrogen fixation by legumes, and invertebrates to consume and recycle organic matter.

3.3 Affected Human Populations.

Many factors influence the health of people, including diet, climate, airborne diseases, cultural traditions, emotional well-being, income, access to medical facilities, and contaminants in soil, air, and water. People living in or near areas with trees could be exposed to the gypsy moth and treatments. Particularly susceptible people include those with allergic reactions to gypsy moth hairs (*Figure 3-3*), respiratory ailments, chemical sensitivities, pregnant women, children, and the elderly (Allen and others 1991, Tuthill and others 1984). Those who work in the woods or with trees, mix or apply insecticides, or work in laboratories with gypsy moths could frequently be exposed to gypsy moths and treatments.

Perceptions and behaviors of individuals vary, depending upon their familiarity with the presence of gypsy moth caterpillars and the use of treatments. Reactions to the gypsy moth are usually strongest where outbreaks occur for the first time; people become alarmed when huge numbers of gypsy moth caterpillars suddenly appear. Perceptions and behaviors in response to the presence of gypsy moth caterpillars and gypsy moth treatment projects may also vary by location. Because urban dwellers are less likely to be exposed to the caterpillars and may never encounter the gypsy moth, they generally do not perceive the moths as being a problem unless the trees in their own yard are directly affected.

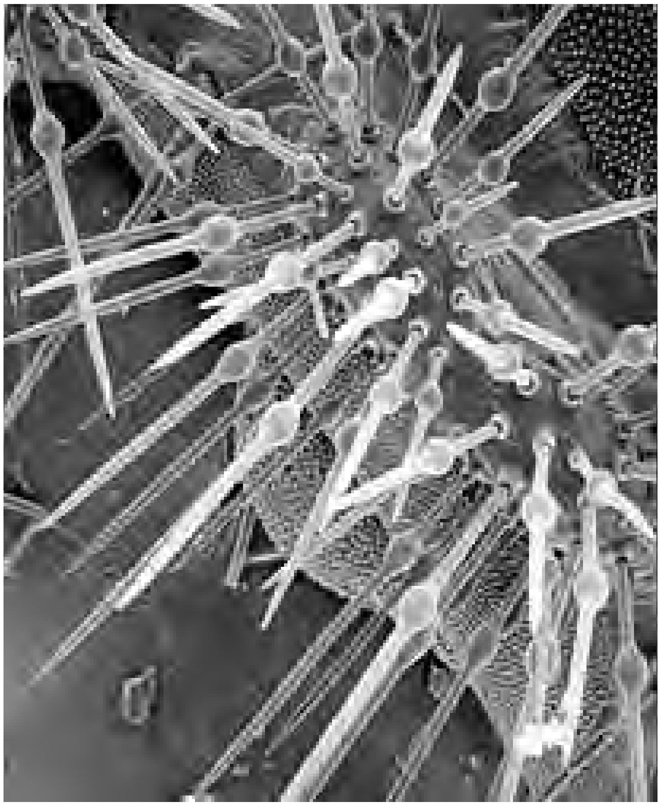

Figure 3-3. Gypsy moth hairs can cause irritation.

Suburban and rural area residents are more likely to be alarmed by large populations of gypsy moth caterpillars and treatment efforts. Inhabitants of rural agricultural areas tend to be less concerned about spraying to control gypsy moth populations due to their familiarity with spraying of agricultural crops.

3.4 Affected Nontarget Organisms.

General.

Virtually all wildlife in the United States that require trees as a part of their environment are within range of the gypsy moth. Mammals, birds, fish, and butterflies, for example, live in environments potentially affected by the gypsy moth or gypsy moth treatments. Detrimental effects of gypsy moths on native Lepidoptera were noted in a West Virginia study (Sample and others 1996).

Animal diversity is generally lower in developed areas, where native animal communities tend to be fragmented and small. Animals that do well in urban or fringe areas usually reproduce rapidly, and exhibit flexible behavior patterns, enabling them to exploit diverse food sources (Gill and Bonnet 1973). Species in urban areas (squirrels and birds like starlings, robins, and crows), which adapt to high human population density, are often found in greater numbers. Domestic animals and pets also comprise a sector of the animal life in areas with high concentrations of people. In contrast, forested areas sustain various populations, including birds (such as warblers, vireos, thrushes, flycatchers, and raptors), as well as large and small mammals such as bobcats and other predators.

Opossum, skunk, raccoon, and squirrel do well in both developed and undeveloped areas, and may be found in areas providing sufficient green space for cover. Larger mammals, such as bear, moose, and wolf, that are sensitive to human disturbances, require larger home ranges and tend to inhabit undeveloped regions.

The diversity of birds is lower in urban settings than in undeveloped areas (Gill and Bonnett 1973). Most bird species in urban areas are year-round residents or short-distance migrants rather than neotropical migrants, which are more common to undeveloped areas.

Reptiles and amphibians do not fare well in developed areas where native vegetation, breeding sites and cover have been disturbed. Loss of habitat, travel barriers and pollution are reasons for fewer numbers of reptiles and amphibians in developed areas than in more natural areas (Campbell 1974a).

Threatened and Endangered Species.

Any species that is listed or proposed for listing as a threatened or endangered species and found in or near forested habitats could potentially be affected by the gypsy moth or gypsy moth treatments. Federally listed species of moths, butterflies, and insect-eating birds are of particular concern.

Chapter 4

Environmental Consequences

Figure 4-1. This experiment station and insectary in Malden, Massachusetts, was used for some of the earliest research on the gypsy moth.

Chapter 4 Environmental Consequences

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This chapter examines, on a national scale, the environmental consequences of the alternatives, as they relate to the issues of human health and nontarget organisms associated with the treatments that could be used. It updates the general background information presented in the 1995 EIS, and the human health and ecological risk information for the gypsy moth and for currently approved treatments. Included is a discussion of the significance of the incidence of human flu and exposure to *B.t.k.* on human health. This chapter also presents human health and ecological risk information for tebufenozide (Alternatives 2 and 3) and other new treatments that may be available in the future (Alternative 3). All of the information on tebufenozide is new.

4.1 Alternatives and Treatments.

Chapter 2 stated the three alternatives. *Table 4-1* lists the treatments that would be available under each alternative.

4.2 Risk Assessments and Risk Characterization.

Overview.

The consequences of the treatments in each alternative were determined by risk assessment for each treatment as well as for gypsy moth (no treatment) and a risk comparison among the treatments and gypsy moth (see Appendixes F-L for the risk assessments, and Appendix M for the risk comparison).

A risk assessment provides a logical process for evaluating data and analyzing potential effects of the gypsy moth and treatments. Risk assessments take into account the manner in which treatments are used in gypsy moth projects, including how treatment agents are applied, the amount applied, and the types of areas that receive treatment.

Standard steps in the risk assessment process were followed:

- Hazard identification—gathers known information from laboratory and field studies on toxicity of the gypsy moth and treatment agents.

Table 4-1. Treatments available for use, by alternative

Treatment	**Alternative 1** **No action**	**Alternative 2** **Add tebufenozide**	**Alternative 3** **Add tebufenozide and other treatments**
*B.t.k.**	●	●	●
Diflubenzuron*	●	●	●
Gypchek*	●	●	●
Mass Trapping (Disparlure, or disparlure and dichlorvos)*	●	●	●
Mating disruption (Disparlure)*	●	●	●
Sterile insect technique*	●	●	●
Tebufenozide		●	●
Other treatments			●

* Currently approved treatments

- Exposure assessment—describes the nature and magnitude of contact with the gypsy moth and with treatment agents as they are used in gypsy moth treatment projects.

- Dose-response assessment—determines how much exposure to the gypsy moth and to treatment agents is needed to produce the response (effect) described in the hazard identification.

- Risk characterization—combines information from previous steps to describe the plausibility of observing certain effects of the gypsy moth and of treatments.

Each step in a risk assessment is accompanied by uncertainties, caused by limitations either in the available data or in the ability to relate the data to scenarios of concern. To compensate for uncertainties, risk assessment results tend to be conservative, meaning they are more likely to overestimate risks than to underestimate them.

Human Health and Ecological Risk Assessments (HHERA) were prepared by risk assessment experts (Syracuse Environmental Research Associates, Inc. [SERA]), using the best available data. The HHERAs also underwent independent technical review by other recognized experts in risk assessment methods, toxicology, and other applicable fields (consultants retained by SERA, and toxicologists and program specialists from APHIS and the Forest Service). The HHERAs and this chapter cover the issues raised in scoping for this SEIS for both human health (human health assessment portion of HHERA) and nontarget organisms (ecological risk assessment portion of HHERA).

Many uncertainties are inherent in conducting and interpreting risk assessments; however, the data available on the agents covered by the risk assessments, modeling, equations and statistics all taken together with the understanding of uncertainties provide adequate information to characterize the relative hazards associated with the agents evaluated. To compensate for missing data and any uncertainties in the data, numerical uncertainty factors are used in the dose-response assessments for potential human health effects, and conservative assumptions are used in both human health and ecological risk assessments. In addition, it is virtually impossible to precisely calculate an exposure value for every situation that may arise. Therefore, models, equations, and statistical techniques were used to quantify both plausible and extreme exposures, and ranges of toxicity values were used to reflect ranges of sensitivity. These ranges for exposure and toxicity were then used to numerically characterize risk with hazard quotients that are typically expressed as central estimates with upper and lower bounds.

HHERAs were prepared for each of the treatments in the alternatives (Appendixes F through K) and for the gypsy moth itself (Appendix L). Results of the HHERAs are summarized later in this chapter. The relative risks of the insecticides and treatments are illustrated in a risk comparison evaluation in Appendix M.

Hazard Quotients.

Risks to human health and to nontarget organisms can be estimated numerically using hazard quotients (HQs). HQs can be calculated only for effects on populations of biotic (living) organisms. The HQ is a screening tool commonly used in risk assessments. The HQ is a ratio of the exposure estimate for a particular and defined situation (labeled or prescribed conditions) for a representative population (human or nontarget species), divided by an effect level (dose or concentration level). The HQ takes into account the inherent toxicity of a substance, as well as its ability to produce specific effects on an organism (or population of organisms), and the degree of exposure. The HQs for currently approved treatments and tebufenozide are described in Appendix M. *Table 4-2* provides the HQs for all of the treatments and for the gypsy moth.

As an example, refer to the upper bound of the HQ for *B.t.k.* for nontarget aquatic species—0.5, in *Table 4-2*. This HQ was derived from an exposure estimate of 0.24 mg/L, which is calculated as the peak concentration of the *B.t.k.* formulation in water after a direct spray. This exposure estimate serves as the numerator for the HQ. The toxicity value of 0.45 mg/L is the NOEC (no observed effect concentration)

Table 4-2. Comparative Hazard Quotients (HQs) for the effects of gypsy moths and treatments on human health and nontarget organisms. (Wherever a 0 appears, the hazard quotient value is less than 0.01.)

Population	**Gypsy Moth HQ**	***B.t.k.* HQ**	**Dichlorvos HQ**	**Diflubenzuron HQ**	**Disparlure HQ**	**Gypchek HQ**	**Tebufenozide HQ**
Human health	1.6 to 625	0 to 0.04	0 to 380	0.05 to 0.5—workers 0.09 to 0.1—public	0	0 to 0.02	0.03 to 1.5
(See Table 3-4 of Appendix M for in-depth comments)	Upper range is based on major outbreaks	Unlikely effects	Upper range based on child tampering with strip	Upper range for workers based on ground spray operations	No potential risk can be identified	No risks are plausible	Highest HQ based on long-term consumption of contaminated fruit following two applications at the highest application rate
Nontarget terrestrial species	0.25 to 400	0.36 to 9.4	0	0.18 to 32	0	0	0 to 4
(See Table 4-4 of Appendix M for in-depth comments)	Upper range based on gypsy moth outbreak in sensitive stands	Upper range based on sensitive caterpillars of moths and butterflies	Effects not likely	Upper range based on sensitive species of invertebrates	No potential hazard identified	Effects not likely	Upper range based on the consumption of contaminated vegetation by a large mammal
Nontarget aquatic species	0	0 to 0.5	0	0 to 5	0 to 0.4	0	0 to 0.4
(See Table 4-5 of Appendix M for in-depth comments)	No adverse effects	Upper level based on sensitive species	No risks plausible in normal use. HQ for aquatic invertebrates could reach up to 8 in accidental exposures	Upper range based on acute exposure to aquatic invertebrates *(Daphnia)*	Upper range based on acute exposures to sensitive aquatic invertebrates *(Daphnia)*	No adverse effects	Upper range based on longer term toxicity in sensitive aquatic invertebrates

from a reproduction study in *Daphnia magna*, an aquatic invertebrate. This toxicity value serves as the denominator for the HQ. Thus, the HQ is calculated as follows:

HQ = exposure estimate/toxicity value
= 0.24 mg/L / 0.45 mg/L
= 0.533… ≈ 0.5

Note that the HQ in the above example is rounded to one significant place. This is a common practice in presenting HQ values except for those in which the level of concern is marginally exceeded, i.e., an HQ of 1.45 would be rounded to 1.4 but not to 1.0.

In risk management, the HQ must be used in conjunction with other factors and characteristics of a substance, such as the quality and quantity of substantiating evidence (published scientific literature, data, models, and risk assessments done by others such as industry and universities), the severity of potential adverse effects, and the nature of the affected species and populations.

In some cases numerical expressions of risk (HQs) do not adequately convey the potential for hazard. For example, a high HQ for a mild effect, such as skin rash, is probably more acceptable than a much lower HQ for a more serious effect like neurotoxicity. Therefore, the use of HQ as an expression of risk and "acceptability" requires that a qualitative perspective also be injected into the analysis. Ecological risk assessments often involve considerations of many different species of plants and animals, and abiotic factors, and their interrelationships and interactions. Invariably, few data sets are available, and field studies provide only an overview of the complex interrelationships and secondary effects among species. Human health risk assessments and ecological risk assessments cannot offer a guarantee of safety. Both risk assessments offer a way to estimate the adverse effects and their severity.

4.3 Consequences of the Gypsy Moth.

This section provides existing and updated information on the gypsy moth. It is intended for use with site-specific project analysis and for general information for the reader. See Appendix E for information on the history and biology of the gypsy moth. See Appendixes L and M for detailed analysis of risks associated with gypsy moth.

General Effects of the Gypsy Moth.

Forest Condition–Effects of Defoliation on Vegetation.

When gypsy moth populations are low, nearly all feeding and defoliation occurs on favored hosts, such as oaks (Campbell and Sloan 1977a). During population outbreaks gypsy moth caterpillars feed on more than 300 species of broad-leaved and coniferous trees and shrubs (Leonard 1981) (Appendix D, Plant List). Trees stripped of 50 percent or more of their leaves are likely to refoliate the same season, although new leaves are fewer and smaller than the originals (Wargo 1981a). The impact of defoliation depends on five key factors:

(1) How much foliage is removed;
(2) The number of successive years of defoliation;
(3) When defoliation occurs in the growing season;
(4) The presence and number of secondary organisms; and
(5) The physiological condition of the tree (Parker 1981).

Defoliated trees already under stress from drought or other factors often succumb more quickly than healthier trees.

After gypsy moth outbreaks, red maple (*Acer rubrum*) numbers may increase and oak numbers decrease in Appalachian forests (Allen and Bowersox 1989, Gansner and others 1994, Hix and others 1991), because red maple is not a preferred host and oaks are preferred. Trends in New England and Pennsylvania reveal a shift in composition towards less oak, with some stands having major losses and others having only minor changes (USDA Forest Service 1994f). Moderate-to-heavy defoliation accelerates forest succession towards more shade-tolerant (and less defoliation-prone) species (Campbell and Sloan 1977a, Clement and Nisbet 1972, Feicht and others 1993, Houston 1981b, Stephens and Hill 1971).

An area that is defoliated for only 1 year will have minimal long-term effects. However, repeated defoliation by even non-epidemic levels of gypsy moth larvae could have a significant, negative effect on the radial growth of preferred trees, except possibly aspen (Muzika and Liebhold 1999, Naidoo and Lechowicz 2001). Small feeder roots die, reducing water and mineral uptake and slowing tree recovery (Wargo 1978b). The effects of a single heavy defoliation in a mixed stand of oaks in eastern New England were visible for 10 years (Campbell and Sloan 1977a). Decreases in stem volume growth in southern New England averaged approximately 20 percent in any year a tree was defoliated compared with no defoliation the previous year, and growth loss was evident up to 3 years after defoliation (Twery 1987, Wargo 1981a). Overall stand volume may decrease initially (Gansner and Herrick 1982, Herrick and Gansner 1988) and then may increase over time (Gansner and others 1993b).

Defoliation reduces carbohydrate (starch) production (Heichel and Turner 1976, Kozlowski 1969) forcing trees to use root starch reserves. Most trees can tolerate 2 years of defoliation before root starch reserves are depleted (Wargo 1981a). Depletion of reserves weakens trees, making them vulnerable to secondary organisms that cause further decline and death. In the eastern United States the principal secondary organisms are the shoestring fungus *(Armillaria mellea)* and the two-lined chestnut borer *(Agrilus bilineatus)* (Houston 1981a, Wargo 1981b).

Increased light due to defoliation causes herbaceous plants to rapidly expand their density and coverage (Gottschalk 1988). In some areas that are subject to intense deer browsing, defoliated trees may fail to regenerate, and shrubs or herbaceous plants can dominate (Gottschalk 1988).

Heavy defoliation by the gypsy moth increases fire danger (Gottschalk 1990a). An abundance of heavy fuel, standing dead snags, dense understory vegetation, and numerous fallen trees act in combination to promote spot fires, impede fire line construction, and extend the time needed for post-fire mop-up operations (Tigner 1992).

Forest Condition—Tree Mortality.

Several factors interact to produce tree and stand mortality: severity, frequency, and distribution of defoliation, site and stand factors, environmental conditions, tree vigor, crown condition, and presence and abundance of secondary organisms (Campbell and Valentine 1971, Kulman 1971, Staley 1965, Campbell and Sloan 1977a, Gansner and others 1978, Wargo 1978a, b, Campbell 1979, Herrick and Gansner 1987, Fosbroke and Hicks 1989, Herrick 1982, Tigner 1992, Feicht and others 1993, Gottschalk and MacFarlane 1993). Oak mortality in initial outbreaks is greater than in later outbreaks (Davidson and others 1999). Oaks and other susceptible species experience more severe and frequent defoliation and have higher mortality than do nonsusceptible species (Campbell and Sloan 1977a; Herrick and Gansner 1987; Quimby 1985, 1987).

Mortality can vary from stand to stand, even when stands have similar characteristics with mortality 80 to 100 percent in some stands (Campbell and Sloan 1977a, Gansner and Herrick 1984). Most mortality occurs during and after the initial outbreak (Twery 1991) with severe mortality along and behind an advancing outbreak front as the gypsy moth invades new areas (Gansner and Herrick 1984, Herrick and Gansner 1986, Twery and Gottschalk 1988). Subdominant trees typically have much higher mortality rates than dominant trees, after heavy defoliation (Campbell 1979, Gansner and others 1993c. Quimby 1993). The most common response to canopy gaps created by tree mortality is increased growth and density of existing understory woody plants (Collins 1961, Ehrenfeld 1980, Feicht and others 1993, Hix and others 1991, USDA Forest Service 1994f).

Drought may increase the severity of gypsy moth effects on trees (Bess and others 1947, Campbell and Sloan 1977a, Stephens and Hill 1971). Should severe drought occur with repeated years of defoliation, the cumulative impacts may increase mortality. Stress from disturbances, such as timber cutting or fire, and naturally occurring oak decline can also increase mortality.

Forest Condition—Seed and Mast Production.

Nuts, seeds, and fruits that serve as food for animals in the forest are called mast. Seed production by defoliated oak trees is reduced directly through consumption of oak flowers and young acorns by gypsy moth caterpillars, and indirectly by abortion of acorns and—in the years after defoliation—reduced initiation of flower buds. Significant mortality of oaks (more than 60 percent of basal area in a stand) must occur before acorn production is reduced significantly (Gottschalk 1990b). Over the long term, an increase in soft mast, particularly berries, replaces the loss of hard mast such as acorns (Gottschalk 1990a), and mammals that usually eat acorns may start eating this soft mast.

Water Quality.

Defoliation by the gypsy moth may affect a number of characteristics of nearby water bodies, including temperature, flow rate and yield, sediment load, acidity levels, oxygen availability, nutrient concentration, and structural habitat for aquatic organisms. Defoliated riparian areas receive increased exposure to the sun. Increases in the amount of light penetrating stream surfaces and changes in water temperature can affect both plants and animals in the stream. Various factors influence stream temperature at a given point, including flow volume, hydraulic gradient, ground water discharge, degree of shading, and upstream conditions. Actual changes to water temperature vary from site to site and depend in part upon the degree and duration of defoliation (USDA Forest Service 1994f). On a headwater stream under a dense tree canopy, light penetration increased from 5 to 18 percent to 73 percent after a “massive” gypsy moth outbreak in Rhode Island (Sheath and others 1986). Water temperature increased by 3.7 °C (6.7 °F) in early July, and algal growth in the streambed increased dramatically.

Defoliation by the gypsy moth has been shown to increase water yield (Corbett and Lynch 1987), in part due to fewer available leaves to transpire moisture from the soil (Twery 1991). Increased water yields from forested watersheds may produce beneficial results, such as creating more wet areas during summer, which might enhance habitat for amphibians. Conversely, increased stream discharge may have a destabilizing effect on herbivorous insects (Eagle 1993).

Sediment loads from forested land are usually low; however, increases in stream velocities due to increased water yield can lead to increased erosion, sedimentation, and turbidity. Timber cutting, exclusive of disturbances caused by road construction and log removal, usually has little if any effect on stream turbidity and sedimentation (Corbett and Lynch 1987). Therefore, gypsy moth defoliation would be unlikely to cause an increase in watershed erosion.

Whenever defoliation by the gypsy moth causes tree mortality in riparian areas, the structural habitat of streams may be altered by deposition of woody debris in affected streams. Debris dams may trap more organic material, lengthening the time it is available for ingestion by benthic invertebrates and leaf shredders, and allowing for more complete energy utilization. Large, woody materials also provide improved fisheries habitat (USDA Forest Service 1994f).

Defoliation by the gypsy moth may contribute to alterations in water chemistry and a reduction in the capacity to neutralize acids in some streams associated with upland watersheds in the southern Appalachian region (USDA Forest Service 1994f). Defoliation temporarily produces conditions typical of winter, such as reduced acid-neutralizing capacity and increased acidity (Downey 1991). Acid-neutralizing capacity determines the concentrations of hydrogen and aluminum in solution, which at elevated levels are toxic to fish and other aquatic organisms. The acid-neutralizing capacity of streams increases seasonally, when deciduous leaves are present in the tree canopy.

Increased organic matter in streams from gypsy moth frass and leaf fragments, in combination with increased light penetrating the surface of the water, may lead to over-enrichment and result in excessive growth of algae and other microorganisms. This bloom could cause a reduction in oxygen available to other organisms in the stream. Large increases in fecal coliform and streptococci densities have been observed in streams where heavy gypsy moth defoliation has occurred (Corbett and Lynch 1987).

Defoliation is also suspected of causing increased nitrate mobility, which would allow nitrate to be lost from a site. Elevated concentrations of nitrate in streams have been associated with forest harvest (Vitousek and Melillo 1979) and defoliation by insects (Swank and others 1981, USDA Forest Service 1994f). Defoliation by the gypsy moth can accelerate the transfer of nutrients from vegetation to the soil surface; however, there is little evidence that these nutrients are lost from the site and enter adjacent water bodies to a significant degree (Eagle 1993, Grace 1986).

Soil Condition.

Gypsy moth defoliation probably increases the rate of decomposition of organic matter and decreases soil moisture content because the greater penetration of sunlight increases biological activity (Grace 1986, Tomblin 1994). These changes should result in short-term increases in biological productivity.

Microclimate.

The microclimate of defoliated areas is affected by rises in soil, leaf litter, and ambient air temperatures due to increased exposure to sunlight (Vaughan and Kasbohm 1993), and the associated effect of increased dessication due to lower humidity.

Risk to Human Health (Issue 1).

General.

People coming in contact with gypsy moth larvae may have skin irritation, resembling mosquito bites, with raised patches of skin approximately 0.25 to 0.5 inches in diameter (Tuthill and others 1984). Some people may have itching persisting several days to 2 weeks and sufficiently severe to cause them to seek medical treatment. Heavy infestations or extreme outbreaks potentially cause eye and respiratory effects in some individuals. Heavy infestations are often considered a public nuisance, causing esthetic damage to the environment through tree defoliation which may induce stress or anxiety in some individuals.

Groups at Special Risk.

Young children are potentially at greater risk of effects from gypsy moth exposure perhaps because they spend more time outdoors than adults (Aber and others 1982, Anderson and Furniss 1983, Tuthill and others 1984).

Risk to Nontarget Organisms (Issue 2).

Mammals.

Fur reduces the risk of direct contact with gypsy moth hairs making skin irritation unlikely. Evidence of irritation to the eyes and or respiratory tract in mammalian wildlife species after direct contact with the gypsy moth was not found in the literature.

To determine the effects of a gypsy moth outbreak on a population of black bears (*Ursus americanus*), Vaughan and Kasbohm (1993) monitored the behavior of 54 radio-collared black bears in the Shenandoah National Park after a gypsy moth outbreak that caused widespread defoliation, hard mast failures, and tree mortality. The outbreak had no apparent effects on cub production or mortality rates of cubs or adults. In the fall, before the gypsy moth infestation, the bears ate mostly acorns. When acorns were no longer available due to defoliation, the bears switched to eating fruit, which had no apparent impact on the nutritional quality of their diets. Seventy-one percent of bear dens were in tree cavities, primarily in living oaks. Gypsy moth-induced mortality of den trees was high and, by the end of the study, 54 percent of the living oaks used as dens were dead. While no short-term effects were noted, Vaughan and Kasbohm (1993) speculated that the long-term adverse impact of defoliation on black bears may be a reduction in den sites, with natural replacement possibly requiring 50 years. Conversely, black bears will use upturned stumps of large dead trees as dens. These would be expected to increase as tree mortality increases.

Variations in acorn and other mast production are directly related to variations in populations of squirrels, mice, and other small mammals (Brooks and others 1998). Acorn crop size in the fall directly affects the population density of mice living in oak-dominated forests the following spring (McShea and Rappole 1992, McShea and Schwede 1993). A decrease in acorn production has been shown to decrease the population of white-footed mice *(Peromyscus leucopus)* (Elkinton and others 1996, 2002).

White-tailed deer will migrate to areas that have not been defoliated. Nesting failures of grouse and turkey may increase. Bear, turkey, and bats may migrate to nondefoliated areas or less defoliated areas (USDA 1995).

Sample and others (1996) found no significant effects on the consumption of insects by Virginia big-eared bats in areas of high gypsy moth infestation and defoliation.

Birds.

Some species of birds appear to avoid the gypsy moth as a prey species (Smith 1985), perhaps because of larval hairs. Reported increases in nesting failures of various species of birds appear to be due to increased predation, increased weather stress, or both, which are associated with defoliation (Thurber and others 1994).

Gypsy moth infestations and subsequent defoliation may be beneficial to some species of birds, especially species that favor dead wood (snags) as a habitat (Bell and Whitmore 1997a, b; DeGraaf 1987; DeGraaf and Holland 1978; Showalter and Whitmore 2002). Available nesting and foraging resources increased for several bird species as a result of more snags, windfall, and shrub cover after defoliation, while there was no substantial impact from upper canopy defoliation on birds residing primarily in the forest canopy (Bell and Whitmore 1997a, b).

Cavity-nesting birds benefit indirectly from a gypsy moth outbreak (Showalter and Whitmore 2002). Bird density increased in plots with low to moderate defoliation (Thurber 1993). Species richness increased from 19 to 23 species per plot, with declines noted only for tree nesters and flycatchers on high-impact plots (Thurber 1993). Increases in low shrub and ground nesters, cavity nesters, low shrub and ground foragers, bark foragers, forest edge species, short-distance migrants, year-round residents, and woodpeckers were widespread, but most pronounced on moderate-impact plots. DeGraaf and Holland (1978) reported similar results, finding significantly fewer numbers of only 4 out of 36 bird species examined in heavily defoliated areas. No substantial effects on abundance of various species of birds in defoliated and nondefoliated stands were noted in central Pennsylvania over a 2-year period (DeGraaf 1987).

Terrestrial Invertebrates.

Some lepidopteran species may be adversely affected by gypsy moth outbreaks. Redman and Scriber (2000) examined the adverse effects of the gypsy moth on the northern tiger swallowtail butterfly *(Papilio canadensi)*. Direct effects included 100 percent mortality in *Papilio* larvae exposed to leaves painted with gypsy moth body fluids, and 84 percent mortality in *Papilio* larvae fed leaves from aspen stands infested with gypsy moth larvae.

The potential adverse effects of gypsy moth outbreaks to Lepidoptera was also investigated in a study designed to compare lepidopteran populations in 50 acre plots in mixed oak, hickory, and pine forests in West Virginia (Sample and others 1996). Decreases in abundance and richness of larvae and adults from the family Arctiidae (tiger moths) were apparent in plots infested with gypsy moth larvae, compared with uncontaminated plots.

The impact of the gypsy moth is negative to only a small proportion of the lepidopteran community, primarily species that feed on oak and for which the larval development of the affected species and gypsy moth presumably coincide (Work and McCullough 2000). Although the study does not address the mechanism(s) by which the gypsy moths adversely affect the lepidopteran community, the investigators suggest they might include altered host plant quality, increases in natural enemies, or microclimate changes.

Some reports suggest that certain lepidopteran species respond positively to gypsy moth infestations. In 1981, the number of butterfly species was at a record high for the New Haven, Connecticut, area, despite the record number of acres defoliated by the gypsy moth that same year (Schweitzer 1988).

Fish.

Little information is available regarding the effects of gypsy moth infestations on fish populations. Defoliation by the gypsy moth can result in an increase in the pH and temperature of ambient water (Downey and others 1994, Webb and others 1995a). Trout, which are very sensitive to changes in pH and temperature, could be adversely affected by such changes (Downey and others 1994). No direct data are available on the biological effects of such changes due to gypsy moth defoliation (Webb and others 1995a).

Aquatic Invertebrates.

The rate of leaf breakdown in streams apparently increased due to gypsy moth defoliation, which might result in food deficits during spring for shredders, such as caddisflies, stoneflies, and some dipterans (Hutchens and Benfield 2000). The number of shredders collected, however, was greater in disturbed streams (i.e., streams in areas of gypsy moth defoliation) than in control streams.

Cumulative Effects of the Gypsy Moth.

Risk to Human Health (Issue 1).

The available data do not permit a definitive assessment of the effects of exposure to the gypsy moth over several seasons. Some individuals may become sensitized to the gypsy moth after repeated exposures over one or more seasons. Young children may be a group at special risk from effects of gypsy moth exposure, but it is not clear whether children are more sensitive than adults to gypsy moth exposure or whether responses in children appear greater because children spend more time outdoors than adults do.

Risk to Nontarget Organisms (Issue 2).

Effects due to the gypsy moth would be cumulative in situations of repeated outbreaks and defoliation in the same area. Repeated defoliation would lead to changes in forest condition that are characterized by increased tree mortality, stand structure and composition changes, a shift from production of hard to soft mast, and increased fire danger.

Habitats of wildlife species are altered more with each successive outbreak of the gypsy moth. Recolonization of species lost or displaced due to changes in habitat is possible; however, large areas of defoliation and frequent repeated defoliation do not favor recolonization by species with low dispersal capabilities.

Economic and recreational consequences that accumulate with repeated multiyear outbreaks include these: costs associated with annual cleanup; maintenance and replacement of trees that die; and loss of value from reduced growth and mortality of trees.

4.4 Consequences of ***Bacillus thuringiensis*** var. ***kurstaki (B.t.k.)*** (Alternatives 1, 2, 3)

See Appendixes F and M for detailed analysis of risks associated with *B.t.k.*

General Effects of ***B.t.k.***

B.t.k. may indirectly help to maintain existing forest conditions, water quality, microclimate, and soil condition by delaying increases in gypsy moth populations, thereby protecting tree foliage.

Risk to Human Health (Issue 1).

General.

B.t.k. and its formulations may cause irritation to the skin, eyes, and respiratory tract; however, serious adverse health effects are improbable. Overt signs of systemic toxicity are not likely to be observed in any group—ground workers, aerial workers, or members of the general public—that is exposed to *B.t.k.* as the result of gypsy moth management programs conducted by the USDA (Appendix M). Throat irritation is the most frequently documented effect of *B.t.k.* on human health in the scientific literature (Appendixes F and M). Dermal and ocular irritations are observed at the extreme upper levels of exposure.

There is little indication that *B.t.k.* is associated with pathogenicity in humans and no indication of endocrine disruption or reproductive effects. Carcinogenic and mutagenic effects are not likely. Neither *B.t.k.* nor its commercial formulations are highly toxic or infectious (Appendixes F and M). Formulations of *B.t.k.* are likely to cause irritant effects to the skin, eyes, and respiratory tract; however, concerns about serious adverse health effects are not plausible. This risk characterization is consistent with the risk characterization in the previous USDA risk assessment (USDA 1995), as well as with more recent risk assessments conducted by the U.S. Environmental Protection Agency (EPA) and the World Health Organization, and the comprehensive review of *B.t.* published by Glare and O'Callaghan (2000).

Pretreatment with an influenza virus substantially increased mortality in mice exposed to various doses of *B.t.k* (Hernandez and others 2000). These results raise questions about the susceptibility of individuals who contract influenza or other viral respiratory infections prior to *B.t.k.* applications and have viral infections at the time of application.

Incidence of Human Flu and Exposure to *B.t.k.*

In preparing the draft SEIS in 2004, the Forest Service and APHIS updated the B.t.k. Risk Assessment. In the process, one study they reviewed was the one by Hernandez and others (2000), which reported that B.t.k. exposure produced lethal pulmonary infections in mice that had been previously infected with a variant of a Type A human influenza virus. The Forest Service and APHIS did not use the study as the basis of a formal quantitative estimate of risk that might arise in actual field operations, because of unknown information in the study about the nature of the specific influenza virus actually tested, and because the means used to expose the mice to the B.t.k. formulation (intranasal instillation) would not occur in people during field operations. The B.t.k. Risk Assessment does note that viral enhancement of bacterial infection is known to occur, and that the issue is likely to be the subject of further studies in coming years (Volume III, Appendix F, Section 3.4.4, page 3-32).

The unprecedented appearance of human flu (the H1N1 “swine” Type A flu) in the United States in spring 2009, coinciding with annual aerial treatment projects, became a cause for concern to the USDA National Gypsy Moth Management Program. As the incidence of the infection reached the eastern United States, and Federal public health agencies anticipated a potentially widespread epidemic, the Forest Service and APHIS reevaluated the B.t.k. Risk Assessment they prepared in 2004.

In April and May 2009, the Forest Service and APHIS conducted an intensive reevaluation of potential human risks in the context of interactions between Type A influenza and B.t.k. after exposure to both. An updated literature search indicated that no research had been published on this subject since the preparation of the 2004 B.t.k. Risk Assessment. Attempts to contact Hernandez to discuss interpretation of the 2000 study results and to determine whether or not there was any follow-up research were unsuccessful.

Findings of the 2009 reevaluation and of consultation with governmental health officials and experts in virology and microbial pathology are as follows:

1. Method of administration of *B.t.k.* to the mice. Intranasal and intratracheal instillation of small volumes of liquid containing the test material of interest (such as by Hernandez and others 2000) is an accepted practice in toxicity and pathogenicity studies, and is a comparatively simple and inexpensive method for delivering a simulated inhalation exposure of particulates and liquids, especially for screening purposes. In contrast, aerosol or vapor inhalation testing, as sometimes required for registration of volatile or gaseous pesticides, is very expensive and requires highly specialized exposure chambers, and sophisticated technical and logistical support. Data from such studies are used to quantitatively assess potential health risks for inhalation exposures; however, inhalation testing was not required by the U.S. EPA for *B.t.k.* registration. As reviewed by the Inhalation Specialty Section of the Society of Toxicology (Driscoll and others 2000), the instillation techniques have advantages for screening large numbers of substances for biological activity (i.e., drug and vaccine testing, biological weapons development), but often will not support extrapolation of results to humans. Specific reasons noted by the Society of Toxicology and by Dr. Vern Seligy of Health Canada (telephone conversation with Rob Mangold and Hank Appleton, U.S. Forest Service, April 30, 2009) included these:

(a) The instillation procedure and the liquid test material can both create localized damage to the mucosal lining of the nasal cavity of the mice, and an inflammation and immunological response that produces an easier infection route than by inhalation of *B.t.k.* spores in ambient aerosol. Further, the bolus dosage of spores by instillation can overwhelm lung defenses compared with more gradual inhalation exposure of the same total dose of spores.

(b) The ability of *B.t.k.* spores in ambient air to “germinate” in the human respiratory tract following inhalation may be less than that for *B.t.k.* spores instilled directly into the airways.

2. Serial lung passage and the nature of the tested Type A virus. The Type A influenza virus used by Hernandez and others (2000) was derived from a human H3N2 variant maintained in cell culture. As human influenza virus is not infective to mice, the H3N2 virus source was “adapted to BALB/c mice;” that is, selected through several (unspecified number) infective passages in mice until a virus variant suitably infective to mice was obtained to use in the study. This “serial passage,” also known as virus “training,” is a common and accepted practice in virological research. As noted by Dr. Seligy and discussed by Brown and others (2001), however, one result of successful serial passage is selection of one or more virus variants infective to the nonhost test mice, and often more virulent to the original host (humans). In other words, the virus variant used by Hernandez and others (2000) to produce *B.t.k.* co-infection probably bore little genetic resemblance to the Type A H3N2 parent strain of human influenza it was derived from, and even less to the H1N1 Type A human strain of 2009 that prompted their reassessment.

These observations and opinions were also offered and confirmed by experts of the Centers for Disease Control, U.S. EPA , and USDA during this follow-up work. The weight of evidence obtained thus far confirms that Hernandez and others (2000) cannot be appropriately used for formal characterization of risks to humans exposed to *B.t.k.* by the respiratory tract. The only remaining means of truly assessing the issue of potentiation of *B.t.k.* toxicity via superinfection following influenza exposure would require the controlled laboratory testing of Foray 48 via aerosol exposure to primates (or other suitable human surrogate species) pre-infected with a representative human Type A influenza virus.

The statements within the original 2004 *B.t.k.* Risk Assessment are accurate regarding the results described in Hernandez and others (2000). Based upon the further review of this study by experts at the Centers for Disease Control and elsewhere, in the context of the H1N1 occurrence, the Forest Service and APHIS concluded that conditions posed by H1N1 influenza in the 2009 spring *B.t.k.* spray areas did not pose a credible concern.

The study of Hernandez and others (2000) appears to be scientifically sound, but it has severe limitations precluding its use in human risk characterization, and is not applicable to the operational use of *B.t.k.* The study may be viewed in the same context as bacterial mutation studies in chemical toxicology, which may provide useful information on the carcinogenic potential of a chemical but cannot be used for quantitative assessment of human cancer risk. Finally, the conclusions stated in Hernandez and others (2000, p. 181), i.e., “Taken together, these results suggest that *Bt* spraying around human populations could be dangerous, especially for immuno-compromised patients,” go far beyond the relevance and robustness of the study results from which they were drawn. As a result of this intensive reevaluation of potential risks to people exposed to both *B.t.k.* and Type A influenza, the Forest Service and APHIS found no reason to change their original assessment of human health risks associated with the use of *B.t.k.* in gypsy moth treatment projects, as was disclosed in the 2004 *B.t.k.* Risk Assessment.

Groups at Special Risk.

The available toxicity data give no indication that subgroups of the general population are likely to be remarkably sensitive to *B.t.k.* Nonetheless, *B.t.k.* formulations are complex mixtures and there is a possibility that certain individuals may be allergic to one or more of the components in the formulations. The study by Hernandez and others (2000) also raises concern regarding the susceptibility of individuals with influenza or other viral respiratory infections to *B.t.k.* toxicity (Appendix F, Sections 3.1.13 and 3.4.5). See Appendixes F and M for detailed information.

Risk to Nontarget Organisms (Issue 2).

Mammals.

Adverse effects due to *B.t.k.* are unlikely in mammals (Appendixes F and M). Most inhalation studies do not suggest the potential for adverse effects, even at *B.t.k.* concentrations much greater than those likely to be encountered in the environment (Appendix F). Bats that feed almost exclusively on lepidopterans might be indirectly affected through a reduction in prey, as suggested by a study in West Virginia (Sample and others 1993a, b; Sample and Whitmore 1993). A 3-year study (1990–1992) conducted in West Virginia on food of the endangered big-eared bat revealed the greatest impact within 3 weeks of *B.t.k.* application due to reduction of prey species. Contrasting these studies, Sample and others (1996) showed that the moths on which bats feed were not affected by *B.t.k.* applications.

Birds.

Acute toxic effects are not likely in birds (Appendixes F and M). Due to the lack of toxicity of *B.t.k.* formulations, as well as of other *B.t.* strains, the U.S. EPA did not require chronic or reproductive toxicity studies in birds (Appendix F). This apparent lack of toxicity is supported by numerous field studies in birds. *B.t.k.* applied at rates sufficient to decrease the number of caterpillars had no substantial adverse effects on most bird species (Nagy and Smith 1997, Rodenhouse and Holmes 1992, Sopuck and others 2002). However, a study showed a significant decline in three species of insectivorous birds (black throated green warbler, eastern tufted titmouse, and yellow-billed cuckoo), but they fully recovered within 3 years (Strazanac and Butler 2005).

A field study that included intensive searches of plots in sprayed and unsprayed areas revealed no differences in the numbers of songbird broods between the two areas for any of the species examined (Sopuck and others 2002). A reduction of lepidopteran larvae due to *B.t.k.* application appeared to have only minimal effects on reproduction in hooded warblers (Nagy and Smith 1997). The reduction in numbers of birds in an area observed in some species was considered indirect and attributed to alterations in the availability of prey rather than to the direct toxicity of *B.t.k.* (Gaddis 1987, Gaddis and Corkran 1986, Norton and others 2001).

Terrestrial Invertebrates.

B.t.k. is toxic to several species of target and nontarget Lepidoptera. The larvae of the Karner blue butterfly (a Federally listed endangered species), two species of swallowtail butterflies, a promethean moth, the cinnabar moth, and various species of Nymphalidae, Lasiocampidae, and Saturniidae are susceptible to *B.t.k.* (Glare and O'Callaghan 2000).

Permanent changes in nontarget caterpillar populations do not appear likely as a result of gypsy moth management projects. An exception might occur in certain habitat types that support small isolated populations of lepidopterans that are highly susceptible to *B.t.k.* If unaffected individuals of the same species are unlikely to, or physically cannot, move from the treated into the untreated area, then one application of *B.t.k.* will have an effect on the ability of those populations to recover. These effects are limited to spring caterpillars that are present during *B.t.k.* treatments (Strazanac and Butler 2005). Full recovery of nontarget spring caterpillars occurred within 1 to 2 years after the treatment (Strazanac and Butler 2005).

In Oregon, Miller (1990) observed reductions in both types and numbers of nontarget caterpillars after three applications of *B.t.k.* The reductions persisted for 1 year after treatment but not for 2 years. In another study (Carter and others 1995), a second application of *B.t.k.* did not increase mortality of five species of Lepidopterans over that caused by one application. The species tested were moderately resistant to *B.t.k.* and had mortality rates below 50 percent after the first application.

While some nontarget lepidopteran species appear to be sensitive to *B.t.k.*, most studies indicate that effects in other terrestrial insects are likely to be of minor significance (Appendix F). There is relatively little information regarding the toxicity of *B.t.k.* or *B.t.k.* formulations to terrestrial invertebrates other than insects. For some Lepidoptera, sensitivity to *B.t.k.* is highly dependent on their developmental stage. This is particularly evident for the cinnabar moth, where late instar larvae are very sensitive to *B.t.k.* and early instar larvae are very tolerant to *B.t.k.* (James and others 1993).

The variability in the response of nontarget Lepidoptera to *B.t.k.* is also illustrated in a recent field study in which a *B.t.k.* formulation was applied to two forests (dominated by oak, hickory, and maple trees) over a 2-year period, at an application rate of 40 BIU/acre (Rastall and others 2003). Researchers monitored nontarget lepidopteran populations in the 2 years prior to application as well as over the 2-year period in which *B.t.k.* was applied. The response of nontarget Lepidoptera varied substantially among different species. Larvae of three lepidopteran species significantly decreased in treatment years: *Lambdina fervidaria* (geometrid), *Heterocampa guttivitta* (notodontid), and *Achatia distincta* (noctuid). For 19 other species, larval counts were significantly higher in treatment years as were the total number of noctuids combined and the total number of all nontarget lepidopteran species combined. The Karner blue butterfly is susceptible to *B.t.k.,* although the larval generation at risk may vary from year to year (Herms and others 1997).

Some predators and parasitoids may be affected indirectly by *B.t.k.* because of the loss of gypsy moth caterpillars that they parasitize or eat. The more specific the parasites and predators are for lepidopterans affected by *B.t.k.,* the greater the chance of an effect. For example, populations of parasitoid tachinid flies and Braconidae wasps and Pentatomidae stinkbugs declined after application of *B.t.k.* (then recovered by the second year), but generalist predators did not decline (Strazanac and Butler 2005).

Fish.

The U.S. EPA classifies *B.t.k.* as virtually nontoxic to fish (Appendix F). This assessment is consistent with the bulk of experimental studies reporting few adverse effects in fish exposed to *B.t.k.* concentrations that exceed environmental concentrations associated with USDA programs (Buckner and others 1975, Otvos and Vanderveen 1993).

Aquatic Invertebrates.

The effects of *B.t.k.* on aquatic invertebrates is examined in standard laboratory studies and in numerous field studies. *B.t.k.* may be lethal to certain aquatic invertebrates, like *Daphnia magna*, at concentrations high enough to cause decreases in dissolved oxygen or increased biological oxygen demand (Young 1990). Most aquatic invertebrates seem relatively tolerant to *B.t.k.* (Appendix F, Section 4.1.3.3). This assessment is supported by several field studies that failed to note effects in most species after suppression application rates and exposures that substantially exceed expected environmental concentrations (Kreutzweiser and others 1992, 1993, 1994; Oldland and others 1994).

Cumulative Effects of ***B.t.k.***

Risk to Human Health (Issue 1).

Given the reversible nature of the irritant effects of *B.t.k.* and the low risks for serious health effects, cumulative human health effects from spray programs conducted over several years are not expected. Mating disruption with disparlure will most likely be the only other treatment used in the same spray blocks with *B.t.k.* However, *B.t.k.* is used to treat gypsy moth larvae, and mating disruption is used against gypsy moth adults, and they are applied weeks apart. These treatments also have different modes of action, and there are no known cumulative effects between the treatments.

Workers or members of the general public who are exposed to aerial or ground sprays of *B.t.k.* are also exposed to the gypsy moth and may be exposed to other control agents for the gypsy moth. No known data indicate that risks posed by these other agents will affect the response, if any, to *B.t.k.* formulations. Similarly, exposure to other chemicals in the environment may impact the sensitivity of individuals to *B.t.k.* or other agents; however, the available data are not useful for assessing the significance of such interactions.

There is no known documented evidence of a subgroup of individuals who are more sensitive than most members of the general public to *B.t.k.* formulations (Appendix F, Sections 3.4.1 and 3.4.4).

Risk to Nontarget Organisms (Issue 2).

Many studies indicate that *B.t.k.* lasts about a week in the environment. Repeated treatments of areas with *B.t.k.* could potentially impact some species of spring-feeding butterfly and moth caterpillars. Since *B.t.k.* is not used in the same spray blocks with other treatments that could affect nontarget organisms, there is no cumulative effect between different treatments and *B.t.k.* on spring-feeding caterpillars.

4.5 Consequences of **Diflubenzuron** (Alternatives 1, 2, 3).

See Appendixes I and M for detailed analysis of risks associated with diflubenzuron.

General Effects of Diflubenzuron.

Diflubenzuron may indirectly help to maintain existing forest conditions, water quality, microclimate, and soil condition by delaying increases in gypsy moth populations, thereby protecting tree foliage.

Risk to Human Health (Issue 1).

General.

Diflubenzuron causes the formation of methemoglobin, a form of hemoglobin incapable of oxygen transport, normally present in the blood in small amounts. Methemoglobinemia, the formation of excess methemoglobin, is the primary toxic effect of diflubenzuron in every species of animal tested, regardless of the route or duration of exposure. While effects on the blood are well documented, there is little indication that diflubenzuron causes other specific forms of toxicity. Diflubenzuron does not appear to be neurotoxic nor immunotoxic, does not appear to affect endocrine function in laboratory mammals, and is not a carcinogen. Additionally, diflubenzuron does not appear to cause birth defects or to affect reproductive processes. Numerous studies regarding the subchronic and chronic toxicity of diflubenzuron in laboratory animals indicate that methemoglobinemia is the most consistent clinical symptom indicative of toxicity. Diflubenzuron can be absorbed via the skin in sufficient amounts to cause hematological effects, that is, methemoglobinemia and sulfhemoglobinemia. Nonetheless, the dermal exposure concentrations necessary to induce these hematological effects are higher than the oral exposure dosage necessary to cause the same effects.

Diflubenzuron rapidly dissipates from vegetation and is broken down by sunlight; in the environment the compound degrades to 4-chloroaniline, which the U.S. EPA considers a potential carcinogen. This is the only identified potential carcinogen associated with any of the agents to control gypsy moth. The compound is not expected to be present in significant amounts during application since 4-chloroaniline does not form during application. The scenario of greatest concern involving 4-chloroaniline is a cancer risk from drinking contaminated water. This risk would be most plausible in areas with sandy soil and annual rainfall rates ranging from about 50 to 250 inches. The estimate of the hazard quotient for the consumption of water contaminated with 4-chloroaniline and based on a cancer risk of 1 in 1 million is 0.09, which is 10 times lower than the level of concern.

None of the hazard quotients for diflubenzuron reaches a level of concern at the highest application rate used in USDA programs (Appendix I). Since many of the exposure assessments overestimate exposure, and because the dose-response assessment is based on similarly protective assumptions, there is no basis for asserting that this use of diflubenzuron poses a hazard to human health (Appendix I).

Groups at Special Risk.

Some individuals have congenital methemoglobinemia and may be at increased risk of adverse effects to compounds that induce methemoglobinemia (Barretto and others 1984). Infants less than 3 months old have lower levels of methemoglobin (cytochrome b5) reductase and higher levels of methemoglobin (1.32 percent), compared with older children or adults (Centa and others 1985, Khakoo and others 1993, Nilsson and others 1990). Some infants with an intolerance to cow's milk or soy protein exhibit methemoglobinemia (Murray and Christie 1993, Wirth and Vogel 1988). These infants would be at increased risk if exposed to any materials contaminated with diflubenzuron or any compound that induces methemoglobinemia.

Individuals with poor diets might be vulnerable to some chemicals. Based on a study in rats, iron deficiency leads to anemia but does not influence methemoglobin reductase activity (Hagler and others 1981). Thus, although individuals with poor nutritional status are generally a group for which there is particular concern, the available information does not support an increased risk for these individuals with respect to diflubenzuron exposure.

Risk to Nontarget Organisms (Issue 2).

Mammals.

The available field studies indicate no substantial impacts on mammalian wildlife from applications of diflubenzuron. Applications of 60 to 280 g a.i./ha (grams active ingredient per hectare) or 0.85 to 4 oz a.i./acre (ounces of active ingredient per acre) had no detectable adverse effects on the abundance of, or reproduction in moles, field mice, and shrews (Henderson and others 1977, O'Connor and Moore 1975). Small mammals increased in abundance on a plot receiving 280 g a.i./ha compared with a control plot (Henderson and others 1977). The adverse effects that diflubenzuron might have on bot flies, a parasite of small and large mammals alike, was suggested as a possible explanation.

A field study reported no effect on body measurements, weight, or fat content in populations of mice in areas treated with diflubenzuron (Seidel and Whitmore 1995). Mice in the treated areas did consume less lepidopteran prey, but total food consumption was not significantly different between treated and untreated plots.

Birds.

The acute toxicity of diflubenzuron to birds appears generally low. The lack of direct effects on birds is supported by several field studies summarized in Appendix I. Effects secondary to a reduction in lepidopteran prey may include increased foraging range (Cooper and others 1990), relocation (Sample and others 1993a, b; Sample and Whitmore 1993) and lower body fat (Whitmore and others 1993).

Terrestrial Invertebrates.

Arthropods, a large group of invertebrates including insects, crustaceans, spiders, mites, and centipedes, are most sensitive to diflubenzuron. Most of these organisms use chitin as a major component of their exoskeleton (outer body shell). Diflubenzuron is an effective insecticide because it inhibits the formation of chitin, disrupting normal growth and development. Both terrestrial and aquatic arthropods are affected, though some substantial differences in sensitivity are apparent.

Invertebrates lacking exoskeletons, such as earthworms and snails, do not utilize chitin, and diflubenzuron is relatively nontoxic to these species (Appendix I). Species that are most sensitive to diflubenzuron include lepidopteran and beetle larvae, grasshoppers, and other chewing herbivorous insects (Berry and others 1993, Butler 1993, Butler and others 1997a, Elliott and Iyer 1982, Jepson and Yemane 1991, Kumar and others 1994, Redfern and others 1980, Sample and others 1993a, Sinha and others 1990). Species that are relatively tolerant to diflubenzuron include flies, parasitic wasps (on insect eggs), adult beetles, and sucking insects (Ables and others 1975, Broadbent and Pree 1984, Brown and Respicio 1981, Bull and Coleman 1985, De Clercq and others 1995, Delbeke and others 1997, Gordon and Cornect 1986, Keever and others 1977, Martinat and others 1988, Webb and others 1989, Zacarias and others 1998, Zungoli and others 1983).

The U.S. EPA uses the honey bee as the standard test species to classify the toxicity of pesticides to nontarget terrestrial invertebrates. Based on early acute oral and contact toxicity studies in honey bees (Atkins and others 1974, Stevenson 1978), the U.S. EPA (1997) classifies diflubenzuron as practically nontoxic to honey bees. Several other laboratory toxicity studies also indicate diflubenzuron is not particularly toxic to bees (Chandel and Gupta 1992, Elliott and Iyer 1982, Gijswijt 1978, Kuijpers 1989, Nation and others 1986, Yu and others 1984). This conclusion is supported by several field studies conducted at application rates comparable to, or substantially higher than, those used to control the gypsy moth (Buckner and others 1975, Emmett and Archer 1980, Matthenius 1975, Schroeder 1978, Schroeder and others 1980). Additionally, no detectable amounts of diflubenzuron were found in honey bees in areas treated with diflubenzuron (Cochran and Poling 1995).

Fish.

Based on the available information, the U.S. EPA (1997) classifies acute exposure to diflubenzuron as “practically nontoxic” to fish. The 96-hour LC_{50} values range from greater than 25 milligrams per liter (mg/L) (the value for yellow perch reported by Johnson and Finley 1980) to greater than 500 mg/L (the value for fathead minnow reported by Reiner and Parke 1975). In addition, no effects were seen in longer-term studies at concentrations up to 100 parts per billion (ppb) (Cannon and Krize 1976) or in two-generation reproduction studies at concentrations of up to 50 ppb (Livingston and Koenig 1977).

Indirect effects on fish are plausible based on a decrease in invertebrate populations as demonstrated in studies in which concentrations as low as 2.5 ppb resulted in decreased growth of fish in littoral enclosures (populations of fish placed in enclosures along the shore of a body of water and monitored) (Moffett 1995, Tanner and Moffett 1995). The reduced growth observed in these studies is attributed to a reduction in macroinvertebrates, a fish food source.

None of the field studies summarized in Appendix I note any adverse effects on fish at application rates comparable to or greater than those used in the control of the gypsy moth. A study by Colwell and Schaefer (1980) did note a shift in the diet of fish (secondary to changes in food availability) but no effect on growth rates or general condition of the fish.

Aquatic Invertebrates.

Because diflubenzuron inhibits the synthesis of chitin, crustaceans are the aquatic invertebrates most sensitive to diflubenzuron. Many bioassays, both acute and chronic, have been conducted on *Daphnia magna* (Hansen and Garton 1982, Kuijpers 1988, Majori and others 1984, Surprenant 1988) as well as a related species, *Ceriodaphnia dubia* (Hall 1986). As detailed further in the dose-response assessment (Appendix I), these organisms are among the most sensitive to diflubenzuron (Hall 1986, Hansen and Garton 1982). Several other crustacean species appear to be about as sensitive as or only somewhat less sensitive to diflubenzuron than daphnids are (Appendix I). Small crustaceans that consume algae and serve as a food source for fish, such as *Daphnia* species, appear to be the most sensitive to diflubenzuron, while larger insect species, such as backswimmers and scavenger beetles, are much less sensitive. Other aquatic invertebrates, crustaceans, and small- to medium-sized aquatic insect larvae appear to have intermediate sensitivities.

Snails, aquatic worms, and bivalves were not affected by exposure to diflubenzuron (Hansen and Garton 1982, Surprenant 1989).

Field studies on the effects of diflubenzuron on aquatic invertebrates reinforce the standard toxicity studies, indicating diflubenzuron will impact invertebrate populations. Several of these studies, however, were conducted at application rates substantially higher than those used to control the gypsy moth. Many of the studies in which severe adverse effects were observed in aquatic invertebrate populations involved multiple applications at rates between about 110 g/ha and 560 g/ha (Ali and Mulla 1978a, b; Ali and others 1988; McAlonan 1975). Concentrations in this range are substantially higher than the application rate of 17.5 g/ha that is likely to be encountered in USDA programs. Similarly, other field studies involve direct applications to open water, a treatment method that is not part of USDA program activities, and which resulted in concentrations of diflubenzuron in water in the range of 10 ppb (Apperson and others 1978, Boyle and others 1996, Colwell and Schaefer 1980, Lahr and others 2000, Sundaram and others 1991).

Diflubenzuron reduces numbers of stream invertebrates that process detritus; however, field studies have shown no decline in detrital decomposition rates (Swift and others 1988). The populations of some invertebrates that feed on algae are reduced by diflubenzuron. An increase in algae could occur after the loss of algal herbivores; however, this has not been observed in field studies.

Field studies using lower application rates that are more typical of USDA gypsy moth management programs noted some effects on freshwater invertebrates, particularly smaller crustaceans (Farlow 1976; Griffith and others 1996, 2000; Hurd and others 1996; Reardon 1995). The effects were much less severe than those seen at higher application rates. See Section 4.4 of Appendix I for further discussion.

Cumulative Effects of Diflubenzuron.

Risk to Human Health (Issue 1).

Diflubenzuron is not likely to be used with other treatments at the same site, so no cumulative effects with other treatments are likely. Multiple applications at lower rates per application result in lower associated risks than with a single application at the maximum approved rate.

Diflubenzuron and tebufenozide could have a cumulative effect on methemoglobinemia. USDA gypsy moth management programs do not use these two chemicals together in the same area at the same time. Exposure to other methemoglobinemia-inducing compounds in the environment may contribute to a cumulative effect. Individuals exposed to combustion smoke or carbon monoxide (agents causing oxidative damage to blood) may be at increased risk of developing methemoglobinemia. Individuals exposed to high levels of nitrates, either in air or in water, demonstrate increased levels of methemoglobin and may be at increased risk with exposure to compounds such as diflubenzuron.

Some infants with congenital methemoglobinemia and an intolerance to cow's milk or soy protein exhibit methemoglobinemia. These infants would be at increased risk if exposed to any materials contaminated with diflubenzuron.

Risk to Nontarget Organisms (Issue 2).

Diflubenzuron is generally not used in conjunction with other treatments; however, diflubenzuron might be applied to the same area in multiple years for eradication projects. In that case, diflubenzuron might have a cumulative effect on nontarget invertebrates, such as caterpillars of moths and butterflies, grasshoppers, parasitic wasps, aquatic insects, bottom dwelling crustaceans, and immature free-floating crustaceans. Diflubenzuron applications as used in USDA treatment projects will otherwise have no cumulative effects.

4.6 Consequences of Disparlure (as Used in Mating Disruption and Mass Trapping) (Alternatives 1, 2, 3).

See Appendixes H and M for detailed analysis of risks associated with disparlure as used in mating disruption and mass trapping.

In mating disruption, a medium is impregnated with disparlure for timed release and formulated for aerial application over the project area. The objective is to flood the area with pheromone, thereby impeding the male moth's ability to find and mate with female moths. Also, in mass trapping, a solid medium is impregnated with disparlure, formulated for timed release, and deployed in small "delta" or large capacity "milk carton" traps. The traps are deployed across the treatment area to attract and capture male moths, thereby preventing them from finding and mating with female moths. The delta and milk carton traps are also used in detection surveys for gypsy moth.

General Effects of Disparlure.

Disparlure is specific to the gypsy moth and may indirectly help to maintain existing forest conditions, water quality, microclimate, and soil condition by delaying increases in gypsy moth populations, thereby protecting tree foliage.

Risk to Human Health (Issue 1).

General.

Insect sex pheromones are chemicals produced by insects for communication between the sexes of the same species. Insect pheromones are generally regarded as nontoxic to mammals and are commonly employed in very low concentrations. Consequently, the U.S. EPA requires less rigorous testing of these products than is required of chemical insecticides. Results of acute exposure studies for oral, dermal, ocular, and inhalation exposure to disparlure reveal no adverse effects. Based on the results of studies on disparlure itself (i.e., the active ingredient), acute exposure to disparlure exhibits very low toxicity to mammals.

No studies were identified investigating the effects of chronic exposure of mammals to disparlure or investigating the effects of disparlure on the nervous, immune, reproductive, or endocrine systems of mammals. The carcinogenic potential of disparlure has not been assessed, though a single study focusing on mutagenicity revealed no indication that disparlure is mutagenic. No information is available regarding the kinetics and metabolism of disparlure in mammals; available literature does not document absorption of disparlure following dermal, oral, or inhalation exposure. A case report of an occupational exposure indicates that disparlure may persist in humans for years (Cameron 1981, 1983).

Although studies on the acute toxicity of disparlure have been conducted in laboratory animals, the lack of either subchronic or chronic toxicity data precludes a quantitative characterization of risk.

Groups at Special Risk.

The toxic effects of disparlure, if any, have not been identified. Consequently, groups at special risk cannot be characterized.

Risk to Nontarget Organisms (Issue 2).

Mammals.

Results of acute toxicity studies for oral, dermal, ocular, and inhalation exposure to disparlure demonstrate very low toxicity to mammals. Information is not available regarding chronic toxicity, and no field studies exist assessing the impact of disparlure on mammals.

Birds.

There is no evidence that birds are affected by USDA treatment projects using disparlure.

Terrestrial Invertebrates.

Disparlure does not attract any other insect found in North America.

Fish.

Limited data are available regarding the toxicity of disparlure to aquatic animals. A major issue in the interpretation of the aquatic toxicity data on disparlure involves the solubility of disparlure in water. While no measured values are available, estimates based on quantitative structure-activity relationships developed by the U.S. EPA suggest that the solubility of disparlure in water is in the range of 0.0019 to 0.0028 mg/L (Appendix H). No risks to fish can be identified under foreseeable circumstances in the use of disparlure formulations.

Aquatic Invertebrates.

As with fish, disparlure does not appear to pose a risk to aquatic invertebrates due to inherent toxicity. At the limit of the solubility of disparlure in water, there is no indication that toxic effects are likely in any aquatic species (Appendix H). Based on the variability in the experimental data as well as the range of application rates used in USDA programs, HQs would vary from about 0.15 to about 0.37 below the level of concern by factors of about 3 to 10. This risk characterization applies to accidental application of disparlure to a body of water 1 meter deep. The HQ will vary with the depth of the water. Since the calculations are based on a 1-meter-deep body of standing water, the HQ would be a factor of 10 lower in a 10-meter-deep body of standing water and a factor of 10 higher in a 0.1-meter-deep body of standing water. In actual field applications using Disrupt II flakes, water bodies such as lakes and rivers are never directly treated with flakes, and levels of exposure in moving water would be magnitudes lower than the calculated static level, providing an even greater margin between exposure and potential toxicity. Further, control tests using the untreated carrier products (small plastic flakes) showed no toxicity.

In summary, the application of disparlure in mating disruption is unlikely to affect aquatic invertebrates.

Cumulative Effects of Disparlure.

Risk to Human Health (Issue 1).

Since disparlure seems to persist in humans, repeated exposures of disparlure will attract the gypsy moth. No information is available on the interaction of disparlure with other control agents or other chemicals usually found in the environment.

Risk to Nontarget Organisms (Issue 2).

Since disparlure attracts only the gypsy moth in North America, no cumulative effects are expected on nontarget organisms.

4.7 Consequences of Dichlorvos (as Used in Mass Trapping) (Alternatives 1, 2, 3).

See Appendixes K and M for detailed analysis of risks associated with the use of dichlorvos in mass trapping. Appendix A provides an in-depth discussion of how dichlorvos is used in mass trapping. Dichlorvos is *not* a distinct treatment in the USDA gypsy moth management program. It is simply an insecticide (formulated in a vinyl strip as a killing agent) used in the large-capacity milk carton trap, which can be deployed for mass trapping of male gypsy moths in a project area. This same kind of milk carton traps (with dichlorvos) are also used in gypsy moth surveys. Without this insecticide in the traps, the male gypsy moths that are attracted to traps (by disparlure) would simply fly back out.

Milk carton traps with dichlorvos have not been used for mass trapping since 1997 and only twice between 1993 and 1997, where no more then 50 acres were treated. Each year for surveys APHIS deploys approximately 19,000 milk carton traps with dichlorvos pest strips. The Forest Service’s slow-the-spread strategy also uses milk carton traps for surveys.

General Effects of Dichlorvos.

Because dichlorvos is used inside traps, no effect on human health and nontarget organisms is expected. A person or animal would have to deliberately eat the resin strip. In the entire history of USDA use of traps containing dichlorvos, such an accidental or deliberate action has not been encountered.

Risk to Human Health (Issue 1).

General.

Dichlorvos is readily absorbed into the body of mammals via all routes of exposure, and is rapidly metabolized and eliminated. Generally, the systemic effects observed after oral, inhalation, or dermal exposure of humans or laboratory animals to dichlorvos result from the inhibition of acetylcholinesterase (AChE). The enclosed nature of milk carton traps containing dichlorvos minimizes the chance that people will come into contact with it. In a risk assessment of the carcinogenic and mutagenic potential of diclorvos, U.S. EPA decided “The carcinogenicity potential of Diclorovos has been classified as ‘suggestive’ under the 1999 Draft Agency Cancer Guidelines and no quantitative assessment of cancer risk is required.” (Section 3.1.10 of Appendix K).

Exposure of both workers and members of the general public should be negligible in most cases. Workers taking prudent steps to limit both dermal and inhalation exposures can minimize the likelihood of exposure to dichlorvos. Similarly, exposure of the general public to substantial amounts of dichlorvos is unlikely. The dichlorvos is contained within a PVC strip to ensure the active ingredient is released slowly over time. The strip, in turn, is placed within a trap and the trap is placed so that it will not be accessed except in the case of intentional tampering or trap monitoring.

The greatest risks for workers are associated with inhalation exposures from assembling the traps in enclosed and poorly ventilated spaces, or while transporting the traps in the passenger compartments of vehicles. These risks are readily avoided. Dermal exposures are usually at lower levels than inhalation exposures.

All of the exposure scenarios for members of the general public described in Appendix K are accidental. Should a child come into contact with a dichlorvos strip, both dermal and oral exposures (if a child ate the strip) could substantially exceed a level of concern. See Appendix K for additional dichlorvos information and risk assessment scenarios.

Groups at Special Risk.

Children are of primary concern as identified in the risk assessment (Appendix K). As noted above, imprudent handling of a dichlorvos-impregnated strip would most likely involve a child. Additionally, very young children (infants less than 6 months old) may be at special risk because of their incompletely developed AChE systems and immature livers (ATSDR 1993).

Several other groups may be at special risk to all cholinesterase-inhibiting compounds, including dichlorvos. A small proportion of the population has an atypical variant of plasma cholinesterase that may make them more susceptible to effects when exposed to dichlorvos and other AChE inhibitors. Other groups known to have low plasma AChE levels are long-distance runners, women in early stages of pregnancy, women using birth control pills, individuals with advanced liver disease, alcoholics, individuals with poor nutritional status, and individuals with skin diseases. Asthmatics may also be at special risk because dichlorvos may induce or exacerbate respiratory distress (ATSDR 1993).

Risk to Nontarget Organisms (Issue 2).

Exposure would be accidental since dichlorvos is used inside traps.

Mammals.

The principal adverse effects of dichlorvos exposure are directly related to inhibition of cholinesterase. In the USDA program for the control of the gypsy moth, the use of milk carton traps employing slow release of dichlorvos from PVC strips essentially precludes rapid exposures to high doses of dichlorvos.

Birds.

No published data is available concerning the acute toxicity to birds of dichlorvos encased in PVC resin.

Terrestrial Invertebrates.

The only terrestrial invertebrates likely to come into close contact with the dichlorvos strip are male gypsy moths attracted by the disparlure in the trap, or carnivorous wasps and hornets that may enter the trap to feed on dead and dying gypsy moths.

Fish.

There is no indication fish are likely to be adversely affected by dichlorvos as used in PVC strips (Section 4.4.3.1, Appendix K). However, dichlorvos itself is classified as highly toxic to both freshwater and estuarine fish (U.S. EPA 1999a). See Appendix K for comprehensive information.

Aquatic Invertebrates.

Based on the same conservative exposure assessment used for both fish and terrestrial vertebrates, some sensitive aquatic invertebrates could be adversely affected by dichlorvos contamination of water if a trap is intentionally thrown into water. As in the other exposure assessments developed in Appendix K involving contaminated water, this exposure scenario should be regarded as an extremely rare accident rather than routine. Under normal circumstances, water contamination from dichlorvos strips is negligible and consistent with the conclusions reached by U.S. EPA (1999a).

Cumulative Effects of Dichlorvos.

Risk to Human Health (Issue 1).

The only substantial exposures to the general public would occur from repeated tampering with traps containing dichlorvos. No such incidents have been reported, despite the long use of dichlorvos in traps for the gypsy moth and other species.

Workers may be exposed repeatedly to dichlorvos if they are involved in the assembly and placement of traps over a period of several weeks. No data exists regarding the effects of exposure to dichlorvos in combination with exposure to the other agents used to control the gypsy moth or to the gypsy moth itself. Inhibition of AChE is the most sensitive effect of dichlorvos; this effect is not associated with exposure to the other control agents or to the gypsy moth. Therefore, there is no plausible basis for assuming that the effects of exposure to dichlorvos and any or all of the other control agents or the gypsy moth are additive.

Risk to Nontarget Organisms (Issue 2).

Experience with traps used in mass trapping and survey programs shows that there are no cumulative effects on nontarget organisms even over years of use.

4.8 Consequences of Gypchek (Alternatives 1, 2, 3).

See Appendixes G and M for detailed analysis of risks associated with Gypchek.

General Effects of Gypchek.

Gypchek may indirectly help to maintain existing forest condition, water quality, microclimate, and soil condition by delaying increases in gypsy moth populations, thereby protecting tree foliage.

Risk to Human Health (Issue 1).

General.

According to Appendix G, there is no plausible risk to either workers or members of the general public from the use of Gypchek to control the gypsy moth.

Groups at Special Risk.

No groups at special risk are identified. Some individuals may be allergic to gypsy moth parts found in Gypchek.

Risk to Nontarget Organisms (Issue 2).

Mammals.

Except for eye irritation, there is little indication that NPV or the Gypchek formulation of NPV has any effect in mammals, even at extremely high levels of exposure. One study that focused on wildlife (Lautenschlager and others 1977) exposed mice, short-tailed shrews, and opossums to various forms of NPV (gypsy moth larvae infected with NPV, a purified formulation of NPV, and a spray preparation of NPV). Based on gross observations, as well as necropsy and microscopic examination of several different tissues, no effects were seen in any of the species.

Birds.

Few studies are available on birds, and the results of these studies are essentially identical to those on mammals. The studies indicate exposures to NPV at levels that are substantially higher than those likely to occur in the environment are not associated with any adverse effects (Podgwaite and Galipeau 1978, Lautenschlager and others 1976).

Terrestrial Invertebrates.

Barber and others (1993) found no indication that NPV is pathogenic to any insect species except the gypsy moth. No adverse effects were observed in any species tested. Additionally, a recent field study noted no effects in nontarget insects following the application of Gypchek (Rastall and others 2003). There is no indication that adverse effects are caused in nontarget insects at any level of exposure.

Fish.

Two studies are available on the toxicity of NPV to fish (Moore 1977, Kreutzweiser and others 1997). The results of both studies show no toxicity in rainbow trout, no effects on mortality, behavior, or growth rate, and no viable NPV detected in the stomach or intestinal tract.

Aquatic Invertebrates.

No effects on mortality or reproduction were observed over exposure periods of up to 4 weeks (Streams 1976).

Cumulative Effects of Gypchek.

Risk to Human Health (Issue 1).

Exposure to both the gypsy moth caterpillars and Gypchek could be additive; however, there are no data showing that this occurs, and Gypchek treatments would eliminate the caterpillars.

Risk to Nontarget Organisms (Issue 2).

Since Gypchek is specific to the gypsy moth, no cumulative effects are expected for nontarget organisms.

4.9 Consequences of Tebufenozide (Alternatives 2 and 3).

See Appendixes J and M for detailed analysis of risks associated with tebufenozide.

The use of tebufenozide to manage the gypsy moth may adversely affect nontarget Lepidoptera. There is little indication that humans or other wildlife species will be adversely affected under normal conditions of use, even at the highest application rate (see the full analysis of tebufenozide in Appendix J). *Table 4-2* provides hazard quotients (HQ) for tebufenozide and the other treatments and gypsy moth.

General Effects of Tebufenozide.

Tebufenozide may indirectly help to maintain existing forest conditions, microclimate, and soil condition by delaying increases in gypsy moth populations, thereby protecting tree foliage. Although tebufenozide is not highly mobile in soil, it may be transported by percolation, sedimentation, or runoff from soil to ambient water. Tebufenozide would not be sprayed over water or areas where surface water is present, and buffers will be maintained around these areas. See Appendix J for additional information on tebufenozide and water quality.

Risk to Human Health (Issue 1).

General.

A relatively detailed and consistent series of studies in mice, rats, and dogs indicates that the primary mechanism of tebufenozide toxicity in mammals involves effects on the blood, specifically the formation of methemoglobin. Tebufenozide does not appear to be carcinogenic and does not appear to cause birth defects. Nonetheless, the compound is associated with adverse reproductive effects in experimental mammals. Tebufenozide itself does not seem to be irritating to the skin or eyes. As discussed in the exposure assessment in Appendix J, dermal absorption is the primary route of exposure for workers. Data regarding the dermal absorption kinetics of tebufenozide are not available in the published or unpublished literature. Potential inhalation toxicity of the compound is not of substantial concern in the risk assessment in Appendix J.

At the maximum application rate, two applications at 0.12 lb (pounds) a.i./acre spaced 3 days apart, there is little indication that adverse effects on human health are likely. The risk assessment at Appendix J suggests, however, that two applications at 0.08 lb a.i./acre or more should be avoided in areas where members of the general public might consume contaminated fruits or other contaminated vegetation.

Groups at Special Risk.

Individuals born with a form of congenital methemoglobinemia may be at increased risk of adverse effects to compounds like tebufenozide that induce methemoglobinemia (Centa and others 1985, Das Gupta and others 1980). Some infants with an intolerance to cow’s milk or soy protein exhibit methemoglobinemia. Infants less than 3 months old have lower levels of methemoglobin (cytochrome b5) reductase and higher levels of methemoglobin (1.32 percent) in comparison with older children or adults (Centa and others 1985, Smith 1996). A similar pattern is seen in many species of mammals (Lo and Agar 1986).

Risk to Nontarget Organisms (Issue 2).

Under normal conditions of use at the highest anticipated application rate, no effects are expected in any group of organisms: vertebrates, invertebrates, or plants.

Mammals.

Several standard toxicity studies in experimental mammals were conducted as part of the registration process for tebufenozide. The most sensitive effect in several species of experimental mammals involves effects on the blood, specifically the formation of methemoglobin.

The acute toxicity of tebufenozide is relatively low, with an oral LD_{50} greater than 5,000 mg/kg. The subchronic and chronic toxicity studies on tebufenozide were conducted in dogs, mice, and rats, with the most sensitive effects involving changes to the blood. There is no apparent dose-duration relationship for tebufenozide; short-term exposures are likely to lead to changes in the blood comparable to those observed following longer-term exposures (Appendix J).

Birds.

Toxicity studies have been conducted on the acute toxicity and reproductive effects of tebufenozide in birds, and a field study is available on reproductive effects. The acute toxicity of tebufenozide is low for birds (Appendix J).

Reproduction studies were conducted in mallard ducks (Beavers and others 1993a) and bobwhite quail (Beavers and others 1993b, Reinert 1995a). Dietary concentrations less than or equal to 1,000 ppm tebufenozide did not cause reproductive effects in mallard ducks. In the quail studies results are inconsistent. In a study by Beavers and others (1993b), reproductive effects included reduced numbers of eggs laid, viable embryos, and 14-day-old survivors, at dietary concentrations of 300 and 1,000 ppm, but not at 100 ppm. A similar study yielded no substantial dose-related effects in quail exposed to dietary concentrations of up to 615 ppm (Reinert 1995a).

A field study on the reproductive performance of Tennessee warblers (*Vermivora peregrina*) in forests treated with tebufenozide has been published (Holmes 1998). In this study, tebufenozide was applied twice at a rate of approximately 0.06 lb a.i./acre with a 4-day interval between applications, in a forest area in Ontario, Canada. Reproductive parameters assayed included number of eggs laid, percent hatch, and growth of the hatchlings as compared with an untreated control plot. A total of six nests were observed in the control plot, and five nests were treated with tebufenozide in the test plots, with no statistically significant adverse effects noted. However, there were decreases in both the average number of eggs per nest (6.3 in the control area and 5.8 in the treated area) as well as the percent hatch (97.4 percent in the control area and 89.7 percent in the treated area). The small sample sizes result in a low statistical power, and the results are "suggestive, although not necessarily compelling, that reproductive parameters were consistently lower in the treated blocks than in the control block" (Holmes 1998, p. 191). Some differences in adult behavior were observed in the plot treated with tebufenozide, such as an increase in foraging time and an associated decrease in brooding time. This suggests that the primary effect on the birds may have been a decrease in food abundance.

This field study by Holmes (1998) combined with the bobwhite quail assay conducted by Beavers and others (1993b) raise concern that tebufenozide could cause adverse reproductive effects in birds. This concern is addressed quantitatively in the risk assessment in Appendix J for exposures involving the consumption of contaminated vegetation, fish, and insects.

Terrestrial Invertebrates.

While tebufenozide will be specifically used by the USDA Forest Service for the control of the gypsy moth, tebufenozide is effective in controlling other pest species, including the apple bud moth (*Platynota idaeusalis*) (Biddinger and others 1998), various species of spruce budworm (Payne and others 1997; Retnakaran and others 1997a, b), and the Indian-meal moth (*Plodia interpunctella*) (Oberlander and others 1998). A complete list of the pest species for which tebufenozide is specified is provided in U.S. EPA (1999e).

The toxicity of tebufenozide has been assayed in several species, and the mechanism of action of tebufenozide in target insects is relatively well understood. Tebufenozide mimics the action of the invertebrate hormone 20-hydroxyecdysone, which controls molting in insects and various terrestrial and aquatic invertebrates by binding to species-specific ecdysone receptors present in the cytoplasm of epidermal cells (Addison 1996, Keller 1998, Smagghe and Degheele 1994a, U.S. EPA 1999e).

While 20-hydroxyecdysone is a hormone common to many invertebrates, the effectiveness of tebufenozide in mimicking 20-hydroxyecdysone activity seems to vary among orders and species of invertebrates. Although the specificity of tebufenozide is not addressed in detail in the recent U.S. EPA (1999e) ecological risk assessment, it was reviewed in detail by Rohm and Haas (Keller 1998). That review is consistent with publications in the open literature relating to species specificity of tebufenozide (Addison 1996; Biddinger and Hull 1995; Biddinger and others 1998; Brown 1996; Butler and others 1997; Dhadialla and others 1998; Rumpf and others 1998; Smagghe and others 1996; Valentine and others 1996). In general, Lepidoptera are sensitive to tebufenozide, but other insects are much less sensitive (Smagghe and Degheele 1994a). The differing levels of sensitivity appear to be related to differences in ecdysone receptor binding (Smagghe and others 1996) rather than differences in pharmacokinetics (Smagghe and Degheele 1994b).

There are four studies regarding the effects of tebufenozide on terrestrial invertebrates under field or field-simulation conditions. Three of these studies are published (Addison 1996, Butler and others 1997b, Valentine and others 1996), and one is an unpublished study conducted by Rohm and Haas (Walgenbach 1995). The studies by Addison (1996) and Butler and others (1997b) are most directly relevant to the risk assessment in Appendix J, because they assayed the effects on nontarget invertebrates in the forest canopy (Butler and others 1997b) and forest soil (Addison 1996) after the application of tebufenozide.

In the study by Addison (1996), tebufenozide was incorporated into forest soil at a concentration of 72.1 ppm. Based on a typical application rate of 70 g/ha and the assumption that tebufenozide will remain in the top 2 cm of soil, Addison (1996) estimated that the soil concentration of 72.1 ppm is equivalent to a concentration that is 100 times greater than expected environmental concentrations. There were no adverse effects on one species of earthworm (*Dendrobaena octaedra*) or on four species of Collembola (*Folsomia candida, Folsomia nivalis, Onychiurus parvicornis, and Hypogastrura pannosa*), which are indigenous to forest soils in Canada and the northern United States.

Consistent with results of the Addison (1996) study, a standard bioassay on earthworms (*Eisenia foetida*) noted no adverse effects at soil concentrations of up to 1,000 ppm over a 14-day exposure period (Garvey 1992).

Butler and others (1997b) conducted a study on canopy arthropods in which tebufenozide was applied at rates of 0.03 and 0.06 lb a.i./acre to a mixed oak plot in Ohio. The investigators examined the efficacy of tebufenozide against gypsy moth larvae and its effects on nontarget arthropods. Population assays included measures of abundance and diversity in 10 arthropod families and 15 lepidopteran species. A decrease in abundance was noted in some lepidopteran species, while no effects on abundance or richness were noted in any organisms other than lepidopteran species.

The studies by Valentine and others (1996) and Walgenbach (1995) involve the application of tebufenozide formulations to apple orchards. Tebufenozide had no effects on species of mites, spiders, various beetles (Coleoptera), and true bugs (Hemiptera), after being applied to apple orchards at rates effective in controlling lepidopteran pest species (Valentine and others 1996). Similarly, Walgenbach (1995) noted no effects on beneficial insect populations. These two studies support the general conclusion that tebufenozide is likely to have an adverse impact on Lepidoptera, but not on nonlepidopteran species.

Fish.

Information on the toxicity of tebufenozide to fish is summarized in Appendix J. All of the available studies were conducted in support of the registration of tebufenozide and submitted to the U.S. EPA.

The acute toxicity of tebufenozide to fish is relatively low with LC_{50} values of 3.0 mg a.i./L in bluegill sunfish (Graves and Smith 1992b) and 5.7 mg a.i./L in rainbow trout (Graves and Smith 1992c). There is greater concern, however, regarding the potential chronic toxicity of tebufenozide to fish. The U.S.

EPA evaluates all studies like those summarized in Appendix J to determine whether the conclusions are consistent with the data, and in many instances the U.S. EPA accepts the study conclusions. For tebufenozide, however, the U.S. EPA has disagreed with conclusions for a fathead minnow egg and fry study as well as a fathead minnow full life cycle study. This disagreement is discussed further in the dose-response assessment (section 4.3.3.1 of Appendix J).

Aquatic Invertebrates.

Unpublished studies on the toxicity of tebufenozide to aquatic invertebrates submitted to the U.S. EPA in support of the registration of tebufenozide are summarized in Appendix J. Some invertebrate assays were conducted in support of the registration of tebufenozide, and the summaries of these studies in Appendix J are based on a review of the full text copies of the studies submitted to the U.S. EPA. Additional studies published in the open literature are discussed below. Unlike some of the fish studies, the studies on aquatic invertebrates, summarized in Appendix J, were accepted without exception by the U.S. EPA (1999e).

In the studies submitted for registration, the acute toxicity of tebufenozide to *Daphnia* (Crustacea) and midges (Insecta) is on the same order as that for fish, with a 48-hour LC_{50} value of 3.8 mg/L for daphnids (Graves and Smith 1992a) and a 96-hour LC_{50} value of 0.3 mg/L for midge larvae (van der Kolk 1997). Similarly, a study published in the open literature and sponsored by the U.S. Geological Survey reported higher LC_{50} values for Crustacea (17.37 mg/L for *Daphnia* and 5.53 mg/L for *Artemia*) than for two species of mosquitoes (0.92 mg/L for *Aedes aegypti* and 0.15 mg/L for *Aedes taeniorhynchus*) (Song and others 1997).

Kreutzweiser and Thomas (1995) assayed the effects of tebufenozide on aquatic invertebrate communities in lake enclosures. A dose-related decrease in cladoceran abundance was noted, persisting for 1-2 months at the two lower concentrations and for 12-13 months at the two higher concentrations. The decrease in cladoceran abundance was accompanied by an increase in the abundance of rotifers, suggesting that the changes in community structure could be attributable to secondary or trophic effects rather than to toxicity.

Rohm and Haas summarized the results of several field studies or field simulation studies (Kreutzweiser and others 1994, 1995) regarding the effects of tebufenozide on aquatic invertebrates (Keller 1998).

Cumulative Effects of Tebufenozide.

Risk to Human Health (Issue 1).

Tebufenozide and diflubenzuron could have a cumulative effect on methemoglobinemia. USDA gypsy moth management programs do not use these two chemicals together in the same area at the same time; however, tebufenozide might be applied to the same area in multiple years for eradication projects. These multiple applications of tebufenozide over a period of time may increase the potential risk of methemoglobinemia. Exposure to other methemoglobinemia-inducing compounds in the environment may contribute to a cumulative effect. For example, individuals exposed to combustion smoke or carbon monoxide (agents causing oxidative damage to blood) in addition to exposure to tebufenozide may be at increased risk of developing methemoglobinemia. Individuals exposed to high levels of nitrates, either in air or in water, demonstrate increased levels of methemoglobin and may be at increased risk with exposure to compounds such as tebufenozide.

Risk to Nontarget Organisms (Issue 2).

Tebufenozide generally would not be used in conjunction with other treatments; however, it might be applied to the same area in multiple years for eradication projects. Generally these areas are small (usually no more than 5,000 acres). As used in USDA gypsy moth treatment projects, tebufenozide might have a cumulative effect on nontarget caterpillars of moths and butterflies by potentially reducing their populations, but it will not affect other aquatic and terrestrial species.

4.10 Consequences of Adding a New Treatment Under Alternative 3.

At this time a prediction can not be made as to what new treatments might become available in the future for the gypsy moth. Given the protocol built into Alternative 3 (see Chapter 2), the effects and cumulative effects associated with any treatment(s) would pose no greater risk to human health and nontarget organisms than are disclosed in this SEIS for the currently approved treatments and for tebufenozide.

4.11 Summary of Effects Including Cumulative Effects.

Risk to Human Health (Issue 1).

General.
During a gypsy moth outbreak, people are exposed to large numbers of gypsy moths and experience skin and eye irritation and respiratory system effects, sometimes to the extent that they may seek medical treatment. Although both *B.t.k.* and Gypchek may also cause these effects, these irritations most likely will be less intense than irritations from a gypsy moth outbreak. No other human health effects are plausible for Gypchek; for disparlure, no human health risks could be identified, the only effect being the nuisance of male moths attracted to people working with traps that contain the female gypsy moth sex pheromone, disparlure.

No human health effects are likely from exposure to diflubenzuron and tebufenozide at application rates used in USDA gypsy moth projects. With very high exposures, increases in methemoglobin, an abnormal blood pigment that reduces the oxygen-carrying capacity of the blood, might be detectable for both insecticides. Should high application rates (0.12 lbs/acre in two applications 3 days apart) of tebufenozide be used, ingestion of tebufenozide becomes a concern. For example, on contaminated fruit, the upper range for the HQ of 1.5 is for long-term consumption of fruit *(Table 4-2)*. Applications at these high levels are not likely to occur in USDA projects.

The risk posed by dichlorvos is greatest for people who might tamper with traps and receive high levels of dermal exposure, or who might ingest the insecticide strip contained in the trap (*Table 4-2).* The upper range of the HQ of 380 depicts a child ingesting a dichlorvos strip. This scenario has never been encountered in USDA projects.

Cumulative Effects.
Repeated defoliation over successive years by gypsy moth caterpillars increases the potential exposure and subsequent skin, eye, and respiratory reactions. All of the treatments would reduce this risk over time. Diflubenzuron and tebufenozide both evoke the formation of methemoglobin; however, these treatments would not be utilized at the same time in the same area. Improper handling of dichlorvos poses a cumulative risk to workers, especially if ventilation is inadequate and proper handling procedures are not followed.

Risk to Nontarget Organisms (Issue 2).

General.
Other than effects on trees, current data and literature on the gypsy moth reveal only minor effects on other terrestrial and aquatic organisms; studies were in many cases of short duration and evaluated only a segment of the ecosystem or only a few species. There is a general lack of long-term, multi-year studies measuring over decades the impact of the gypsy moth on terrestrial and aquatic species and ecosystems. This deficiency of extended studies may mask and underestimate the long-term impacts of gypsy moth on terrestrial and

aquatic systems. Gypchek, mass trapping (dichlorvos), and disparlure have no long- or short-term effects on nontarget terrestrial species; all hazard quotients are less than 0.01 *(Table 4-2)*. Gypchek and dichlorvos in USDA treatment projects do not affect aquatic nontarget organisms. The highest calculated disparlure hazard quotient in any aquatic organism is 0.37 (some small aquatic invertebrates). Under normal conditions of USDA gypsy moth management projects, disparlure is not expected to impact aquatic organisms.

B.t.k. applications impact certain spring-feeding butterflies and moths. Many lepidopteran species are not affected, especially those not present in the treated foliage and species arriving in treatment areas after the *B.t.k.* has disappeared from the foliage.

Compared with any of the other treatments, diflubenzuron affects a greater variety of terrestrial and aquatic nontarget species: moths and butterflies, grasshoppers, parasitic wasps, aquatic insects, bottom-dwelling crustaceans, and immature free-floating crustaceans (*Table 4-2*).

Tebufenozide affects only Lepidopterans, having no other expected significant effect on other terrestrial species or aquatic invertebrates (*Table 4-2*). There is no expectation that tebufenozide would be used at the highest application rates in USDA treatment projects; as a result the hazard quotient derived from a mammal eating contaminated fruit is likely to be lower than 1.5 (*Table 4-2*).

Cumulative Effects.

Repeated spraying with *B.t.k.*, diflubenzuron, or tebufenozide is likely to decrease lepidopteran species populations if the same areas are sprayed over 2 or more years. An expected result of cumulative impact on sensitive lepidopteran species from repeated annual spraying with any of these treatments is reasonable, as is the expectation that repeated annual spraying with diflubenzuron would have a cumulative impact on aquatic organisms if this insecticide reached aquatic ecosystems.

4.12 Operational Flexibility of Treatments.

In order to minimize possible effects on threatened and endangered species that may be present in areas proposed for treatment, for example, Gypchek, mass trapping, and mating disruption (where appropriate) could be selected instead of using *B.t.k.*, diflubenzuron, or tebufenozide.

Tebufenozide (Alternative 2) provides the USDA National Gypsy Moth Management Program with an additional treatment option that may prove useful for reducing the threat posed by gypsy moth outbreaks. Alternative 3 affords the greatest flexibility to the National Gypsy Moth Management Program.

4.13 Unavoidable Adverse Effects.

Since this SEIS is programmatic in nature, no unavoidable adverse effects were identified for any of the alternatives. Any adverse effects that might occur would be identified and addressed in environmental analyses at the site-specific project level.

4.14 Short-Term Uses and Long-Term Productivity.

The National Environmental Policy Act (NEPA) requires consideration of “the relationship between short-term uses of man’s environment and the maintenance and enhancement of long-term productivity” (42 U.S.C. 4322 (2)(C)). As declared by the Congress, this relationship includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (NEPA Section 101).

The gypsy moth threatens the forest resources in the United States both in the short and long term, as described in Section 4.3 and in Appendix L. Each alternative provides treatments to lessen and delay the impacts of the gypsy moth on these forest resources. Alternative 2 provides an additional treatment and increased operational flexibility for gypsy moth treatment projects. Alternative 3 provides the greatest operational flexibility for gypsy moth treatment projects. Although the treatments may have short-term effects as outlined in Sections 4.4 – 4.9 and *Table 4-2*, no long-term effect could be identified—except for *B.t.k.* where sensitive spring lepidopteran species may take longer to recover. Mitigation measures at the site-specific project level will reduce the short- and long-term impacts of the treatments for each of the alternatives.

4.15 Measures to Mitigate Adverse Environmental Impacts.

Given the variety of places and circumstances where gypsy moth projects could be implemented, it will be necessary to develop and implement specific mitigation measures for each project. Mitigation measures will be developed and implemented on a site-specific basis for each project based on local conditions and concerns. See Chapter 2 for mitigation measures.

4.16 Urban Quality, Historic and Cultural Resources, and Design of the Built Environment.

In-depth, site-specific environmental analyses will be performed for individual projects, as this SEIS is programmatic in nature.

4.17 Energy Requirements and Conservation Potential of Various Alternatives.

All of the alternatives involve energy use, primarily aviation fuel used by aircraft and helicopters for treatment application. Designing spray blocks for efficiency reduces flight time and conserves fuel.

4.18 Natural or Depleted Resource Requirements and Conservation Potential of Various Alternatives.

All alternatives reduce the impact of the gypsy moth on forest resources in protecting forests from gypsy moth outbreaks that may cause tree mortality. Other than the use of air space over treatment areas, with the short-term impacts of aviation noise and limitation of public use during application, no inherent natural or cultural resource requirements exist for the three alternatives. Impacting factors for specific projects will be addressed with site-specific environmental analyses.

4.19 Irreversible and Irretrievable Commitments of Resources.

Irreversible and irretrievable commitments of resources due to the presence of the gypsy moth, defoliation, and specific treatments occur at the project level and are disclosed through site-specific analyses.

4.20 Other Required Disclosures.

NEPA at 40 CFR 1502.25(a) directs “to the fullest extent possible, agencies shall prepare draft environmental impact statements concurrently with and integrated with … other environmental review laws and executive orders.”

Because this SEIS is programmatic in nature, the Forest Service and APHIS will ensure that site-specific consultations will be done as necessary at the project level for the Endangered Species Act (ESA), the National Historic Preservation Act (NHPA), and any other laws, regulations, executive orders, and agency policies that apply.

Chapter 5
Preparers and Contributors

Figure 5-1. Civilian Conservation Corps workers traveled by truck to perform gypsy moth field work.

Chapter 5 Preparers and Contributors

Contents

Figure

Individuals listed as preparers were responsible for developing the content of this document. Contributors shared information and expertise. Those named under Business Operations Staff assembled the document, posted material on the Web, and managed supporting information.

5.1 Preparers.

Interdisciplinary Team

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More than 30 years with the USDA Forest Service Forest Health Protection Program with assignments in Hamden, CT, Delaware, OH, Morgantown, WV, and Newtown Square, PA. Has participated in the preparation of many past gypsy moth environmental impact statements, including most recently serving as the team entomologist for the 1995 EIS, for which this current supplement was prepared. Holds a master's degree in forest entomology (1976) from Duke University and a bachelor's degree in biology (1974) from Wittenberg University.

Julie S. Spaulding, Gypsy Moth Program manager, USDA Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Emergency and Domestic Programs, Riverdale, MD. Assigned SEIS Team co-leader in 2010.

Nine years with the USDA working on forest pest issues. Responsibilities include overseeing the Plant Protection and Quarantine Gypsy Moth Program in addition to working on other forest pests. Spent 8 years working on the Asian Longhorned Beetle Eradication Program. Prior to joining the USDA, worked as an environmental stewardship information coordinator for Syngenta and a regulatory assistant at Zeneca Ag Products. Earned a Master of Science in Environmental Science and Policy from Johns Hopkins University in 2007 and a Bachelor of Science in Entomology from the University of Delaware in 1998.

Joseph L. Cook Supervisory entomologist and SEIS Team leader, USDA Forest Service, Northeastern Area State and Private Forestry, Morgantown, WV.

Five years with the Forest Service and more than 30 years of government service to various agencies and military branches, including the Navy, Army and Marine Corps. Positions held in the fields of natural resources, fisheries, marine biology, forestry, pest management, entomology, wildlife biology, cultural resources management, environmental management and planning. Participated in National Environmental Policy Act document preparation, implementation and administration at the local, regional and national level in a variety of assignments both in the United States and overseas. Served in the U.S. Army (active and reserve) as a medical entomologist. Academic degrees include a Bachelor of Science in Natural Resources from the University of Michigan in 1970, Master of Science in Entomology (Forest Entomology) from the University of Minnesota in 1996, and M.B.A. from University of the Incarnate Word in 1991. Served on the SEIS Team from 2003 to 2008. Left the Forest Service for a new assignment in 2008.

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Ten years with the USDA, including 5 years with APHIS Pest Detection and Management Programs (now Emergency and Domestic Programs) as Gypsy Moth Program manager working to address phytosanitation issues domestically and internationally, focusing on Latin America. Prior to joining the USDA, taught at the university level for 5 years and spent 15 years in overseas programs addressing food production planning and implementation. Academic degrees include a Master of Science in Crop Genetics with a minor in plant pathology from Purdue University, and a doctorate in agricultural genetics with a minor in economics of international development from the University of Tennessee in 1983. Served on the SEIS Team from 2004 to 2010. Retired from APHIS in 2010.

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Three years with the Forest Service, 11 years with the U.S. Navy and U.S. Navy Reserves. Responsibilities included community relations, speech writing, and media relations. Earned a Bachelor of Arts in English from Hampton University in 1994. Served on the SEIS Team from 2004 to 2007. Left the Forest Service in 2007 for a new assignment.

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Six years as an entomologist with the USDA Forest Service and 8 years with the Tennessee Valley Authority (TVA) as contract and Federal employee. Served as TVA's medical entomologist for 2 of these 8 years; responsibilities included monitoring mosquito populations for West Nile Virus, malaria, several strains of encephalitis (EEE, SLE, LAC) and writing the vector chapters for the TVA EIS/Reservoir Operations Study. While serving as environmental scientist for the TVA, his duties included sample collection, evaluation and compliance report composition for TVA Power Plants. While a contract entomologist at the TVA, he assisted in the management of a biological control program for hydrilla and purple loosestrife. Bill also spent 2 years in private industry as a wildlife biologist/forester. He earned a Bachelor of Science in Wildlife Management in 1991 and Master of Science in Entomology in 1993 from West Virginia University. Served on the SEIS Team from 2004 to 2010. In 2010 he was reassigned to the Forest Health Protection Staff.

Mary Ann White Writer-editor, USDA Forest Service, Northeastern Area State and Private Forestry, Morgantown, WV.

Three years with the Forest Service, 6 years on active duty in the U.S. Navy. Received an Associate of Science in Medical Laboratory Technology from The George Washington University in 1979, and bachelor's (1984) and master's (1986) degrees in history from the University of Texas at El Paso. Served on the SEIS Team from 2004 to 2007. Left the Forest Service in 2007 for a new assignment.

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Chapter 6

Mailing List

Figure 6-1. Early aerial gypsy moth treatments were manually released.

Chapter 6 Mailing List

Contents

Figure

This chapter lists agencies, organizations, tribes, libraries, and individuals who requested and were mailed copies of the final supplemental environmental impact statement or who were notified of its availability.

6.1 Federal Agencies

Alabama

Federal Highway Administration
U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ)

Alaska

Federal Aviation Administration
Federal Highway Administration
National Marine Fisheries Service
USDA, APHIS, PPQ
USDA, Forest Service, Alaska Region
USDA, Forest Service, Southeast Alaska and Interior Alaska Field Offices

Arizona

Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, Arizona Zone Office

Arkansas

Federal Highway Administration
USDA, APHIS, PPQ

California

Bureau of Indian Affairs (BIA)
Federal Aviation Administration, Western-Pacific Region
Federal Highway Administration
National Marine Fisheries Service
United States Environmental Protection Agency (U.S. EPA), Region IX
U.S. Army Corps of Engineers, South Pacific Division (CESPD-CMP)
USDA, APHIS, PPQ
USDA, Forest Service, Pacific Southwest Region
USDA, Forest Service, Pacific Southwest Research Station
USDA, Forest Service, Truckee Ranger District

Colorado

Federal Highway Administration
U.S. EPA, Region VIII
USDA, APHIS, PPQ
USDA, Forest Service, Forest Health Technology Enterprise Team
USDA, Forest Service, Gunnison District Ranger’s Office
USDA, Forest Service, Rocky Mountain Region

Connecticut

Federal Highway Administration
USDA, APHIS, PPQ

Delaware

Federal Highway Administration
USDA, Agricultural Research Service (ARS)
USDA, APHIS, PPQ

District of Columbia

Department of Defense (DOD), U.S. Navy, Office of Chief of Naval Operations
Federal Highway Administration
U.S. Coast Guard, Environmental Impact Branch, Marine Environmental and Protection Division (G-MEP)
USDA, Forest Service, Forest Health Protection (FHP)
USDA, Natural Resources Conservation Service (NRCS)
U.S. Department of Energy (DOE), Office of National Environmental Policy Act (NEPA) Policy and Compliance

U.S. Department of the Interior (USDI), Office of Environmental Policy and Compliance
U.S. EPA, Office of Federal Activities

Florida

Federal Highway Administration
National Marine Fisheries Service, Habitat Conservation Division, Southeast Region
USDA, APHIS, PPQ

Georgia

Federal Aviation Administration, Southern Region
Federal Highway Administration
U.S. Army Corps of Engineers, South Atlantic Division (CESAD)
USDA, APHIS, PPQ
USDA, Forest Service, Southern Region
USDA, Forest Service, Southern Research Station
U.S. EPA, Region IV

Hawaii

Federal Highway Administration
U.S. Army Corps of Engineers, Pacific Ocean Division (CEPOD)
USDA, APHIS, PPQ

Idaho

Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, Boise Field Office
USDA, Forest Service, Forest Supervisors' Office
USDA, Forest Service, Payette National Forest, New Meadows District Ranger Office

Illinois

Federal Aviation Administration, Great Lakes Region
Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, Midewin National Tallgrass Prairie
USDA, Forest Service, Mississippi Bluffs Ranger District
USDA, Forest Service, Shawnee National Forest
U.S. EPA, Region V

Indiana

Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, Hoosier National Forest

Iowa

Federal Highway Administration
USDA, APHIS, PPQ

Kansas

Federal Highway Administration
U.S. EPA, Region VII

Kentucky

Federal Highway Administration
USDA, APHIS, PPQ

Louisiana

Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, Southern Research Station

Maine

Federal Highway Administration
USDA, APHIS, PPQ

Maryland

Federal Highway Administration
USDA, ARS
USDA, APHIS, Policy and Program Development/ Environmental Analysis and Documentation (PPD/ EAD)
USDA, APHIS, PPQ
USDA, National Agricultural Library

Massachusetts

Federal Aviation Administration, New England Region
Federal Highway Administration
National Marine Fisheries Service

USDA, APHIS, PPQ
U.S. EPA, Region I

Michigan

Federal Highway Administration
USDA, APHIS, PPQ
USDI, BIA, Forestry
USDI, National Park Service (NPS), Sleeping Bear Dunes National Lakeshore

Minnesota

Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, Northeastern Area State and Private Forestry (NA S&PF), St. Paul Field Office
USDA, Forest Service, Superior National Forest
USDA, Forest Service, Tofte Ranger District, Superior National Forest
USDI, Fish and Wildlife Service (FWS), Minnesota Valley National Wildlife Refuge (NWR)

Mississippi

Federal Highway Administration
U.S. Army Corps of Engineers, Mississippi Valley Division
USDA, APHIS, PPQ
USDA, Forest Service, Southern Hardwoods Laboratory

Missouri

Federal Aviation Administration, Central Region
Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, Mark Twain National Forest

Montana

Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, Lolo National Forest
USDA, Forest Service, Northern Region
USDA, Forest Service, Rocky Mountain Research Station

Nebraska

Federal Highway Administration
USDA, APHIS, PPQ

Nevada

Federal Highway Administration
USDI, BIA, Realty Services

New Hampshire

Federal Highway Administration
USDA, Forest Service, NA S&PF, Durham Field Office

New Jersey

Federal Highway Administration
USDA, APHIS, PPQ

New Mexico

Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, Southwestern Region, Forestry and Forest Health

New York

Federal Aviation Administration, Eastern Region
Federal Highway Administration, New York Division
U.S. Army Corps of Engineers, North Atlantic Division
USDA, APHIS, PPQ
U.S. EPA, Region II

North Carolina

Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, Forestry Sciences Laboratory
USDA, Forest Service, Southern Research Station, FHP

North Dakota

Federal Highway Administration
USDA, APHIS, PPQ

Ohio

Federal Highway Administration

U.S. Army Corps of Engineers, Great Lakes and Ohio Division
USDA, APHIS, PPQ
USDA, Forest Service, Wayne National Forest

Oklahoma

Federal Highway Administration
USDA, APHIS, PPQ

Oregon

Federal Highway Administration
National Marine Fisheries Service, Habitat Conservation Division, Northwest Region
U.S. Army Corps of Engineers, Northwestern Division
USDA, APHIS, PPQ
USDA, Forest Service, Pacific Northwest Region, FHP
USDA, Forest Service, Siuslaw National Forest, Mapleton District Ranger Station

Pennsylvania

USDA, APHIS, PPQ
USDA, Forest Service, Allegheny National Forest
USDI, NPS, Delaware Water Gap National Recreation Area
USDI, NPS, Fort Necessity National Battlefield
USDI, NPS, Northeast Region
U.S. EPA, Region III

Puerto Rico

USDA, APHIS, PPQ
USDA, Forest Service, International Institute of Tropical Forestry

Rhode Island

Federal Highway Administration

South Carolina

Federal Highway Administration
USDA, APHIS, PPQ

South Dakota

Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, Rocky Mountain Region, Forest Health Management

Tennessee

Federal Highway Administration
Tennessee Valley Authority
USDA, APHIS, PPQ
USDI, BIA
USDI, NPS, Great Smoky Mountains National Park

Texas

Federal Aviation Administration, Southwest Region
Federal Highway Administration
U.S. Army Corps of Engineers, Southwestern Division
USDA, APHIS, PPQ
U.S. EPA, Region VI

Utah

Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, FHP
USDA, Forest Service, Intermountain Region, State and Private Forestry (S&PF)

Vermont

Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, Green Mountain and Finger Lakes National Forests

Virginia

Federal Highway Administration
USDA, APHIS, PPQ

Washington

Federal Aviation Administration, Northwest Mountain Region
Federal Highway Administration
USDA, APHIS, PPQ
U.S. EPA, Region X

West Virginia

Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, Forest Health Technology Enterprise Team
USDA, Forest Service, Monongahela National Forest
USDA, Forest Service, NA S&PF, FHP
USDA, Forest Service, Timber and Watershed Laboratory

Wisconsin

Federal Highway Administration
USDA, APHIS, PPQ
USDA, Forest Service, Eastern Region

Wyoming

Federal Highway Administration
USDA, APHIS, PPQ

6.2 State and Local Agencies, including Puerto Rico

Alabama

Department of Agriculture and Industries
Forestry Commission

Alaska

Department of Natural Resources, Division of Agriculture
Division of Forestry

Arizona

Department of Agriculture
Game and Fish Department
State Forestry Division

Arkansas

Forestry Commission
Division of Plant Industry

California

Department of Food and Agriculture
Department of Forestry and Fire Protection

Colorado

Department of Agriculture
State Forest Service

Connecticut

Division of Forestry
The Connecticut Agricultural Experimental Station

Delaware

Department of Agriculture
Forest Service

District of Columbia

District Department of Transportation
District Department of Transportation, Urban Forestry Administration

Florida

Department of Agriculture and Consumer Services
Division of Forestry

Georgia

Department of Agriculture
Forestry Commission

Hawaii

Department of Agriculture
Division of Forestry and Wildlife

Idaho

Department of Agriculture
Department of Lands, North Operations
Department of Lands, South Operations
Owyhee County Natural Resources Committee

Illinois

Department of Agriculture

Department of Agriculture, Bureau of Environmental Programs
Department of Natural Resources (DNR)
DNR, Division of Forestry
University of Illinois Extension, Boone County
University of Illinois Extension, Winnebago County

Indiana

DNR, Division of Entomology and Plant Pathology
DNR, Division of Forestry
DNR, Vallonia State Nursery
Purdue University Cooperative Extension Service (CES), Scott County Office
Purdue University CES, Vermillion County Office

Iowa

Department of Agriculture and Land Stewardship
DNR
Iowa State University, Howard County Extension
Iowa State University, Mills County Extension

Kansas

Department of Agriculture
Forest Service

Kentucky

Department of Fish and Wildlife Resources
Division of Forestry

Louisiana

Department of Agriculture and Forestry

Maine

Department of Agriculture
Forest Service

Maryland

Department of Agriculture, Forest Pest Management
Department of Agriculture, Plant Protection and Weed Management Section
DNR, Forest Service

Massachusetts

Department of Agricultural Resources
Department of Conservation and Recreation (DCR), State Parks and Recreation Division

Michigan

Bay County Gypsy Moth Program
Bloomfield Township
Department of Agriculture
DNR, Forest Management Division
Gladwin County Gypsy Moth Program Coordinator
Macomb County Gypsy Moth Suppression Program
Midland County Gypsy Moth Suppression Program
Montcalm County, Michigan State University Extension
Ottawa Conservation District Gypsy Moth Coordinator
Roscommon County Gypsy Moth Suppression Program
Van Buren County, Michigan State University Extension

Minnesota

Anoka County, Bunker Hills Activity Center
Department of Agriculture
DNR, Division of Forestry
Itasca County, University of Minnesota Extension Service

Mississippi

Department of Agriculture and Commerce, Bureau of Plant Industry
Forestry Commission

Missouri

Department of Agriculture
Department of Agriculture, Forest Resources
Department of Conservation
DNR

Montana

Department of Agriculture, Agricultural Sciences Division

Department of Natural Resources and Conservation (DNRC), Forestry Division

Nebraska

Department of Agriculture, Bureau of Plant Industry
Forest Service

Nevada

Department of Agriculture, Division of Plant Industry
Division of Forestry

New Hampshire

Department of Agriculture, Markets, and Food, Division of Plant Industry
Division of Forests and Lands

New Jersey

Department of Agriculture, Plant Industry Division
Forestry Service

New Mexico

Department of Agriculture, Bureau of Entomology and Nursery Industries
Forestry Division

New York

Cornell University, Delaware County Cooperative Extension Resource Center
Cornell University Extension
Department of Agriculture and Markets, Division of Plant Industry
Department of Health
Orange County Department of Parks, Recreation, and Conservation
Orleans County, Cornell Cooperative Extension
State Department of Environmental Conservation (SDEC)
Town of Mamaroneck, Conservation Department

North Carolina

Department of Agriculture and Consumer Services, Plant Industry Division
Division of Forest Resources

North Dakota

Department of Agriculture
Forest Service

Ohio

Cleveland Metroparks
Department of Agriculture, Division of Plant Industry, Gypsy Moth Program
Department of Agriculture, Division of Plant Industry, Plant Pest Control Section
Division of Forestry
Ohio State University Extension

Oklahoma

Department of Agriculture, Food, and Forestry, Consumer Protection Services Division
Department of Agriculture, Food, and Forestry, Forestry Services

Oregon

Department of Agriculture
Department of Forestry
Urban Forestry, City of Eugene, Parks and Open Space Division

Pennsylvania

Department of Agriculture
Department of Conservation and Natural Resources (DCNR), Bureau of Forestry, Forest Pest Management Division
DCNR, Bureau of Forestry, State Forester’s Office

Puerto Rico

Department of Agriculture
Department of Natural and Environmental Resources

Rhode Island

Department of Environmental Management (DEM), Division of Agriculture and Resource Marketing, Chief's Office
DEM, Division of Agriculture and Resource Marketing, Plant Industry Section
Division of Forest Environment

South Carolina

Department of Plant Industry
Forestry Commission

South Dakota

Department of Agriculture
Division of Resource Conservation and Forestry

Tennessee

Department of Agriculture, Division of Forestry
Department of Agriculture, Division of Regulatory Services

Texas

Department of Agriculture
Forest Service

Utah

Department of Agriculture and Food, Division of Plant Industry
Department of Natural Resources

Vermont

Agency of Agriculture
Department of Forests, Parks, and Recreation

Virginia

Craig County Cooperative Extension Service (CES)
Department of Agriculture and Consumer Services (DACS), Gypsy Moth Slow the Spread (STS) Program
DACS, Plant Industry Services
Department of Forestry
Dinwiddie County CES
Isle of Wight County CES
Spotsylvania County CES

Washington

Department of Agriculture, Pest Program
DNR
DNR, Resource Protection Division
DNR, Washington State Forester
Public Health – Seattle and King County
Washington State Parks and Recreation Commission (WSPRC)

West Virginia

Department of Agriculture, Plant Industries Division
Division of Forestry
DNR

Wisconsin

Burnett County Land and Water Conservation Department (LWCD)
Department of Agriculture
DNR, Division of Forestry
DNR, Division of Forestry, South Central Region Gypsy Moth Suppression Program
DNR, Division of Forestry, State Forester's Office
DNR, Division of Forestry, West Region Gypsy Moth Suppression Program
Fond du Lac County, University of Wisconsin Extension
Portage County Office, University of Wisconsin Extension
Walworth County Land Use and Resource Management (LURM)

Wyoming

Department of Agriculture
Department of Agriculture, Technical Services Division
State Forestry Division

6.3 American Indian Nations, Tribes, and Related Agencies

Alabama

Poarch Band of Creek Indians of Alabama

Alaska

Agdaagux Tribe of King Cove
Akiachak Native Community (IRA)
Akiak Native Community (IRA)
Alatna Village
Aleut Community of St. Paul Island
Algaaciq Native Village (St. Mary's)
Allakaket Village
Angoon Community Association (IRA)
Anvik Village
Arctic Village Council (Gwich'in Arctic Village)
Asa'carsarmiut Tribe
Atqasuk Village
Beaver Village Council
Birch Creek Village
Central Council Tlingit and Haida Indian Tribes of Alaska
Chalkyitsik Village
Cheesh-na Tribe
Chevak Native Village
Chickaloon Village Traditional Council
Chignik Lake Village
Chilkat Indian Village (Klukwan) (IRA)
Chilkoot Indian Association
Chinik Eskimo Community (a.k.a. Golovin)
Chitina Traditional Village Council
Chuloonawick Native Village
Circle Native Community (IRA)
Craig Tribal Association (IRA)
Crooked Creek Traditional Council
Curyung Tribal Council
Douglas Indian Association (IRA)
Egegik Village
Eklutna Native Village
Ekwok Village Council
Elim IRA Council
Emmonak Village
Evansville Tribe
Gambell IRA Council
Gulkana Village
Gwichyaa Zhee Gwichi'in Tribal Government (Fort Yukon [IRA])
Healy Lake Traditional Council
Holy Cross Village
Hoonah Indian Association (IRA)
Hughes Village
Huslia Village Council
Hydaburg Cooperative Association (IRA)
Igiugig Village
Inupiat Community of Arctic Slope (IRA)
Iqurmiut Traditonal Council
Ivanoff Bay Tribe
Kaguyak Village
Kaktovik Village
Kenaitze Indian Tribe
Ketchikan Indian Community
King Island Native Community
King Salmon Tribe
Klawock Cooperative Association (IRA)
Knik Tribal Council
Kobuk Traditional Council
Kokhanok Village
Kongiganak Traditional Council
Koyukuk Native Village
Larsen Bay Tribal Council
Leisnoi Village (a.k.a. Woody Island)
Levelock Village
Lime Village Traditional Council
Louden Tribal Council
Manley Village Council
Manokotak Village
Mary's Igloo Traditional Council
McGrath Native Village Council
Mentasta Traditional Tribal Council
Metlakatla Indian Community
Naknek Native Village Council
Native Tribe of Kanatak
Native Village of Afognak
Native Village of Akhiok

Native Village of Akutan
Native Village of Aleknagik
Native Village of Alakanuk
Native Village of Alatna
Native Village of Ambler
Native Village of Atka
Native Village of Barrow
Native Village of Belkofski
Native Village of Brevig Mission
Native Village of Buckland (IRA)
Native Village of Cantwell
Native Village of Chenega
Native Village of Chignik Lagoon
Native Village of Chitina
Native Village of Chuathbaluk
Native Village of Council
Native Village of Deering (IRA)
Native Village of Diomede (IRA) (Inalik)
Native Village of Eagle (IRA)
Native Village of Eek
Native Village of Ekuk
Native Village of Eyak
Native Village of False Pass
Native Village of Fort Yukon
Native Village of Gakona
Native Village of Georgetown
Native Village of Goodnews Bay
Native Village of Hamilton
Native Village of Hooper Bay
Native Village of Karluk (IRA)
Native Village of Kasigluk
Native Village of Kiana
Native Village of Kipnuk
Native Village of Kivalina (IRA)
Native Village of Kluti-Kaah (Copper Center)
Native Village of Kotzebue (IRA)
Native Village of Koyuk (IRA)
Native Village of Kwigillingok
Native Village of Kwinhagak (IRA)
Native Village of Marshall
Native Village of Mekoryuk (IRA)
Native Village of Minto (IRA)
Native Village of Nanwalek (English Bay)
Native Village of Napaimute
Native Village of Napakiak (IRA)
Native Village of Napaskiak
Native Village of Nightmute
Native Village of Nikolski (IRA)
Native Village of Noatak (IRA)
Native Village of Nuiqsut
Native Village of Nunam Iqua
Native Village of Nunapitchuk (IRA)
Native Village of Ouzinkie
Native Village of Paimiut
Native Village of Perryville
Native Village of Pitka’s Point
Native Village of Point Hope (IRA)
Native Village of Point Lay (IRA)
Native Village of Port Heiden
Native Village of Port Lions
Native Village of Port Lions, Environmental Department
Native Village of Ruby Tribal Council
Native Village of Saint Michael (IRA)
Native Village of Savoonga (IRA)
Native Village of Shaktoolik (IRA)
Native Village of Shishmaref (IRA)
Native Village of Shungnak (IRA)
Native Village of South Naknek
Native Village of Stevens (IRA)
Native Village of Tanana (IRA)
Native Village of Tatitlek (IRA)
Native Village of Tazlina
Native Village of Tetlin (IRA)
Native Village of Tyonek (IRA)
Native Village of Unalakleet (IRA)
Native Village of Venetie Tribe (IRA)
Native Village of Wales (IRA)
Native Village of White Mountain (IRA)
Nelson Lagoon Tribal Council
Nenana Native Association
New Koliganek Village Council
New Stuyahok Village
Newhalen Village
Newtok Traditional Council
Nikolai Village Council

Ninilchik Traditional Council
Nome Eskimo Community
Nondalton Village
Noorvik Native Community (IRA)
Northway Village
Nulato Tribal Council
Nunakauyarmiut Tribe
Ohogamiut Traditional Council
Organized Village of Grayling (IRA)
Organized Village of Kake (IRA)
Organized Village of Kasaan (IRA)
Organized Village of Kwethluk (IRA)
Organized Village of Saxman (IRA)
Orutsararmuit Native Council
Oscarville Tribal Council
Pauloff Harbor Village
Pedro Bay Village Council
Petersburg Indian Association (IRA)
Pilot Point Tribal Council
Pilot Station Traditional Village
Platinum Traditional Village Council
Port Graham Village Council
Portage Creek Village Council
Qagan Tayagungin Tribe of Sand Point Village
Qawalangin Tribe of Unalaska
Rampart Village
Saint George Island
Scammon Bay Traditional Council
Selawik IRA Council
Seldovia Village Tribe (IRA)
Shageluk Native Village (IRA)
Sitka Tribe of Alaska (IRA)
Skagway Traditional Council
Sleetmute Traditional Council
Solomon Traditional Council
Stebbins Community Association (IRA)
Sun’aq Tribe of Kodiak
Takotna Village
Tanacross Village Council
Telida Village
Teller Traditional Council
Traditional Village of Togiak
Tuluksak Native Community (IRA)
Tuntutuliak Traditional Council
Tununak IRA Council
Twin Hills Village Council
Ugashik Traditional Village Council
Umkumiut Native Village
Unga Tribal Council
Venetie Village Council
Village of Alakanuk
Village of Anaktuvuk Pass
Village of Aniak
Village of Atmautluak
Village of Bill Moore’s Slough
Village of Chefornak
Village of Clarks Point
Village of Dot Lake
Village of Iliamna
Village of Kalskag
Village of Kaltag
Village of Kotlik
Village of Lower Kalskag
Village of Old Harbor
Village of Red Devil
Village of Salamatoff
Village of Stony River
Village of Wainwright
Wrangell Cooperative Association (IRA)
Yakutat Tlingit Tribe
Yupiit of Andreafski

Arizona

Ak Chin Indian Community of Maricopa Indian Reservation
Cocopah Tribe of Arizona
Colorado River Indian Tribes of the Colorado River Indian Reservation
Fort McDowell Yavapai Nation
Gila River Indian Community of the Gila River Indian Reservation
Havasupai Tribe of the Havasupai Reservation
Hopi Tribe of Arizona
Hualapai Indian Tribe of the Hualapai Indian Reservation

Kaibab Band of Paiute Indians of Kaibab Indian Reservation
Navajo Nation
Pascua Yaqui Tribe of Arizona
Quechan Tribe of Fort Yuma Indian Reservation
Salt River Pima-Maricopa Indian Community of the Salt River Reservation
San Carlos Apache Tribe of the San Carlos Reservation
San Juan Southern Paiute Tribe of Arizona
Tohono O'odham Nation of Arizona
Tonto Apache Tribe of Arizona
White Mountain Apache Tribe of the Fort Apache Reservation
Yavapai-Apache Nation of the Camp Verde Indian Reservation
Yavapai-Prescott Tribe of the Yavapai Reservation

California

Agua Caliente Band of Cahuilla Indians of the Agua Caliente Indian Reservation
Alturas Indian Rancheria
Augustine Band of Cahuilla Indians
Barona Group of Capitan Grande Band of Mission Indians of the Barona Reservation
Bear River Band of the Rohnerville Rancheria
Berry Creek Rancheria of Maidu Indians of California
Big Lagoon Rancheria
Big Pine Band of Owens Valley Paiute Shoshone Indians of the Big Pine Reservation
Big Sandy Rancheria of Mono Indians of California
Big Valley Band of Pomo Indians of the Big Valley Rancheria
Blue Lake Rancheria
Bridgeport Paiute Indian Colony of California
Buena Vista Rancheria of Me-Wuk Indians of California
Cabazon Band of Mission Indians
Cachil DeHe Band of Wintun Indians of the Colusa Indian Community of the Colusa Rancheria
Cahto Indian Tribe of the Laytonville Rancheria
Cahuilla Band of Mission Indians of the Cahuilla Reservation
California Valley Miwok Tribe
Campo Band of Diegueno Mission Indians of the Campo Indian Reservation
Capitan Grande Band of Diegueno Mission Indians of California
Cedarville Rancheria
Chemehuevi Indian Tribe of the Chemehuevi Reservation
Cher-Ae Heights Indian Community of Trinidad Rancheria
Chicken Ranch Rancheria of Me-Wuk Indians of California
Cloverdale Rancheria of Pomo Indians of California
Cold Springs Rancheria of Mono Indians of California
Cortina Indian Rancheria of Wintun Indians of California
Coyote Valley Band of Pomo Indians of California
Death Valley Timbi-Sha Shoshone Band of California
Dry Creek Rancheria of Pomo Indians of California
Elem Indian Colony of Pomo Indians of the Sulphur Bank Rancheria
Elk Valley Rancheria
Enterprise Rancheria of Maidu Indians of California
Ewiiaapaayp Band of Kumeyaay Indians
Federated Indians of Graton Rancheria
Fort Bidwell Indian Community of the Fort Bidwell Reservation of California
Fort Independence Indian Community of Paiute Indians of the Fort Independence Reservation
Fort Mojave Indian Tribe of Arizona, California and Nevada
Greenville Rancheria of Maidu Indians of California
Grindstone Indian Rancheria of Wintun-Wailaki Indians of California
Guidiville Rancheria of California
Habematolel Pomo of Upper Lake
Hoopa Valley Tribe
Hopland Band of Pomo Indians of the Hopland Rancheria
Iipay Nation of Santa Ysabel
Inaja Band of Diegueno Mission Indians of the Inaja and Cosmit Reservation
Ione Band of Miwok Indians of California

Jackson Rancheria of Me-Wuk Indians of California
Jamul Indian Village of California
Karuk Tribe
Kashia Band of Pomo Indians of the Stewarts Point Rancheria
La Jolla Band of Luiseno Indians
La Posta Band of Diegueno Mission Indians of the La Posta Indian Reservation
Los Coyotes Band of Cahuilla and Cupeno Indians
Lower Lake Rancheria
Lytton Rancheria of California
Manchester Band of Pomo Indians of the Manchester-Point Arena Rancheria
Manzanita Band of Diegueno Mission Indians of the Manzanita Reservation
Mechoopda Indian Tribe of the Chico Rancheria
Mesa Grande Band of Diegueno Mission Indians of the Mesa Grande Reservation
Middletown Rancheria of Pomo Indians of California
Mooretown Rancheria of Maidu Indians of California
Morongo Band of Mission Indians
Northfork Rancheria of Mono Indians of California
Paiute-Shoshone Indians of the Bishop Community of the Bishop Colony
Paiute-Shoshone Indians of the Lone Pine Community of the Lone Pine Reservation
Pala Band of Luiseno Mission Indians of the Pala Reservation
Paskenta Band of Nomlaki Indians of California
Pauma Band of Luiseno Mission Indians of the Pauma and Yuima Reservation
Pechanga Band of Luiseno Mission Indians of the Pechanga Reservation
Picayune Rancheria of Chukchansi Indians of California
Pinoleville Pomo Nation
Pit River Tribe
Potter Valley Tribe
Quartz Valley Indian Community of the Quartz Valley Reservation of California
Ramona Band of Cahuilla
Redding Rancheria
Redwood Valley Rancheria of Pomo Indians of California
Resighini Rancheria
Rincon Band of Luiseno Mission Indians of the Rincon Reservation
Robinson Rancheria of Pomo Indians of California
Round Valley Indian Tribes of the Round Valley Reservation
San Manuel Band of Mission Indians
San Pasqual Band of Diegueno Mission Indians of California
Santa Rosa Band of Cahuilla Indians
Santa Rosa Indian Community of Santa Rosa Rancheria
Santa Ynez Band of Chumash Mission Indians of the Santa Ynez Reservation
Scotts Valley Band of Pomo Indians of California
Sherwood Valley Rancheria of Pomo Indians of California
Shingle Springs Band of Miwok Indians
Smith River Rancheria
Soboba Band of Luiseno Indians
Susanville Indian Rancheria
Sycuan Band of the Kumeyaay Nation
Table Mountain Rancheria of California
Torres Martinez Desert Cahuilla Indians
Tule River Indian Tribe of the Tule River Reservation
Tuolumne Band of Me-Wuk Indians of the Tuolumne Rancheria of California
Twenty-Nine Palms Band of Mission Indians of California
United Auburn Indian Community of the Auburn Rancheria of California
Utu Utu Gwaitu Paiute Tribe of the Benton Paiute Reservation
Viejas (Baron Long) Group of Capitan Grande Band of Mission Indians of the Viejas Reservation
Wilton Rancheria
Wiyot Tribe
Yocha Dehe Wintun Nation
Yurok Tribe of the Yurok Reservation

Colorado

Southern Ute Indian Tribe of the Southern Ute Reservation
Ute Mountain Tribe of the Ute Mountain Reservation

Connecticut

Mashantucket Pequot Tribe of Connecticut
Mohegan Indian Tribe of Connecticut

Florida

Miccosukee Tribe of Indians of Florida
Seminole Nation of Florida

Idaho

Coeur d'Alene Tribe of the Coeur d'Alene Reservation
Kootenai Tribe of Idaho
Nez Perce Tribe
Northwestern Band of Shoshoni Nation of Utah
Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho

Iowa

Sac and Fox Tribe of the Mississippi in Iowa

Kansas

Iowa Tribe of Kansas and Nebraska
Kickapoo Tribe of Indians of the Kickapoo Reservation in Kansas
Prairie Band of Potawatomi Nation
Sac and Fox Nation of Missouri in Kansas and Nebraska

Louisiana

Chitimacha Tribe of Louisiana
Coushatta Tribe of Louisiana
Jena Band of Choctaw Indians
Tunica-Biloxim Indian Tribe of Louisiana

Maine

Aroostook Band of Micmacs Indians of Maine
Houlton Band of Maliseet Indians of Maine
Passamaquoddy Tribe of Maine
Penobscot Tribe of Maine

Massachusetts

Mashpee Wampanoag Tribe
Wampanoag Tribe of Gay Head (Aquinnah) of Massachusetts

Michigan

Bay Mills Indian Community
Grand Traverse Band of Ottawa and Chippewa Indians
Gun Lake Tribe
Hannahville Indian Community
Keweenaw Bay Indian Community
Lac Vieux Desert Band of Lake Superior Chippewa Indians
Little River Band of Ottawa Indians
Little Traverse Bay Bands of Odawa Indians
Match-e-be-nash-she-wish Band of Pottawatomi Indians of Michigan
Nottawaseppi Huron Band of the Potawatomi
Pokagon Band of Potawatomi Indians
Saginaw Chippewa Indian Tribe of Michigan
Sault Ste. Marie Tribe of Chippewa Indians of Michigan

Minnesota

Grand Portage Reservation Tribal Council
Lower Sioux Indian Community in the State of Minnesota
Minnesota Chippewa Tribe
Prairie Island Indian Community in the State of Minnesota
Red Lake Band of Chippewa Indians
Shakopee Mdewakanton Sioux Community of Minnesota
Upper Sioux Community

Mississippi

Mississippi Band of Choctaw Indians

Missouri

Eastern Shawnee Tribe of Oklahoma

Montana

Assiniboine and Sioux Tribes of Fort Peck Indian Reservation
Blackfeet Tribe of the Blackfeet Indian Reservation of Montana
Chippewa-Cree Indians of the Rocky Boy's Reservation
Confederated Salish and Kootenai Tribes of the Flathead Reservation
Crow Tribe of Montana
Fort Belknap Indian Community of the Fort Belknap Reservation of Montana
Northern Cheyenne Tribe of the Northern Cheyenne Indian Reservation

Nebraska

Omaha Tribe of Nebraska
Omaha Tribe Wildlife
Ponca Tribe of Nebraska
Santee Sioux Nation
Winnebago Tribe of Nebraska

Nevada

Duckwater Shoshone Tribe of Duckwater Reservation
Ely Shoshone Tribe of Nevada
Fort McDermitt Paiute and Shoshone Tribes of the Fort McDermitt Indian Reservation
Las Vegas Tribe of Paiute Indians of the Las Vegas Indian Colony
Lovelock Paiute Tribe of the Lovelock Indian Colony
Moapa Band of Paiute Indians of the Moapa River Indian Reservation
Paiute-Shoshone Tribe of the Fallon Reservation and Colony
Pyramid Lake Paiute Tribe of the Pyramid Lake Reservation
Reno-Sparks Indian Colony
Shoshone-Paiute Tribes
Shoshone-Paiute Tribes of the Duck Valley Reservation
Summit Lake Paiute Tribe of Nevada
Te-Moak Tribe of Western Shoshone Indians of Nevada
Walker River Paiute Tribe of the Walker River Reservation
Washoe Tribe of Nevada and California
Winnemucca Indian Colony of Nevada
Yerington Paiute Tribe of the Yerington Colony and Campbell Ranch
Yomba Shoshone Tribe of the Yomba Reservation

New Mexico

Jicarilla Apache Nation
Kewa Pueblo (formerly Pueblo of Santo Domingo)
Mescalero Apache Tribe of the Mescalero Reservation
Ohkay Owingeh
Pueblo of Acoma
Pueblo of Cochiti
Pueblo of Isleta
Pueblo of Jemez
Pueblo of Laguna
Pueblo of Nambe
Pueblo of Picuris
Pueblo of Pojoaque
Pueblo of San Felipe
Pueblo of San Ildefonso
Pueblo of Sandia
Pueblo of Santa Ana
Pueblo of Santa Clara
Pueblo of Taos
Pueblo of Tesuque
Pueblo of Zia
Zuni Tribe of the Zuni Reservation

New York

Cayuga Nation of New York
Oneida Nation of New York
Onondaga Nation of New York
Saint Regis Mohawk Tribe
Seneca Nation of New York
Shinnecock Indian Nation
Tonawanda Band of Seneca Indians of New York
Tuscarora Nation of New York

North Carolina

Eastern Band of Cherokee Indians of North Carolina

North Dakota

Spirit Lake Tribe
Standing Rock Sioux Tribe
Three Affiliated Tribes of the Fort Berthold Reservation
Turtle Mountain Band of Chippewa Indians of North Dakota

Oklahoma

Absentee-Shawnee Tribe of Indians of Oklahoma
Alabama-Quassarte Tribal Town
Apache Tribe of Oklahoma
Caddo Nation of Oklahoma
Cherokee Nation
Cheyenne and Arapaho Tribes
Chickasaw Nation
Choctaw Nation of Oklahoma
Citizen Potawatomi Nation
Comanche Nation
Delaware Nation
Delaware Tribe of Indians
Fort Sill Apache Tribe of Oklahoma
Iowa Tribe of Oklahoma
Kaw Nation
Kialegee Tribal Town
Kickapoo Tribe of Oklahoma
Kiowa Indian Tribe of Oklahoma
Miami Tribe of Oklahoma
Modoc Tribe of Oklahoma
Muscogee (Creek) Nation
Osage Nation
Otoe-Missouria Tribe of Indians
Ottawa Tribe of Oklahoma
Pawnee Nation of Oklahoma
Peoria Tribe of Indians of Oklahoma
Ponca Tribe of Indians of Oklahoma
Quapaw Tribe of Indians
Sac and Fox Nation
Seminole Nation of Oklahoma
Seneca-Cayuga Tribe of Oklahoma
Shawnee Tribe
Thlopthlocco Tribal Town
Tonkawa Tribe of Indians of Oklahoma
United Keetoowah Band of Cherokee Indians in Oklahoma
Wichita and Affiliated Tribes
Wyandotte Nation

Oregon

Burns Paiute Tribe of the Burns Paiute Indian Colony of Oregon
Confederated Tribes of Coos, Lower Umpqua and Siuslaw Indians of Oregon
Confederated Tribes of Siletz Indians of Oregon
Confederated Tribes of the Grand Ronde Community of Oregon
Confederated Tribes of the Umatilla Reservation
Confederated Tribes of the Warm Springs Reservation of Oregon
Coquille Tribe of Oregon
Cow Creek Band of Umpqua Indians of Oregon
Klamath Tribes

Rhode Island

Narragansett Indian Tribe of Rhode Island

South Carolina

Catawba Indian Nation

South Dakota

Cheyenne River Sioux Tribe of the Cheyenne River Reservation
Crow Creek Sioux Tribe of the Crow Creek Reservation
Flandreau Santee Sioux Tribe of South Dakota
Lower Brule Sioux Tribe of the Lower Brule Reservation
Oglala Sioux Tribe of the Pine Ridge Reservation
Rosebud Sioux Tribe of the Rosebud Indian Reservation

Sisseton-Wahpeton Oyate of the Lake Traverse Reservation
Yankton Sioux Tribe of South Dakota

Texas

Alabama-Coushatta Tribes of Texas
Kickapoo Traditional Tribe of Texas
Ysleta del Sur Pueblo of Texas

Utah

Confederated Tribes of the Goshute Reservation
Paiute Indian Tribe of Utah
Skull Valley Band of Goshute Indians of Utah
Ute Indian Tribe of the Uintah and Ouray Reservation

Washington

Confederated Tribes and Bands of the Yakama Nation
Confederated Tribes of the Chehalis Reservation
Confederated Tribes of the Colville Reservation
Cowlitz Indian Tribe
Hoh Indian Tribe of the Hoh Indian Reservation
Jamestown S'Klallam Tribe of Washington
Kalispel Indian Community of the Kalispel Reservation
Lower Elwha Tribal Community of the Lower Elawha Reservation
Lummi Tribe of the Lummi Reservation
Makah Indian Tribe of the Makah Indian Reservation
Muckleshoot Indian Tribe of the Muckleshoot Reservation
Nisqually Indian Tribe of the Nisqually Reservation
Nooksack Indian Tribe of Washington
Port Gamble Indian Community of the Port Gamble Reservation
Puyallup Tribe of the Puyallup Reservation
Quileute Tribe of the Quileute Reservation
Quinault Tribe of the Quinault Reservation
Samish Indian Tribe
Sauk-Suiattle Indian Tribe of Washington
Shoalwater Bay Tribe of the Shoalwater Bay Indian Reservation
Skokomish Indian Tribe of the Skokomish Reservation
Spokane Tribe of the Spokane Reservation
Squaxin Island Tribe of the Squaxin Island Reservation
Stillaguamish Tribe of Washington
Suquamish Indian Tribe of the Port Madison Reservation
Swinomish Indians of the Swinomish Reservation
Tulalip Tribes of the Tulalip Reservation
Upper Skagit Indian Tribe of Washington
Snoqualmie Tribe

Wisconsin

Bad River Band of Lake Superior Tribe of Chippewa Indians
Bad River Band of Lake Superior Tribe of Chippewa Indians of the Bad River Reservation
Forest County Potawatomi Community
Ho-Chunk Nation, DNR
Ho-Chunk Nation of Wisconsin
Lac Courte Oreilles Band of Lake Superior Chippewa Indians of Wisconsin
Lac du Flambeau Band of Lake Superior Chippewa Indians of the Lac du Flambeau Reservation of Wisconsin
Menominee Indian Tribe of Wisconsin
Oneida Tribe of Indians of Wisconsin
Red Cliff Band of Lake Superior Chippewa Indians of Wisconsin
Sokaogon Chippewa Community
St. Croix Chippewa Indians of Wisconsin
Stockbridge Munsee Community

Wyoming

Northern Arapaho Tribe of the Wind River Reservation
Shoshone Tribe of the Wind River Reservation

6.4 Organizations

Alabama

Auburn University, Department of Entomology and Plant Pathology

Auburn University, School of Forestry and Wildlife Sciences

Arizona

Center for Biological Diversity
Fort Apache Timber Co.

California

California Forestry Association
Central Sierra Environmental Resource Center
Environmental Protection Information Center
National Plant Board
Sequoia Forest Keeper

Connecticut

Connwood Foresters, Inc.

Delaware

Delaware State University

District of Columbia

Advisory Council on Historic Preservation
National Association of State Foresters (NASF), Washington Office
Susquehanna River Basins Commission

Idaho

Idaho Conservation League
Kootenai Environmental Alliance (KEA)

Illinois

Joliet Junior College, Horticulture
University of Illinois, Natural Resources and Environmental Sciences

Indiana

Dow AgroSciences, LLC
Purdue University, Department of Entomology
Valparaiso University

Iowa

Cascade Forestry Service
Murphy's Walnut Hill Nursery

Kentucky

Ohio River Basin Commission

Michigan

Michigan Nature Association
Michigan State University, Department of Entomology
Northern Hardwoods
Sprinkler Lake Education Center

Missouri

Missouri Native Plant Society
Ozark Chapter Sierra Club

Montana

Scentry Biologicals, Inc.
Wilderness Watch

Nebraska

University of Nebraska, East Campus

New Jersey

Interstate Pest Control Compact
Palisades Nature Association
Weis Ecology Center
Woodwinds Association

New York

Greenbelt Environmental Education Center
Lake George Forestry, Inc.
Nisso America, Inc.
Muttontown Preserve
Trailside Museums and Zoo
Westmoreland Sanctuary

Oregon

Forest Service Employees for Environmental Ethics
Friends of Greensprings

Northwest Center for Alternatives to Pesticides
Northwest Power Planning Council
Ochoco Lumber Co.
Oregon State University
Oregon Tilth, Inc.
Pacific University
The Bulletin
Xerces Society

Pennsylvania

American Forestry Consultants
Asbury Woods Nature Center
Family Campers and RVers National Conservation Program
Hercon Environmental
Open Land Conservancy
Penn Forestry Co., Inc.
Rolling Rock Farms
West Chester University of Pennsylvania, Department of Biology

South Carolina

Newberry College, Biology, Chemistry, and Veterinary Technology Department

Tennessee

Hardwood Forest Foundation
Nisso America, Inc.

Texas

Bat Conservation International

Vermont

University of Vermont, Department of Forestry

Virginia

Virginia Tech University, Department of Entomology

Washington

Inland Empire Paper Co.
Methow Valley News
The Lands Council

West Virginia

Coastal Timberlands Co.
Davis and Elkins College, Department of Biology and Environmental Science
West Virginia University, Division of Plant and Soil Sciences

Wisconsin

Blue Ox Forestry Service, Inc.

6.5 Libraries

Alabama

Baldwin County Library Cooperative

Arkansas

Magale Library, Southern Arkansas University
Pope County Library System

California

Los Angeles Public Library, Central Library
Marian Koshland Bioscience and Natural Resources Library, University of California, Berkeley
San Luis Obispo City-County Library

Colorado

Morgan Library, Colorado State University

Georgia

Dalton State College (DSC) Library
Newton County Library
Thomas County Public Library System

Kentucky

Graves County Public Library
Grayson County Public Library
Jackson County Public Library

Maine

Maine State Library

Maryland

Carroll County Public Library

Massachusetts

Wellesley College Library

Michigan

Benton Harbor Public Library

Minnesota

Forestry Library, University of Minnesota
Library 104, Winona State University

Missouri

Douglas County Public Library
Jefferson County Library
Koshkonong Public Library
New Madrid County Library
Saint Clair County Library

New Hampshire

Nashua Public Library

New Jersey

Monmouth County Library

New York

Albert R. Mann Library, Cornell University

North Carolina

Bladen County Public Library
Wiggins Memorial Library, Campbell University

North Dakota

Chester Fritz Library, University of North Dakota
Valley City/Barnes County Public Library

Ohio

Akron-Summit County Public Library
The College of Wooster Libraries

Oklahoma

J.W. Martin Library, Northwestern Oklahoma State University

Oregon

Paul L. Boley Law Library, Northwestern School of Law

Pennsylvania

Cambria County Library
Lebanon Community Library, Lebanon County Library System
The Life Sciences Library, Penn State University

Texas

Central University Libraries, Southern Methodist University
Newton Gresham Library, Sam Houston State University
Reeves County Library
Yoakum County/Cecil Bickley Library

Utah

Stewart Library, Weber State University

Vermont

Bailey/Howe Library, University of Vermont

Washington

Daniel J. Evans Library, Evergreen State College
University Of Washington Libraries

West Virginia

Marsh Library, Concord University
Monroe County Public Library

Wisconsin

McIntyre Library, University of Wisconsin-Eau Claire
University Library, University of Wisconsin – Stevens Point

Wyoming

Teton County Library

6.6 Individuals

United States

Arizona

David Bertelsen
Walter L. Craig
Robert and Elvia Gillies
Bawden Kayhoe
Kimberly Larsen
Jim Linch
Darryl Martinez
Bob McNichols
Lowanda Pugh
Don Schuster
Marty Solberg

Arkansas

Al and Jane Brooks
Basil Kyriakakis

California

Charles L. Boyce
Mildred Filiberti
R. Gustafson
Jim Rains
Kathy J. Smits
Istvan Toth
Roland Weidenkeller
Wilma Wheeler

Colorado

Kelsey Alexander
Sanford V. Griffin
Scott Leslie
Dorothy E. O'Connell
Robert Porter
David Samples
McKinley Srelaff

Connecticut

William H. Hull
Michael L. McManus
Victoria Lynn Smith

Delaware

Bob Tichner

Idaho

Jerry S. Hamilton
Jim Shake
R. Vaughn Spiker
Lyle Thompson
Jack T. Williams

Illinois

William A. Calvert
John Croft
Mark Papuga
Marion Shier

Indiana

Jeff Burbrink
Mary Day
Greg Koontz
Zachary M. Smith

Iowa

Jerry Chizek
Brian Fankhauser

Kentucky

Marcia K. Carlson
Carl Harper
Bekele Tegegne

Maine

Clifton Foster

Fredrick C. Herrick
Robert Leso
Edwin Rosso
Carl Sjogren

Maryland

Stewart Collis
John Houser
Rolf Hubbe
Margaret Leary
Charles Studyvin
Mark Taylor
Jim Winterberg

Massachusetts

Warren Archey
James Caffrey
Gary Loranger
Michael V. Sikora
Peter Tucker

Michigan

Jim Aherns
Doug Born
Maurice Brackenbury
Sean Dunlap
Brian Kroll
Carol Lenchek
Jack Lockwood
Rose Treppa
Jack C. Tucker
Anne Vaara
Alicia H. Wallace

Minnesota

Steve Cook
Gene Dressely
Ralph H. Olson
Mr. and Mrs. John R. Swanson
Steve Windels

Missouri

Troy Gordon
J. C. Keesey
Tom Robertson
Bob Schultheis
Cora Tridenhocr

Montana

Tom Benedict

New Hampshire

Charles D. Bond
Bruce Jacobs
Bruce Sloat
David A. Thompson

New Jersey

Nancy Coleman
Nicholas Polanin
Jean Public
William H. Thomas

New York

Rick Coughlan
Toru Haneda
Jack J. Karnig
Marianna Quartararo

North Carolina

Kevin Carpenter

North Dakota

John Brauner

Ohio

Lynne Ebel
Mark Goeke
Greg LaBarge
Frank Luppino
Steve McKee
Mark Mechling

Deborah Reed
Chris Richards
Ken Simeral

Oklahoma

Jacob A. Frank

Oregon

Leslie Bensloter
Daniel G. Brown
S. Bulkin
Karen Coulter
Marcia Denison
James B. Eblin
Susan Glarum
Lexie Hallahan
Steve Holmes
Emery Ingham
G. W. Kazda
Elise Ross
Robert Sallinger
Owen Schmidt
L. R. Scofield
Annette K. Simonson-Higinbotham
Donald K. Stroeber
John Thornton
Roberta Ulrich
Roberta Vamdehay
Thomas Wiemann
Dan Wroncy

Pennsylvania

James Angelo
Chris Bobick
Marion R. Deppen
Keith Horn
Mark A. Kane
Timothy R. Marasco
Dave Miller
Timothy S. Murphy
Donald F. Partsch
Larry G. Powell
David Radzavich
Sam Reback
Brian Shema
David Steckel
Norman R. Sunderland

Tennessee

John Guion
Mark Young

Texas

James Heater
Thomas Matthews
Laurie L. York

Utah

Edward Bianco

Vermont

William Kinsley
L. Samuel Miller
Elizabeth S. Mills

Virginia

Corine A. Blank
Jack Edmundson
David R. Gilliam
David Hoyt
Matthias E. Kayhoe
Jim Ruckman
Bjim Smalls
Pat Therrien
Tom Trykowski
Charlotte L. Umboltz

Washington

Susan Bacon
Ray A. Borden
Jenni Cena
Mike Coe
Dean Gaiser

Ron Gregory
Jerolee W. Hickey
John A. Holmberg
Edward J. Johannes
William A. Johns
John Kamerrer
Phil Loe
Louise B.W. Luce
Jim Marra
Linda McDaniel
Richard G. Mewes
Peter Morrison
Chad H. Phillips
Bill Schlagel
B. Smith
Stuart Smythe
John Townsend
John Townsley
Clint G. Watkins
Carol D. Wilcox
Barbara J. Wolf
Bill Yaue

West Virginia

Frank Ames
Jerry Atkins
Thomas Berlin
Matthew J. Blackwood
Kerry Bledsoe
Samuel Cuppett
Edward G. Dauchess
Glen Juergens
Howard D. Moore
Ward C. Moyers
Roy Nutter
Butch Sayers
Douglas N. Toothman

Wisconsin

R. F. Camp
Robert Dahl
Sharon Gaskill
Steve Jackson
Colin Kelley
Chris Lettau
Peter U. Luxenhofer
Parry D. Pierre
Michael J. Smith
Daniel Weiss
Bill Williams

Wyoming

Chris Thomas

Canada

Jon Bell, British Columbia
John Borden, British Columbia
Stephen Nicholson, Ontario

Italy

Alberto Cozzi, Pisa

Chapter 7
Glossary

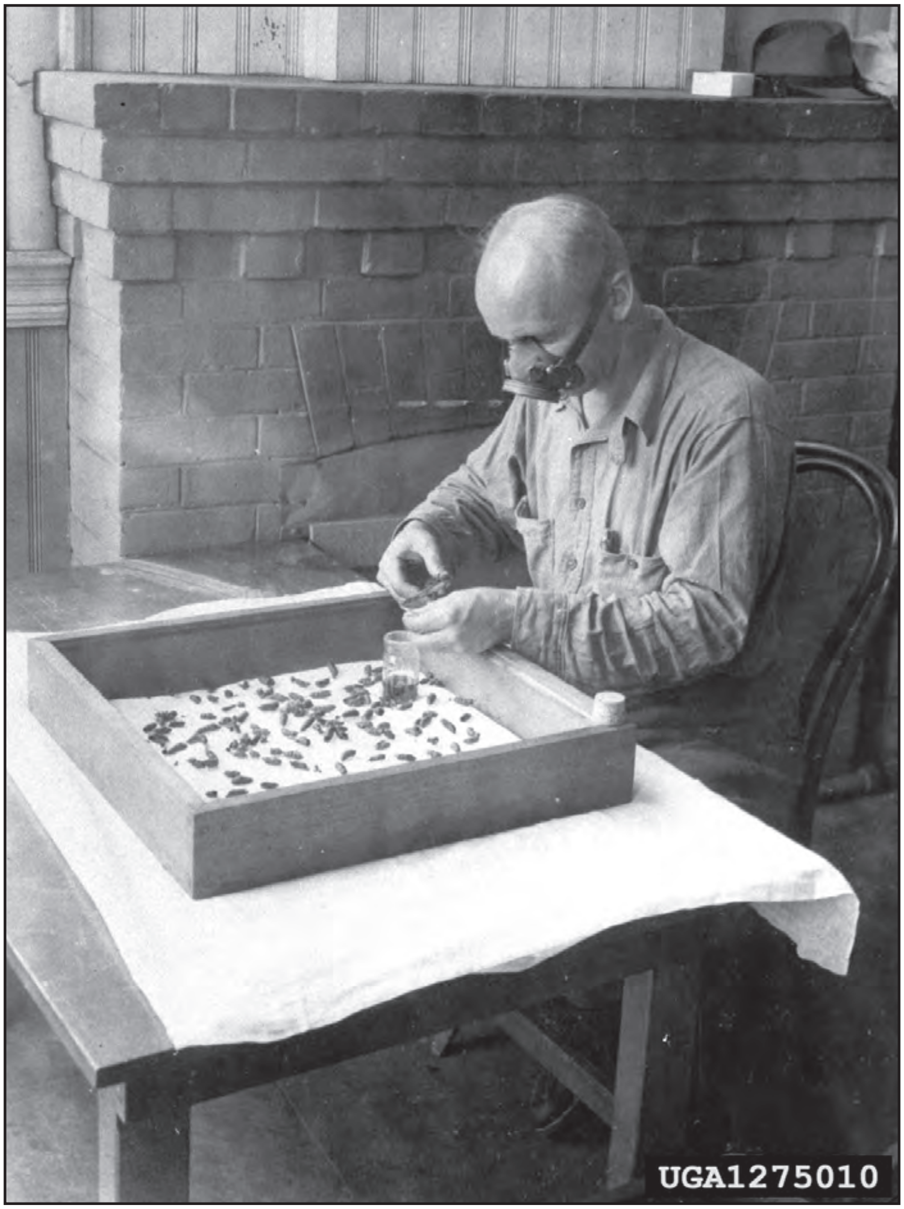

Figure 7-1. A respirator prevented inhalation of wing scales and fine hairy particles from gypsy moth life stages.

Chapter 7 Glossary

Figure

Terms are defined as they pertain to this Supplemental Environmental Impact Statement (SEIS).

A

absorption — process by which the agent is able to pass through the body membranes and enter the bloodstream. The main routes by which toxic agents are absorbed are the gastrointestinal tract, lungs, and skin

acetylcholine — compound released at nerve endings, active in the transmission of the nerve impulse

acetylcholinesterase — enzyme that occurs in nerve endings and prevents accumulation of acetylcholine; acetylcholinesterase inhibition results in acetylcholine accumulation, which impairs the nervous system

acinar-cell adenomas — type of benign tumor

actinomycete — any bacterium in the order Actinomycetales, which contains filamentous branching bacteria of the genera Actinomyces and Streptomyces

active ingredient — (a.i.) the component of an insecticide formulation that kills the insect

acute exposure — single exposure or multiple exposures occurring within a short time frame (24 hours or less)

acute toxicity — potential of a substance to cause injury or illness in a single dose or in multiple doses over a period of 24 hours or less

adenoma — benign epithelial tumor; glandular

additive effect — combined effect of two chemicals is equal to the sum of the effect of each chemical alone. The effect most commonly observed when two chemicals are administered together is an additive effect

adjuvant(s) — formulation factors used to enhance the pharmacological or toxic effect of the active ingredient

adsorption — tendency of one chemical to adhere to another material

adverse-effect level — (AEL) signs of toxicity that must be detected by invasive methods, external monitoring devices, or prolonged systematic observations. Symptoms that are not accompanied by grossly observable signs of toxicity

AEL — acronym for adverse-effect level.

aerobes — organisms that require oxygen.

aesthetic damage — undesirable change in appearance

Agricultural Research Service (ARS) — USDA agency that develops the means to protect trees in forests, parks, yards, and other nonforest environments; conducts research to support activities against the gypsy moth

a.i. — abbreviation for active ingredient

alkaline — having a high pH; a basic solution, compared with an acidic solution

allergic reaction — situation where a pre-exposure of the chemical is required to produce the toxic effect via an antibody

alopecia — hair loss

alternative — one possible way to accomplish a proposed action; a way to manage the gypsy moth in the United States

amino acids — relatively simple carbon-nitrogen molecules that are the subunits of proteins

amphiphod — any of the various small crustaceans in the order Amphipoda, with laterally compressed bodies found primarily in aquatic habits; examples are sandhoppers, beach fleas and skeleton shrimp

anaerobes — organisms that do not require oxygen

analogy to other compounds — using data on one set of compounds to predict the activity of another set of compounds

anemia — decrease in the concentration of red blood cells in whole blood

Animal and Plant Health Inspection Service — (APHIS) joint-lead agency for this environmental impact statement on the gypsy moth; the USDA Agency that enforces national quarantine, coordinates with States on the National Gypsy Moth Survey, provides assistance to States to eradicate isolated infestations of the gypsy moth on 640 acres or less, develops new methods to improve gypsy moth quarantine and eradication practices, and conducts technology transfer activities

anthelmintic — compound used to rid an organism of parasitic worms

antibodies — large protein molecules that interact with antigens and deactivate antigens

antigen — substance capable of inducing an immune response

APHIS — acronym for Animal and Plant Health Inspection Service

aplastic — pertaining to or characterized by aplasia– the lack of development of an organ or tissue, or of the cellular products from an organ or tissue

aplastic anemia — form of anemia that is difficult to treat

ARS — acronym for Agricultural Research Service

arthropods — large group of invertebrate animals that includes insects, spiders and crustaceans

artificial spread — spread of the gypsy moth by other than natural means, for example, by insect life stages attaching to and being moved on recreational vehicles, automobiles, nursery stock, outdoor household articles, and cargo

Asian strain — refers to strains of the gypsy moth originating in the Far East, which have some females that can fly, and may have the capacity to establish in a broader host range, be larger, and hatch earlier than the European strain

assay — a test (noun); to test (verb)

atrophy — decrease in the size of a cell, tissue, or organ, often associated with exposure to a toxic agent

B

***Bacillus thuringiensis* (*B.t.*)** — bacterium; found in most of the world useful in regulation and/or control of insect populations. This microorganism produces several agents (toxins) active against insects

Bacillus thuringiensis* var. *kurstaki (*B.t.k.*) — scientific name of a bacterium that is specifically pathogenic to caterpillars of many moths and butterflies; the active ingredient in biological insecticides sold under the trade names Dipel, Foray, and Thuricide

basal area — cross-sectional area of a tree determined from the diameter of the trunk at breast height; the total area of ground covered by trees measured at breast height

benchmarks — results of toxicological tests, such as LCD or EC_{50} values.

beneficial organism — any organism that eats, parasitizes, or regulates in some way populations of other organisms that are pests

benign — not malignant, not recurrent, favorable for recovery

benthic — pertaining to the sea bed, river bed, or lake floor

beta-exotoxin — proteinaceous toxin in some forms of *B.t.* that is mutagenic in mammals; this toxin is not present in *B.t.k.*

biliary — referring to bile, a substance in which many chemicals are eliminated from the body

bioassay — determination of the relative strength of a substance (e.g., drug, insecticide) by comparing its effect on a test organism with that of a standard preparation

biodiversity — variety of life and its processes; includes the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur

biologically sensitive — term used to identify a group of individuals who, because of their developmental stage or some other biological condition, are more susceptible than the general population to a chemical or biological agent in the environment

biomass — total weight, volume, or energy equivalent of organisms in a given area

biota — plants and animals

BIU — acronym for billion international units

B.t.k. — abbreviation for *Bacillus thuringiensis* var. *kurstaki*

C

cancer potency parameter — model-dependent measure of cancer potency (mg/kg/day) over lifetime exposure; often expressed as a q, which is the upper 95 percent confidence limit of the first dose coefficient (q,) from the multistage model

canopy — uppermost layer of foliage in forest vegetation, formed by the crowns of trees

carcinogen — chemical capable of inducing cancer

carcinoma — malignant tumor

carrier — in commercial formulations of insecticides or control agents, a substance added to the formulation to make it easier to handle or apply

caterpillar — soft-bodied larva of the gypsy moth or other moth, butterfly, or sawfly

cell-mediated response — response originating from materials within the cell, in contrast to a humoral response

cfu — acronym for colony forming units

chironomid — ecologically important group of aquatic insects belonging to the family Chironomidae (order Diptera), often occurring in high densities and diversity, and feeding on a great variety of organic substrates; important prey of most aquatic predators

chitin — hard substance made of a complex carbohydrate (acetyl glucosamine) similar to cellulose; main component in the skin (cuticle) of insects, spiders, and crustaceans

cholinergic — refers to nerve cells that release acetylcholine

cholinesterase — group of enzymes that degrade acetylcholine and similar compounds. Cholinesterases that occur in nerve tissues have a clear function. Other cholinesterases, such as those occurring in red blood cells or plasma, do not have a clear function but are used as indicators of insecticide exposure

chromatography — method of separating chemicals prior to quantitative analysis

chronic exposure — long-term exposure studies often used to determine the carcinogenic potential of chemicals; these studies are usually performed on rats, mice, or dogs and extend over the average lifetime of the species; for example, chronic exposure for a rat is 2 years

chronic toxicity — adverse biologic response, such as mortality or an effect on growth or reproductive success, resulting from repeated or long-term (equal to or greater than 3 months) doses (exposures) of a compound, usually at low concentrations

circadian rhythm — influence of the time of day on the rate of metabolism of foreign compounds, often observed in a given animal species; a variation in the metabolic rate often correlated with variations in endocrine functions, as influenced by the light-dark cycle to which the animal is exposed

cladoceran — small aquatic crustaceans in the order Cladocera; water fleas

coliforms — bacteria that indicate recent fecal contamination of water

colony forming unit (cfu) — index of bacterial levels in a medium such as air or water; a cfu represents a collection of a droplet or particulate from air that contains one or more viable spores or vegetative cells of *B.t.k.*

common logarithm — common logarithm of a number, X, is defined as the number, Y, which when used as the exponent of 10 results in X. Thus, if X = 10^1, then the log of X = Y, which is often written using the notation, log(X) = Y

community — association of potentially interacting plants and/or animals, more or less distinguishable from other such associations, usually defined by the nature of their interaction or the place in which they live

compliance agreement — written agreement between APHIS Plant Protection and Quarantine and a person who grows, handles, or moves regulated articles to comply with APHIS regulations

confounders — term used in discussions of studies regarding human populations (epidemiology studies) to refer to additional risk factors which, if unaccounted for in a study, may lead to erroneous conclusions

congenital — refers to conditions present at birth, regardless of their cause

conidium — asexual spore produced by fungi (pl. conidia)

conjugation — in metabolism, a linkage of one molecule with another; common step in the elimination of many chemicals from the body

conjunctiva — thin mucous membrane that lines the eyelids

conjunctivitis — inflammation of the membrane that lines the eyelids

connected actions — exposure to other chemical and biological agents in addition to exposure to a treatment agent used to control gypsy moth

connective tissue — tissue that binds together and supports the various structures of the body

contaminants — for chemicals, impurities present in a chemical-grade chemical; for biological agents, other agents that may be present in a commercial product

control — maintain or try to maintain a population density of insects or other undesirable animals below the point where injury to human interests occurs

conspecific — belonging to the same species

cooperative project — management project conducted by a State or Federal agency, under agreement and with financial and technical assistance of the U.S. Department of Agriculture, to control forest diseases and insects such as the gypsy moth

Cooperative State Research, Education, and Extension Service — (CSREES) USDA agency that administers a research grants program, including gypsy moth research; plans cooperative research projects through the State Agriculture Experiment Station

System and coordinates information and education activities

cooperator — State or Federal agency that enters into an agreement with the U.S. Department of Agriculture to conduct a cooperative project

copepod — small marine or freshwater crustaceans in the class Copepoda, exhibiting great diversity in form and life history

corixid — insects in the family Corixidae (order Hemiptera); referred to as true water bugs

corneal opacity — cloudy area on the cornea

corneal ulcer — small area of damaged tissue on the surface of the eye

corticosteroid — anti-inflammatory agent

corrosive effect — effect that causes visible destruction and alteration in tissue at the site of contact

cover type — vegetation, described in terms of its general form or dominant species, comprising the plant community in a given area

critical habitat — area determined by the U.S. Fish and Wildlife Service to be essential to the conservation of threatened or endangered species and that may require special management considerations or protection

crown condition — combination of tree crown density, coloration, leaf-rolling, mortality, or other factors that provide an indication of tree health

crustaceans — organisms such as crabs, lobsters, shrimp, crayfish, wood lice, pill bugs, and water fleas that have hard exoskeletons made of chitin, as do other arthropods

CSREES — acronym for Cooperative State Research, Education, and Extension Service

cumulative effects — effects attributable to exposure(s) that may last for several days to several months, or effects resulting from gypsy moth program activities that are repeated more than once during a year or for several consecutive years

cumulative exposure — exposure that may last for several days to several months or exposures resulting from program activities that are repeated more than once during a year or for several consecutive years

cytosolic — found in the cytoplasm of a cell

D

dam(s) — female parent(s)

DDVP — abbreviation of the chemical name for dichlorvos—2,2 dichloroethenyl dimethyl ester phosphoric acid—an insecticide contained in some gypsy moth traps

defoliation — loss of foliage due to feeding by insects, such as gypsy moth caterpillars; light defoliation is normal background defoliation of less than 30 percent, moderate defoliation is 30 to 60 percent, heavy defoliation is greater than 60 percent

defoliation survey — visually examining trees from the ground or the air, to detect defoliation

degradation — breakdown of a compound by physical and chemical or biochemical processes, into basic components with properties different from those of the original compound

degraded — broken-down or destroyed

degrees of freedom — number of data points minus the number of parameters in a model. For example, two points are required to define a straight line. In statistical jargon, using two points to define a straight line is fitting a two-parameter model with zero degrees of freedom

delimiting survey — using pheromone-baited traps to determine the approximate size of an infested area

delineation — a process used in slow the spread to estimate numbers and presence of gypsy moths in an area

delta-endotoxin — proteinaceous toxin in *B.t.k.* that is toxic to gypsy moth larvae

dermal — pertaining to the skin

dermatitis — inflammation of the skin; characterized by redness, swelling, pain, and warmth

detection survey — using pheromone-baited traps to determine whether the gypsy moth is present and where delimiting may be necessary

detritus — fragmented, particulate-organic matter resulting from the decomposition of plant and animal remains

developed forest — privately owned forested residential areas

dichlorvos — another name for DDVP

diflubenzuron — active ingredient of chemical insecticide formulations sold under the trade name Dimilin®; acts as a growth regulator by interfering with chitin synthesis, preventing molting in gypsy moth caterpillars, some other immature insects, and crustaceans

Dimilin® — trade name of diflubenzuron formulations registered for use against the gypsy moth

DiPel — one of the commercial formulations of *B.t.k.*

dipteran — insect belonging to the order Diptera (meaning two wings), which includes flies and mosquitoes

direct effect — reaction of an organism after exposure to a chemical or non-chemical agent that is not mediated through another organism. For example, caterpillars that eat leaves with diflubenzuron on them fail to molt, and die as a result of their direct exposure to this insecticide; the direct effect of an unchecked gypsy moth infestation could be a change in species composition of trees

dislodgeable residues — residue of a chemical or biological agent on foliage as a result of aerial or ground spray applications, which can be removed readily from the foliage by washing, rubbing, or having some other form of direct contact with the treated vegetation

disparlure — synthetic version of the pheromone produced by female gypsy moths to attract males for mating

diuresis — increased urinary excretion

diurnal rhythm — normal changes in the body that occur during the day; most diurnal variations have been shown to be related to eating and sleeping habits

dominant trees — trees with crowns extending above the general level of the canopy and receiving full light from above and from the side

dose — quantity of material that is taken into the body; dosage is usually expressed in amount of substance per unit of animal body weight, often in milligrams of substance per kilogram (mg/kg) of animal body weight, or other appropriate units; in radiology, the quantity of energy, or radiation absorbed

dose-response assessment — description of the relationship between the dose of a chemical and the occurrence or intensity of an effect

draft environmental impact statement — detailed, written statement of effects expected as a result of a major Federal action that is released to the public and other agencies for review and comment, as required under Section 102 (2)(c) of the National Environmental Policy Act

E

EC_{50} — acronym for median effective concentrate

ecology — study of the interrelationships between living organisms and their environment

ecosystem — living organisms interacting with each other and with their physical environment, usually described as an area for which it is meaningful to address these interrelationships

ecosystem management — holistic approach to achieving productive healthy ecosystems by blending social, physical, economic, and biological needs and values

eczema — form of dermatitis associated with swelling and redness of the skin

effect level — dose or concentration of a substance reported to have no harmful (adverse) effects on people or animals.

effector cell — cell stimulated by a nerve cell to effect a certain function. Examples include muscle and sensory cells

egg mass survey — visually examining an area in a systemic manner, either (1) outside the generally infested area, to obtain evidence that gypsy moths are present and reproducing, or (2) in an infested area, to assess the population density

EIS — acronym for environmental impact statement

empirical — refers to an observed, but not necessarily fully understood relationship; in contrast to a hypothesized or theoretical relationship

enantiomers — molecules that are identical except for differences in their three-dimensional symmetry

endangered species — Federal designation for any species that is in danger of extinction throughout all or a significant part of its range. The Federal list of endangered species is maintained by the Secretary of the Interior

endemic — something that is always present in a population but not always prevalent or present in high numbers; often applied to diseases or infestations

endospore — thick-walled body containing genetic material that forms inside the vegetative cell of some types of bacteria, including bacillus, under adverse conditions. When conditions improve, the endospore can develop into a vegetative cell

endpoints — components of an ecosystem that indicate its sensitivity to the type of disturbance expected from the gypsy moth or treatments; five endpoints were selected for the ecological risk assessment: nontarget organisms, forest condition, water quality, microclimate, and soil fertility and productivity

Entomophaga maimaiga — scientific name for a fungus that causes disease in gypsy moth caterpillars

environmental analysis — investigation of alternative actions and their predictable environmental effects through a systematic interdisciplinary approach, which ensures the integrated use of the natural and social sciences and the environmental design arts in planning and in decision making that may have an impact on the human environment

Environmental Assessment — (EA) a concise public document that a Federal agency prepares under the National Environmental Protection Act (NEPA) to provide sufficient analysis and evidence for either a finding of no significant impact or preparation of an environmental impact statement

Environmental Impact Statement — (EIS) a detailed public document written by a Federal agency to disclose significant environmental impacts that would result from a planned action and used to make decisions about the action

enzyme — biological catalyst; a protein produced by an organism itself, which enables the splitting (as in digestion) or fusion of other chemicals

Ephemeroptera — order of aquatic insects including mayflies

epidemiology — branch of science that deals with the incidence, distribution, and control of disease in a population

epidermis — outermost layer of the skin

epizootic — occurrence of a disease in animals that is widely prevalent and spreads rapidly

eradication — strategy of eliminating an isolated infestation of the gypsy moth

erythema — name applied to redness of the skin produced by congestion of the capillaries, which may result from a variety of causes

erythrocyte — red blood cell

European strain — strain of the gypsy moth historically found in Western Europe and the original source of the North American population, which has females that do not fly

evaluation — gypsy moth survey to determine the need for treatment or to determine the effectiveness of treatment

exclusion — policy pursued by APHIS to prevent animal and plant pests and diseases, including the gypsy moth, from being introduced into the United States

exotic — refers to all species of plants and animals not naturally occurring, either now or in the past, in an ecosystem of the United States

exposure — skin contact, inhalation, or ingestion of a substance that may have a harmful effect

exposure assessment — process of estimating the extent to which a population will come into contact with a chemical or biological agent

extra risk — risk in the population that can be attributed to exposure to the agent

extrapolation — use of a model to make estimates outside of the observable range

exuviae — cast-off skins or outer coverings of insects and animals that shed skin

F

fecal — relating to feces (solid waste)

fibroma — benign tumor composed mainly of fibrous or fully developed connective tissue

fibrosarcoma — malignant tumor derived from fibroblasts that produce collagen

FIFRA — Federal Insecticide, Fungicide, and Rodenticide Act; establishes procedures for the registration, classification, and regulation of pesticides

final environmental impact statement — detailed, written statement of the analysis of a major Federal action, released to the public as required under sec. 102 (2)(c) of the National Environmental Policy Act

financial assistance — money provided by the Forest Service and APHIS to Federal and State agencies through several pest control or management programs to suppress, eradicate, or slow the spread of the gypsy moth. On Federal lands the cost of gypsy moth projects are paid in full; on State and private lands cost may be shared with State cooperators. See technical assistance for other assistance provided

food chain — feeding sequence used to describe the flow of energy and materials through the system

food web — interconnected food chains in the ecosystem, representing the various paths of energy flow through populations in the community

Foray — one of the commercial formulations of *B.t.k.*

forest — land at least 10 percent occupied by forest trees or formerly having had such tree cover and not currently developed for non-forest use. Lands developed for non-forest use include areas for crops, improved pasture, residential or administrative areas, improved roads of any width, and adjoining road-clearing and power line clearing of any width

forest condition — species composition, tree growth rates and mortality rates, productivity, and degree of insect damage

forest cover type — description based on and named after the tree species that forms a plurality of the basal area in a stand; other tree species may also be part of the stand

Forest Service — lead agency for this environmental impact statement; the largest USDA agency, which conducts research and develops the means to control the gypsy moth in forests; conducts surveys and evaluations on lands managed by other Federal agencies; helps State and other Federal agencies to conduct detection surveys, evaluation and suppression; to test and transfer technology designed to improve gypsy moth control and reduce damage; and to conduct eradication on Federal or adjacent land, and on non-Federal land for infestations of more than 640 acres

forest type group — grouping of forest cover types for inventory, mapping, or other purposes

forestomach — front or foremost portion of the stomach in animals

formulation — commercial preparation of a chemical including any inert ingredients or contaminants

frank effects — obvious signs of toxicity

Frank Effect Level (FEL) — dose or concentration of a chemical or biological agent that causes gross and immediately observable signs of toxicity

frass — fecal excrement of gypsy moth caterpillars

fumigant — pesticide applied as a liquid or powder which volatilizes to gas; usually applied beneath a tarp, sheet, or other enclosure

fumigation — process of using a fumigant to destroy pests, usually applied under a cover or shelter

FWS — Fish and Wildlife Service, an agency of the U.S. Department of the Interior

G

gavage — placement of a toxic agent directly into the stomach of an animal, using a gastric tube

gene — basic unit of inheritance, by which hereditary characteristics are transmitted from parent to offspring. Genes consist of short lengths of DNA (or RNA in some viruses) that direct the synthesis of protein. These in turn influence the form and function of the organism

generally infested area — (regulated or quarantined area) the area in the eastern United States where the European strain of the gypsy moth is considered to be permanently established; also the area quarantined by APHIS and the States. All life stages are present, and populations are continuous. Population outbreaks occur, and defoliation is common. In 1994, the area extended from Maine to northern North Carolina and west to West Virginia, Ohio, and Michigan

genotoxic — causing direct damage to genetic material, associated with carcinogenicity

genotoxicity — specific adverse effect on the genome (the complement of genes contained in the haploid set of chromosomes) of living cells, which upon the duplication of the effected cells can be expressed as a mutagenic or carcinogenic event because of specific alteration of the molecular structure of the genome

geocorid — big-eyed bug

geometric mean — measure of an average value often applied to numbers for which a log-normal distribution is assumed

gestation — period between conception and birth; in humans, the period known as pregnancy

gram (g) — metric unit of measure for weight or mass

growth regulator — chemical that controls the rate of growth, or interferes with successful growth in an animal; diflubenzuron is a growth regulator for insects and other chitinous animals

guild — group of species with similar modes of existence

Gypchek — trade name for a biological insecticide containing gypsy moth nucleopolyhedrosis virus, which is registered and produced by the Forest Service and APHIS

gypsy moth — all life stages of the Asian and European strains of the insect with the scientific name *Lymantria dispar* (L.), previously *Porthetria dispar* (L.)

H

Haber's Law — in toxicology, the assumption that the concentration or dose, multiplied by the duration of exposure (time) will always have the same effect. This relationship is true for some chemicals and some endpoints but not true for others. Even when true for a particular chemical and effect, it may be true only over certain ranges of exposure

habitat — place or type of site where a plant or animal naturally or normally lives and grows

half-life — time required for the concentration of a chemical to decrease by half of the original concentration (the longer the half-life, the more persistent a chemical is considered to be)

hazard — adverse effects to humans or the environment as a result of exposure to the gypsy moth or treatments; compare risk

hazard assessment — component of a risk assessment that consists of the review and evaluation of toxicological data to identify the nature of the hazards associated with a chemical, and to quantify the relationship between dose and response

hazard identification — process of identifying the array of potential effects that an agent may induce in an exposed population

hazard quotient — ratio of the estimated level of exposure to the risk-reference value or some other index of acceptable exposure; a hazard quotient greater than 1 raises concern

Heinz bodies — dark-staining granules found in red blood cells, which are signs of oxidative damage; formation of Heinz bodies can lead to red cell dysfunction and breakdown of the cell membrane

hemangiosarcoma — malignant tumor formed by proliferation of endothelial and fibroblastic tissue

hematological — pertaining to the blood

hemipteran — insect belonging to the order Hemiptera, including the true bugs

hemoglobin — iron-containing respiratory pigment in red blood cells of vertebrates

herbaceous — relating to plants that have nonwoody stems and die down annually

herbivorous insect — insect that eats plants and plant material; the gypsy moth is an herbivorous insect because it eats leaves

HHERA — acronym for Human Health and Ecological Risk Assessment

histamine — naturally occurring chemical; causes dilation of the capillaries and muscle contraction

histopathology — signs of tissue damage that can be observed only by microscopic examination

homopteran — insect in the order Homoptera, which includes aphids, scale insects, and cicadas

host — living organism that provides subsistence or lodging for another organism

humoral — associated with agents dissolved in the blood or body fluids, in contrast to materials contained in cells (cell-mediated)

hydroxylation — addition of a hydrogen-oxygen or hydroxy (−OH) group to one of the electron rings of a compound. Hydroxylation increases the water solubility of aromatic compounds, particularly when followed by conjugation with other water-soluble compounds in the body, such as sugars or amino acids, hydroxylation greatly facilitates the elimination of the compound in the urine or bile

hymenopteran — any of highly specialized insects in the order Hymenoptera, usually with four membranous wings, the abdomen borne on a slender pedicel and associated with large colonies and complex social organization; includes bees, wasps, ants, ichneumonid flies, sawflies, and gall wasps

hypoactivity — less active than normal

I

immunocompetent — having normal immune function

immunocompromised — having an impaired immune system, such as people with HIV or AIDS

immunodeficient — organism with impaired immune function

in vitro — in glass; a test-tube culture; any laboratory test using living cells taken from an organism

in vivo — in the living organism; in vivo tests are those laboratory experiments carried out on whole animals or human volunteers

indirect effect — reaction of an organism to a change in the environment that is a direct result of exposure to a chemical or non-chemical agent. For example, wasps that prey on caterpillars that eat leaves with diflubenzuron on them could obtain diflubenzuron that the caterpillars ate, thus exposed indirectly to the chemical; the indirect effect of an unchecked gypsy moth infestation could be the change in woodland structure, a direct effect of the gypsy moth

inerts — adjuvants or additives in commercial formulations of gypsy moth control agents that do not cause mortality in the gypsy moth

inert ingredients — additives in insecticide formulations that do not effect the organism targeted but are added for a variety of reasons, such as to stabilize the formulation, to improve its weatherability, or to prevent growth of contaminating microorganisms

infestation — presence of the gypsy moth and an indication of a reproducing population, based on the results of surveys

infested area — isolated infestation or generally infested area

inhalation — act of breathing

innocuous — something that produces no injury; harmless; inoffensive

insecticide — pesticide that kills, debilitates, or controls the growth of insects

instar — stage between molts in the development of the gypsy moth caterpillar and other arthropods

Integrated Pest Management (IPM) — selecting strategies to mange pest-host systems for specific objectives; includes planning, detection, evaluation, monitoring, establishing acceptable damage thresholds, and use of appropriate management practices to prevent or control pest-caused damage and losses

intercept — in a simple linear equation, the value of the dependent variable when the independent variable is zero

interdisciplinary team — team of varied resource specialists with different professional backgrounds who conduct an environmental analysis; members of the interdisciplinary team who prepared this environmental impact statement are listed in chapter 5, Preparers and Contributors

interpolation — use of mathematical models within the range of observations

intraperitoneal — injection into the abdominal cavity

invertebrates — animals without a spinal column, such as insects, spiders, and crustaceans

IPM — acronym for Integrated Pest Management

iritis — inflammation of the iris

irritant effect — reversible effect, compared with a corrosive effect

isolated infestation — defined area infested with the gypsy moth outside the generally infested area; or, a defined area infested with the Asian strain of the gypsy moth within the generally infested area

issue — public concern or significant problem that might occur when the gypsy moth is present or treatments are applied

IU — International Unit

L

land use — type of activity occurring on the land surface, e.g. forestland, farmland, pastureland, etc

landscape — physical features of an area (e.g. slope, aspect, drainage) that affects the characteristics of the plant and animal communities in the ecosystem

Latin Hypercube — stratified sampling technique designed to sample from all portions of a distribution

larva — stage in development between hatching and attaining adult form

larval survey — placing tar paper, burlap, or similar material around the trunks of susceptible trees, to create hiding places for gypsy moth caterpillars so they can be captured and counted

LC_{50} — acronym for lethal concentration$_{50}$

LD_1 — acronym for lethal dose$_1$

LD_{50} — acronym for lethal dose$_{50}$

leaf expansion — percentage of leaf growth from 0 to 100

lentic — water bodies that do not flow (e.g., lakes, ponds)

lepidopteran — insects in the order Lepidopteran, characterized by adults with two pairs of scale-covered wings and coiled sucking-mouthparts, including moth and butterflies

lethal concentration$_{50}$ (LC_{50}) — calculated concentration of a toxicant in air (or water) to which exposure for a specific length of time is expected to cause death in 50 percent of a defined test animal population

lethal dose$_1$ (LD_1) — dose of a chemical or biological agent calculated to cause death in 1 percent of a defined test animal population

lethal dose$_{50}$ (LD_{50}) — dose of a chemical or biological agent calculated to cause death in 50 percent of a defined test animal population

lethargy — decrease in the normal amount of activity

life stage — distinctive period in an insect's life (Nichols 1989); life stages of the gypsy moth are: egg (in an egg mass), larva or caterpillar, pupa, and adult moth

lipophilic — having a tendency to dissolve or partition to fatty substances

LOAEL — acronym for lowest-observed-adverse-effect level

log-normally — a logarithmic function with a normal distribution

lotic — water bodies that flow and have running waters (e.g. streams, rivers)

lowest-observed-adverse-effect level (LOAEL) — lowest measured amount of a chemical that produces significant increases in frequency or severity of adverse effects in an exposed human population

M

macroinvertebrates — invertebrates large enough to be seen with the unaided eye

malignant — cancerous

mammary gland — breast

management practice — specific act, measure, cause of action, or treatment

mass trapping — using pheromone-baited traps to catch all or nearly all the male gypsy moths in an area having low gypsy moth populations

mast — fruit and seeds of trees and other forest vegetation eaten by wildlife; hard-mast includes nuts and seeds (such as acorns, walnuts, hickory nuts, maple seeds); soft-mast is fruit (such as apples, blackberries, wild grapes)

mating disruption — saturating an area with gypsy moth pheromone to confuse male gypsy moths, thereby preventing them from locating and mating with females

median effective concentration (EC_{50}) — concentration of a substance that results in some effect being exhibited by 50 percent of the test organisms

median lethal concentration — concentration of a toxicant necessary to kill 50 percent of the organisms in a population being tested; usually expressed in parts per million (ppm), milligrams per liter (mg/L), or milligrams per cubic meter (mg/m^3)

median lethal dose — dose necessary to kill 50 percent of the test organisms; usually expressed in milligrams of chemical per kilogram of body weight (mg/kg)

metabolite — compound formed as a result of the metabolism or biochemical change of another compound

metastatic — pertaining to or of the nature of metastasis; the transfer of disease from one organ or part to another not directly connected with it; may be due either to the transfer of pathogenic microorganisms (e.g., bacilli) or to the transfer of cells, as in malignant tumors

methemoglobinemia — rare blood disorder in which there is a deficiency of the enzyme that turns methemoglobin into hemoglobin (methemoglobin differs from hemoglobin in being unable to combine reversibly with oxygen)

mg/cm^2 — milligrams per square centimeter

mg/kg — milligrams per kilogram

mg/m^3 — milligrams per cubic meter

microclimate — climate of the immediate surroundings or habitat, differing from the macroclimate, as a result of the influences of local topography, vegetation and soil

microinvertebrates — invertebrates too small to be seen without magnification

microlepidopterans — general term for the most primitive families of moths whose members usually have the smallest body size among lepidopterans

microorganism — organism so small that a microscope is necessary to see it

microsomal — pertaining to portions of cell preparations commonly associated with the oxidative metabolism of chemicals

mineralization — conversion of an organic substance into an inorganic substance as a result of microbial decomposition

minimal risk level (MRL) — route-specific (oral or inhalation) and duration-specific estimate of an exposure level that is not likely to be associated with adverse effects in the general population, including sensitive subgroups

mixture of concern — mixture on which a risk assessment is being conducted. See sufficient similarity.

molting — process of shedding an old skin and creating a new one, as an insect grows or changes in form

monitor — to observe or check that treatments are carried out as planned, or to determine whether effects of treatments are those that were predicted

Monte Carlo simulation — technique used to simulate systems with probabilistic elements; one or more variable in a Monte Carlo simulation is determined by drawing a random number from a probability distribution (such as the normal or uniform distribution), which describes the natural variation in that variable

most-sensitive effect — adverse effect observed at the lowest dose of a substance—an important concept in risk assessments; if the most-sensitive effect is prevented, no other effects will develop

multiple-chemical sensitivity — syndrome that affects individuals who are extremely sensitive to chemicals at extremely low levels of exposure

mutagenicity — ability of a substance (mutagen) to cause genetic damage, that is, damage to DNA or RNA (mutation); mutations can lead to birth defects, miscarriages, or cancer

N

nabid — damselbug belonging to Order Hemiptera of Class Insecta

NADH — acronym for nicotinamide adenine dinucleotide phosphate; a molecule that is common in all living systems and is necessary for the proper function of many enzymes

nanogram (ng) — one billionth of a gram

National Environmental Policy Act (NEPA) Act of 1969 (42 U.S.C. 4321) — established a national policy that encourages harmony between man and the environment; requires that Federal agencies proposing legislation or a major action use a systematic, interdisciplinary approach to planning and decisionmaking, and prepare a detailed statement that includes the following: the environmental impact of the proposed action, any adverse environmental effects that cannot be avoided, alternatives to the proposed action, the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitment of resources

National Gypsy Moth Survey — minimal detection survey administered by APHIS in cooperation with the States to detect isolated infestations of the gypsy moth outside the generally infested area

natural landmark — site on the National Registry of Natural Landmarks, administered by the National Park Service, U.S. Department of the Interior, preserved as an outstanding example of plant or animal communities, geological features, scenic grandeur, or other attribute

natural spread — movement of gypsy moths from an infested area: (1) of first instar larvae by wind, (2) of larger larvae by crawling, (3) of adult females of the European strain by crawling, (4) of some adult females of the Asian strain by flying

necropsy — examination of a body after death, usually refers to a gross examination of the major organs

nematodes — elongated cylindrical worms that are parasitic in animals or plants or free-living in soil or water

neotropical migrant — bird that nests in North America but migrates to the Neotropics (region of the New World south of the Tropic of Cancer, includes South America, Central America, southern Mexico, the West Indies, and Caribbean) during winter

NEPA — acronym for National Environmental Policy Act

neuropathy — damage to the peripheral nervous system

ng — nanogram, one billionth of a gram

NIOSH — acronym for the National Institute for Occupational Safety and Health

nm — nanometer, one billionth of a meter

NOAEL — acronym for non-observed-adverse-effect level

NOEL — acronym for no-observed-effect level

no-observed-adverse-effect level (NOAEL) — highest measured amount of a chemical at which no increase in frequency or severity of adverse effects is observed in an exposed human population when compared with a control; effects may be produced, but they are not considered to be adverse

no-observed-effect level (NOEL) — dose of a chemical or biological agent at which there are no biologically or statistically significant effects attributable to treatment

noninsecticidal treatments — gypsy moth treatments that do not involve spraying of insecticides; in this environmental impact statement, they include mass trapping, mating disruption, and the sterile insect technique

nontarget organism — any living organism that is not the target of a management practice

normal distribution — theoretical frequency-distribution of variable data generally represented by a bell-shaped curve

Notice of Intent — announcement that preparation of a new national gypsy moth supplemental environmental impact statement was beginning, which appeared in the April 29, 2004, Federal Register (vol. 69, no. 83, p. 23,492 – 23,493)

NPV — acronym for nucleopolyhedrosis virus

nucleopolyhedrovirus (NPV) — category of naturally occurring viruses that cause a usually fatal disease, mainly in larvae of moths, butterflies, sawflies, wasps, ants, bees, and others. The nucleopolyhedrovirus specific to the gypsy moth is the active ingredient in the insecticide Gypchek

nymph — larvae of an insect with incomplete metamorphosis that differs chiefly in size and degree of differentiation from the final adult stage

O

OB — acronym for occlusion bodies

occlusion bodies (OB) — virus particles containing variable amounts of genetic material within one protein envelope

octanol-water partition coefficient (K_{ow}) — equilibrium ratio of the concentrations of a chemical in n-octanol and water, in dilute solution

ocular — pertaining to the eye

odonates — insects in the order Odonata; dragonflies and damselflies

1-day health advisory — drinking water concentration (mg/L) not likely to cause adverse effects in the general population, including sensitive subgroups, after 1 day of exposure

one-storied stand — stand of trees that is characterized by predominantly the same size trees

ophthalmic — pertaining to the eye, as an ophthalmic solution–a solution of medication intended to be applied to the eye

oral — pertaining to the mouth

oral toxicity — toxicity of a compound when given or taken by mouth, usually expressed as milligrams of chemical per kilogram of body weight of animal (mg/kg)

organoleptic — relating to an objectionable taste or smell

organophosphate — class of insecticides that are toxic to the nervous system

orthopteran — insects in the order Orthoptera, which includes grasshoppers, crickets, locusts, and cockroaches

osteosarcoma — malignant tumor derived from bone tissue

outbreak — cyclic rise in gypsy moth populations when feeding by caterpillars causes widespread moderate-to-heavy defoliation

ovicide — chemical toxic to the eggs of the target animal

P

parasite — organism that lives in, on, or at the expense of another, from which it obtains food, shelter, or other requirements; a parasite is usually smaller than the host and weakens it

parasitoid — parasite that eventually kills its host, for example, insects that kill life-stages of the gypsy moth

parenteral — any form of injection

partition — in chemistry, the process by which a compound or mixture moves between two or more media

pathogen — an agent, such as a virus or bacterium, that causes disease

pathogenic — causing or capable of causing disease

pathway — in metabolism, a sequence of metabolic reactions

peroxide — molecule that contains two or more oxygen atoms in series, such as —O—O—; these molecules are often involved in the degradation of polymers, including proteins

persistence — characteristic of an insecticide or a compound to remain in the environment as an effective residue; persistence is related to volatility, chemical stability, and degradation

pesticide — substance or mixture of substances that kill insects, rodents, fungi, weeds, or other forms of plant or animal life that are considered to be pests

pH — measure of acidity and alkalinity on a scale from 0 to 14, of which 7 is neutral; lower numbers are acidic, higher numbers are alkaline; numbers vary by a factor of 10, i.e., pH 3 is 10 times more acidic than pH 4

pharmacokinetics — quantitative study of the metabolic processes of absorption, distribution, biotransformation, and elimination of drugs

pheromone — chemical produced and emitted by an animal as a form of communication with other individuals of the same species, for example, the sex attractant given off by the female gypsy moth to attract males for mating

phytoplankton — small algal cells suspended in the water column of water bodies

phytotoxic — toxic or harmful to plants

piloerection — condition in which the hair stands on end

pituitary-adrenal axis — hormonal interaction between the pituitary and the adrenal glands

planktonic — suspended in the water of seas, lakes, rivers, or other water bodies

plasma cholinesterase — another term for pseudocholinesterase; the normal physiological role of this cholinesterase is not known, inhibition of this enzyme is considered an index of exposure to many oganophosphate insecticides

plasma — fluid portion of the blood in which particulates are suspended

plasmid — sub-cellular elements in bacteria that contain genetic material for relatively narrow and specific traits; plasmids can be transferred from one microorganism to another of the same species; transfer may also occur between two microorganisms of different species

Plecoptera — order of insects; includes stoneflies

polymer — generic term for a molecule composed of repeating units of less complex molecules; for example, proteins are polymers of amino acids

polyvinyl chloride — nontoxic polymer of vinyl chloride

population — group of gypsy moths that occupy a defined area, separated to some degree from other groups, and are reproducing

population survey — counting egg masses in the generally infested area to determine if suppression treatments are warranted, or using pheromone traps in the transition area to determine if slow-the-spread treatments are warranted

post-treatment evaluation or survey — defoliation, egg mass, or larval survey conducted in a treatment area to evaluate treatment effectiveness

potentiation — action of two or more substances from which one or more (the potentiator) enhances the toxicity of another

ppb — parts per billion; the number of parts of chemical substance per billion parts of the substrate in question

ppm — parts per million; the number of parts of chemical substance per million parts of the substrate in question

predator — animal that obtains the energy it needs to live and grow by eating animals of other species, for example, some mice are predators of the gypsy moth

probit analysis — analysis technique that relates doses to measures of standard deviation away from the 50 percent response level, using the cumulative normal distribution

programmatic — broad or general rather than site specific

proposed species — any species of fish, wildlife, or plant that is proposed in the Federal Register for listing as a threatened or endangered species under the Endangered Species Act

proteinaceous — consisting or composed of proteins

proteolytic enzymes — enzymes that breakdown proteins

prototoxins — proteins that can be converted to toxins

pruritis — itching; an unpleasant skin sensation that provokes the desire to rub or scratch

pseudocholinesterase — term for cholinesterase found in the plasma; the normal physiological role of this cholinesterase is not known; inhibition of this enzyme is considered an index of exposure to many organophosphate insecticides

public involvement — actions taken by the Forest Service and APHIS to involve the various individuals, groups, and organizations who are interested in or may be affected by this environmental impact statement and the decision that may result

pupa — developmental stage of gypsy moth or any lepidoptera, between the caterpillar and adult moth stages, during which the insect undergoes major structural changes

Q

quarantine — designating an area as generally infested, so as to regulate the movement of articles (such as outdoor household articles, logs, and nursery stock) and prevent artificial spread of gypsy moth life-stages to uninfested areas of the United States

R

racemic mixture — 50:50 blend of a (+) enantiomer and (−) enantiomer

recreational forest — publicly owned forest used predominantly for hiking, hunting, camping, day-use, and sightseeing

reference concentration — concentration in air (mg/m^3) not likely to be associated with adverse effects over lifetime-exposure, in the general population, including sensitive subgroups

reference dose (RfD) — oral dose (mg/kg/day) not likely to be associated with adverse effects over lifetime exposure in the general population, including sensitive subgroups

regeneration — renewal of a tree or stand of trees; restocking of an area

regulatory activities — activities conducted by APHIS and the States to prevent the artificial spread of the gypsy moth from the regulated area to the uninfested area; activities include inspection and treatment of regulated articles on which the gypsy moth commonly deposits egg masses. See quarantine

renal — pertaining to the kidneys

reproductive effects — adverse effects on the reproductive system that may result from exposure to a chemical or biological agent. The toxicity of the agent may be directed to the reproductive organs or the related endocrine system. The manifestations of these effects may be noted as alternatives in sexual behavior, fertility, pregnancy outcomes, or modification in other functions dependent on the integrity of the reproductive system

residue — quantity of insecticide and its metabolites remaining on and in vegetation, soil, or water

resistance — ability of a population or ecosystem to absorb an impact without significant change from normal fluctuations; for plants and animals, the ability to withstand adverse environmental conditions and/or exposure to toxic chemicals or disease

RfD — acronym for reference dose

rhinitis — inflammation of the mucous membranes of the nose

riparian — pertaining to, living in, or situated on, the banks of rivers and streams (Lincoln and Boxshall 1987)

risk — likelihood that adverse effects will occur; compare hazard

risk assessment — evaluation of the likelihood that adverse effects may occur in humans or the environment as a result of exposure to one or more stressors, such as the gypsy moth and treatments

risk characterization — process of estimating the incidence of a healthy effect in a human population under the different conditions of exposure described in the exposure assessment

risk comparison — the practice of comparing one risk to another in order to promote a better understanding of the consequences of different treatment options as well as the consequences of no treatment

risk reference-value (RRV) — generic term used as an estimate of dose that is not likely to induce adverse health effects in humans under specific conditions of exposure such as duration and route

route-of-exposure — way in which a chemical or biological agent enters the body. Most typical routes include oral (eating or drinking), dermal (contact of the agent with the skin), and inhalation

RRV — acronym for risk reference value

S

safety factor — factor used to give a margin-of-error to the screening index in the Ecological Risk Assessment; safety factors are selected based on the amount of error likely in estimating toxicological benchmark values or concentrations of a toxicant in the environment

salvage — cutting and removing dead, dying, or deteriorating trees before they lose their value as timber

sarcoma — tumor made up of a substance like embryonic connective tissue; often highly malignant

scientific notation — the method of expressing quantities as the product of a number between 1 and 10, multiplied by 10 raised to some power. For example, in scientific notation,
1 kg = 1,000 g [is expressed as] 1 kg = 1×10^3 g; 1 mg = 0.001 [is expressed as] 1 mg = 1×10^{-3} g

scission — in metabolism, breaking or cleavage of part of a molecule

scoping — open process, including public notification and participation, by which an agency identifies significant environmental issues and determines the extent of analysis needed to make an informed decision on a proposed action

screening index — index used to determine whether a species exposed to a toxic agent is at risk. The screening index is a conservative estimate of species at risk. It is more likely to indicate that a species is at risk when it actually may not be than to miss species that are at risk

secondary organism — pathogens or insects that attack trees already weakened by defoliation and that sometimes cause death of the trees

SEIS — acronym for Supplemental Environmental Impact Statement

sensitive subgroup — subpopulation that is much more sensitive than the general public to certain agents in the environment

septicemia — occurrence of pathogens or pathogenic toxins in the blood or other body fluids

serotype — classification of a microorganism based on occurrence of antigens in the cell

silviculture — practice of applying treatments to forest stands, to maintain and enhance them for any purpose (Smith 1986); silvicultural treatments may also be applied to forested areas in urban and suburban areas

slow the spread — strategy used on a large-scale to slow the gypsy moth's natural spread from areas where it is already established or is a permanent resident by keeping low-level populations from increasing

species composition — assemblage of species inhabiting a defined area

species diversity — ecological concept that incorporates both the number of species in a given area and the number of individuals per species

species richness — number of species in a local area, region, or community

species-to-species extrapolation — method involving the use of exposure data on one species (usually an experimental mammal) to estimate the effects of exposure in another species (usually humans)

squamous-cell papillomas — type of benign tumor

stand — contiguous group of trees sufficiently uniform in species composition, age, and condition to be distinguishable as a unit

stand composition — variety of vegetation species in a stand

stand growth — increases in wood, dry matter, or biomass within a stand

stand structure — combination of species, ages, sizes, and numbers of trees that describe a stand

standard deviation — expression of the variability in a sample or population

standard-normal distribution — normal distribution with a mean of zero and a standard deviation of one

sterile insect technique — gypsy moth treatment that reduces the chance of fertile female gypsy moths mating with fertile males and producing fertile eggs, by the release of large numbers of (1) male pupae sterilized by radiation, (2) male pupae irradiated but not sterilized, or (3) eggs from mating of irradiated males with non-irradiated females

stewardship and stewardship incentives programs — cooperative programs between the Forest Service and States, to provide financial and technical assistance for silvicultural planning on non-Federal forested areas for private landowners

strain — group within a species that differs physiologically rather than in form or structure

strategy — planned actions with specific objectives; the strategies of eradication, suppression, and slow the spread make-up the alternatives examined in this environmental impact statement

***Streptococcus* (pl. *Streptococci*)** — genus of bacteria, which—depending on its classification—may be associated with infections in humans

stressor — an agent, such as an insecticide or the gypsy moth, that causes stress to an ecosystem

subcanopy — cover of branches and foliage formed collectively by trees and other woody growth that is below the principal canopy

subchronic exposure — exposure studies that can last for different periods of time, but 90 days is the most common duration; the subchronic exposure study is usually performed in two species (rat and dog) by the route of intended use or exposure

subchronic reference dose — oral dose (mg/kg/day) not likely to be associated with adverse effects over a less-than-lifetime exposure, in the general population, including sensitive subgroups

subchronic toxicity — adverse biologic response of an organism, such as mortality or an effect on growth or reproductive success, resulting from repeated or short-term (3 month) doses (exposures) of a compound, usually at low concentrations

subconjunctival — refers to the area beneath the membrane that lines the eyelids and eyeball

subcutaneous — just below the skin

subdominant trees — trees with crowns below the general level of the canopy and that receive little or no direct light from above; trees whose crowns make up the subcanopy (Smith 1986)

substrate — with reference to enzymes, the chemical that the enzyme acts upon

succession — natural and gradual replacement of one community of plants by another

succinylcholine — neuromuscular blocking agent

sufficient similarity — as applied to chemical mixtures, whether or not the data on one or more samples of a complex and variable mixture can or should be used for dose-response assessments for all such mixtures

sulfhemoglobinemia — presence of abnormal pigments, other than methemoglobin, in red blood cells

Supplemental Environmental Impact Statement — a document that is written to provide a supplement to the original Environmental Impact Statement

suppression — strategy of reducing outbreak populations of the gypsy moth in areas where it is already established, or is a permanent resident, to prevent or minimize damage to resources

survey — see defoliation survey, delimiting survey, detection survey, egg mass survey, larval survey, National Gypsy Moth Survey, population survey, post-treatment survey, and transition area survey

susceptible plants — plants with leaves the gypsy moth will eat

synapse — space between two nerve cells or a nerve cell and an effector cell such as muscle

synergism — action of two or more substances to achieve an effect of which each is individually incapable; synergistic effects may be greater or less than the sum of effects of the substances in question

synergistic effect — situation in which the combined effects of two chemicals are much greater than the sum of the effect of each given agent alone

systemic — entering and then distributing throughout the body of an organism

systemic effects — effects that require absorption of a toxic agent at an entry point and distribution to a distant site at which effects are produced

systemic toxicity — effects that require absorption and distribution of a toxic agent to a site distant from its entry point at which point effects are produced; systemic effects are the obverse of local effects

T

technical assistance — any of a whole range of direct and indirect help that USDA provides to Federal and State cooperators, short of providing monetary funds; this assistance includes but is not limited to providing training, providing assistance in preparing environmental documents, work and safety plans, contracts, and monitoring plans, and providing assistance on site during the conduct and evaluation of gypsy moth projects

technology transfer — disseminating research results and adapting innovations so government and private parties can use them

1-day health advisory — drinking water concentration (mg/L) not likely to cause adverse effects in the general population, including sensitive subgroups, after 1 day of exposure

teratogenic — relating to or causing developmental malformations

teratology — study of malformations induced during development from conception to birth

thinning from below — silvicultural technique of removing the subdominant trees in a forest stand, leaving the dominant trees more or less evenly distributed over the stand

threatened species — Federal designation for any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range (the Federal list of threatened species is maintained by the Secretary of the Interior)

threshold — maximum dose or concentration level of a chemical or biological agent that will not cause an effect in the organism

threshold-limit value — air concentration, in milligrams per cubic meter (mg/m^3), not likely to cause adverse effects in exposed workers, over a normal period of work

Thuricide — one of the commercial formulations of *B.t.k.*

toxic — poisonous to organisms

toxicant — poisonous substance such as the active ingredient in pesticide formulations that can injure or kill plants, animals, or microorganisms

toxicity — capacity of a poison to cause adverse effects

toxicological benchmark value (or benchmark value) — values determined for any of a number of toxicological tests, such as lethal dose $_{50}$, lethal concentration $_{50}$, no-observed-adverse-effect level, lowest-observed-adverse-effect level

toxicology — science that deals with poisons and their effects and problems involved (such as clinical, industrial, or legal)

toxins — chemicals that may cause toxic effects, often used when referring to naturally occurring toxic agents, especially proteins

transition area — area between the uninfested area and generally infested area; populations are discontinuous, consist mostly of adult male moths, and occasionally other life stages; population outbreaks do not occur, and defoliation is uncommon

transition area survey — monitoring gypsy moths in the transition area to provide date that support the decision to quarantine an area or to take other management action

treatment threshold — population level reached by an insect pest that indicates treatment is necessary to prevent unacceptable damage to other resources

triangular distribution — theoretical frequency-distribution shaped like a triangle and described by a minimum, maximum, and likeliest values

trichopteran — insects in the order Trichoptera, in which the adults are terrestrial and immature life stages are almost exclusively aquatic in freshwater; caddisflies

trophic levels — feeding levels—for example, primary producer, herbivore, and first-level carnivore

U

uncertainty factor — factor used in deriving the risk-reference values and similar values from experimental data; uncertainty factors are intended to account for variation in sensitivity among people, the uncertainty in extrapolating animal data to humans, and other sources of uncertainty; common uncertainty factors are 10, 100, and 1,000

understory — vegetation layer below the canopy of other plants, formed by shade-tolerant trees and low shrubs, grasses, and other herbaceous plants

uninfested area — area outside the generally infested area and ahead of the transition area; adult male moths are occasionally found, other life stages are rarely found; no populations are found, and no outbreaks occur

uniform distribution — theoretical frequency-distribution described by a minimum and a maximum value; all values in the uniform distribution have an equal probability of occurrence

Urban and Community Forestry Program — cooperative program between the USDA Forest Service and States to provide financial and technical assistance to municipalities, school districts, communities, and nonprofit organizations for managing trees on non-Federal lands in urban environments

urban forest — forested areas in cities, towns, and communities

urinalysis — testing of urine samples to determine whether toxic or other physical effects have occurred in an organism

urticaria — skin condition marked by the development of wheals

USDA — acronym for U.S. Department of Agriculture

U.S. EPA — acronym for U.S. Environmental Protection Agency

V

vehicle — substance (usually a liquid) used as a medium for suspending or dissolving the active ingredient; commonly used vehicles include water, acetone, and corn oil

vertebrates — animals with a spinal column, such as mammals, fish, birds, amphibians, and reptiles

volatile — referring to compounds or substances that have a tendency to vaporize; material that will evaporate quickly

volatility — tendency of a substance to evaporate at normal temperatures and pressures

vulnerability — likelihood that a tree or plant will die if defoliated

W

watershed — area of land with a characteristic drainage network that contributes to the same surface flow

wheal — smooth, slightly elevated area on the body surface, which is more red or more pale than the surrounding skin; often accompanied by severe itching and usually changing size or shape or disappearing within a few hours; the typical lesion of urticaria, the dermal evidence of an allergic reaction (allergy), and in sensitive persons may be provoked by mechanical irritation of the skin; also called a hive

X

xenobiotic — chemical that does not naturally occur in an organism; term is often applied generically to all synthetic or man-made chemicals

Z

zooplankton — animals that are dependent on movement of water or air for their position or distribution

Chapter 8
References

Figure 8-1. Civilian Conservation Corps workers scouted for gypsy moths.

Chapter 8 References

Figure

References listed are cited in Chapters 1–4 and Appendixes A–E.

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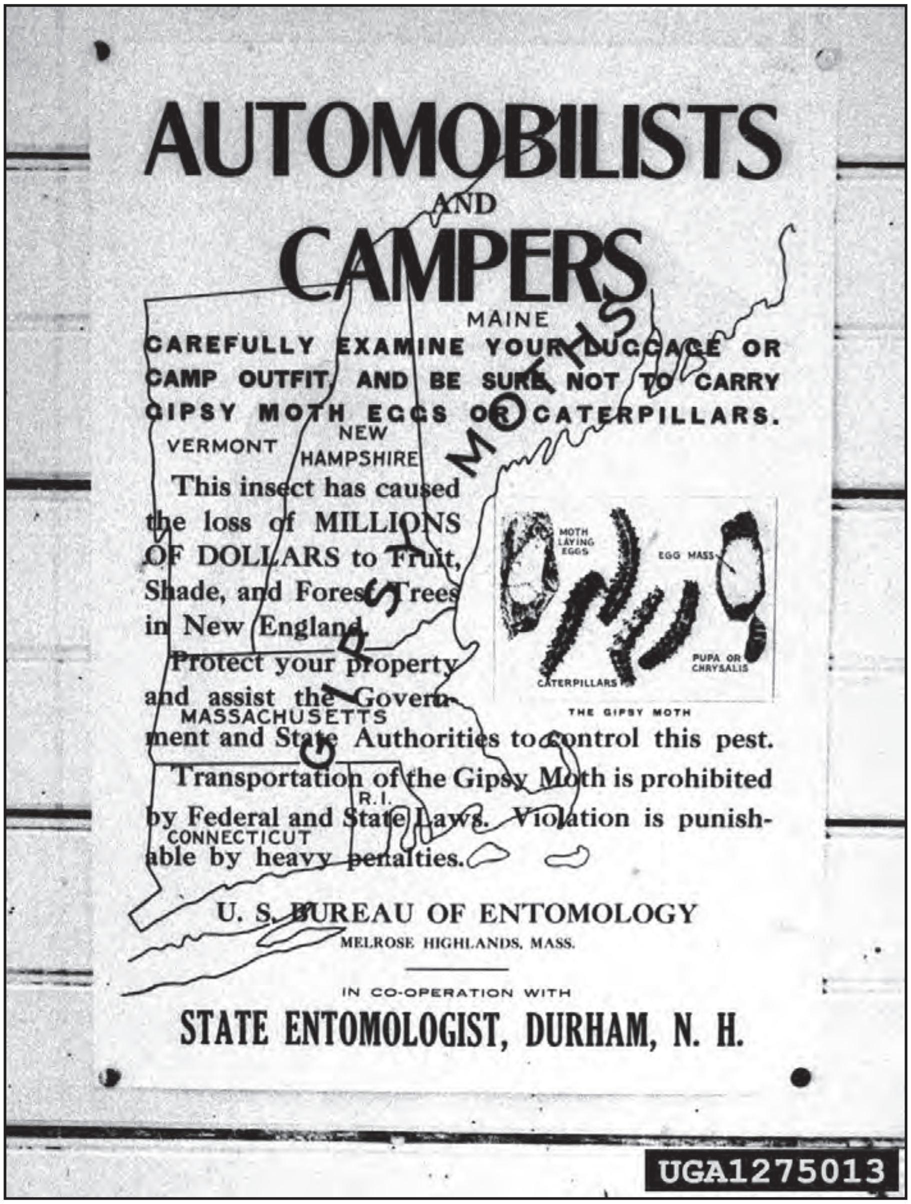
Appendix A
Gypsy Moth Treatments and Application Technology



AUTOMOBILISTS AND CAMPERS

CAREFULLY EXAMINE YOUR LUGGAGE OR CAMP OUTFIT, AND BE SURE NOT TO CARRY GIPSY MOTH EGGS OR CATERPILLARS.

This insect has caused the loss of MILLIONS OF DOLLARS to Fruit, Shade, and Forest Trees in New England.

Protect your property and assist the Government and State Authorities to control this pest.

Transportation of the Gipsy Moth is prohibited by Federal and State Laws. Violation is punishable by heavy penalties.

U. S. BUREAU OF ENTOMOLOGY
MELROSE HIGHLANDS, MASS.

IN CO-OPERATION WITH

STATE ENTOMOLOGIST, DURHAM, N. H.

Figure A-1. Public notices warned campers about transporting gypsy moth eggs and caterpillars.

Appendix A Gypsy Moth Treatments and Application Technology

Contents

Figures

This appendix describes treatments used and proposed for use in managing the gypsy moth. These treatments vary in effectiveness in different situations. Some are not effective in meeting the objectives of eradication, suppression, or slow-the-spread projects; but they are presented in order to provide the reader with a fuller understanding of the range of control and natural agents that regulate gypsy moth populations.

The treatments are divided into four categories. The first category includes those treatments in the 1996 Record of Decision: *Bacillus thuringiensis* var. *kurstaki (B.t.k)*, diflubenzuron, the gypsy moth nucleopolyhedrovirus product (Gypchek), mating disruption, mass trapping, and sterile insect technique. The second treatment category consists of the new proposed treatment of tebufenozide. The environmental and human health risks associated with the use of treatments in these first two categories are analyzed and presented in Appendixes F–K of this supplemental environmental impact statement (SEIS). The environmental effects are summarized in Chapter 4.

The third category contains some natural control agents that help regulate gypsy moth populations in North America and in other places around the world where gypsy moth exists. These natural control agents include fungal pathogens, parasitoids, predators, nematodes, and microsporidia. Unfortunately, cost effective technology does not yet exist to develop and propagate these agents for use within the USDA gypsy moth management program.

The fourth category contains the miscellaneous treatments of removing and destroying egg masses, tree trunk bands and barriers, broad-spectrum insecticides, and silviculture. These treatment methods do not meet the objectives of eradication, suppression, and slow-the-spread projects. Some of the treatments may have value, however, for protecting individual trees in homeowner's yards or other landscape situations, rather than in a forest setting or in a large treatment area.

A.1 Treatments in the 1996 Record of Decision.

Bacillus thuringiensis var. kurstaki (B.t.k.).

Bacillus thuringiensis, commonly called *B.t.*, is a bacterium that moves by using whip-like appendages called flagella and forms a resting spore. *B.t.* occurs naturally in soils throughout the world. Unique to this species is formation of a protein crystal next to the spore at the time of sporulation.

B.t. commercial formulations used for managing defoliating forest caterpillars in North America are preparations of the HD-1 strain of *B.t.* variety *kurstaki* (*B.t.k.*). *B.t.k.* spores and crystals are ingested by the gypsy moth caterpillar along with foliage. Enzymes in the mid-gut of the caterpillar dissolve the crystals and release delta-endotoxins, which are insecticidal crystal proteins. The proteins bind to specific receptors on the cellular lining of the midgut and penetrate the cell membrane. The insect stops feeding and dies within a few hours or days.

Natural epizootics caused by *B.t.k.* have not been observed as a control factor for the gypsy moth (Reardon and others 1994). *B.t.k.* is not expected to infect more than the current year generation of gypsy moths present when it is applied (Dubois and others 1988).

B.t.k. Use.

A number of commercial preparations of *B.t.k.* are registered for aerial and ground application to gypsy moth populations. The typical application rate used in USDA cooperative suppression projects is one application at 24 to 38 BIU per acre (60–95 BIU/ha). For eradication treatments, the typical dose rate is 24 to 25 BIU per acre (60–63 BIU/ha), applied one to three times with application times being from a few days to over a week apart.

The United States Department of Agriculture (USDA) first used *B.t.k.* in cooperative suppression projects for the gypsy moth in 1980. Between 2001 and 2010, *B.t.k.* was used in more than 75 percent of the total acreage treated in cooperative suppression projects, more than 1.6 million acres (0.6 million ha) in nine States (USDA Forest Service 2011).

The timing of *B.t.k.* application in gypsy moth projects is generally dictated by foliage and insect development (Dubois 1991). The optimal timing of application is when most of the insects are in the second instar, and not delayed beyond early third instar. To be effective, *B.t.k.* must be consumed by the caterpillar. The timing of *B.t.k.* application is a subjective judgment considering foliage expansion, larval stage, population density and predicted level of defoliation (Reardon and others 1994).

Phenology models such as BIOSIM may be used to help predict insect development in eradication projects where gypsy moth numbers are so low that egg masses and larvae cannot be located and monitored. This allows application of *B.t.k.* at the most opportune time. Caged egg masses are sometimes deployed in treatment areas and monitored for egg hatch so that the optimal timing of *B.t.k.* application can be estimated.

B.t.k. Effectiveness.

The effectiveness of *B.t.k.* in cooperative suppression projects from 2000 to 2003 varied from a low of 84 percent to a high of 100 percent; the average success rate of suppression projects was 95 percent in reducing gypsy moth populations (USDA Forest Service 2003). Between 2004 and 2010 the average success rate was about 92 percent (USDA Forest Service 2011). Greater reductions in gypsy moth populations generally occurred with higher dose rates (24 and 38 BIU per acre: 60 and 95 BIU/ha) (USDA Forest Service 2003).

Many factors affect *B.t.k.* efficacy, including the timing of the application with regard to insect and foliage development, weather conditions during and after application, and the quality of the application, that is, good pilot skills and properly functioning equipment. Most important is application timing and delivery of a dose sufficient to kill the insects. The species of host plant may also affect the effectiveness of *B.t.k.* (Farrar and others 1996).

During eradication applications in or near areas that contain rare, endangered, or desirable moths and butterflies, extra effort should be taken to minimize drift (see Advances in Application Technology later in this appendix). See Appendix F for the risk assessment on *B.t.k.*

Diflubenzuron.

Diflubenzuron belongs to a group of compounds called insect growth regulators. When ingested by gypsy moth caterpillars, diflubenzuron disrupts the formation of a new cuticle (outer skin) during molting. The caterpillar cannot complete the molting process, its body wall ruptures from internal pressure, and the insect dies. Ingestion of diflubenzuron is lethal to the gypsy moth caterpillar.

Diflubenzuron Use.

Diflubenzuron is registered for aerial or ground application for gypsy moth. The label prohibits application directly to water, to areas where surface water is present, or to intertidal areas below the high water mark—except under the forest canopy when aerially applied. Typically, diflubenzuron is aerially applied at the rate of 0.5 ounces active ingredient in 0.75 to 1.00 gallon spray volume-per-acre, twice in eradication projects and once in suppression projects. Diflubenzuron application in suppression projects may be at a much lower dosage than the commonly used 0.5 ounce active ingredient per acre and still achieve project objectives (McLane 1993).

Diflubenzuron Effectiveness.

Diflubenzuron effectively reduces gypsy moth populations and protects foliage, both key objectives of suppression projects. Data collected from 2000 to 2003, in areas treated with diflubenzuron in cooperative suppression projects with States, reveal diflubenzuron has a 95 to 98 percent success rate in meeting foliage protection objectives. From 2001 to 2010 diflubenzuron was used on about 23 percent of the total acres treated in cooperative suppression projects. Use of diflubenzuron has steadily declined since 2001. Between 2006 and 2010 diflubenzuron was applied to about 163,000 acres representing only about 13 percent of the more than 1.2 million acres treated during that period (USDA Forest Service 2011). See Appendix I for the Diflubenzuron Risk Assessment.

Gypchek (Nucleopolyhedrovirus).

The gypsy moth nucleopolyhedrovirus (NPV) is one of several natural agents found in eastern North America that infect gypsy moth (Podgwaite and Campbell 1972). The virus is a member of the genus *Baculovirus* and is unrelated to arthropod-borne viruses and other viruses that infect man (Mazzone and others 1976). The disease caused by the gypsy moth virus is commonly referred to as “wilt disease” because of the limp appearance of infected caterpillars.

The disease can reach outbreak levels naturally as gypsy moth populations increase. Epizootics caused by the gypsy moth virus are thought to be density dependent, and display one or more waves of mortality; intensity is proportional to larval density and viral inoculum (Doane 1970, Woods and others 1990). Outbreaks of this type result from increased transmission rates of the virus within and between generations of the gypsy moth. Small gypsy moth caterpillars become infected and die on leaves in the tree crowns, the cadavers disintegrate, and the viral particles disperse, infecting other gypsy moth caterpillars.

The virus appears to spread rather easily when egg masses are laid on virus-contaminated surfaces. Birds, mammals, gypsy moth parasitoids, and invertebrate predators may also play a role in spreading the virus, although they themselves are not affected. The virus may kill up to 90 percent of the caterpillars in dense gypsy moth populations, reducing populations to levels that cause only minimal defoliation the following year (Reardon and Podgwaite 1992, Reardon and others 1996).

USDA began investigating the feasibility of developing gypsy moth virus as an alternative to chemical insecticides in the late 1950s. The viral product Gypchek was registered with the U.S. Environmental Protection Agency (U.S. EPA) in 1978 as a general use insecticide for ground and aerial application (Reardon and Podgwaite 1992, Reardon and others 1996). Gypchek is labelled for use in wide-area public pest control programs sponsored by government entities.

Gypchek is specific to the gypsy moth and does not affect other caterpillar species or any other nontarget organisms that might be present in treatment areas (Barber and others 1993, Rastall and others 2003). This fact renders Gypchek a desirable insecticide for use where threatened or endangered species might be found or in other environmentally sensitive areas; however, the availability of Gypchek is limited.

Gypchek is produced by the Forest Service and APHIS in quantities sufficient to treat about 8,000 acres (3,240 ha) each year. Production involves raising large numbers of gypsy moth caterpillars, inoculating and then processing the infected caterpillars at the appropriate time. Anywhere from 500 to 1,000 infected caterpillars are required to produce enough Gypchek to treat 1 acre. Widespread operational use of Gypchek hinges on availability and cost (Reardon and Podgwaite 1992, Reardon and others 1996). Gypchek can be applied with aerial or ground techniques, and when applied properly can achieve suppression rates similar to *B.t.k.* (Thorpe and others 1998).

On-going research may result in the future ability to manufacture Gypchek in bioreactors, avoiding the higher costs and difficulty of rearing caterpillars to produce the virus *(Figure A-2)*. Research also seeks to produce a strain of Gypchek that is more effective against the gypsy moth.

Gypchek must be ingested by the gypsy moth caterpillar. The rod-shaped virus particles, or virions, are liberated in the gut of the insect. The virions invade the gut wall and attack the internal organs and tissues, causing infection. The virus multiplies rapidly in cells of the insect and eventually causes breakdown of internal tissue and death. The entire process takes from 10 to 14 days, depending on the size of the caterpillar, viral dose, and ambient temperature. First and second instar caterpillars are most susceptible to Gypchek. Dead caterpillars typically hang in an inverted "V" from foliage and branches and often rupture, releasing more virus that can infect other gypsy moths (Reardon and Podgwaite 1992, Reardon and others 1996) (*Figure A-3)*.

Gypchek Use.

It is recommended that Gypchek be formulated at the mixing and loading site before aerial application, but it will stay viable for up to 3 months if stored under the proper conditions after mixing with the carrier. The standard tank mix consists of water (pH 5.0–8.0), ultraviolet-light sunscreen and a sticking agent (to aid adhesion to leaf surfaces). During the years 2001 to 2010, Gypchek was used on an average of about 8,000 acres per year in suppression, eradication, and slow-the-spread projects (USDA Forest Service 2011). Gypchek is usually applied against first or second instars of the gypsy moth.

Gypchek Effectiveness.

Gypchek is preferably used against moderate-to-high gypsy moth populations (300–5,000 egg masses/acre [741–12,355 egg masses/ha]). Gypchek does not adversely affect nontarget species (Rastall and others 2003). See Appendix G for the risk assessment on Gypchek.

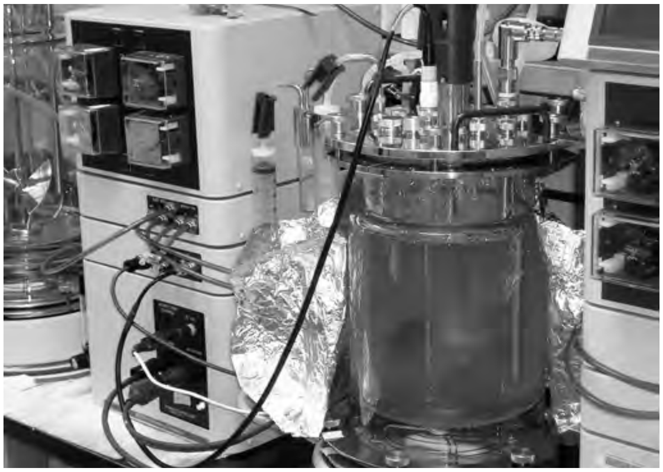


Figure A-2. Researchers hope to be able to manufacture Gypchek in bioreactors such as this. (Forest Service laboratory, Delaware, OH)

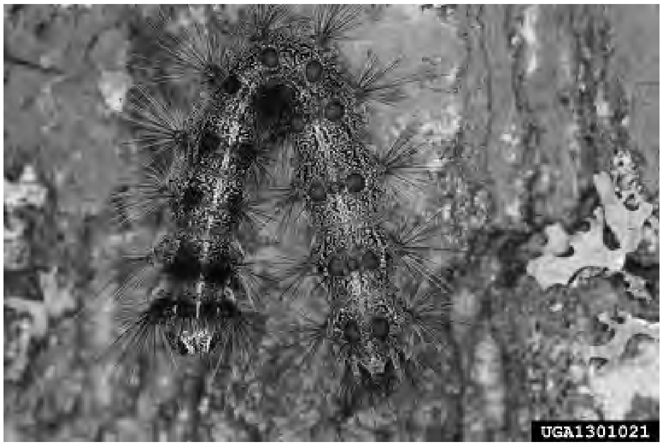


Figure A-3. Gypsy moth larvae killed by the nucleopolyhedrovirus typically hang in an inverted V.

Mass Trapping (Disparlure Only, or Disparlure and Dichlorvos).

Mass trapping uses disparlure (synthetic sex pheromone) to attract male moths to traps placed in a grid pattern across a target area, with the objective of capturing male gypsy moths before they are able to locate and mate with female moths. Two types of traps are used, depending on the expected number of moths to be caught: the smaller delta trap and larger milk carton trap.

The standard "delta" trap is a small-capacity trap, approximately 8 inches (20 cm) long, 4 inches (10 cm) high, and triangular in cross section. A tiny plastic strip impregnated with disparlure or a string impregnated with disparlure is stapled to the inside of the trap to attract male gypsy moths. The inside surface of the trap is coated with a sticky substance to capture the moths and prevent their escape from the traps.

The second type of trap is called the “milk carton” trap because it resembles a half-gallon cardboard milk container. This type of trap is used in areas where large numbers of male moths are expected to be caught and would quickly overwhelm the sticky surface of the smaller delta trap. As in the delta trap, a small pheromone wick containing disparlure is placed inside the milk carton trap to attract moths. Unlike the delta trap, the milk carton trap also contains a 1-inch by 4-inch (2.5 cm by 10 cm) laminated plastic strip impregnated with the insecticide dichlorvos (2,3 dichloroethenyl dimethyl ester phosphoric acid [DDVP]) to kill the moths and prevent their escape from the traps. Dichlorvos, registered with the U.S. EPA, is manufactured by AMVAC Chemical Corporation (City of Commerce, CA). When used in milk carton traps, dichlorvos is formulated and registered as Vaportape II (Hercon Environmental Company, Emigsville, PA). A risk analysis for dichlorvos is found in Appendix K of this SEIS.

Mass Trapping Use.

Both types of traps are used for detecting and monitoring gypsy moth populations. Delta traps are most commonly used in the uninfested area of the United States to detect and delimit isolated infestations of the gypsy moth. Milk carton traps are more commonly used in areas where large numbers of male moths are likely to be caught. The delta trap is primarily used for mass trapping, though milk carton traps might be considered if the expected catch per trap is greater than 15 moths, which would overwhelm the sticky surface in the smaller delta trap. When used for mass trapping, delta or milk carton traps are deployed in an intensive grid pattern across an infested area and an adjacent buffer area, at the rate of at least 9 traps per acre (25 traps/ha).

Mass Trapping Effectiveness.

The success of mass trapping depends on the density of the gypsy moth population in the treatment area, because the tactic relies on luring all male moths into the traps before they can mate with females. The higher the population density, the greater the risk that a male will find and mate with a female before being lured into a trap. Therefore, the treatment is best used where there are less than 10 egg masses per acre (25 egg masses/ha) (USDA Forest Service 1989).

Mass trapping is a labor-intensive treatment, especially over large areas; it is typically used on small infestations of less than 100 acres (40.4 ha). Nontarget organisms are unaffected, except those that accidentally find their way into the traps (primarily flying insects).

See Appendix H for the risk assessment on disparlure, and Appendix K for the risk assessment on dichlorvos.

Mating Disruption (Disparlure).

Pheromones are chemicals produced by insects and used in communication. Disparlure is the gypsy moth pheromone that attracts male moths to female moths for mating. Synthetically produced disparlure can be used to disrupt the mating of gypsy moths. Mating disruption relies on the use of the gypsy moth pheromone disparlure (cis-7,8-epoxy-2-methyloctadecane [racemic disparlure]) as the active ingredient; however, a 50:50 mixture of the plus (+) and minus (−) enantiomers of synthetic disparlure are used rather than only the +enantiomer used in trap lures (Thorpe and others 2006). This 50:50 mixture of enantiomers, called racemic disparlure, lacks the highly attractive characteristics of +disparlure. Instead of luring adult male gypsy moths away from females, application of racemic disparlure interferes, or “disrupts,” the male moths’ normal mate search behavior, which prevents them from finding females and mating with them.

Mating Disruption Use.

Mating disruption was first used operationally in a USDA cooperative eradication project in Virginia in 1983. Widespread use of this treatment did not begin until initiation of the Slow-the-Spread (STS) Pilot Project in 1993. Research and technology development accelerated during the pilot project (1993 to 1999). By the time STS transitioned to operational status in 2000, mating disruption evolved into the treatment of choice. Between 2001 and 2010, mating disruption accounted for about 85 percent of the total acres treated in slow-the-spread projects. During that decade of the more than 5.0 million acres that received slow-the-spread treatment, about 4.3 million acres received mating disruption treatments. By comparison, between 1983 and 2010 less than 2 percent of the total acreage treated in eradication projects received mating disruption as the primary treatment (USDA Forest Service 2011).

Mating disruption can be accomplished either by ground or aerial application of controlled-release dispensers, formulated to slowly exude their load of active ingredient (racemic disparlure) into the environment. The formulations used for ground application consist of a laminated polymeric tape or an amorphous polymer matrix impregnated with the pheromone, for gradual release into the environment. The products are manually applied to trees in a grid pattern, making this method labor intensive, especially over large treatment areas. An evaluation of the ground application method concluded that additional research is needed before considering it for operational use (Kolodny-Hirsch and others 1990). The tape is no longer produced, but it is still registered with the U.S. EPA and could be made available in the future if requested from the manufacturer (Hercon Environmental Co., Emigsville, PA). The polymer matrix is available from ISCA Technologies (Riverside, CA).

Although numerous controlled-release dispensers have been evaluated for use in aerial gypsy moth mating disruption projects, only two products are registered with U.S. EPA and available for commercial use (Disrupt II, Hercon Environmental, and SPLAT-GM, ISCA Technologies). Disrupt II consists of a layer of resin impregnated with racemic disparlure sandwiched between two outer layers of plastic laminate. The laminate is chopped into small flakes; thus the term “pheromone flakes” or simply “flakes” is commonly used when referring to Disrupt II treatments. SPLAT-GM consists of a flowable polymer matrix that is applied in droplets. Aircraft using custom-designed application equipment apply Disrupt II or SPLAT-GM, which slowly releases its load of pheromone into the environment over 3 to 4 months. Other promising formulations, such as microcapsules, microtubes, or emulsified concentrates, will continue to be evaluated for use in gypsy moth mating disruption projects.

Mating Disruption Effectiveness.

The effectiveness of mating disruption varies with the population density of gypsy moths in the treatment and surrounding areas. Mating disruption is only effective when used against very low-density populations of the gypsy moth. In higher-density populations where dozens of moths of both sexes may emerge on the same tree bole, the chance of male moths locating females without the use of pheromone cues is high (Thorpe and others 2000). Therefore, mating disruption is best suited for areas that contain less than 10 egg masses per acre (25 egg masses/ha) (USDA Forest Service 1989). Populations of this low density are typically found in the STS or eradication area, but not in the suppression area.

The trend in recent years has been towards lower doses for gypsy moth slow-the-spread projects. Until 1999, the standard dose used in slow-the-spread mating disruption projects was 30 grams active ingredient (g a.i.) per acre. Reduction of the standard dose to 15 g a.i. per acre started in 2000. Further research confirmed that a dose as low as 6 g a.i. per acre effectively disrupts mating in low-density populations of gypsy moth (Tcheslavskaia and others 2005). The 6 g a.i. per acre dose has been the most widely used in STS mating disruption treatments since 2004.

Mating disruption may be used alone or in conjunction with other treatments. Typically, it is used alone, but in some situations large infestations contain core population(s) that already exceed the threshold at which mating disruption can be effective. In these cases, a small area treated with *B.t.k.*, diflubenzuron, or Gypchek might be embedded within the boundaries of the larger mating disruption block.

Treatments that used mating disruption as part of cooperative slow-the-spread projects between 1993 and 2001 were at least as effective as treatments using *B.t.k.* Further, the frequency of repeated treatments was higher after using *B.t.k.* than after using mating disruption. This information must be further evaluated, considering that mating disruption is typically used on the lower population densities, whereas *B.t.k.* is used on both low and high population densities (Sharov and others 2002a).

The use of disparlure as a mating disruption agent is desirable because the pheromone does not affect nontarget organisms. Once the pheromone dissipates, the inert ingredients in the dispensers remain in the environment from several months (SPLAT-GM) to several years (Disrupt II) before disintegrating. Nonetheless, the use of this treatment will continue to be critical to STS projects where rare, threatened, or endangered species are commonly encountered.

See Appendix H for the Disparlure Risk Assessment.

Sterile Insect Technique.

The sterile insect technique has not been used in recent years, but is available as a treatment tool for gypsy moth control. The objective of the sterile insect technique is to reduce the chance that female moths will mate with fertile males. Its success is more likely with the release of large numbers of sterile males in consecutive years. The resultant progressive reduction of fertile egg mass production leads to the eventual elimination of the population.

Sterile insect technique is ideally suited for application to gypsy moth populations with one generation per year. Male moths may mate several times; female moths usually mate only once and lay an egg mass that may contain up to 1,600 eggs (Reardon and Mastro 1993). Recognition of the potential of this approach for managing low-density and isolated infestations of the gypsy moth took place in the mid-1950s. Treatment was not practical, however, until the development of methodologies for rearing large quantities of quality insects and quantifying the impact of the releases (Mastro and others 1981).

Sterile Insect Technique Use.

One of three different approaches is selected (Reardon and Mastro 1993): (1) deploying male pupae sterilized by irradiation; (2) deploying male pupae irradiated, but not fully sterilized (substerile); or (3) broadcasting eggs from a female mated with an irradiated male (inherited sterility). None of these approaches is without biological or logistical limitations, which hamper operational use.

Sterile and Substerile Male Pupae.

Initially, the sterile insect technique focused on deploying male pupae treated with a sterilizing dose of radiation. Pilot projects in Maryland, Michigan, and South Carolina during the 1970s and 1980s demonstrated the efficacy of this technique. Nevertheless, the limited time period during which pupae must be released and the need to synchronize rearing of mass quantities of pupae for that release (treated pupae cannot be stockpiled) are obstacles to an operational program *(Figure A-4)* (Reardon and Mastro 1993). A major logistical difficulty is the necessity of repeatedly releasing the treated insects over the 4-week flight period because male moths live only 2 to 3 days.

Figure A-4. Sterile gypsy moths are reared on artificial diet in a climate-controlled environmental chamber.

Deploying substerile insects is the preferred of the two techniques that release male pupae, because (1) the substerile insects suffer less tissue damage and are therefore more competitive than sterile males; (2) the progeny of substerile males and wild females develop in the field and are, in theory, hardy and in synchrony with the native population; and (3) the suppressive effect on the native population spans at least two life cycles (Knipling 1979, Snow and others 1971).

Inherited Sterility.

For induced inherited sterility (or F1 sterility), males are irradiated but not sterilized before they mate with non-irradiated females in the laboratory. More of the resulting progeny are sterile than in the treated parental generation, and the sex-ratio of the progeny is skewed in favor of males (LaChance 1985, North 1975). Release of F1 sterile eggs has advantages over the other two techniques: only a single release of treated gypsy moth eggs is required before wild eggs hatch, the production window is wider because eggs can be stockpiled, and the logistics of shipment and release are simpler.

Sterile Insect Technique Effectiveness.

Between 1988 and 1992, eight isolated infestations of the gypsy moth were treated by releasing F1 sterile eggs, with favorable results; but numerous problems were identified (Reardon and Mastro 1993): (1) how to predict when wild eggs hatch, and how to synchronize release and hatching of eggs produced in the laboratory; (2) how to reduce mortality that occurs in early F1 instars; (3) dispersal of F1 young caterpillars and adult males; and (4) the relative competitiveness of caterpillars.

When evaluated against low-level gypsy moth populations in Virginia (Reardon 1991), results with substerile pupae generally proved more favorable than with F1 sterile eggs. Of the three approaches, the deployment of sterile male pupae is the least desirable. Release of F1 sterile eggs is preferred; however, the obstacles described are major impediments to more general use of this technique (Reardon and Mastro 1993). The deployment of substerile pupae, in spite of its disadvantages, appears closest to operational use, although availability of substerile insects is limited.

Recent advances in insect engineering for use in sterile insect technique programs show promise for increasing the effectiveness and efficiency of the program. At this writing, however, no operational program has been developed for the gypsy moth.

A.2 The New Proposed **Treatment of Tebufenozide.**

Tebufenozide, like diflubenzuron, belongs to a group of compounds called insect growth regulators.

Tebufenozide, which induces premature molts by direct stimulation of the ecdysteroid receptors (whereas diflubenzuron affects chitin synthesis at the regularly scheduled molt), mimics the action of a natural insect hormone. Upon ingestion of tebufenozide, larvae stop feeding and undergo an early, incomplete and lethal molt.

Tebufenozide Use.

Label instructions permit ground or aerial applications of tebufenozide. The labeled application rates for tebufenozide range from 0.06 lbs a.i. per acre to 0.12 lbs a.i. per acre. Tebufenozide is applied to early first to third instar larvae.

Tebufenozide Effectiveness.

Tebufenozide has not been used operationally by the USDA in suppression, eradication, or slow-the-spread projects. Forest Service tests of tebufenozide at 0.06 lbs a.i. per acre generally found the product to be effective with 95 to 99 percent control achieved (Reardon and others 2000). See Appendix J for the risk assessment on tebufenozide.

A.3 Treatments That Include Natural Control Agents.

Few natural control agents accompanied the accidental introduction of the gypsy moth to this country. Some of those agents, as well as agents native to the United States, can play an important role in regulating gypsy moth populations throughout the generally infested area.

Fungal Pathogens.

Fungal products labeled for use against the gypsy moth are not available at this writing. A fungus capable of infecting the gypsy moth is *Entomophaga maimaiga* Humber, Shimazu, and Soper. This fungus, commonly found in Japan (Soper and others 1988), was brought to the United States in the early 1900s and released, but was not recovered until 1989 (Hajek and others 1996). *E. maimaiga* is known to infect only the gypsy moth and other closely related caterpillars that spend significant periods of time on the soil surface (Reardon and Hajek 1993, Hajek and others 2000).

A field survey, conducted from 1989 to 1995 of lepidopteran cadavers infected with *E. maimaiga*, found three species of lymantriids, from the genus *Dasychira*, infected with *E. maimaiga* (Hajek and others 1996b). The field survey method was chosen because entomopathogens can infect hosts in the laboratory that are never found infected in the field. During a similar study in 1994, Hajek and others tested and found two species infected with *E. maimaiga*. Under laboratory conditions, conidia (infective spores) produced by an alternate host were determined to be ineffective (Hajek and others 1995b).

Epizootics of *E. maimaiga* in gypsy moth identified in the northeastern United States in 1989 represent the first reported occurrence of this fungus in North American gypsy moth populations (Andreadis and Weseloh 1990, Hajek and others 1990). Unlike the gypsy moth nucleopolyhedrosis virus, associated with high gypsy moth population densities, the fungus appears capable of causing dramatic mortality to middle-and late-stage gypsy moth caterpillars at low densities (Shimazu and Soper 1986). Since the fungus tends to cause mortality earlier than the virus, tree defoliation may not be as severe. Prediction of long-term impacts of *E. maimaiga* is inconclusive (Valenti 1998).

A gypsy moth larvae infected with *E. maimaiga* produces one or both types of spores—resting spores (azygospores) and conidia spores (infectious spores).

The age of the larvae is the primary factor in determining which type of spore is produced. Second instar larvae rarely contain resting spores, while fifth instar larvae produce resting spores when temperatures are increasing (Hajek and Shimazu 1996). The resting spore of the fungus overwinters on the bark of trees, in leaf litter, and in soil (Shimazu and others 1986). The resting spore germinates in the spring and produces a single conidium, which is released into the environment and may be carried in the air. Once on a susceptible caterpillar, the conidium germinates, penetrates the insect's skin, spreads throughout the caterpillar and kills it. Infected dying caterpillars typically hang with head down, in a stretched-out position on the stems of infested trees (Hajek and Roberts 1992). The fungal spores may remain alive in the soil for up to 10 years (Weseloh and Andreadis 2002).

With favorable conditions, high humidity and temperatures between 13 °C to 19 °C, the fungus grows out of the caterpillar through the skin and produces and releases more conidia, which may subsequently infect other caterpillars (Hajek and others 1996c). This secondary infection cycle is a major contributor to the dramatic epizootics observed in gypsy moth populations. When conditions are unfavorable, or mid-to-late June as the end of the feeding period of gypsy moth caterpillars approaches, *E. maimaiga* begins to produce resting spores inside the dead caterpillars, which slowly disintegrate and scatter the resting spores into the environment, with most accumulating in the soil. Laboratory determinations indicate that spores buried at least 1 cm below the surface are unable to infect gypsy moth larvae (Hajek and others 1998a). These resting spores will not germinate for approximately 9 months after production (Hajek and Humber 1997). Diet of the gypsy moth larvae could also influence the development of *E. maimaiga* (Hajek and others 1995b).

Since 1989, the fungus has spread across a large portion of the generally infested area, apparently by spore movement on the wind and intentional introduction (Elkinton and others 1991, Smitley and others 1995), infecting gypsy moth throughout its range (Hajek and others 1999). Epizootics of *E. maimaiga* have occurred in New England and some Middle Atlantic States, and its distribution continues into areas more recently colonized by the gypsy moth. The fungus is so widespread in parts of Michigan and Virginia that it is difficult to determine whether the presence of the fungus at an individual location resulted from natural migration or spread from a release (inoculation) site (Reardon and Hajek 1995).

It is not clear why the fungus suddenly appeared almost 80 years after its initial introduction into the United States. Among the hypotheses offered, the most plausible may be these two: (1) a more aggressive strain of *E. maimaiga* arose through natural selection some time after its release in 1910–1911; or (2) more of the fungus was accidentally introduced (Hajek and others 1995a, Weseloh 1998b).

Numerous constraints limit the development of *E. maimaiga* for use as an insecticide (Reardon and Hajek 1993). Fungi are often short-lived in storage and relatively expensive to produce, and foliar applications of fungi are sensitive to heat, humidity, sunlight, and rainfall. Formulation and application of dried fungal preparations also present the unique challenges of their adherence to leaf surfaces and protecting them from adverse environmental conditions.

The release of *E. maimaiga* into uninfested areas on a large scale is problematic as well. Because of its natural rate of spread, it is probably not necessary to physically introduce it into new areas. Intentional introduction of the fungus by moving soil or other inoculation into the soil would require registration and labeling of a product for this purpose with the Environmental Protection Agency (Podgwaite, John, Microbiologist, USDA Forest Service [Conversation with Joseph L. Cook]. 28 July 2004). Though *E. maimaiga* is a virulent pathogen of the gypsy moth, known to cause extensive epizootics in Japan (Shimazu and Soper 1986), it poses no known health risks to humans or pets.

E. maimaiga may eventually contribute to the long-term control of the gypsy moth. However, studies have only begun to identify the information about host-pathogen interactions that are vital to developing the fungus for effective biological control of the gypsy moth. Computer models can assist in management decisions by predicting short-term gypsy moth-fungus interactions and the effectiveness of the fungus (Weseloh 2003b).

Parasitoids.

Parasitoids live in or on another organism and benefit from the relationship, at a cost to the host, which often dies *(Figure A-5)*. Two approaches used to introduce parasitoids into the gypsy moth population in North America are classic biological control and augmentation. The discovery, importation, release, and attempted establishment of exotic natural enemies of the gypsy moth are all part of classic biological control (Reardon 1981). Manipulation to initiate or increase effective biological control through established parasites is termed augmentation (Blumenthal and others 1981).

Parasitoids, in conjunction with other natural enemies (predators and pathogens), help regulate populations of the European strain of the gypsy moth by reducing their numbers. Most researchers do not believe that they play a major role in regulating gypsy moth populations (Elkinton and Liebhold 1990).

The rate of parasitism by a particular parasitoid species varies from site-to-site and from year-to-year, depending on such factors as the number of gypsy moth caterpillars, the number of alternative hosts, and the weather. Parasitoids are thought to help maintain low-density populations of the European strain, but do not prevent the buildup of already increasing populations (Campbell 1974b). The tachinid flies, *Compsilura concinnata* (Meigen) and *Parasetigena silvestris* (Robineau-Devoidy), may play a role in suppressing incipient outbreak populations, but such population declines may go unnoticed (Elkinton and Liebhold 1990).

Figure A-5. A parasitic wasp lays eggs on gypsy moth pupal case; eggs hatch into wasp larvae, which feed on and kill the host.

The State of Massachusetts and the (then) Federal Bureau of Entomology initiated foreign exploration for gypsy moth parasitoids in 1904, and the effort continues today by the USDA. Over 250,000 parasitoids of more than 85 species have been sent to the United States from collection areas around the world. Ten of these imported species were released and became established in the United States (Elkinton and Liebhold 1990). Additionally, several parasitoids native to the United States have become opportunistic parasitoids of the gypsy moth.

The principal egg parasitoids in North America are *Ooencyrtus kuvanae* (Howard) (Hymenoptera: Encyrtidae) and, to a much lesser degree, *Anasatus disparis* (Ruschka [Hymenoptera; Eupelmidae]). *O. kuvanae* typically attacks 10 to 40 percent of the eggs in an egg mass (Brown 1984). The rate of parasitism is greater in the smaller egg masses typical of high-density declining gypsy moth populations (Bellinger and others 1988, Brown and Cameron 1979).

Cotesia (Apanteles) melanoscelus (Ratzeburg) is a small braconid wasp that parasitizes early instar gypsy moth caterpillars, and has two generations per year. Hyperparasitoids, which prey on other parasitoids, severely reduce the numbers of *C. melanoscelus* that overwinter (Weseloh 1983). Also limiting the wasps' effectiveness is the poor synchronization of the parasitoid's second generation with its host (Weseloh 1976). Higher parasitism rates, however, reportedly occur when early gypsy moth instars are prolonged, as when they ingest sublethal doses of *B.t.k.* (Weseloh and Andreadis 1982).

Parasetigena silvestris (Diptera: Tachinidae) is a tachinid fly that lays an egg on the outer skin of the gypsy moth caterpillar, and has a single generation per year. Most active during daylight, the fly often causes more mortality than any other parasitoid. Peak parasitism tends to occur after gypsy moth populations decline from high densities (Elkinton and Liebhold 1990). In Europe, parasitism by *P. silvestris* sometimes exceeds 95 percent (Bogenschutz and others 1989).

The tachinid fly, *Blepharipa pratensis* (Meigen) (Diptera: Tachinidae), is a major source of mortality in intermediate-density gypsy moth populations (Ticehurst and others 1978) *(Figure A-6)*. It lays small eggs on foliage being fed upon by gypsy moth caterpillars. The eggs hatch after being ingested by caterpillars.

Brachymeria intermedia (Nees) (Hymenoptera: Chalcididae) is a small wasp that attacks gypsy moth pupae and other hosts. Introduced in 1908 but not recovered until 1942, it was abundant by 1971 (Doane 1971). The parasitoid was observed causing high mortality of gypsy moths in Pennsylvania (Ticehurst and others 1978) and on Cape Cod (Elkinton and others 1989). *B. intermedia* tends to be scarce in low-density gypsy moth populations (Elkinton and Liebhold 1990).

Lastly, the tachinid fly *Comsilura concinnata* (Diptera: Tachinidae) has many hosts and several generations per year; it can remain abundant when gypsy moth populations are low. This fly often causes higher mortality than other parasitoids in low-density gypsy moth populations (Elkinton and Liebhold 1990).

Figure A-6. Tachinid flies will parasitize gypsy moth caterpillars. (Mongolia).

Augmentation of these established parasitoids has not proven to be an effective means to control gypsy moth populations (Blumenthal and others 1981). Classic biological control efforts continue to be an important avenue for study, and the search for and importation of gypsy-moth-specific natural enemies from Europe and Asia remains promising.

Predators.

Many species of animals eat the gypsy moth as well as other forest-defoliating insects. Some predators feed on only one life stage of the gypsy moth, while others consume two or more life stages (Smith 1985). Predation can help maintain sparse, stable gypsy moth populations indefinitely, though periods of low predatory pressure do not necessarily lead to an outbreak. Once an outbreak starts, as well as during subsequent outbreak decline, predation has no significant effect on population densities (Smith and Lautenschlager 1981).

The gypsy moth predator community is complex and includes approximately 50 species of birds, 20 species of mammals, some amphibians, reptiles, fish, insects, and spiders. Only a few of these predators are known to affect gypsy moth population dynamics (Elkinton and Liebhold 1990, Smith and Lautenschlager 1981). The predators are all opportunistic feeders, meaning that their taste for the gypsy moth depends upon the scarcity of preferred food. Robins, for example, may eat gypsy moth caterpillars when earthworms become scarce.

Bess and others (1947) first suggested that predation by small mammals is important to gypsy moth population dynamics in North America. Vertebrate predators, especially the white-footed mouse *(Peromyscus leucopus) (Figure A-7)*, are major sources of late-larval and pupal mortality in low-density gypsy moth populations (Campbell and Sloan 1977b, c, Campbell and others 1977), but not at higher gypsy moth densities (Campbell and others 1975, 1977). Small mammals help to maintain low-density gypsy moth populations (Elkinton and Liebhold 1990).

The earliest study of predation by birds, conducted by Forbush and Fernald in 1896, listed 38 bird species seen eating one or more life stages of the gypsy moth. Studies of bird predation tend to show that gypsy moth is not a major food item of most species (Cooper 1988). In feeding preference studies birds favored hairless caterpillars over gypsy moth caterpillars (Whelan and others 1989). Predation by birds is frequently cited in European literature as an important influence on gypsy moth population dynamics, but few studies exist to support that claim (Elkinton and Liebhold 1990).

The impact of invertebrate predators, such as ground beetles and ants, on gypsy moth pupae is less than that of vertebrates (Campbell and Sloan 1976, Elkinton and others 1989). Most predation by invertebrates occurs in leaf litter; little predation occurs in the tree canopy (Weseloh 1988). Adult and immature stages of *Calosoma sycophanta* (L.), a large, predaceous ground beetle introduced into North America from Europe, feed on gypsy moth caterpillars and pupae *(Figure A-8)*. *C. sycophanta* populations increase in response to high-density gypsy moth populations and tend to lag 1 to 3 years behind the onset of gypsy moth outbreaks (Weseloh 1985a, Smith and Lautenschlager 1978). The impact of *C. sycophanta* on low-density gypsy moth populations is thought to be minor (Weseloh 1985b, Smith and Lautenschlager 1978). Gypsy moth hairs defend the moth from spiders (Bardwell and Averill 1996).

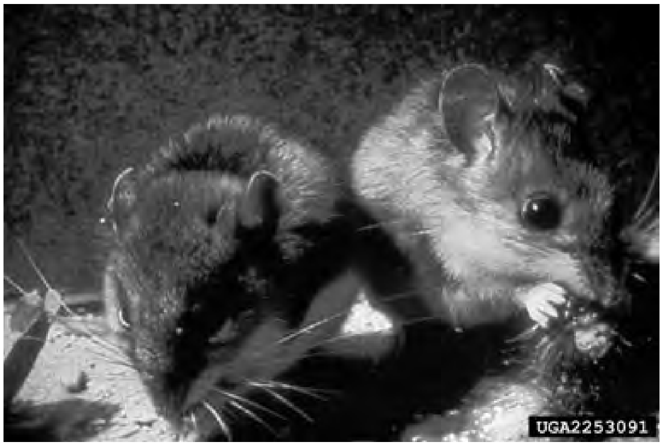


Figure A-7. White-footed mice feed on gypsy moth larvae.

Figure A-8. The Calosoma beetle is a gypsy moth predator introduced from Europe.

Predators can be encouraged by maintaining habitat diversity. People unknowingly destroy good habitat for predators by removing brush in an effort to "clean up" yards and woodlots. Such cleanup efforts significantly decrease the survival of small mammals and increase the survival of gypsy moths. For example, leaving dead "snag" trees increases populations of cavity nesting birds such as woodpeckers, which eat gypsy moths. Placing nesting boxes to supplement snags may also encourage cavity-nesting birds. Leaving piles of brush might encourage populations of small mammals, such as mice and shrews, which eat gypsy moths. Forest type may also affect predation (Liebhold and others 1998). Forest thinning does not affect predation, but it was found that invertebrates are the main predators on larvae, and small mammals the major predators on pupae (Grushecky and others 1998). As vertebrate densities increase, invertebrate predation may decrease (Cook and others 1995, Hastings and others 2002).

Nematodes.

Nematode results against defoliators such as the gypsy moth are inconsistent (Gaugler 1981, Kaya and Reardon 1982, Kaya and others 1981). Depending on the species, nematodes may actively search out their hosts and enter their body openings. In one study, two species of commercially available nematodes, *Steinernema carpocapsae* (Weiser) and *S. feltiae* (Filipjev), were applied to cloth-lined burlap and plastic bands around the tree boles to infect resting gypsy moth caterpillars. The results were highly variable between trees, primarily due to the nematode's need for a humid environment (Reardon and others 1986). Because nematodes may have potential for use against the gypsy moth, research continues.

Microsporidia.

The gypsy moth was introduced into North America without the normal complement of natural enemies that help to regulate populations in Europe. There are many groups of entomopathogens (organisms that infect insects), viruses, fungi, and protozoans found in gypsy moth populations in Europe (especially during outbreak years) that are not found in this country.

Microsporidia (protozoa) are a diverse group of obligate intracellular parasites that use most animals (including insects) and humans as hosts and are relatively host specific. According to Maddox and others (1999), six species of microsporidia described from gypsy moth populations in Europe and several isolates that have not been described or identified are recorded in the literature; microsporidia have never been reported from gypsy moth populations in North America.

The significance of microsporidian pathogens as mortality agents of gypsy moths is frequently overlooked. Among the pathogens commonly found in European gypsy moth populations, microsporidia are prevalent during the gradation period prior to outbreaks and then persist at low levels among gypsy moth populations in the years between outbreaks. Different microsporidian species that infect the gypsy moth target various tissues within their host, including the silk glands, midgut and associated muscle tissue, body fat, nerve tissue, and reproductive organs. Several authors from Europe report that microsporidia caused over 80 percent mortality of late-stage gypsy moth larvae in the Balkans and Ukraine, and caused high mortality in overwintering egg masses.

Because this strong evidence suggests that microsporidia are significant mortality factors in the dynamics of gypsy moth populations in central Europe, the USDA Forest Service initiated a foreign exploration program in 1993 to search for microsporidia in gypsy moth populations in several European countries. The program compares these isolates with previously described species and evaluates isolates that might be candidates for introduction as classical biological control agents, to enhance the natural control of this pest in North America.

Significant progress has been made in accumulating basic knowledge of the biology and life history of select isolates, which is necessary to resolve safety and regulatory issues of concern prior to consideration for possible introduction into the United States (McManus and Solter 2003). An extensive series of laboratory studies assesses the host specificity of select isolates against 49 species of non-target Lepidoptera known to occur in U.S. oak forests. Multi-year studies in Bulgaria and Slovakia evaluated the susceptibility of non-target forest Lepidoptera found with the gypsy moth in those countries. The development of molecular techniques aids in clarifying the taxonomy of European isolates and in fingerprinting individual isolates.

Preliminary discussions are ongoing with the EPA and APHIS to review the biological and ecological data accumulated on these gypsy moth pathogens during the past 10 years and to assess the feasibility of introducing them as classical biological control agents in small controlled experiments.

A.4 Miscellaneous Means of Gypsy Moth Management.

Removing and Destroying Egg Masses.

One of the first gypsy moth treatments involved removing and destroying egg masses. Broad application of this technique to control the gypsy moth reached its zenith in the 1930s with the employment of Civilian Conservation Corps workers in New England during the fall, winter, and early spring, to seek out and destroy egg masses in towns and woodlands. The technique is labor- and time-intensive and impractical for large areas. Experience has shown that in a forested area, many more egg masses are present than are actually seen and disposed of, though the technique may be helpful in urban or suburban areas on accessible trees or ornamental plantings. Careful searching, removal, and destruction of egg masses may help reduce the potential for damage due to the gypsy moth in these situations.

Tree Trunk Bands and Barriers.

As with removal and destruction of egg masses, removal and destruction of gypsy moth caterpillars may be useful in localized urban and suburban situations where small numbers of trees are at risk. The habit of caterpillars to move down from the crown and rest in protected areas during the day can be used to collect them. Bands, commonly of burlap, are placed around the trunks of susceptible trees to serve as resting areas for caterpillars seeking shelter. During an outbreak, the bands must be checked and the larvae need to be scraped off and killed. However, caterpillars may remain in the canopy and feed night and day during an outbreak, thus reducing the effectiveness of this method. Except as a survey tool, use of this technique in a forest situation is impractical.

A variety of trunk barriers is commercially available. Shown to be the most effective are barriers that include a sticky surface (Webb and Boyd 1983). An effective sticky barrier can be fashioned by wrapping the trunk of a susceptible tree with duct tape (to protect the bark and provide a smooth surface) and applying a thin layer of Tanglefoot. Gaps between the tape and the tree surface can be filled with fabric, polyester pillow stuffing, or any other suitable material. Trunk barriers should be placed just before gypsy moth eggs hatch, usually in March or April, depending on location. Insecticides can be combined with trunk barriers. A product that combines an insecticidal latex coating and burlap trunk barriers (White and others 1997) caused significant larval mortality for 30 days after application and reduced the need for manual removal of larvae.

While properly maintained sticky barriers are extremely effective at preventing caterpillars from climbing trees, they have no effect on caterpillars already in the canopy. For this reason, the impact of the barriers is usually limited to a 20- to 30-percent reduction in caterpillar numbers in treated trees over the season (Thorpe and Ridgway 1994, Thorpe and others 1993). The expected degree of foliage protection is even more variable, but usually averages 20 to 30 percent as well. Therefore, while trunk barriers provide some benefit, they should never be relied upon as the sole method to protect foliage.

Broad-Spectrum Insecticides.

A number of insecticides other than *B.t.k.*, diflubenzuron, tebufenozide, and Gypchek are registered by the U.S. EPA for gypsy moth control. These include carbaryl, which was used in the past by USDA for gypsy moth management programs. Some insecticides are registered either for gypsy moth control or for control of pests where gypsy moth is likely to be present; for example, in areas with susceptible shade or ornamental trees. Insecticides such as carbaryl and diazinon may be available for homeowners. All of these insecticides are excluded from this SEIS because they affect a wider range of non-target organisms than do *B.t.k.*, diflubenzuron, and tebufenozide and, therefore, are not part of the USDA program. However any of these registered insecticides may be used by private applicators outside of the USDA program.

Silviculture.

Silviculture is the practice of applying treatments to forest stands to maintain and enhance their utility for any purpose (Smith 1986). Silvicultural guidelines are designed to minimize the effects of the gypsy moth on forest stands and trees and are being evaluated for effectiveness. The guidelines recommend application of treatments to minimize gypsy moth impacts before, during, and after outbreaks (Gottschalk 1993).

The greatest number of silvicultural options for gypsy moth control are available before the insect becomes established in an area. Before outbreaks, silvicultural treatments may reduce stand susceptibility and vulnerability. Treatments might include these: increasing stand and tree vigor, removing trees most likely to die, reducing gypsy moth habitat (trees with large numbers of dead branches with rough peeling bark), reducing preferred gypsy moth food sources, improving predator and parasite habitats, regenerating stands that are close to maturity or understocked, and encouraging regeneration of nonpreferred gypsy moth food sources. Silvicultural considerations in urban and suburban areas include planting trees that are less susceptible to the gypsy moth. These silvicultural treatments should be conducted at least 2 years before gypsy moth arrives in an area to allow the remaining or newly planted trees to recover from the stress of treatment.

Silvicultural techniques vary according to the condition of the site, as in converting a stand to nonpreferred species. A thinning of healthy and vigorous sites performed 1 year before or after a gypsy moth outbreak enhances the vigor of the residual stand (Brooks and Hall 1997). When considering regeneration of preferred gypsy moth species, stump sprouts should be thinned to one stem per stump to improve vigor and resistance.

Another silviculture technique is the use of prescribed burns. This technique is occasionally used for oak regeneration. When a prescribed burn is properly used, it does not enhance susceptibility to gypsy moth.

Once the gypsy moth becomes established, or outbreaks occur or are imminent, silvicultural options are reduced. During outbreaks, silvicultural guidelines help prioritize stands that are candidates for receiving treatments and help determine if stands can be regenerated. Performing thinning during these times may reduce the density of egg masses.

Following gypsy moth outbreaks, silvicultural treatments focus on the efficient salvage of dead trees and the regeneration of stands that suffered heavy mortality or are close to maturity.

One advantage of silvicultural treatments is that action can be taken long before the gypsy moth arrives. Years might be required to treat large areas, as other resource considerations may limit the amount of cutting in an area. These treatments are prohibited in select areas, such as designated wilderness. Silviculture techniques are not quick-fixes for protection against gypsy moth or for gypsy moth suppression, but can be useful given proper planning.

A.5 Advances in Application Technology.

Advances in aerial application technology since 1990 have dramatically improved the (pilot's) applicator's ability to control aerially applied sprays, thus reducing drift and minimizing unintended environmental consequences.

The primary advance came in the early 1990s with the introduction of Global Positioning System (GPS) navigation technology for use with aerial applicator apparatus. Prior to availability of this technology, the pilot used visual markers on the ground as guidance to direct spraying. Prior to this it was difficult to know the true location of an aircraft at any instant, and standard errors in absolute position were typically around 300 meters, with no truly accurate methodology to precisely log flight paths.

GPS navigation systems revolutionized aerial application by providing knowledge of the aircraft's absolute position within 1m (as of 2004) and the ability to log that information at 1Hz (once per second).

Use of the technology begins on the ground, marking block corners (defining the area to be treated) using GPS and then moving this electronic file into the cockpit GPS or by marking the desired block into a GIS system and loading that file. Most of the modern systems allow the pilot to view either a full map of the block in the cockpit or an idealized block outline. This map can be used to mark aviation hazards, landing pads, home base and other items. Current capabilities allow the pilot to automate flow control on and off functions, enabling the system to automatically turn on the spray at the block edge.

This technology is coupled with high-speed flow control, allowing precise application based on accurate aircraft position information. As powerful as the guidance functions are, the logging capabilities allow an operational manager to see exactly where the plane flew as well as evaluate the amount of material released throughout the entire operation.

Current state-of-the-art technology facilitates the use of highly accurate meteorological data and affords the ability to log release height and even provide predictions of spray movement after leaving the aircraft. These technologies greatly improve the ability of the pilot to execute an accurate, neat application—reducing costs, drift, and unintended environmental effects (Thistle 2004).

Appendix B
Gypsy Moth Management Program

Figure B-1. Early efforts to treat the gypsy moth followed a piecemeal approach that focused on roadsides and towns.

Appendix B Gypsy Moth Management Program

Contents

Figures

This appendix describes the activities that make up the Federal gypsy moth management program, which is conducted by agencies of the U.S. Department of Agriculture under authority of public law.

B.1 General.

The gypsy moth (*Lymantria dispar*) is a nonnative invasive species. It was intentionally imported into North America in the late 1800's by a private researcher. In 1869 near Boston, Massachusetts, it escaped. The gypsy moth has spread steadily since that time. Various strains of the gypsy moth are defoliators of forest and shade trees on four continents (Asia, Africa, Europe, and North America). The gypsy moth can cause profound changes in forest ecosystems (Work and McCullough 2000) and, in the case of severe population outbreaks, adverse human health effects (Anderson and Furniss 1983; Tuthill and others 1984).

The United States Department of Agriculture (USDA) has played a role in gypsy moth management since 1906, when Connecticut and Massachusetts first requested aid from the Federal government. The USDA Forest Service, the USDA Cooperative State Research, Education, and Extension Service (CSREES), Agricultural Research Service (ARS), and Animal and Plant Health Inspection Service (APHIS) all play a role. APHIS maintains a quarantine of the generally infested area and enforces regulations to prevent human-assisted spread of the pest (*Figure B-2*). In collaboration with State departments of agriculture, APHIS also implements an intense program for early detection and eradication of the moth when it is found outside the quarantine area. This monitoring program includes the deployment of approximately 225,000 pheromone traps nationwide, outside the quarantine area.

A memorandum of understanding between the Forest Service and APHIS identifies the roles and responsibilities in eradicating the European strain of the gypsy moth (USDA 1989). APHIS is responsible for conducting eradication projects on non-Federal lands when infestations cover less than 640 acres (259 ha). The Forest Service conducts eradication on National Forest System lands and cooperates with other agencies in projects on other Federal lands. The Forest Service also conducts eradication projects in cooperation with States on non-Federal land, when infestations cover 640 or more contiguous acres.

The USDA Forest Service carries out activities to suppress gypsy moth populations on Federal lands within the quarantine area. The Forest Service also conducts research on gypsy moth and develops tools for forest managers and others to use to help manage the insect. Slow the spread, as the name implies, is a program implemented by the Forest Service and APHIS to reduce the natural and short range artificial rate of spread of gypsy moth populations from quarantine areas to adjacent non-infested areas.

The CSREES provides technical information to businesses and landowners for management and eradication of gypsy moth on private property. ARS conducts research and evaluations on gypsy moth and development of tools to help manage the insect. ARS also conducts research and evaluations in support of the slow-the-spread strategy.

The USDA assigned responsibilities to these agencies, defined their roles to avoid duplication, and established the following policy by Departmental Regulation (USDA 1990):

- Provide a comprehensive program of gypsy moth management activities coordinated by a designated lead agency (Forest Service);
- Prevent establishment of gypsy moth outside the quarantine area;
- Develop and implement effective gypsy moth eradication and suppression measures;
- Conduct gypsy moth detection surveys and population assessments in cooperation with the States;
- Protect Federal lands and assist States in protecting

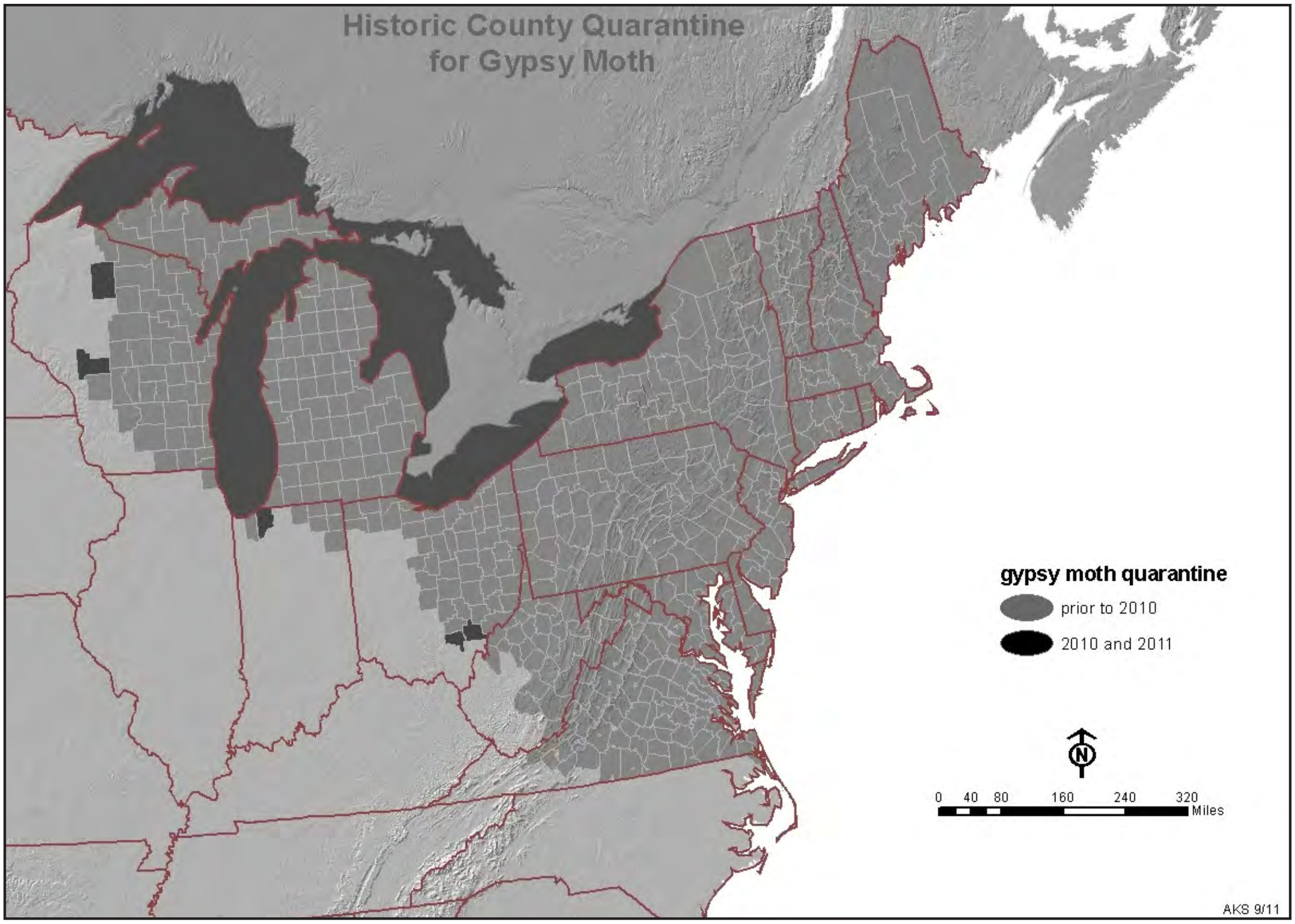


Figure B-2. As of spring 2011 the gypsy moth quarantine area covered all or parts of 19 States and the District of Columbia (USDA APHIS 2011).

non-Federal lands from gypsy moth damage;

- Plan and conduct research on the gypsy moth in partnership with the agricultural experimental stations and other cooperators, to support Federal and State gypsy moth programs;
- Prevent further introduction of the gypsy moth from abroad;
- Coordinate research planning and cooperation within USDA and other Federal and State and private agencies;
- Emphasize research deemed necessary by Federal and State cooperators from the research, extension, and action communities;
- Follow an integrated pest management approach (USDA 1993)

USDA performs its duty as defined under authority provided by several statutes:

- The Plant Protection Act (7 U.S.C. section 7701-7759)—Prevent the introduction of pests into the United States, and prevent the movement of pests across state lines.
- Cooperation with State Agencies in Administration and Enforcement of Certain Federal Laws (7 U.S.C. section 450)—Enter into cooperative agreements with States to avoid duplication of functions, facilities, and personnel and to attain closer coordination and greater effectiveness in administering Federal and State laws and regulations to control or eradicate plant pests.
- The Cooperative Forestry Assistance Act of 1978 (16 U.S.C. section 2101), as amended by the Forest

Stewardship Act of 1990 (16 U.S.C. section 2101)—Assist in controlling forest insects and diseases directly on National Forest System lands, and in cooperation with other Federal Departments and States for control of pests on other Federal land and non-Federal lands of all ownerships.

B.2 Prevention.

Port-of-Entry Activities.

APHIS is responsible for developing policies and operational guidelines to prevent the introduction of harmful, exotic agricultural quarantine organisms from entering at air, sea, and land border ports of entry. Vessels and cargo are inspected for gypsy moth contamination by the Department of Homeland Security, Customs and Border Protection.

Regulatory Activities.

The Secretary of Agriculture is authorized to quarantine States or portions of States generally infested by the gypsy moth when necessary to prevent human assisted spread of gypsy moth. Regulated articles, such as nursery stock, trees without roots, outdoor household articles, mobile homes, logs, firewood, and pulpwood, are inspected for the presence of gypsy moth life stages. Articles found to be infested are treated or cleaned of the gypsy moth life stages before movement of the articles is permitted. Public information campaigns serve to increase awareness and compliance with regulatory efforts to prevent the spread of gypsy moth.

B.3 Survey.

Surveys are conducted to monitor gypsy moth populations and to determine the extent of infestations.

Population Survey Within the Quarantine and Transition Areas.

The Forest Service monitors gypsy moth populations within the generally infested area to determine when suppression activities are warranted. The Forest Service also tracks incipient gypsy moth populations within the transition area to guide STS activities. The Forest Service is responsible for conducting surveys within the National Forests, on other Federal lands in cooperation with Federal agencies, and on non-Federal lands in cooperation with States. Surveys are accomplished in the generally infested area primarily by visual examination for egg masses *(Figure B-3)*. Surveys are conducted in the transition area using specially designed traps baited with a manufactured version of the pheromone produced by the female gypsy moth to attract male moths.

Larval Survey.

Larval surveys may be conducted to assess development of gypsy moth caterpillars to determine the proper timing for insecticide applications. Larval surveys use sticky bands, burlap, or similar material placed around the trunks of trees to capture the larvae (USDA APHIS 1990).

Detection Survey Outside the Quarantine Area.

APHIS and the Forest Service conduct detection surveys with pheromone traps to locate new infestations and monitor treated areas. APHIS is responsible for conducting detection surveys for gypsy moth on all lands outside the generally infested area (USDA 1989). State agencies cooperate on non-Federal lands, and Federal agencies cooperate on Federal lands. Detection surveys are conducted from late spring to late summer.

Delimiting Survey.

When adult male gypsy moths are caught, a delimiting survey using pheromone-baited traps may be used to confirm the presence of a reproducing population, the

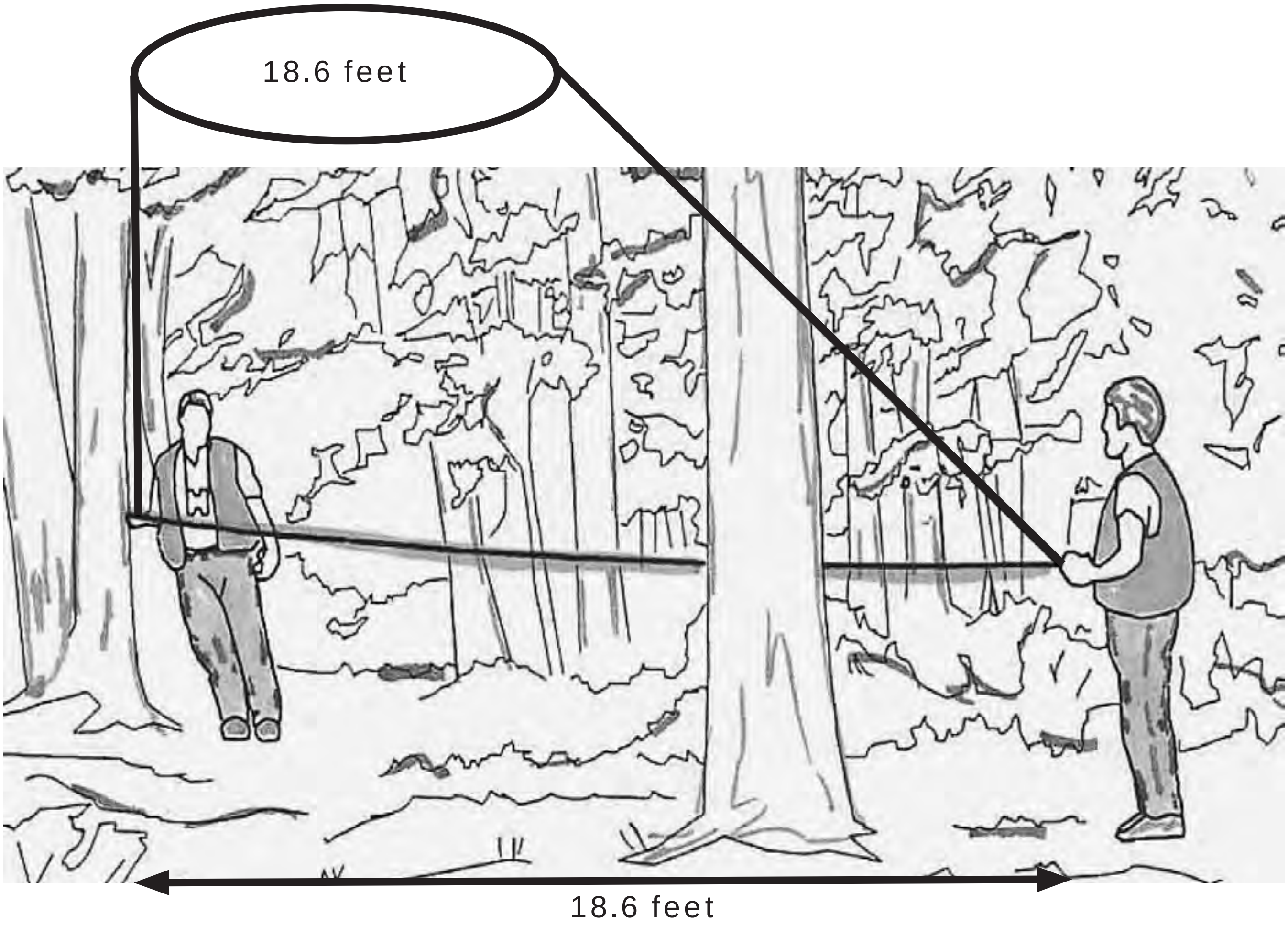


Figure B-3. Egg mass survey plots typically consist of 1/40-acre fixed radius plots (18.6 feet) throughout a sample area. The total sample is based on management goals of the site and distribution of host species.

approximate size of the population, and the geographic range of the infestation. The information from the delimiting survey is used to design the appropriate eradication treatment. Delimiting surveys are conducted in cooperation with the respective State governments.

B.4 Public Involvement and Notification.

The Forest Service and APHIS actively seek public participation at the local level for planned treatment projects. Before suppression, eradication, or slow-the-spread projects are carried out, public outreach is carried out and generally includes the following actions:

- Convening of public meetings facilitated by USDA;
- Identification of Federal officials who may be contacted to answer questions;
- Notification about planned treatment activities in local newspapers, and through newsletters and other media such as radio or television;
- Presentation of the SEIS, environmental assessments, and related documents to agencies, groups, and individuals who are interested in the proposed action;
- Announcement of treatment dates and times to make it possible for those with concerns about insecticide application to avoid exposure.

Public meetings facilitated by USDA may include these elements:

- Presentation of the reason for the treatment project and its objective;
- Discussion of the recommended treatment and various alternatives, and their consequences;
- Soliciting of public input to identify local issues that should be addressed in the design and deployment of the project;
- Review of the details of the implementation procedure and the timing of activities.

B.5 Treatment Projects.

Any of the treatments authorized under the USDA gypsy moth management program may be conducted under any one of the strategic objectives of suppression, eradication, or slow the spread *(Figure B-4).* These strategies include planning, detection, evaluation, monitoring, and using appropriate methods to prevent establishment of new infestations, reduce damage caused by outbreaks, and slow the natural and short range spread of the gypsy moth. A project authorized under the program must be developed in compliance with Federal statutes, such as the Endangered Species Act and the National Environmental Policy Act.

Suppression.

The objective of suppression is to reduce damage caused by outbreak populations of gypsy moth in the generally infested area, thus minimizing severe defoliation of trees. Suppression does not attempt to eliminate the gypsy moth from the generally infested area, but reduces damage to ecosystems and effects on people.

Participation of State and Tribal governments or other Federal agencies in cooperative suppression projects is voluntary; private landowners may participate by coordinating with State and local agencies. In some communities, however, local nuisance ordinances or other orders may not permit private landowners to voluntarily withdraw from treatments. Within the generally infested area, USDA provides assistance to Federal, Tribal, and State agencies for suppression projects wherever gypsy moth outbreaks cause unacceptable levels of defoliation, by conducting projects in residential and recreational areas, forests, and special use areas, such as scenic byways and watersheds.

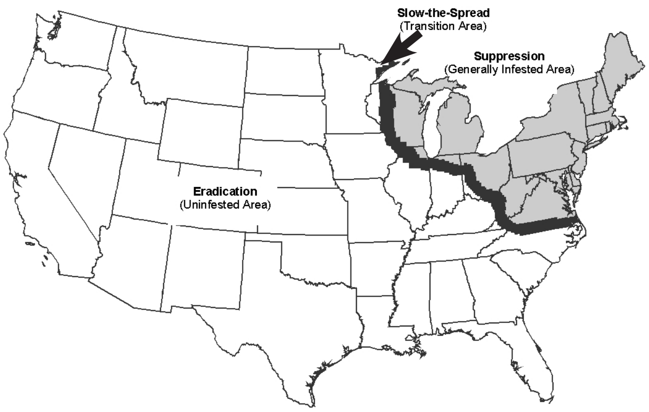


Figure B-4. Three strategies have proven successful against the gypsy moth: suppression in the generally infested area, slow the spread in the transition area, and eradication in the uninfested area.

Site-specific environmental analyses are prepared by Federal resource managers on Federal lands, by forest supervisors on National Forests, and by Forest Service regional foresters or the Northeastern Area director on State and private lands. Gypsy moth populations are suppressed directly by the Forest Service on National Forest System lands, in cooperation with State agencies on non-Federal lands, and in cooperation with responsible officials on other Federal and Tribal lands. Proposed suppression projects must meet these criteria to be considered by the U.S. Department of Agriculture for funding (USDA Forest Service 1990b):

- Show strong potential for effective control
- Be supported by a biological evaluation that substantiates the need for the project
- Be environmentally acceptable, having met requirements of the National Environmental Policy Act
- Be economically viable and be supported by project work, safety, and aircraft security plans.

Eradication.

The objective of eradication projects is to eliminate infestations detected in the uninfested area of the United States. The most common cause of isolated infestations is people moving egg masses or pupae on outdoor household articles, recreational vehicles, and boats, from the generally infested area to the uninfested area. Locations most likely to have isolated infestations in the future are wooded residential areas with high rates of relocation by people, as well as sawmills, plant nurseries, mobile home parks, and tourist attractions such as campgrounds and State and National parks.

Participation in eradication projects is governed by State law and by policies and regulations of the cooperating State agency. In some states, participation of land owners in eradication projects may be mandatory; if it is determined that State actions are inadequate, the U.S. Secretary of Agriculture can declare an emergency and conduct an eradication project.

Eradication activities may also target the Asian strain of the gypsy moth in the area generally infested by the European gypsy moth, as well as in the uninfested area. Eradication projects are conducted in cooperation with Federal and State agencies and based on the availability of Federal funds, a mutually agreed-upon plan of work, and the results of site-specific environmental analyses conducted in accordance with the National Environmental Policy Act (CEQ 1992).

Slow the Spread.

The objectives of slow the spread are to slow the natural and short-range artificial spread of the European strain of the gypsy moth from the generally infested area to uninfested areas, and to delay the adverse effects associated with infestations of new areas. Mating disruption and *B.t.k.* are used most frequently in slow-the-spread projects (Tobin and Blackburn 2007). Mating disruption is accomplished by the application of tiny flakes containing disparlure to confuse male gypsy moths and disrupt their normal mate-search behavior, preventing them from finding and mating with females. Slow-the-spread treatments have reduced the historic rate of spread of 13 miles per year (20.9 kilometers/year) to less than 6.25 miles per year (10.1 kilometers/year), as the gypsy moth moves into previously uninfested areas (Sharov and others 2002b).

Slow-the-spread treatments are applied in the transition area (also called the slow-the-spread action zone). When detected, gypsy moth populations are further delineated, then treated to eliminate the moths and retard their spread (*Figure B-5*). Spread is caused by “leapfrogging,” which occurs when recently established populations (beyond the expanding population front) grow and coalesce, contributing to the movement of the population front (Sharov and Liebhold 1998). A more detailed description of slow the spread and how the program works can be found on page 32 of Sharov and others (2002b).

Slow the spread includes conducting intensive surveys with pheromone-baited traps to detect low-level gypsy moth populations in the transition area. Populations meeting specific criteria (based on counts of male moths, or other life stages, or both) are treated.

B.6 Monitoring and Evaluation.

The Forest Service and APHIS monitor treatment projects, with particular attention to those in environmentally sensitive areas, to ensure treatments are executed as prescribed. Environmental monitoring determines treatment effects and evaluates treated areas to assess project effectiveness.

B.7 Assistance in Planning for Forests and Trees.

The Stewardship Program, led by the Forest Service in cooperation with the States, provides technical and financial assistance for forest management planning.

STS Treatment Grid

Transition Zone populations are recently established, still at low levels, and discontinuous from one another.

STS uses grids of pheromone traps to locate and delimit isolated populations.

Once these populations have been delineated, they are eradicated before they grow too large.

STS locates and retards isolated populations in the transition zone to prevent them from growing and coalescing, thereby slowing the spread of gypsy moth.

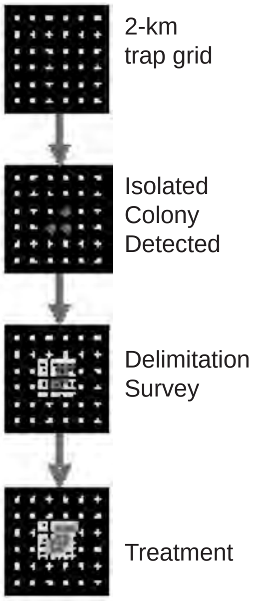


Figure B-5. Slow-the-spread treatments are planned in a systematic step-wise fashion.

These programs furnish an opportunity to assess potential damage from the gypsy moth and to develop contingency management plans.

The Urban and Community Forestry Program, also led by the Forest Service, encourages replacing susceptible tree species with resistant or less susceptible species (USDA Forest Service 1993). In keeping with the Forest Service's philosophy of ecosystem management, long-range tree care plans and continued inventories need to emphasize species that are less preferred by gypsy moth caterpillars. Financial and technical assistance, with the gypsy moth as a major management consideration, are available to municipalities, school districts, communities, and nonprofit organizations (but not individual landowners) for managing individual trees or groups of trees on non-Federal lands in urban environments.

B.8 Methods Development, Technology Transfer, and Research.

The Forest Service, APHIS, and Agricultural Research Service (ARS) research and identify new or improved methods of dealing with the gypsy moth. The Forest Service and APHIS also implement new technology required to support gypsy moth management activities (USDA 1990). Forest Service research develops ways to manage the gypsy moth where forests and wildlands meet urban areas, emphasizing safe and cost-effective practices that prevent populations from increasing above harmless levels and that suppress outbreaks. ARS develops the means to protect high-value trees for yards, communities, parks, and other nonforest environments and technology to support the activities of the Forest Service and APHIS. The APHIS Center for Plant Health and Science Technology emphasizes development of gypsy moth trapping technology, pheromones, and rearing and monitoring techniques.

B.9 Information and Education.

USDA agencies participating in the Department's gypsy moth program conduct information and education activities to support their specific management responsibilities. Activities include these: developing, printing, and distributing technical publications, research reports, and briefs on the gypsy moth and gypsy moth management, preparing and distributing slide programs and videos for use in public information and education activities, developing computer software programs and geographic information systems to assist in gypsy moth management, making presentations and participating in gypsy moth workshops, and participating in public meetings and hearings.

Appendix C
Scoping and Public Involvement

Figure C-1. This undated photo shows woodland defoliation caused by gypsy moths in Princeton, MA.

Appendix C **Scoping and** Public Involvement

Contents

Figures

This appendix describes the public involvement activities that were planned and carried out for this SEIS, summarizes comments received on the draft SEIS, and presents the USDA's response to the comments received.

C.1 Public Involvement Activities.

Planned activities informed the public and created a process to enable comment by individuals and groups with concerns, suggestions, and ideas for shaping the content of this gypsy moth supplemental environmental impact statement (SEIS). To identify and reach the interested and affected public across the United States, the interdisciplinary team joined with public affairs and forest pest management contacts throughout the Forest Service and the Animal and Plant Health Inspection Service (APHIS) (see Chapter 5 for names of those who contributed to this document). This network also provided technical review and guidance to ensure that this SEIS serves all areas of the United States. A public outreach plan was developed and implemented in June 2004. A national mailing list was compiled, and informational materials prepared about the SEIS project and the gypsy moth.

In April 2004, the Forest Service and APHIS published a Notice of Intent (NOI) to Prepare a Supplement to the Final EIS for Gypsy Moth Management in the United States: a Cooperative Approach (69 Federal Register (FR) 23492-93, April 29, 2004). The public was invited to comment on the proposed supplement. Other notices were published on March 13, 2006 (71 FR 12674-75), February 7, 2007 (72 FR 5675), July 2, 2008 (73 FR 37928), September 19, 2008 (73 FR 54397), and November 21, 2008 (73 FR 70640) revising the dates for filing the draft and final SEIS.

Using a mailing list developed for the SEIS, an informational bulletin asking for comments was mailed to nearly 13,000 individuals and organizations in May 2004, including scientists, members of conservation and environmental groups, persons working in forestry and related industries, homeowners, landowners, over 2,000 libraries, and Federal, State, and local officials. A distribution of letters to personnel within the Forest Service and APHIS solicited their input.

Team members personally met with Forest Service officials in Regions 1, 2, 3, 4, 5, 6, 8 and 9, and Northeastern Area State and Private Forestry field offices, and with APHIS representatives from the same areas. Team members conferred with agencies of 25 different States interested in the SEIS and gave presentations at several meetings and conferences on the gypsy moth. Attendees represented (at least) an additional 21 States, APHIS personnel from across the country, and additional Forest Service and USDA personnel with gypsy moth management and research duties from across the country. Because gypsy moth management occurs on Department of Defense lands, the team delivered a presentation, by invitation, to representatives from the Marine Corps, Air Force, Army, and Navy, at the 2004 Department of Defense Pest Management Workshop and Entomology Meeting.

Informational Bulletins.

Four informational bulletins were developed and mailed throughout the development of the SEIS. The first conveyed information about the April 29, 2004, Notice of Intent to prepare an SEIS; the second bulletin provided information about the biology, host preferences, and current distribution of the moth; the third covered gypsy moth management; and the fourth covered gypsy moth research.

Other Communications.

Periodic press releases were made during the development of the SEIS to update interested parties on the status of the SEIS and its availability.

C.2 Outcome and Analysis of Scoping Activities.

The initial comment period concluded in June 2004; all comments were acknowledged by postcard. Comments and suggestions identified from these letters and various meetings and conferences were grouped under two significant issues. Significant issues were defined as those directly or indirectly caused by implementing the proposed action. No nonsignificant issues were identified. Nonsignificant issues would have included those … (1) outside the scope of the proposed action; (2) already decided by law, regulation, Forest Plan, or other higher level decision; (3) irrelevant to the decision to be made; or (4) conjectural and not supported by scientific or factual evidence.

The Forest Service identified the following significant issues during scoping:

Issue 1— Risk to human health.

Issue 2— Risk to nontarget organisms.

Issue 1—Risk to Human Health.

The issue of human health includes the potential effects from contact with the gypsy moth and from exposure to treatments. Effects are measured by risk assessments (RAs) done for the gypsy moth and each of the treatments to include hazard identification, exposure assessment, dose-response assessment, and risk characterization. Included are the potential effects on project workers, the general public, and groups of people who may be at special or increased risk. The potential high risk group includes those who are sensitive to specific chemicals and those with multiple chemical sensitivity. Mitigation measures that can be implemented to lessen or remediate effects on human health are identified in Chapter 2.

Issue 2—Risk to Nontarget Organisms.

The issue of nontarget organisms includes potential effects due to the gypsy moth and the treatments on mammals, birds, terrestrial invertebrates, fish, and aquatic invertebrates. These effects are measured by risk assessments (RAs) done for the gypsy moth and each of the treatments, to include hazard identification, exposure assessment, dose response assessment, and risk characterization. Mitigation measures that can be implemented to remediate effects on nontarget organisms are identified in Chapter 2.

C.3 Public Comments on the Draft SEIS and Agency Responses

This section describes public involvement activities and names those who commented on the draft supplemental environmental impact statement (SEIS) by letter, e-mail, and facsimile. It describes the procedure followed in analyzing the comments, summarizes the contents, and gives the responses by the USDA Forest Service and Animal and Plant Health Inspection Service (APHIS).

Public Involvement

The Forest Service and APHIS mailed 419 hard copies and 765 electronic copies (Compact Disc) of the complete draft to individuals and organizations who requested it, and to Federal and State agencies interested in the gypsy moth, public health, or the environment. An additional 146 copies of the summary were mailed to individuals and organizations with the suggestion that they review the complete document if they wished to submit comments. The draft SEIS was also available on the Internet and had 1,240 individuals visit; 792 visited once, and 448 visited more than once.

The notice of availability of the draft SEIS was published in the Federal Register on September 19, 2008, and the comment period lasted to December 18, 2008. Thirty-four people sent a total of 41 comment letters in the form of 18 letters, 22 e-mails, and 1 fax. Some people sent more than one letter. The total includes five additional comment letters that were received after December 18, 2008.

Letters were received from people in 14 states and the District of Columbia. These states are on the east coast and west coast, reflecting the national scope of this SEIS. Affiliations indicate that a broad range of interests was represented:

Individual	(11)
Environmental or conservation organization	(1)
Federal agency	(3)
Forest products industry	(2)
Private business	(1)
Local government	(3)
Multiple chemical sensitivity groups or individuals	(9)
State agency	(4)

People Who Provided Comments, by Number

The following is a list of people who provided comments, in order of receipt of their letter, e-mail, or fax. Two respondents are each listed twice, reflecting that each sent two distinct comment letters. One respondent sent three nearly identical comment letters, as indicated by (3) after their name.

1. Dorothy O’Connell
2. Edward G. Dauchess
3. Sally Perry, Reeves County Library
4. Marion R. Deppen, Pennsylvania Tree Farmer
5. Jerry R. Presley, Missouri Forest Products Association
6. Richard E. Layton, M.D., Allergy Connection
7. Grace Ziem, M.D., Dr., P.H., Occupational and Environmental Medicine
8. Stephen P. Schmidt, North Carolina Department of Agriculture and Consumer Services
9. Carol Van Strum
10. Paula M. Trudeau, U.S. Forest Service
11. Phillip T. Marshall, Indiana Department of Natural Resources
12. Pat McNabb, Yoakum County Library
13. Harry and Mary Winkler, Writers
14. William Johns
15. Stephanie Connolly, U.S. Forest Service
16. Carol Montgomery
17. Max Ventura (3)
18. Sandra Miller Ross and Edward S. Ross, Curator Emeritus, California Academy of Sciences

19. Don Eggen, Pennsylvania Department of Conservation and Natural Resources
20. Neal Kittelson, Idaho Department of Lands
21. Lawrence A. Plumlee, Chemical Sensitivity Disorders Association
22. Ruth Berlin, Maryland Pesticide Network
23. Veronika Carella, Maryland Parent Teacher Association
24. Nichelle Harriott, Beyond Pesticides
25. Carol L. Moyer
26. John Wayne Kennedy, Retired APHIS
27. Claude Ginsburg, No Spray Zone
28. Lawrence A. Plumlee, Chemical Sensitivity Disorders Association
29. Lisa Arkin, Oregon Toxics Alliance
30. Alan Vinitsky, Enlightened Medicine
31. Debbie Schlenoff, Lane County Audubon Society
32. Susan E. Bromm, Environmental Protection Agency
33. Jan Wroncy
34. Jan Wroncy
35. B. Sachau
36. Willie R. Taylor, U.S. Department of the Interior

People Who Provided Comments, by Last Name

This alphabetical listing by last name includes the numbers assigned in the previous list.

Arkin, Lisa	29
Berlin, Ruth	22
Bromm, Susan E.	32
Carella, Veronika	23
Connolly, Stephanie	15
Dauchess, Edward G.	2
Deppen, Marion R.	4
Eggen, Don	19
Ginsburg, Claude	27
Harriott, Nichelle	24
Johns, William	14
Kennedy, John Wayne	26
Kittelson, Neal	20
Layton, M.D., Richard E.	6
Marshall, Phillip T.	11
McNabb, Pat	12
Montgomery, Carol	16
Moyer, Carol L.	25
O’Connell, Dorothy	1
Perry, Sally	3
Plumlee, Lawrence A.	21, 28
Presley, Jerry R.	5
Ross, Sandra Miller and Edward S.	18
Sachau, B.	35
Schlenoff, Debbie	31
Schmidt, Stephen P.	8
Taylor, Willie R.	36
Trudeau, Paula M.	10
Van Strum, Carol	9
Ventura, Max	17
Vinitsky, Alan	30
Winkler, Harry and Mary	13
Wroncy, Jan	33, 34
Ziem, M.D., Dr., P.H., Grace	7

Procedure Followed in Analyzing Public Comments

In their interest to provide opportunity for public involvement and to consider public input in the decision process, the Forest Service and APHIS considered all comment letters received in preparing this final SEIS.

The preparers read all letters and identified substantive comments. The preparers then grouped the comments into categories. Because of the number of letters received and the lengths of many of them, comments were summarized.

The Forest Service and APHIS thank those who reviewed the draft SEIS and provided comments. The changes made in response to the comments have resulted in a better document. As an example, more information was added to Chapter 4, Section 4.4, to discuss the significance of the incidence of H1N1 flu and potential exposure to *B.t.k.* on human health.

Above and beyond the changes suggested by the public, the preparers have refined the document in a number of ways. Most notable is the use of updated data collected since the draft document was printed. Tables and figures have been updated to show the most current data, and information from recent literature has been added where appropriate.

Chapter 5 was updated to include individuals who helped prepare this final SEIS. Chapter 7 was updated to reflect changes to the mailing list since the draft SEIS was published.

Comments are grouped into two sections: general comments and topical comments, The numbers in parentheses after the comments are those assigned to the people who sent in comment letters. Using the listing of People Who Provided Comments by Number, the reader can identify who gave the comments. Some comments were answered under more than one category, for the convenience of the reader.

General Comments

a. Support for the USDA National Gypsy Moth Management Program (1, 2, 5, 12, 14, 31)

Comment

Summary:

Six commenters indicated that they support a gypsy moth program, or the effort that the Forest Service and APHIS are taking in implementing the program, or both. Three stated their general support for the USDA National Gypsy Moth Management Program.

Response:

No response required.

b. Opposition to the USDA Gypsy Moth Management Program, and in Some Cases, Suggestions That Would Make the Program Acceptable to Commenters (9, 29, 34, 35)

Comment

Summary:

One commenter (9) stated that the SEIS should consider additional alternatives since the proposed alternative is based on a strategy that has failed in the past to eliminate gypsy moth from the United States. Commenter 35 did not support any gypsy moth program because she believes it is a government conspiracy.

Response:

The USDA National Gypsy Moth Management Program is very successful and responds to state and local needs. The program is based upon sound science and achievable objectives. The management approach consists of three separate strategies. Implementation of the strategies is based upon the geographical distribution of gypsy moth in the United States, and on an understanding from past initiatives that total elimination or eradication of the insect from North America is neither practical nor achievable. Over the last 25 years the program has abandoned the use of broad spectrum chemical insecticides in favor of insecticides and treatments that are much more targeted to gypsy moth and that pose fewer risks to people and the environment. The three strategies employed in the National Gypsy Moth Management Program are implemented in cooperation with State and local officials, using treatments that have proven to be effective in achieving project objectives, and that address concerns about effects on human health and the environment (e.g., nontarget organisms). Human health and ecological risk assessments were prepared for the treatments as a means to closely examine and quantify potential human health and ecological effects. A description of the strategies follows.

The first strategy is suppression of gypsy moth outbreaks within the quarantined area where the insect is considered to be a permanent resident (currently all or parts of 19 States and the District of Columbia). The objective is to reduce the damage caused by these periodic outbreaks. During the period 2000–2010, the suppression treatments successfully protected forest and tree resources on about 2.4 million acres or about 219,000 acres per year.

The second strategy is eradication of gypsy moth infestations that occur in uninfested (not quarantined) parts of the United States as a result of the artificial movement of the insect by people through household moves and general commerce. Eradicating these discrete isolated infestations prevents the further establishment of gypsy moth. Eradication efforts have succeeded in preventing gypsy moth from becoming established elsewhere in the country outside the generally infested area.

The third strategy is slow the spread, which is effected across the advancing front of the generally infested area, to reduce the natural and short range artificial spread of gypsy moth. Implementation of this strategy has slowed the rate of spread to 3 km per year, a 60-percent reduction or more in the historical rate of spread (1966–1989) of about 21 km per year and producing significant benefits downrange to State and local governments, homeowners, forest landowners, and others. It is estimated that the slow-the-spread strategy has successfully prevented the spread of gypsy moth to about 80 million new acres during the period 2000–2010.

The National Gypsy Moth Management Program is not a government conspiracy to gain power or money for USDA, as one commenter suggests. The program was designed with the objective of protecting our nation’s forest and tree resources. Funding for the program is not kept by the Forest Service and APHIS, but is largely transferred to cooperating State forestry and agriculture agencies that plan and implement gypsy moth management projects, most often in cooperation with local governments. The Federal funding for gypsy moth supports state and local objectives, and provides benefits to communities and people.

Comment

Summary:
One commenter (29) requested that no aerial sprays be used in Oregon for gypsy moth in a treatment that was scheduled to occur in 2009 by the Oregon Department of Agriculture.

Response:
Decisions pertaining to site-specific treatment projects are outside the scope of this SEIS. The 1995 EIS (USDA 1995), however, does guide the planning and implementation of site-specific projects including the need to conduct site-specific analyses for individual projects, identify issues and concerns, develop mitigating measures where necessary, and document such in accordance with the National Environmental Policy Act (NEPA) and Forest Service or APHIS procedures for implementing NEPA. The decisions regarding areas to be treated and the treatments to be used, such as those in Oregon in 2009, while guided by the 1996 Record of Decision (USDA 1996) for the USDA National Gypsy Moth Management Program, are local decisions made by project officials with the consideration of public input.

Comment

Summary:
Two commenters (29 and 34) wrote that nonconsensual exposure to biological and chemical pesticides is a violation of human rights. Commenter 34 also stated that nonconsensual exposure is a violation of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

Response:
The Forest Service and APHIS comply with all Federal and State laws, as well as international treaty obligations. The application of pesticides to control or eradicate gypsy moth, as defined under Alternative 3 in this

SEIS, does not violate human rights and is in accordance with the Federal statutes that regulate pesticide application. This pesticide application does not violate Federal constitutional rights, and the Forest Service and APHIS know of no other human rights protections that may be compromised by gypsy moth treatments. Alternative 3 proposes to use only registered pesticides, and in a manner consistent with their labeling as prescribed by FIFRA. Solicitation of public input during the project planning process, as well as notification of the public when treatments are to commence, provide key opportunities for people to express their concerns so that project officials can try to address them during the planning process, and so that people can take steps to avoid direct exposure to the treatments. Thus the comment is not accurate in stating that treatment violates FIFRA and human rights.

c. Support for Alternative 3 (2, 4, 5, 8, 11, 19)

Comment

Summary:

Six commenters (2, 4, 5, 8, 11, 19) stated their support for Alternative 3 (preferred alternative) of the draft SEIS.

Response: No response required.

d. Opposition to Alternative 3 (16, 17, 21, 22, 24, 31)

Comment

Summary:

A number of commenters (16, 17, 21, 22, 31) indicated that they did not support Alternative 3. Many of them raised concern for people who experience multiple chemical sensitivity.

Response:

Readers are referred to comment category e, Comments on Multiple Chemical Sensitivity or Immunocompromised or Sensitive Individuals, for a response to comments on multiple chemical sensitivity.

Comment

Summary:

One commenter (21) objected to Alternative 3 because he thought that new pesticides would be added without public input.

Response:

The protocol for adding new treatments under Alternative 3 requires that a public notice be published in the Federal Register providing a 30-day period for public review and comment (Volume I, Section 4, and this volume, Chapter 2, Section 2.3).

Comment

Summary:

One commenter (21) suggested that USDA should use other tests or measurements for risk assessment including proteomic microarrays that measure chemically induced changes in protein levels.

Response:

The comments on the role of proteomics (the large-scale study of proteins, particularly their structures and functions) in risk assessment have general merit. There is little doubt that the field of risk assessment will progress as many specific areas of biology and chemistry progress, enhancing the ability to identify medical conditions in individuals through protein biomarkers, for example. This branch of toxicology and risk assessment is in its infancy and has not progressed enough to use operationally. The U. S. Environmental Protection Agency (U.S. EPA) currently does not require proteomic techniques including microarray analyses to test for changes in protein levels from exposure to pathogens or other environmental agents. Neither are there any published studies that utilized proteomic microarrays with the treatments described in this SEIS. The risk assessments are based on information and studies provided to the U.S. EPA by the registrants of the treatments, in addition to a comprehensive review (preferably peer review) of other published or otherwise available information.

Comment

Summary:

One commenter (24) stated an opposition to "… the addition of yet another hazardous chemical (tebufenozide) to the program instituted for the management of the gypsy moth and encourages the agencies to support and utilize the least toxic alternatives included in the 1996 Record of Decision (ROD) described in the 1995 Environmental Impact Statement (EIS)."

Response:

The 1996 ROD (USDA 1996) does not identify "least toxic alternatives." The alternatives described relate to the mix of strategic objectives that could be included in the USDA National Gypsy Moth Management Program. The selected alternative (Alternative 6) in the 1996 ROD was to implement a national program that encompassed three strategic objectives: to reduce damage from gypsy moth outbreaks; to eliminate isolated infestations before they become permanently established; and to slow the spread of gypsy moth into uninfested areas. This was also identified as the "Environmentally Preferable Alternative" in the 1996 ROD.

This decision in the 1996 ROD continues under Alternative 3 in this SEIS and includes the addition of a new insecticide to the list of approved treatments available for use. Gypsy moth treatments may become the preferred intervention method when natural control agents are not present or fail to regulate gypsy moth populations, or when isolated infestations are detected outside the regulated area. In such cases public input plays a critical and vital role in identifying the major issues and concerns about the planned treatments and the insecticides to be used. The Forest Service and APHIS are confident that based upon the local issues and concerns raised during project-level public involvement, project officials can implement appropriate mitigating measures and select the treatment(s) that provide an acceptable balance between meeting project objectives, and public issues and concerns.

Comment

Summary:

One commenter (22) raised a number of issues relating to *B.t.k.*, all of which are cited from and noted in the human health and ecological risk assessments on *B.t.k.* The commenter implied that effects disclosed in the hazard identification portion of the risk assessments are effects that will actually occur during gypsy moth treatments.

Response:

The comments made are essentially quotations from or reiterations of the *B.t.k.* Risk Assessment. The Hernandez and others (2000) study in the *B.t.k.* Risk Assessment (Volume III, Appendix F, Section 3.1.7) referenced by the commenter is addressed in this SEIS (Chapter 4, Section 4). This commenter (and perhaps others) appears to confuse hazard identification with risk characterization, and incorrectly concludes that any hazard that could occur will occur.

The risk assessments conducted in support of this SEIS consist of both human health and ecological risks. Each risk assessment follows a four-step process recommended by the National Academy of Sciences, National Research Council (1983): hazard identification, exposure assessment, dose-response assessment, and risk characterization (Figure C-2).

Hazard identification is the process of identifying the effects a compound is known to cause at a given dose. Hazard identification is the first and most critical step in any risk assessment. Hazard identification uses *in vivo* and *in vitro* data from experimental animal studies. Additional sources of information such

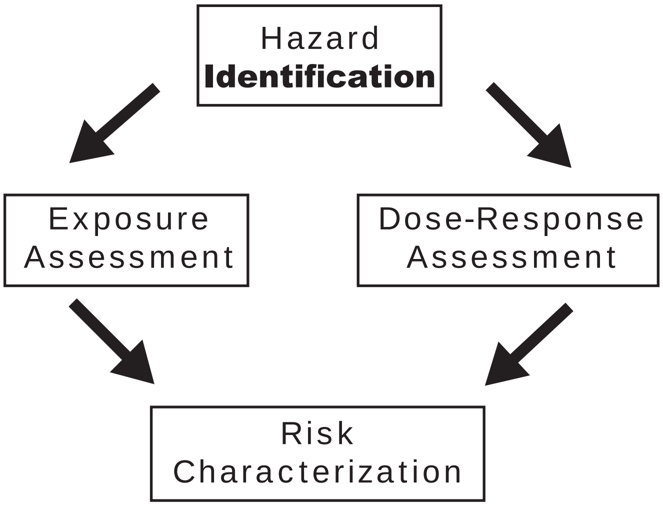


Figure C-2. Risk assessments follow a four-step process.

as epidemiology studies, case reports, and clinical investigations, are used to prepare a human health risk assessment. Studies on various model nontarget test species (e.g., ducks, quail, fish, aquatic invertebrates, plants, and terrestrial invertebrates) are commonly available to strengthen an ecological risk assessment. In addition, available field studies on nontarget species are used in ecological risk assessments in much the same way epidemiology studies are used in human health risk assessments. The primary role of the hazard identification is to describe the effects a given agent might cause, regardless of the nature of the exposure. Unless some plausible biological effect can be demonstrated at this step, any conclusions resulting from the subsequent dose-response assessment and risk characterization steps will be extremely limited.

Exposure assessment is the process of describing the routes by which exposures could occur. In gypsy moth projects a major route of exposure is through dermal contact, either directly if a person is outside and exposed when treatments are being applied, or indirectly through contact with insecticide residues on objects. Other exposure routes examined include oral and inhalation.

Dose-response assessment is the process of estimating the dose or how much people or nontarget organisms could receive through the exposure routes that were identified by the exposure assessment process.

Risk characterization is the culmination of the risk assessment process. It is the process of comparing the exposure assessment to the dose-response assessment, and analyzing and describing the likely effects, if any, to people and nontarget organisms from the treatments used in the USDA National Gypsy Moth Management Program. In the assessment process the risk characterization places some numerical measure on the likelihood that a hazardous effect will be observed. Because the risk characterization flows directly from the exposure and dose-response assessments, the complexity and clarity of the risk characterization will depend on complexity and clarity of both the exposure and dose-response assessments. In most cases, risk will be quantitatively characterized as a ratio: a level of exposure divided by some defined effect level. In a human health risk assessment, the defined effect level is almost always the reference dose (RfD), and the ratio of the exposure to the reference dose is referred to as the hazard quotient (HQ). In an ecological risk assessment, the defined effect level may be a no-observed-effect concentration (NOEC) or a risk level. The risk level may be a lethal dose (e.g., LD_{50} or some other response level such as LD_{25}), or an effective dose causing some risk of a nonlethal effect (e.g., ED_{25}). For aquatic and some terrestrial organisms exposure is characterized by a concentration rather than a dose. In that case the defined risk levels may be a lethal concentration (LC_{50} or some other response level such as LC_{25}) or an effective concentration that leads to some nonlethal effect (e.g., EC_{25}). In general, the Forest Service and APHIS prefer to use no-observed-adverse-effect level (NOAEL) or NOEC values in risk characterizations.

Thus, it is not appropriate to suggest that activities conducted to control gypsy moth will cause an adverse effect unless there is a plausible basis for asserting that the levels of exposure during gypsy moth treatment projects will be so high that adverse effects are likely to occur.

e. Comments on Multiple Chemical Sensitivity or Immunocompromised or Sensitive Individuals
(6, 7, 16, 17, 21, 22, 26, 27, 31)

Comment

Summary:

Nine commenters (6, 7, 16, 17, 21, 22, 26, 27, and 31) expressed concerns about people who are immunocompromised and those who may have multiple chemical sensitivity (MCS). These concerns included a host of medical symptoms believed to result from exposure to *B.t.k.*, diflubenzuron, or tebufenozide, depending on the treatment used on the nearest spray block. One respondent (26) requested extra consideration in identifying chemically sensitive people and caring for their needs, such as moving to lodging that accommodates their chemical sensitivity. One commenter (27) stated that it is imperative that the SEIS err on the side of protecting sensitive populations, and that their comments were from this viewpoint.

Response:

In general, individuals reporting MCS state that they experience a variety of adverse effects as a result of exposures to very low levels of environmental chemicals that are tolerated by the general population. To be protective of potentially sensitive individuals in exposed populations the reference doses (RfDs) derived by the U.S. EPA and used in Forest Service and APHIS risk assessments for this SEIS incorporate an uncertainty factor of 10.

This uncertainty factor for sensitive individuals, however, estimates variability in tolerances within a normal population. Individuals reporting MCS assert, either explicitly or implicitly, that they are atypically sensitive. For example, one comment letter noted that the individual was exposed to “pesticides, which at the time was considered safe, but today they are considered toxic and therefore harmful to the human body.” The individual is asserting that MCS makes this individual much more sensitive to environmental exposures than other individuals without MCS.

Comments from individuals with MCS state that the uncertainty factor for sensitive individuals in a normal population does not encompass individuals with MCS. In more formal statistical terms, the standard uncertainty factor for sensitive individuals involves variability in a normal distribution of tolerances. In contrast, individuals with MCS are asserting that they should be regarded as a separate and highly sensitive subgroup for which normal risk assessment methods are not sufficiently protective. The condition of MCS clearly exists and is the subject of serious study by the medical community. The key issue is that the medical cause of MCS is unclear. Further, the nature of the affected subpopulation, and the dose-response characteristics and spectrum of chemicals and substances involved, are poorly defined. Therefore, use of uncertainty factors other than 10 for sensitive individuals has yet to gain general acceptance and routine use in the scientific and medical communities.

Concerns exist that immunocompromised individuals may also be more vulnerable to pesticide exposure than is the general population. The human health risk assessment that was completed for this SEIS as well as the one done for the previous EIS (USDA 1995) and all the evaluations done prior to this one have carefully evaluated the potential for adverse effects from exposure to gypsy moth treatments, including the existence of unusually sensitive responses in humans or test animals. These analyses also incorporate a tenfold uncertainty factor, to be protective of sensitive individuals. The outputs of the risk assessments show that while some people and groups of people may be more sensitive than others to a particular effect, or more exposed than others, there is no reason to believe that the health of such populations will be compromised due to gypsy moth treatment projects.

The USDA takes seriously these claims of MCS and concerns expressed about immunocompromised and other sensitive individuals, when planning gypsy moth treatment projects. Through the solicitation of public input, which is required in the USDA National Gypsy Moth Management Program (Appendix B, Section B.4), people claiming to have MCS can identify themselves and work with project officials to implement measures to minimize exposure.

f. Questions on Alternative 3 (32)

Comment

Summary:

One commenter (32) felt that the draft SEIS was not clear on whether new treatments added under Alternative 3 will be limited to U.S. EPA-approved or -registered insecticides.

Response:

Only U.S. EPA-registered insecticides are used in the USDA National Gypsy Moth Management Program. A statement was added to this final SEIS (Chapter 2, Section 2.3) to clarify that if a new treatment added under the protocol in Alternative 3 involves the use of an insecticide, then that insecticide must first be registered by the U.S. EPA.

g. Recommendations That Other Alternatives Be Examined (9, 24, 29, 31, 34)

Comment

Summary:

Several commenters recommended that other alternatives be examined. Four commenters made general statements that alternatives such as a no-spray option should be considered (9, 29, 31, 34). One commenter (24) urged the use of least-toxic alternatives, such as natural predators and parasitic wasps.

Response:

This SEIS updates the 1995 final EIS (USDA 1995). Alternative 1 presented in the 1995 EIS (no suppression, no eradication, no slow the spread) is the no-action (or no-spray) alternative. Appendix A of this SEIS lists and describes the wide variety of treatments that have been used for gypsy moth. The treatments have included microbial and chemical insecticides, natural control agents such as parasitoids, predators, and fungal pathogens, and other methods such as the use of barrier bands, destruction of life stages (e.g., egg mass removal), and silviculture. The only treatments that have been found effective for meeting the USDA National Gypsy Moth Management Program objectives to reduce damage from outbreaks of gypsy moth, eliminate isolated infestations before they become established, and slow the spread of gypsy moth into uninfested areas, are those approved for use in the 1996 ROD for the USDA program, and tebufenozide, under consideration in this SEIS in Alternative 3. Also see the response to comment category h, Recommendation to Stop Spraying.

Comment

Summary:

Several commenters recommended that other alternatives be examined. Three commenters made the general statement that alternatives other than the aerial spraying should be considered (8, 28, 31). Two commenters (29, 24) urged alternatives to the use of pesticides. One commenter (21) wondered if any environmental alternative practices would provide adequate control of gypsy moth.

Response:

Biological control and natural control agents are discussed in Appendix A (Section A.3). Although Alternative 3 adds pesticide choices to the treatment options, the overarching strategy still allows decisions to be made at the local level about what treatment to use, where to use it, and how to apply it. Many factors are considered and weighed in reaching those decisions, including but not limited to ecological effects, health risks, costs, objectives to be achieved, local issues and concerns, as well as State and local regulations that agencies must follow.

Topical Comments

h. Recommendation to Stop Spraying (21, 29)

Comment

Summary:

One commenter (21) urged that there be a cessation to spraying all chemicals in the air. Another commenter (29) advocated for no aerial spraying for gypsy moth in Oregon.

Response:

This SEIS describes the framework for the USDA National Gypsy Moth Management Program, including the three strategies and the key objectives of each. Only treatments that have been shown to be effective in meeting those objectives are sanctioned for use in the National Gypsy Moth Management Program. The Forest Service and APHIS thoroughly considered aerial application in the development of the 1995 EIS (USDA 1995) and determined in the 1996 ROD (USDA 1996) that this option was necessary in order to meet the objectives of the National Gypsy Moth Management Program. Nothing that has occurred since then, or been seen or heard during the development of this SEIS calls for eliminating the aerial application option.

The decision on which treatment or set of treatments to use in a given project and in a given year (such as Oregon in 2009) is made by the responsible officials at the State and local levels, after consideration of site-specific issues and concerns, and input from the general public.

i. Recommendations to Use Non-toxic or Less-Toxic Treatments or to Minimize Pesticide Use (7, 15, 21, 23, 24, 25, 29, 30, 36)

Comment

Summary:

One commenter (15), in discussing tebufenozide, wondered why this SEIS introduces another substance into the forest when other methods proposed are less harmful.

Response:

The addition of tebufenozide is addressed in the Risk Comparison (Volume IV, Appendix M) and is most relevant when discussing the use of tebufenozide as an alternative to diflubenzuron. Diflubenzuron appears to have substantially higher risks than tebufenozide to sensitive aquatic and terrestrial invertebrates. Thus, adding tebufenozide may be beneficial in reducing risks to some nontarget invertebrates in some situations. The treatments examined in this SEIS have been shown to be effective in meeting the objectives of suppression, eradication, and slow-the-spread projects. The human health and ecological risk assessments (Volumes III and IV, Appendixes F–L) prepared for these treatments disclose the potential effects. Appendix M (Volume IV) summarizes, in a comparative manner, the relative risks associated with these treatments. The goal of project managers is to balance the need for treatments that are effective in meeting project objectives and that pose the least risk to people and the environment. The treatments examined in this SEIS provide an array of options to project managers.

Comment

Summary:

One commenter (25) supported the use of proven, safe, and organic products to reduce gypsy moth populations.

Response:

The treatments examined in this SEIS represent a compromise between effectiveness and concern about minimizing human health and ecological risks. Other existing chemical insecticides are more effective, in some situations, than those examined, but they raise the risks to human health and the environment. The USDA National Gypsy Moth Management Program moved away from using such chemicals in large-scale aerial treatment projects decades ago. The human health and ecological risks associated with the current treatments in this SEIS are well documented and disclosed in the individual risk assessments (Volumes III and IV, Appendixes F–L) and in the comparison of risks (Volume IV, Appendix M). The Forest Service and APHIS are committed to evaluating new or improved treatments (such as organic products) that are effective and reduce ecological and human health risks. One *B.t.k.* formulation now being used in the National Gypsy Moth Management Program has an organic certification from the Organic Materials Review Institute.

Comment

Summary:

Eight commenters (7, 15, 21, 23, 25, 29, 30, 36) made general comments recommending that the gypsy moth program use treatments that are less toxic, nontoxic, or nonpesticidal. Other comments included a recommendation to ban toxic sprays, do further testing and not use new chemicals, use fewer pesticides, examine environmental or nontraditional alternatives, and favor treatments that minimize the impacts on nontarget organisms.

Response:

This SEIS examines treatments that have been shown to be effective for meeting the objectives of suppression, eradication, and slow-the-spread projects under a range of conditions. The potential human health and ecological risks associated with the use of these treatments has been thoroughly examined and disclosed in the various risk assessments (Volumes III and IV, Appendixes F–L) and in the comparison of risks (Volume IV, Appendix M). Whenever gypsy moth treatment projects are proposed, the Forest Service and APHIS and partners examine the best treatment(s) to use based upon factors such as the project objectives, the gypsy moth population levels in the affected area, issues and concerns from the public, threatened and endangered species consultations, and availability of treatments (e.g., the Gypchek supply is limited). The final treatment recommendations are made considering the potential risks to human health and the environment, including nontarget organisms. All of the insecticidal treatments used in the USDA National Gypsy Moth Management Program are registered by the U.S. EPA and are applied according to the label instructions. The treatment being added in this SEIS is the insecticide tebufenozide, which is not new. It is just “new” to the gypsy moth program. The Forest Service and APHIS do not believe that additional testing of the insecticides described in this SEIS is necessary. The Forest Service, however, through its Pesticide Impact Assessment Program, has the ability to gather additional data on U.S. EPA-registered pesticides used in Forest Service programs, should that be necessary.

Appendix B (Gypsy Moth Management Program) describes all of the activities that make up the USDA National Gypsy Moth Management Program. This program is a comprehensive integrated pest management approach, in which the use of insecticides is only one component. The analysis in this SEIS focuses only on the insecticide use portion of the National Gypsy Moth Management Program. While this focus may give the reader the impression that the use of insecticides for gypsy moth control is prevalent across the landscape, in reality it is implemented only in situations where noninsecticidal treatments are ineffective in achieving the project objectives.

The use of gypsy moth pheromone to disrupt mating between male and female moths has increased significantly in recent years as the majority “treatment type” used in the gypsy moth Slow-the-Spread (STS)

Program, and as an important alternative to the use of traditional insecticides in gypsy moth eradication projects. During the period 2001–2010, mating disruption (pheromone treatment) accounted for the majority of STS acres treated (85%), *B.t.k.* accounted for about 14 percent, Gypchek for about 1 percent, and diflubenzuron for less than 1 percent. During the same period across all types of gypsy moth projects (suppression, eradication, and STS) mating disruption has accounted for about 59 percent, *B.t.k.* for 33 percent, diflubenzuron for about 7 percent, and Gypchek for 1 percent of the total acres treated (USDA Forest Service 2011).

Comment

Summary:

Four commenters (21, 24, 29, 36) favored the use of Gypchek and other natural or physical means to control gypsy moth. This included references to biocontrol or natural predators, parasitic wasps, fungus, burlap banded trees, and pesticide tapes. One commenter (28) specifically recommended the use of mating disruption in place of *B.t.k.*

Response:

The choices of whether to treat, which treatment to use, where to use it, and how to apply it are made on a site-specific basis. Many factors are considered and weighed in reaching those decisions, including but not limited to ecological effects, health risks, costs, objectives to be achieved, local issues and concerns, as well as State and local regulations agencies must follow. The insecticide treatments described in this SEIS are registered by the U.S. EPA for treatment of gypsy moth.

In terms of potential unintended risks, Gypchek, a virus that is specific to the gypsy moth and has no nontarget effects, is clearly preferable to *B.t.k.*, tebufenozide, or diflubenzuron. The relative risks of these chemicals are discussed at some length in the risk comparison section of this SEIS (Volume IV, Appendix M). Production of Gypchek is labor intensive and expensive, so very limited quantities are produced every year, and it is not yet available for broad scale application. Other limitations include the narrow application window (timing, weather conditions) necessary to maximize its efficacy. The use of Gypchek is largely targeted to unique areas containing threatened and endangered species that could be at greater potential risk if exposed to the other available treatments.

Other natural methods, such as biocontrol agents, fungus, and parasitic wasps, are important components that help to regulate gypsy moth populations. These agents help to keep gypsy moth population levels below a damaging threshold across most of its range in North America. Gypsy moth populations are monitored, and occasionally the insect exhibits episodes when these natural control agents cannot stop a population outbreak. When this occurs, other means (i.e., those presented in this SEIS) are needed to reduce damage until natural control agents can again exert a regulating influence. In short, treatments are used only when necessary. Natural control agents play little to no role in areas where slow-the-spread and eradication projects are conducted, because gypsy moth population levels are not high enough to support these biocontrol agents.

The use of burlap bands or insecticidal tapes has not been shown to be effective in suppressing, eradicating, or slowing the spread of gypsy moth. Some data suggest that in some cases these treatments might help to protect individual landscape trees from migrating caterpillars, but not from caterpillars already in the tree. More information on gypsy moth control techniques can be found in Appendix A.

j. Recommendation to Use IPM Practices (23, 36)

Comment

Summary:

Two commenters (23, 36) supported the use of an integrated pest management (IPM) approach in the program.

Response:

This SEIS focuses on an examination of the USDA National Gypsy Moth Management Program as it relates to treatment of gypsy moth populations to reduce damage from outbreaks, eliminate isolated infestations, and slow the spread of the insect. Additional information provided in Appendix B provides a broader picture of the scope of activities that make up the National Gypsy Moth Management Program. This program includes IPM and IPM-support activities such as prevention; public involvement and notification; treatments (this is the scope of this SEIS); pest monitoring and evaluation; assistance in planning for forests and trees; methods development, technology transfer, and research; and information and education. Taken together all of these activities (including direct treatments) represent a comprehensive national IPM approach to gypsy moth management.

k. Concerns Regarding the Effects of Treatments on Nontarget Organisms Other Than Humans (21, 22)

Comment

Summary:

Two commenters (21, 22) were concerned about the lack of data presented on impacts to various taxa, including bees, wasps, butterflies, crabs, race horses, dogs, and cats. They also requested a summary of studies relating to the Chesapeake Bay.

Response:

The treatments proposed for use in this SEIS have been studied for a number of years, and, in most cases, several decades. Consequently, a large number of studies have been conducted. The human health and ecological risk assessments that were prepared for this SEIS are, by necessity, not inclusive of all data that have been generated. Instead, the risk assessments use scientifically appropriate representative studies and draw conclusions from them. When data are lacking for particular species or groups of species, available data for the closest related species is extrapolated to address the data gap. Such extrapolation is a generally accepted technique used in risk assessments.

The Forest Service and APHIS update the risk assessments periodically (as was done for this SEIS) and welcome input from the general public regarding the selection of studies included in the risk assessments. This input is most helpful if recommendations for considering additional studies specify why the new (or not previously included) information is likely to alter the conclusions. This process ensures that the updated risk assessment has considered the most relevant information available. This system provides for an accurate assessment of risk to all nontarget species from the treatments approved for use in the USDA National Gypsy Moth Management Program.

This SEIS is a programmatic document intended to disclose and discuss the potential impacts of the National Gypsy Moth Management Program, but not of specific treatment projects. Site-specific environmental analyses, including consultation with the U.S. Fish and Wildlife Service and others (when threatened or endangered species may be affected), and input from the public are required for each project that is proposed. If the public expresses concern that a proposed project may affect the Chesapeake Bay, for example, then this issue would be analyzed and addressed at the project level; and if necessary, other treatment options would be examined, and mitigating measures implemented.

I. Concerns Regarding Environmental Fate of Pesticides (7, 10, 15, 25)

Comment

Summary:

Commenters were concerned that the risk assessments and draft SEIS did not include analyses of various additional specific circumstances involving the environmental fate of the pesticides, which commenters considered an omission in the discussion of potential human health consequences. For example, one commenter (10) was concerned that the program analyzed treatment conditions (in the Eastern United States) in a climate dissimilar to that where other projects could be conducted (in the West), possibly assuming that different issues affecting human health would result. This commenter also stated that the document did not cover the adverse health effects of burning leaves that contain chemicals used for gypsy moth control, questioning whether toxins would be released from burning leaves. An additional concern regarding the environmental fate of the pesticides was raised by another commenter (15) who requested information on metabolites (breakdown products) of the pesticides in soil and water.

Response:

Gypsy moth is a permanent resident in all or parts of 19 states and the District of Columbia, extending from Maine to Wisconsin and south to Virginia and West Virginia. At one time or another gypsy moth suppression projects have been conducted in these states. Eradication projects to eliminate isolated infestations of the insect that are detected outside of the quarantined areas have occurred across the United States, including states in the Rocky Mountain region, the Great Plains, the South, and all the states along the Pacific coast. Gypsy moth projects have been conducted across a variety of climatic regimes, and all have been conducted under the conditions specified in the current program requirements with consistent results. The analyses in the risk assessments and the information provided in this SEIS are based on the program requirements; however, to err on the side of safety the analyses consider a conservative range of conditions of exposure and toxicity that would be incorporated into any numerical model to determine risk outcomes. Therefore, while the analyses did not specifically address whether the climate in Western states versus Eastern states could affect the program risk parameters, these variations were nonetheless encompassed in the analyses and reflected in the human health consequences sections of the SEIS (Chapter 4).

Over the many years gypsy moth treatments have been conducted, the scenario of a treated area burning has not arisen as an issue. While it could be possible for an area that has been treated with pesticides to be subject to burning, it is unlikely since gypsy moths prefer live, healthy trees and not dead trees, which are more likely to burn. Stands of dead trees killed by the feeding activity of gypsy moth would not likely have any remaining significant pesticide residues, which could then pose a risk to people who inhale smoke from these fires. Treatments to any of these stands would have occurred at some time (years) prior to the death of the trees. Homeowners who burn leaves would be burning fall leaves, which would not be expected to still contain substantial amounts of pesticides due to degradation and wash-off. (See Table 2-1 of the Diflubenzuron Risk Assessment in Appendix I and the Tebufenozide Risk Assessment in Appendix J, for their specific properties.) In addition, unless specific information is available on the extent of exposure to decomposition products from burning forested areas or treated leaves, it is not possible to quantitatively determine whether there is an effect on human health. Some work on exposures to herbicide residues during prescribed fires has been conducted (e.g., McMahon and Bush 1992), and the major hazards involved in burning vegetation include general exposures to particulate matter and carbon monoxide. We suspect that the major hazards (particulate matter and carbon monoxide) would be the same for people exposed to burning leaves containing residues from gypsy moth treatments.

Quantitative information on persistence and transport of the pesticides and metabolites in soil and water is included in the water modeling for diflubenzuron and tebufenozide in the risk assessments, and reflected in this SEIS. The toxic degradation product of diflubenzuron, i.e., 4chloroaniline, is also addressed quantitatively in the Diflubenzuron Risk Assessment (Volume III, Appendix I, Section 3.3.3). Drift as well as direct spray of ponds and streams is considered in Section 3.2.3.4.2 of the Diflubenzuron Risk Assessment (Volume III, Appendix I) and the Tebufenozide Risk Assessment (Volume IV, Appendix J). These scenarios are not included for the other agents for reasons specific to each of the agents, as detailed in each risk assessment.

Comment

Summary:

Commenters (7, 25) raised concerns regarding information reported in the risk assessments that the insecticides *B.t.k.*, tebufenozide, or both enter homes, sometimes via foot traffic, and in some cases persist for long periods, and at levels greater than the levels outside (25), potentially increasing and prolonging exposures above and beyond those that would occur outside.

Response:

As reported in the risk assessments, insecticides can persist in the environment and can be transported indoors on shoes as well as other surfaces. This is clearly demonstrated in the literature (e.g., Obendorf and others 2006). While transfer of pesticides from outdoors to indoors is plausible, and pesticides can remain in homes after pesticides sprayed outside have mostly dissipated (likely because the pesticides will disperse more rapidly outdoors than in confined areas), the exposure assessments for the general public are based on very conservative exposure assumptions that overestimate exposures indoors and outdoors according to conclusions in the risk assessments. Exposures under these circumstances would not be hazardous. For example, the risk assessment determined that for tebufenozide sprayed outside a house, 5,000 hours (or about 7 months) of continuous direct contact to contaminated turf, disregarding dissipation and elimination, would be necessary to reach a level posing concern about health.

Comment

Summary:

One commenter (7) was concerned that the half-life of the insecticide Confirm (tebufenozide), as reported in the Hazardous Substances Data Base, was 3–6 months in debris in woods and on the forest floor.

Response:

The Hazardous Substances Data Bank (HSDB) does state that the half-lives for tebufenozide range "… from 62.3 to 115 days for sandy forest litter and 52.4 to 62.2 days for sandy forest soil" (U.S. National Institutes of Health, National Library of Medicine, 2010) In the HSDB, these half-lives are attributed to Sundaram (1997), which is cited in the Tebufenozide Risk Assessment (Volume IV, Appendix J) as Sundaram (1997a). While this Sundaram study does address the persistence of tebufenozide in litter, the half-times reported in HSDB do not appear to be from the Sundaram paper. In addition, when checking HSDB, mention of a 6-month half-life was not found for tebufenozide in forest litter. For this and many other reasons, preparers of the risk assessments may consult HSDB and other secondary sources for the identification of relevant references, but generally prefer data from original studies. Nonetheless, the Tebufenozide Risk Assessment does use conservative soil half-lives for modeling concentrations of tebufenozide in water, i.e., 270 (100 to 730) days (Volume IV, Appendix J, Table 31).

m. Questions That Are Outside the Scope of This SEIS (17, 21)

Comment

Summary:

One commenter (17) asked a series of questions on the history of the gypsy moth situation within the State of California along with questions regarding other projects within California, including light brown apple moth and the glassy-winged sharp shooter. The same commenter requested personal information and names of individuals working within the gypsy moth program and possible conflicts with other pest programs, and was concerned about the economic impacts to California from the treatment of specific sites.

Response:

Although the history and impacts of the gypsy moth program and other pest programs (such as light brown apple moth and glassy-winged sharp shooter) in California may provide lessons useful for future activities, these considerations are explored during site-specific analysis when public discussions are carried out and decisions are developed at the local level, and therefore are outside the scope of this SEIS. Specific programs other than the gypsy moth program, such as light brown apple moth and glassy-winged sharp shooter, are outside the scope of this SEIS, and requests for information should be made through other channels. To the extent the comments refer to gypsy moth treatment activities conducted by the California Department of Food and Agriculture (CDFA), those comments are outside the scope of this SEIS and can best be answered by the CDFA. This SEIS, however, does cover considerations applicable to all treatment sites, such as notifying the public when aerial pesticide treatments will be conducted (Appendix B, Section B-4).

This SEIS examined the overall strategy of the USDA National Gypsy Moth Management Program and the environmental impacts of the treatments that could be used. Personal information about individuals who work on the program, past, present, or future, as well as possible interactions with other pest programs are outside the scope of this SEIS and could not be disclosed for privacy reasons. See category z, Program Questions, for more information.

Each treatment project involves different site-specific characteristics. Evaluation of impacts of specific projects, such as those in California, are made on a project-by-project basis at the local level and generally involve public input to the decision process when a treatment is being considered. This SEIS outlines the general framework for the National Gypsy Moth Management Program. Site-specific considerations are deferred to project level analyses and therefore are outside the scope of this SEIS. See category z, Program Questions, for more information.

Comment

Summary:

One commenter (21) expressed concerns about terrorists hijacking planes that may be used in aerial application of treatments and using them in an attack.

Response:

The agricultural aviation industry is required to operate under the Federal Aviation Regulations Part 137, Agricultural Aircraft Operations. After September 11, 2001, the Federal Aviation Administration (FAA) promulgated a revised set of rules to deal specifically with security. These are contained in FAA Advisory Circular 137-1A (U.S. Department of Transportation, FAA, 2007). That Circular reads as follows (Chapter 3, p. 5–6):

> “d. Agricultural Aviation Security Measures.
>
> "(1) An aerial application plane has never been involved in any terrorist activity. Various industry organizations have aggressively promoted enhanced security procedures. In an effort to mitigate

the potential of a threat, the agricultural aviation industry has adopted the following security measures:

"(a) Store aircraft and crop protection products in locked hangars with electronic security systems.

"(b) Park and disable loader trucks, forklifts, or use other equipment to block aircraft.

"(c) In cases where the aircraft must be left outdoors, use propeller locks, propeller chains, or tie-downs on aircraft.

"(d) Remove batteries and render engines mechanically inoperable on unused aircraft.

"(e) Install hidden security switches to prevent unauthorized startup of the aircraft.

"(f) Establish contact with Federal and local law enforcement agencies to coordinate responses to security breaches at agricultural aviation facilities. Encourage operators to list the appropriate law enforcement agency telephone numbers in a prominent place within their operations.

"(g) Encourage the use of outdoor security lighting around hangars and operations."

Aircraft operators who apply insecticides for gypsy moth control are required to follow the FAA security regulations outlined in Advisory Circular 137-1A, regardless of whether they work under Federal or non-Federal gypsy moth contracts. In addition, gypsy moth project officials may require that a site-specific security plan be developed, if necessary, in response to public issues and concerns, the security threat level identified by the Department of Homeland Security at the time of the project, and direction by the FAA, Department of Homeland Security, or USDA.

Current security regulations for the operation of agricultural aircraft and specifically the project planning and oversight associated with gypsy moth treatment projects will continue to make it very unlikely for unauthorized people to tamper with or hijack aircraft, insecticides, and other application-related equipment.

For more information on the security regulations that the agricultural aviation industry must implement, see Advisory Circular 137-1A on the FAA Web site: http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/list/AC%20137-1A/$FILE/AC137-1A.pdf.

n. Concerns About Cumulative Impacts of Spraying (17, 25)

Comment

Summary:

Two commenters (17, 25) expressed concern about the cumulative effects from annual spraying, including toxicity risks not yet evaluated.

Response:

NEPA requires cumulative effects to be evaluated in an environmental impact statement. Chapter 4 of this SEIS considers the cumulative impact of each treatment chemical at the maximum level and frequency allowed according to the label, as well as the cumulative impact of gypsy moth infestation. In addition, the human health and ecological risk assessments (Volumes III and IV, Appendixes F–M) prepared for each treatment also considered cumulative impacts.

The risk assessment process that has been followed for this gypsy moth SEIS (comment category d, Opposition to Alternative 3) is designed to identify and address risks as they become known. This is accomplished through periodic updates to the risk assessments, at which time new literature is reviewed, evaluated, and incorporated as appropriate. If new risks have been reported or suspected, an analysis is included in the updated risk assessment. Before being finalized, new risk assessments and updates to existing ones go through a scientific peer review process. The assessments are also available to the public for examination and comment. This process helps to ensure that new potential risks are addressed.

o. Mitigation Measures

Mitigation of Diflubenzuron and Tebufenozide (36, 19)

Comment

Summary:

Two commenters (36, 19) expressed support for the continued cooperation and coordination of States and the USDA, particularly in relation to developing site-specific mitigations for gypsy moth projects. Commenter 19 hoped that State agencies and USDA would be able to develop a set of mitigation measures to reduce nontarget impacts that would be broadly applicable to the use of tebufenozide and diflubenzuron.

Response:

The Forest Service and APHIS continue to strive to work collaboratively with State partners to deliver the most effective gypsy moth management projects possible that minimize potential adverse effects on nontarget organisms, people, and the environment. These projects continue to evolve and improve as more information becomes available, including new issues and concerns and the development of all practical mitigating measures to address them. A general set of mitigating measures are identified in this SEIS in Chapter 2, Section 2.5. The programmatic mitigation measures are limited because they must be applicable to all projects. Because gypsy moth treatment projects occur in such a wide variety of places, under a wide range of conditions, and may encounter unique local issues and concerns, project-specific measures are also developed.

Mitigation of Drift (24, 30)

Comment

Summary:

Two commenters (24 and 30) expressed concern about the offsite drift of pesticides during application. Commenter 30 was particularly concerned about active and inert ingredients being blown too far by the wind and to unpredictable sites where they would be encountered by unsuspecting human and wildlife populations in which some individuals may be chemically sensitive. This individual concluded their comments by stating that the spraying of pesticides should be rejected. Commenter 24 expressed concern that buffer zones are not large enough to protect areas and populations outside the target site. She noted that her office often received calls complaining about toxic exposures as a result of pesticide applications on windy days or days when rain is forecast. She noted that buffer zones become irrelevant when pesticides are applied without regard to environmental conditions. She also noted that most drift incidents occur as a result of operator negligence and, therefore, urged agencies to become more proactive in reducing drift by enforcing the rules associated with minimizing drift and pursuing violations. This commenter also felt that the restriction for not spraying tebufenozide over water or where surface water is present is insufficient to protect resources, and recommended that no treatments be implemented in watershed areas, especially those with a history of contamination, for example the Chesapeake Bay watershed.

Response:
The insecticides used in gypsy moth projects are registered by the U.S. EPA for gypsy moth and are applied according to the label consistent with the Federal Insecticide, Fungicide, and Rodenticide Act. Among the general mitigation measures required in the USDA National Gypsy Moth Management Program are those related to minimizing drift (Chapter 2, Section 2.5). Through the site-specific project planning process, particularly the solicitation of comments by the public and others, the specific issues and concerns such as drift are considered and dealt with.

All USDA-sponsored gypsy moth treatments are applied under the direct supervision and oversight of trained and experienced Federal, State, and local personnel. Personnel who monitor spray application commonly are in and near the treatment areas. Such personnel are sometimes positioned in observer aircraft monitoring the location of the spray aircraft and the application to the intended treatment area, and at the airport or helispot where the application aircraft lands and loads the insecticide. Project personnel also have radio contact with the spray pilot, which permits them to monitor the applications in real time and to have the pilot cease spraying if the treatments are not settling into the intended treatment area(s). Furthermore, contract specifications for aerial application services require that pilots be experienced in gypsy moth treatments and that they fly the type of aircraft with which they are familiar. Advances in agricultural aircraft and spraying systems and the use of Global Positioning System (GPS) navigation have greatly improved the precision and accuracy of aerial insecticide applications compared with those of a decade ago. GPS navigation equipment and other computer-based application support systems in the aircraft permit the uploading of geo-referenced spray area boundaries, which tell the pilot where he or she is in the spray blocks. With the aid of drift models, current weather parameters can be monitored and pilots advised of recommended offsets to their spray tracks to minimize drift.

The recommendation that treatment with tebufenozide not be allowed within watersheds is not practical, since every place in the country lies within some watershed. As with any gypsy moth treatment, however, tebufenozide would be used in a project only after a site-specific analysis is completed and any issues and concerns relative to proposed treatments in specific watersheds are considered. After a site-specific analysis, mitigation measures may be developed and implemented in response to issues and concerns raised. As with other insecticides, tebufenozide will be applied according to label instructions.

With regard to the comment about specifically not treating for gypsy moth within the Chesapeake Bay watershed, it is helpful to put the scope of gypsy moth treatments in any given year into perspective. The Chesapeake Bay watershed covers more than 41 million acres in six states (Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia) and the District of Columbia. During the period 2001–2010 approximately 1.7 million acres (about 170,000 acres per year) were treated in those States and the District of Columbia through the USDA National Gypsy Moth Management Program. Even if all of the treatments during that period occurred in the Chesapeake Bay watershed—which they did not—that would represent a minuscule 0.4 percent of the watershed receiving treatments on average each year. Furthermore, only about 50,000 acres per year during that 10-year period or about 0.1 percent of the total were treated with a chemical insecticide; the majority of acres were treated with the nonchemical insecticides *B.t.k.* and Gypchek. In any given year on average only a miniscule number of acres within the Chesapeake Bay Watershed are likely to be treated, and mostly with nonchemical insecticides. The benefits of those treatments, that is, protecting the tree canopy and thereby protecting the function of the watershed, far outweigh any possible, however unlikely, adverse effects from treatments over such a small area of the Chesapeake Bay watershed.

Mitigation to Protect Water (31, 32)

Comment

Summary:

Two commenters (31 and 32) noted that the draft SEIS did not provide specific mitigation measures to ensure that aquatic areas were not adversely impacted by spraying of *B.t.k.* or tebufenozide, and asked that such measures be included in the final SEIS.

Response:

This final SEIS does describe some general mitigation measures that will be implemented on projects (Chapter 2, Section 2.5). All treatment sites are different and thus, in order to ensure that appropriate mitigations are used, such as to protect aquatic resources, each site is individually examined to determine how treatments should be applied at that site. This analysis takes into consideration the issues and concerns raised by the general public and others. In all cases the gypsy moth treatments are applied according to label instructions. Nevertheless, should additional measures be deemed necessary to protect aquatic resources or other sensitive areas, the project can be adjusted. This might include, but would not be limited to, use of nospray buffer zones, reconfiguration of treatment blocks to minimize potential drift, restricting environmental conditions (temperature, humidity, windspeed) for treatment, and using a more "environmentally friendly" treatment (like Gypchek or *B.t.k.*) that will still meet project objectives. The Forest Service and APHIS give gypsy moth project managers the flexibility to address local issues and concerns and to implement mitigating measures that best address those issues and concerns.

Mitigation of Impacts to Nontarget, Threatened, Endangered or Rare Species (31, 32, 36)

Comment

Summary:

Three commenters (31, 32, 36) expressed concern about potential impacts to nontarget species, such as honeybees and species that are rare, threatened, or endangered. These commenters recommended that monitoring plans be developed to determine if impacts occur. One commenter (32) recommended that tebufenozide not be used in areas where threatened Lepidoptera are found. Another commenter (36) reiterated that they will continue to support park managers' use of integrated pest management techniques and the most species-specific control methods to meet site-specific goals.

Response:

For federally listed threatened and endangered species, both the Forest Service and APHIS are required by law and agency policy to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. In consultation with the U.S. Fish and Widllife Service, National Marine Fisheries Service, or both, the Forest Service and APHIS are required to use the best scientific and commercial data available to determine what risk, if any, is possible from the proposed treatments. States may have similar consultation requirements for certain State-identified species of concern, and individual agencies may have developed specific policy and protocols for addressing nontarget organisms with which they are concerned. In all cases, the Forest Service and APHIS and their cooperating partners follow the prescribed consultation procedures and protocols associated with any laws, policies, and other requirements (Chapter 1, Section 1.7).

If it is determined that a proposed action could affect nontarget species, then appropriate agency actions will be determined through consultation with the responsible Federal and State agencies. That may include the use of a different treatment that have no effect or minimal effects on the organism in question. For example, if tebufenozide is planned for use and there is a concern about unwanted effects on nearby aquatic invertebrates, then another insecticide that does not affect aquatic invertebrates, such as *B.t.k.*, could be proposed instead. Similarly, in areas with nontarget caterpillar species that could be affected by chemical insecticides or even *B.t.k.*, gypsy moth virus (Gypchek) could be proposed for use instead. In addition to changing the insecticide proposed for use, mitigation measures such as no-spray buffer zones, or monitoring activities agreed to through consultation with responsible Federal and State authorities could be implemented. If alternative treatments, mitigation measures, or both are not sufficient to protect nontarget organisms, then the project manager could drop the proposed treatment area from the project and not treat it at all, as a last resort. These are all project-level decisions, however, based upon site-specific discussions with the appropriate Federal, State, and local officials as well as the general public. This process has always been a part of the USDA National Gypsy Moth Management Program. The Forest Service and APHIS do not see a need to be more prescriptive.

Populated Areas (21, 29, 30, 31)

Comment

Summary:

Four commenters (21, 29, 30, 31) requested that populated areas, parks, schools, and residences not be sprayed with pesticides. One commenter (31) also questioned why workers were warned to stay away from treated areas for hours after a spray, but residents did not receive the same warning.

Response:

Gypsy moths are found throughout the generally infested area in places where people live and wherever there are suitable host plants. This includes residential areas, parks, school zones, and other areas frequented by people, as well as forested areas where the presence of people may not be as noticeable. When gypsy moth populations increase to outbreak levels the insect defoliates trees across the landscape, and the presence of the insect in large numbers increases the exposure of people to caterpillar hairs. People move gypsy moth life stages around the country on outdoor household articles, so eradication projects often occur in places where people live. Public input is a required part of gypsy moth project planning in order to identify site-specific issues and concerns, such as these: how the public will be notified of pending treatments; any restrictions on aerial spraying when school children or school buses are in treatment areas; identification of sensitive areas that should be buffered from spraying; and any other concerns related to reducing the public's exposure to the treatments as stated in this SEIS (Appendix B, Section B.4). To minimize the public's exposure to gypsy moth treatments, some State and local governments may implement other requirements beyond the recommendations in this SEIS. For example, some State and local governments order a shutdown of all aerial treatments in residential areas during specified morning hours when school buses usually pick up children. Other State and local governments are not as restrictive but do ask project managers to cease aerial operations in spray blocks when ground personnel or aerial observers notice school buses or school children in the treatment area. In such cases aerial spraying is not shut down, rather the aerial applicator is directed to another treatment area where school buses and children are not present. In other cases no-spray buffer zones around such places as schools and hospitals have been implemented in response to local issues and concerns and requests by local officials. Tailoring such measures to consider local issues and concerns rather than prescribing them at the national level is responsive to State and local needs and has been successful in the USDA National Gypsy Moth Management Program. The Forest Service and APHIS do not see a need to change the recommendations described in this SEIS (Chapter 2, Section 2.5; Appendix B, Section B.4).

Some pesticide labels do include a reentry warning for workers because workers can be exposed to considerably more pesticide during treatment projects than the general public would be exposed to. When human health issues are being evaluated by the pesticide manufacturer to determine the kind of warnings that are appropriate to put on the U. S. EPA-approved pesticide label, workers are considered to be working with and exposed to the pesticide for 8 hours per day for up to 40 years (lifetime occupational exposure). This estimate of exposure is many times the potential exposure for the general population.

p. Concerns Regarding Specific State Projects

(6, 21, 22, 23, 25, 26, 29, 33, 34)

Comment

Summary:

One commenter (21) in Maryland remarked that other States do not spray and can control their gypsy moth populations, and recommended that Maryland look for a less-pesticide-use alternative. Another commenter (6) added that the chemicals used to control gypsy moth are putting the health of Maryland's citizens at significant risk.

Response:

The choice by the State of Maryland of which treatment to use on a particular project, while outside the scope of this SEIS, is made after considering a host of local issues and concerns including the potential human health risks. The choice of treatment options and the implementation of mitigating measures are local decisions. This SEIS provides information to help guide those local deliberations. The potential risk to human health associated with the treatments has been analyzed and disclosed in Volumes III and IV, Appendixes F–K and M.

The USDA National Gypsy Moth Management Program does not mandate that any treatments be conducted and does not prescribe the particular treatment to use, and neither does any alternative in this SEIS. Officials at the project level determine whether to treat for gypsy moth, as well as which treatment option(s) to implement, after gathering public input about the proposed project and identifying site-specific issues and concerns. This local input and the local situation with gypsy moth become the basis for the development of a site-specific environmental analysis conducted and documented in accordance with the National Environmental Policy Act and agency procedures. Through this analysis, issues and concerns help to drive the examination of treatment alternatives and the development of any necessary mitigating measures.

Comment

Summary:

One commenter (26) remarked that the Forest Service and APHIS should remember past concerns in the gypsy moth program and should incorporate lessons learned into the current program.

Response:

Appendix E, Sections E.3–E.7, of this SEIS describe the history of gypsy moth program. Past concerns are mentioned and how experience with current technology has changed the program. The development and implementation of the Slow-the-Spread Strategy is a result of incorporating lessons learned into the current program. The analysis of human health and ecological risks documented in Volumes III and IV, Appendixes F–M, is another example of the evolution of the program to better identify and quantify the potential risks to people and nontarget organisms from exposure to treatments.

Comment

Summary:

Several commenters (29, 33, 34) provided a great deal of background information dealing with site-specific issues associated with a 2003 gypsy moth eradication project in Lincoln County, OR.

Response:

The issues related to specific gypsy moth projects are outside the scope of this SEIS. Any relevant issues and "lessons learned" during past projects, however, should be identified and addressed in conducting site-specific analyses of future projects in the same or similar areas. The general history of the gypsy moth management program and lessons learned from past experience are described in Appendix E, Sections E.3–E.7.

Comment

Summary:

Four commenters (21, 22, 23, 25) remarked that New York and the New England States do not use “chemical means” or do not spray at all, and can control gypsy moth. One commenter (22) noted that the draft SEIS did not discuss how these states are faring. One commenter (25) referenced a 33-year-old study in which large gypsy moth egg masses were observed in the area after treatment with *B.t.k.* The commenter suggested that this explained why Connecticut does not spray for gypsy moth.

Response:

Gypsy moth is a permanent resident in all or parts of 19 states including those States (New England and New York) noted by the commenters as not having gypsy moth control programs. State agencies in New England and New York have not organized and implemented State-coordinated gypsy moth treatment projects in cooperation with USDA for many years; however, all treatments have not ceased. Where treatment projects occur in those States, such projects are conducted by local governments and private citizens at their own expense. Whether treatments are occurring, gypsy moth still causes damage (defoliation) in New England and New York. For example, during the period 2004–2008, about 5.2 million acres were defoliated across the entire gypsy moth generally infested area in the United States. Some 20 percent of that defoliation (954,000 acres) occurred in New England and New York.

The State of Connecticut has not organized or run gypsy moth treatment projects in more than three decades. It is not known, however, if the 1976 study cited by the commenter had any influence on that decision or if there were other issues that were considered. In any case, gypsy moth outbreaks still occur in Connecticut. For example, in 2006 in Connecticut more than a quarter million acres were defoliated by gypsy moth—the most damage recorded in the State in 24 years. The task of reducing damage caused by episodes of gypsy moth outbreaks resides with individual homeowners, landowners, and communities. In any given year treatments for gypsy moth are implemented in Connecticut using registered insecticides, but these treatments are not sponsored by the Forest Service, APHIS, or the State of Connecticut. Such private treatments are outside the scope of the USDA National Gypsy Moth Management Program described in this SEIS.

q. Concerns About Human Health and Environmental Safety

(6, 17, 21, 22)

Comment

Summary:

One commenter (6) indicated that individuals exposed to gypsy moth spraying develop a host of medical symptoms including cognitive impairment (short-term memory deficit), fatigue, headaches, and muscle and joint pain.

Response:

Where information concerning human health effects was found in the published literature or from other credible sources, it was discussed in this SEIS (Chapter 3, Section 3.3; Chapter 4, Sections 4.3–4.11). In some cases, such as with *B.t.k.*, actual epidemiology studies (human health data) are available and were used to characterize risk. The human health risk assessments that were completed for this SEIS have carefully evaluated the potential for human health impacts associated with insecticides that could be used in the USDA National Gypsy Moth Management Program. The assessments show that there is no reason to believe that the health of people will be compromised due to gypsy moth treatments.

Comment

Summary:

One commenter (6) indicated that by not testing for immunotoxicity, endocrine effects, and neurotoxicity, the U.S. EPA is failing to detect these symptoms.

Response:

The Forest Service and APHIS cannot speak for the U.S. EPA or address the status of their testing standards. The Forest Service and APHIS have, however, examined the available data on neurotoxicity, immunotoxicity, and endocrine function and have incorporated any relevant data on these effects into the risk assessments (Volumes III and IV, Appendixes F–K).

Comment

Summary:

One commenter (6) stated that chemicals used to control gypsy moth are putting the citizens of Maryland at significant health risk.

Response:

The decision to plan and implement gypsy moth suppression projects in Maryland rests with state and local officials. This SEIS provides guidelines for partners to follow and identifies a list of treatment options that the USDA recognizes as being effective to reduce damage from gypsy moth outbreaks and not likely to cause adverse effects to the environment, nontarget organisms, or human health. The choice of specific treatments to use is strictly a project level decision, which considers local input, issues, and concerns. The potential risks to human health associated with the treatments and exposure to hairs from the gypsy moth have been analyzed and disclosed in Appendixes F–M. The choice by the State of Maryland of which treatment to use on a particular project, while outside the scope of this SEIS, is made after considering a host of local issues and concerns, including the potential human health risks and available mitigation measures. While some effects on individuals of the general public are remotely possible with some agents, the risk assessments do not support assertions of significant health risks from any of the treatment options discussed in this SEIS. Furthermore where public concerns are expressed project managers can implement mitigation measures to reduce potential exposure of individuals and subsequent risk.

Comment

Summary:

One commenter (17) requested that this SEIS detail several elements of the gypsy moth program, including the toxicology of any pesticides or toxics used, all pesticide and toxics delivery systems, synergism within any product or formulation in any state, dangers of male gypsy moth trapping, and dangers of pheromones.

Response:

This SEIS and accompanying appendixes provide detailed information about gypsy moth, the USDA National Gypsy Moth Management Program including how insecticides are delivered, and gypsy moth treatments. A comprehensive review of the available literature on the toxicology and human health, nontarget and environmental effects associated with the approved insecticides (Chapters 3 and 4) are presented in the human health and ecological risk assessments prepared for each insecticide (Volumes III and IV, Appendixes F–K) . The Forest Service and APHIS are not aware of any other credible literature available on the health effects or toxicology of these insecticides that would significantly change the conclusions of the risk assessments and the decision to include these insecticides in the National Gypsy Moth Management Program. The Forest Service and APHIS stand by those conclusions and deem the risks discussed to be acceptable.

Comment

Summary:

One commenter (17) requested an independent investigative medical review of every health complaint they suspected had been exacerbated by the gypsy moth program and the unrelated light brown apple moth program.

Response:

During the preparation of the risk assessments for this SEIS, a comprehensive review was made of the human health related literature available on the insecticides. This included information, studies, and reports available in the open literature, as well as information provided to the U.S. EPA by industry for registration of the insecticides. In risk assessments conducted by the U.S. EPA the information provided by the registrant almost always takes precedence over the open literature for several reasons: the registrant-submitted studies meet the specific guidelines developed by the U.S. EPA; the studies are conducted under Good Laboratory Practices; and full copies of the studies, including all raw data, are available to the U.S. EPA for review. The risk assessments for this SEIS were prepared to comply with NEPA and included reviews of published and unpublished literature in order to cover the widest body of credible information possible. These risk assessments generally used all of the relevant information that could be located. Where data gaps exist, the risk assessments used conservative assumptions for both the exposure and doseresponse portions of the assessments. The Forest Service and APHIS believe that if any human health effects associated with gypsy moth treatments were routinely reported over the years, then such effects would have emerged in the literature that was examined in preparation of the risk assessments. There is no basis for concluding that treatments in the USDA National Gypsy Moth Management Program exacerbate human health, or for suggesting the need for an independent medical review.

Comments related to the light brown apple moth program are outside the scope of this SEIS.

Comment

Summary:

One commenter (21) requested that dermal exposure during wide-scale spraying of residential areas be properly assessed.

Response:

The risk assessments prepared for the chemical insecticides that could be used in wide-scale spraying (i.e., diflubenzuron and tebufenozide) do contain assessments of dermal exposure as a key component of the risk characterization. For these insecticides, the dermal exposure estimated for gypsy moth projects did not result in unacceptable risk estimates. Dermal exposure to disparlure was also considered but not quantitatively assessed, due to lack of appropriate toxicity data to complete a quantitative risk characterization. The risks associated with exposure to disparlure were therefore characterized qualitatively as low, and longer-term exposure risks were indeterminate but presumed low due to the very low levels of expected exposure and the insectspecific nature of disparlure’s biological activity. For the microbial insecticides (Gypchek and *B.t.k.*), inhalation was considered to be the predominant means of exposure.

Comment

Summary:

One commenter (21) requested that officials consider the impacts on infants, children, chemically sensitive adults, or other populations likely to be at risk (both human and other animals).

Response:

The potential human health and ecological risks associated with the use of the insecticides presented in this SEIS have been extensively examined and disclosed in the human health and ecological risk assessments (Volumes III and IV, Appendixes F–K) and in the comparison of risks (Volume IV, Appendix M). The analyses documented in the risk assessments examine the potential risks to adults, young children, and other potentially susceptible sensitive members of the general public. The results of these analyses show that the treatments as used in USDA-sponsored gypsy moth projects do not pose any significant risks to people living in treatment areas. Readers are also referred to the information provided in comment category e, Comments on Multiple Chemical Sensitivity or Immunocompromised or Sensitive Individuals.

The Forest Service and APHIS take the concerns about exposure to insecticides seriously when planning gypsy moth treatment projects and seek to identify, through the public involvement process, the major issues and concerns that people have with any proposed treatments. If necessary, measures can be developed to help minimize exposure of people living in proposed treatment areas. Public involvement is a required part of the USDA National Gypsy Moth Management Program (Appendix B, Section B.4), and the means by which people can make their concerns known to officials and project planners. Public notification in advance of gypsy moth treatments is strongly encouraged by the Forest Service and APHIS, and most State gypsy moth program managers have implemented some form of advanced notification of pending treatments. With sufficient notification of pending treatments, individuals can take measures to reduce their own exposure.

Comment

Summary:

One commenter (22) indicated that there is little discussion of drift of any of the pesticides, and asked how far away from a treatment area a sensitive individual needs to be to avoid symptoms. The commenter also stated that the draft SEIS is often contradictory and cited a specific example in Appendix F, page 3-30, Section 3.4.3 (Volume III), which states: "… there remains no basis for asserting that the use of *B.t.k.* to control the gypsy moth is likely to have adverse toxic effects on any group" and then pointed to the subsequent discussion of several groups at special risk in Section 3.4.4.

Response:

Drift of insecticides as well as the direct spraying of ponds and streams is considered in Section 3.2.3.4.2 of the risk assessments for diflubenzuron (Volume III, Appendix I) and tebufenozide (Volume IV, Appendix J), because exposure to either insecticide in sufficient quantity could have adverse effects on aquatic organisms and cause the development of methemoglobinemia in some people. Similar discussions are not presented in the risk assessments for the other insecticides because the risks associated with direct spraying or drift are not significant.

The statement cited by this commenter, "there remains no basis for asserting that the use of *B.t.k.* to control the gypsy moth is likely to have adverse toxic effects on any group" (Volume III, Appendix F, Section 3.4.3, p. 3-30) and which then goes on to discuss several groups at special risk in Section 3.4.4, is taken out of context. The quotation cited by the commenter is preceded by the phrase, "Within this definition of safety or acceptable risk …." so that the entire sentence reads, "Within this definition of safety or acceptable risk, there remains no basis for asserting that the use of *B.t.k.* to control the gypsy moth is likely to have adverse toxic effects on any group." The "definition" referred to in the quoted sentence is taken from Burges (1981, p. 738–739), as cited by Siegel (2001), and makes the point that absolute safety cannot be guaranteed. The quotation from the *B.t.k.* Risk Assessment (Volume III, Appendix F) as cited by the commenter is also taken out of context in that the discussion refers to serious adverse effects (Section 3.4.3) distinct from irritant effects that are discussed in Section 3.4.2. In short, the statement thought to be contradictory by the commenter is accurate as presented and discussed in the *B.t.k.* Risk Assessment.

Comment

Summary:

One commenter (22) expressed concern about the potential synergistic effects of pesticides with other chemicals or other factors in the environment, and stated that the testing requirements are inadequate for assessing such interactions and their potential health or environmental impacts.

Response:

The potential synergy between the treatments described in this SEIS and other chemicals is considered in the risk assessments where credible data exist to permit a quantitative or qualitative assessment of risk. All of the insecticides used and proposed for use in the USDA National Gypsy Moth Management Program have received all of the required testing and evaluations required for registration by the U.S. EPA. At present, the U.S. EPA does not require testing for synergy beyond toxicity testing of commercially formulated pesticide products. The risk assessments incorporate a review of all the available public literature as well as unpublished studies that may not be readily available to the public, such as those submitted to the U.S. EPA for registering the insecticides. In all cases there was no information documenting any known or suggested situations demonstrating possible synergy between the insecticides and other chemicals.

Comment

Summary:

One commenter (22) quoted several points from the Gypchek Risk Assessment (Volume III, Appendix G) regarding the lack of testing for hormone-like activity, such that no definitive hazard identification is possible for this effect.

Response:

These data gap limitations are disclosed in the Gypchek Risk Assessment (Volume III, Appendix G, Section 3.1.8). The information that was available for the Gypchek Risk Assessment consisted of studies required by the U.S. EPA to provide an accurate assessment of the potential health and environmental risks posed by the use of a pesticide. These required studies support the registration of Gypchek, in compliance with the Federal Insecticide, Fungicide, and Rodenticide Act, and Food Quality Protection Act, and associated Federal regulations. During the preparation of the Gypchek Risk Assessment, every effort was made to include all additional relevant information from the open literature. Nothing resulting from that literature review casts any doubt on the risks disclosed for the use of Gypchek in the USDA National Gypsy Moth Management Program.

r. Questions, Comments, or **Concerns on the Use of Diflubenzuron** (Dimilin) (7, 21)

Comment

Summary:

One commenter (7) asserted that patients have been seen with significant neurologic, respiratory, and systemic symptoms due to diflubenzuron exposure.

Response:

The Diflubenzuron Risk Assessment (Volume III, Appendix I, Section 3.1) addresses the information from epidemiology studies, case reports, and toxicity studies, which do not support this commenter's assertion of significant human symptoms from diflubenzuron exposure. The statements made in the comment may be viewed as a very brief and not well-documented summary of case reports.

Comment

Summary:

One commenter (21) offered a technical presentation of diflubenzuron, tebufenozide, and *B.t.k.*, and included a large number of references. The commenter also pointed out that 4chloroaniline, a breakdown product associated with diflubenzuron, is a carcinogen.

Response:
This commenter indicated that the Summary under Effects of Treatments, Diflubenzuron, and Risk to Human Health (Volume I, Section 8) of the draft SEIS erroneously cited the U.S. EPA classification of 4chloroaniline as a "potential carcinogen," but that the U.S. EPA classification is "probable human carcinogen" (Diflubenzuron; pesticide tolerances, Final rule. Federal Register 71: 229, p. 69031). This comment is correct. The different classification terms used by the U.S. EPA and the International Agency for Research on Cancer (Volume III, Appendix I, Section 3.1.15) may have led to this error in the draft SEIS. The error was corrected in this final SEIS to read "probable carcinogen."

Comment
Summary:
Commenter 21 stated that Dimilin should not be used because 4chloroaniline is a carcinogen, and Dimilin's hazard quotient (HQ) for aquatics is higher than tebufenozide's HQ for terrestrial and aquatic species.

Response:
The carcinogenicity of 4chloroaniline is considered in detail in the Diflubenzuron Risk Assessment (Volume III, Appendix I). Also, as noted in this SEIS, the highest HQ is 0.4 based on a cancer risk of one in 1 million. The reference to higher HQs for diflubenzuron relative to tebufenozide (0.03) is correct. The higher HQ, however, does not suggest that diflubenzuron should never be used, but it does argue for the use of tebufenozide in areas where impacts on aquatic species are a particular concern. This lower HQ is one of the key rationales for adding tebufenozide as one of the treatments that may be used for gypsy moth control. More generally, the recognition that different agents will present differing spectra of risks to humans and nontarget species is one of the reasons for proposing Alternative 3.

s. Questions, Comments, or Concerns on the Use of Tebufenozide **(Confirm, Mimic) (25, 27, 31, 21)**

Comment
Summary:
Commenter 21gave a technical discussion of diflubenzuron, tebufenozide, and *B.t.k.* that includes a large number of references and raises issues concerning human health for tebufenozide (Mimic, Confirm).

Response:
Two pages of this comment focused on tebufenozide, and three paragraphs focused on sensitive subgroups. Much of this discussion may be viewed as an elaboration of Section 3.4.4 of the Tebufenozide Risk Assessment (Volume IV, Appendix J), and several of the points made in this elaboration have merit. For example, the comment suggested that individuals with sickle cell anemia may be at increased risk from tebufenozide or any other agent that causes methemoglobinemia. This is a good point and appears to be correct. At present, it is not known whether uncertainty factors used for sensitive individuals in general populations are adequately protective for individuals with preexisting blood disease. The uncertainty factors used, however, represent the currently accepted method for addressing sensitive subgroups in the general population.

This is also true for several of the other groups noted in the comment which essentially suggests that Section 3.4.4 of the Tebufenozide Risk Assessment (Volume IV, Appendix J) is underdeveloped. By comparison with Section 3.4.4 of the Diflubenzuron Risk Assessment (Volume III, Appendix I), this may be true. In terms of subgroups that may be sensitive based on methemoglobinemia, the discussions of tebufenozide and diflubenzuron in Section 3.4.4 should be similar. The discussion in the Tebufenozide Risk Assessment, however, is much less developed than that in the Diflubenzuron Risk Assessment. Nonetheless, the risks posed by exposure to tebufenozide are similar, if not identical, to those from exposure to diflubenzuron. The Diflubenzuron Risk Assessment has a well developed discussion on the risks to sensitive subgroups, and this information is applicable for tebufenozide as well.

Notwithstanding the above statements, the comment was in error when it contended: "The draft report [i.e., the Tebufenozide Risk Assessment] states that there are no sensitive human populations." Section 3.4.4 clearly notes that infants as well as individuals with congenital methemoglobinemia could be at increased risk.

A more important consideration in the commenter's discussion of groups at increased risk from tebufenozide involves the implication that the risk characterization may not adequately cover sensitive subgroups. On the contrary, the topic is explicitly discussed in Section 3.4.4 of the Diflubenzuron Risk Assessment, i.e., the last paragraph dealing with the uncertainty factor. This type of discussion also applies to tebufenozide.

The commenter devoted more than a paragraph to the general issue of inert ingredients. While publicly disclosing all of the inerts in a pesticide might improve the confidence in the risk assessment, the U.S. EPA does review all inerts in all pesticide formulations and has recently completed a full review of inerts. Inert ingredients permitted in pesticide products are listed on the U.S. EPA Web site (http://www.epa.gov/opprd001/inerts/). Risk assessments conducted outside of the U.S. EPA, however, do not have access to and cannot disclose all of the inert ingredients in pesticide formulations. Proprietary rights are granted to pesticide registrants under the Federal Insecticide, Fungicide, and Rodenticide Act, and risk assessments must therefore rely on the review by the U.S. EPA.

The main point made by the commenter in discussing inert ingredients was this: "Without knowing the contents of the mixture used in Mimic, there is no way to judge the hazard based on "active" ingredients only." This statement is incorrect. Some assessment of the significance of inert ingredients in pesticide formulations can be made by comparing the toxicity of the formulation (i.e., with inerts) to the toxicity of the active ingredient. This information is discussed in Section 3.1.14 of the Tebufenozide Risk Assessment (Volume IV, Appendix J). The risk assessment clearly recognizes and discloses the potential impact of inert ingredients (p. 3-8):

> "… in terms of acute irritant effects that might be associated with the handling or application of Mimic, it is likely that the adjuvants or other inerts are of greater concern than tebufenozide. In terms of potential systemic toxic effects, however, there is no information to suggest that the adjuvants or inerts have an impact on the toxicity of this product."

The commenter suggested that inhalation may be an exposure of concern. This was based on statements in the Tebufenozide Risk Assessment (p. 3-8), i.e., 4-hour exposure to 1.33 mg/L caused irritant changes to the respiratory tract. Here, the comment is moving directly from hazard identification to a risk characterization, despite the fact that they are two separate steps in the risk assessment process, as is explained in comment category d, Opposition to Alternative 3. Also, the commenter stated that inhalation is the most toxic route of exposure for sprayed pesticides. This statement is not substantiated. In general, the oral or dermal exposures are the routes of greatest concern, as discussed in Section 3.2.2.2 of the Tebufenozide Risk Assessment (Volume IV, Appendix J).

This commenter also expressed concern about aquatic species and suggested that the SEIS is contradictory in its conclusion that no adverse effects on aquatic species are anticipated. The SEIS acknowledges that low concentrations will cause adverse effects. This is another example of not clearly distinguishing between the hazard identification and the risk characterization steps. The important point is that the anticipated levels of exposure are below the levels of concern.

The commenter pointed out that the only available data on honeybees involves acute toxicity studies and that longer-term studies would be useful. While data from longer-term studies would be useful, such data would not be considered significant or critical to the overall discussion of risk to nontarget organisms as disclosed in the risk assessment.

One paragraph of the comment discussed the toxicity of diflubenzuron to aquatic organisms, noted similarities between diflubenzuron and tebufenozide, and discussed decline of blue crab populations in the Chesapeake Bay. The inference is that the comment relates tebufenozide to decline of blue crab populations in the Chesapeake Bay, but the commenter does not provide a rationale to support it.

Comment

Summary:

One commenter (21) asserted that since essentially all of the eastern United States is populated or is a recreation area with hiking trails, tebufenozide should not be used. The inference is that the comment links tebufenozide to killing hunting dogs and should not be approved for use on gypsy moth.

Response:

This assertion/opinion is not supported by any documentation. To the contrary, the toxicity to mammals is considered low.

Comment

Summary:

Commenter 25 suggested that the ecological risk assessment section of the Tebufenozide Risk Assessment is based on relatively few species.

Response:

The discussion in the Tebufenozide Risk Assessment (Volume IV, Appendix J) is less developed than that in the Diflubenzuron Risk Assessment (Volume III, Appendix I), for example, due to the relative abundance of data for diflubenzuron. Tebufenozide is a much newer insecticide. Nonetheless, the ecological and human health toxicity data available are adequate to support the U.S. EPA registration of tebufenozide and the proposed use of this pesticide in gypsy moth management.

Comment

Summary:

Another commenter (27) provided a list of issues associated with the use of tebufenozide: lack of longer-term studies on humans (i.e., epidemiology), individuals with higher than normal blood carbon monoxide, insufficient data on inhaled dose rates, and lack of recommendations to protect infants.

Response:

Commenter 27 is correct in stating that there are no longer-term epidemiology studies on tebufenozide. Tebufenozide is a recently developed pesticide, and hence long-term epidemiology data cannot have been developed. Also there is no indication that such data need be generated for this reduced risk (and in this case, an insect-specific) pesticide. The suggestion by the commenter that longer-term risks cannot be characterized, however, is incorrect. As detailed in Section 3.1.5 of the Tebufenozide Risk Assessment (Volume IV, Appendix J), the longer-term toxicity of tebufenozide is characterized well in experimental mammals. After reviewing it the U.S. EPA considers the information sufficient to derive a chronic reference dose (RfD), as detailed in Section 3.3.2 of the Tebufenozide Risk Assessment, and to grant a full registration based on human health and environmental considerations. The commenter is correct in indicating that individuals with higher than normal exposures to carbon monoxide, such as exposure to tobacco smoke, may be at increased risk. This is discussed in Section

3.4.4 of the Tebufenozide Risk Assessment. This RfD incorporates an uncertainty factor of 10 to account for sensitive subgroups. Also, as is true for most pesticides, inhalation exposures to tebufenozide are not explicitly modeled in the risk assessment. Inhalation is not likely to be a significant route of exposure because of the low vapor pressure of tebufenozide (Volume IV, Appendix J, Table 2-1).

Commenter 27 is incorrect in indicating that risks to infants are not considered. The U.S. EPA explicitly considered risks to infants and children in the derivation of the chronic RfD, which was adopted in the Tebufenozide Risk Assessment (Volume IV, Appendix J, Section 3.3.2). In addition, several exposure scenarios for members of the general public do explicitly model exposures to a young child. None of the hazard quotients for tebufenozide reach a level of concern.

Comment

Summary:

One commenter (31) cited several limitations in the Tebufenozide Risk Assessment (Volume IV, Appendix J). Four discrete topics were identified: no information on water quality effects, toxicity to spiders and earthworms, irritant effects to skin and eyes of people, and effects on blood.

Response:

The commenter's reference to water quality effects is unclear. Within the context of the comment, the reference appears to be focused on the effects of tebufenozide on aquatic organisms. As detailed in Appendix J, Sections 4.1.3, 4.2.5, 4.3.3, and 4.4.3, risks to aquatic organisms are covered as fully as possible based upon the available literature. The commenter appears to reiterate statements in the risk assessment of the potential effects of tebufenozide on earthworms (Sections 4.1.2, 4.2.2, and 4.3.3) and spiders (Section 4.1.2 and Appendix 6). While risks to spiders are not assigned a hazard quotient, the risks are acknowledged. As noted in the risk characterization, risk to earthworms appears to be below the level of concern by a factor of 10,000. The commenter also reiterated statements concerning skin and eye irritation (Sections 3.1.11, 3.2.2.2, and 3.4.2). The effects of tebufenozide on the blood are discussed throughout the human health risk assessment (Section 3).

t. Questions, Comments or Concerns About the Use of ***B.t.k.***
(7, 21, 25, 27, 28, 29, 31)

Comment

Summary:

Commenter 7 asserted that patients have been seen with significant neurologic, respiratory, and systemic symptoms due to Dimilin (diflubenzuron) and *B.t.k.*

Response:

The risk assessments for *B.t.k.* (Volume III, Appendix F) and diflubenzuron (Volume III, Appendix I)) each address the information from epidemiology studies, case reports, and toxicity studies, and conclude that the risks from human exposure to these insecticides as used for gypsy moth control are acceptable. The statements made in this comment are a brief and not well-documented summary of case reports; this type of unpublished summary would not typically be included in a risk assessment.

Comment

Summary:

Commenter 21 expressed a concern about bacterial superinfection, drawing on the data from Hernandez and others (2000).

Response:
Many individuals commented on the Hernandez and others (2000) study. In response, the Forest Service and APHIS have added a detailed discussion to Chapter 4, Section 4.4, on the incidence of human flu and exposure to *B.t.k.* in gypsy moth programs.

Comment

Summary:

Commenter 21 cited recent evidence that *B.t.k.* is a human pathogen and can be lethal to a human co-infected with influenza virus, and requires reconsideration for use in populated and recreation areas, including parks.

Response:
This comment misstated the content of the Hernandez and others (2000) study. The study was limited to mice and did not involve risks to humans. The significance of the Hernandez and others (2000) study is discussed in Chapter 4 (Section 4.4).

Comment

Summary:
Commenter 25 expressed concern about risks based on Hernandez and others (2000) as discussed in the *B.t.k.* Risk Assessment, stating that the results of the study make it "obvious that this chemical should definitely not be used."

Response:
The commenter proceeded directly from identification of a decision not to use *B.t.k.*, without first examining the potential for people to be exposed to *B.t.k.*, the quality of the data, and the objective of the study by Hernandez and others (2000). The risk assessment process is discussed in comment category d, Opposition to Alternative 3. A detailed discussion of the Hernandez and others (2000) study was added to Chapter 4 (Section 4.4).

Comment

Summary:

Commenter 25 quoted from the *B.t.k.* Risk Assessment: "…there remains no basis for asserting that the use of *B.t.k.* to control the gypsy moth is likely to have adverse toxic effects on any group." The commenter suggested that this statement cannot be true in view of the concerns with the study by Hernandez and others (2000).

Response:
The comment failed to quote the first part of the sentence and the previous paragraph in the *B.t.k.* Risk Assessment (Volume III, Appendix F, Section 3.4.3, p. 3-30):

> "These or any other numerical expressions of risk must be interpreted with some caution. In the recent review of the toxicity of several strains of *B.t.k.* to mammals, Siegel (2001) quotes an earlier assessment by Burges (1981) concerning general testing needs for microbial pesticides, and this quotation bears repeating:
>
> > '... a "no risk" situation does not exist, certainly not with chemical pesticides and even with biological agents one cannot absolutely prove a negative. Registration of a chemical is essentially a statement of usage in which the risks are acceptable. The same must apply to biological agents.
> >
> > —Burges (1981, pp. 738–739).'
>
> "Within this definition of safety or acceptable risk, there remains no basis for asserting that the use of *B.t.k.* to control gypsy moth is likely to have adverse toxic effects on any group."

The risk assessment then goes on to talk about the concerns regarding the significance of Hernandez and others (2000), and notes that the study is not of a design that allows its use in quantitative human health risk assessment. The risk assessment and risk characterization for *B.t.k.* are complicated and make a clear distinction between less severe irritant effects and serious adverse effects.

Comment

Summary:

One commenter (27) noted that there is a lack of long-term studies demonstrating the safety of *B.t.k.* to humans, and provided a 2008 report by Claude Ginsburg, The safety to humans of Bacillus thuringiensis insecticidal sprays: a reassessment.

Response:

The *B.t.k.* Risk Assessment is based exclusively on human data, although no long-term epidemiology studies have been conducted on the same human populations. All of the points raised in the commenter's letter, however, including the points and the literature cited in the report that was provided, are addressed in the *B.t.k.* Risk Assessment (Volume III, Appendix F, Section 2.3). The information provided in the comment letter does not change the risks that are associated with the use of *B.t.k.* in the USDA National Gypsy Moth Management Program as disclosed in the *B.t.k.* Risk Assessment.

Comment

Summary:

Commenter 29 stated that *B.t.k.* delivered by helicopter is not safe, and raised concern about the need for people to relocate to avoid aerial spray. To quote the comment in part, "There has not been sufficient research, but there has been a massive collection of anecdotal evidence of significant health risks from its use."

Response:

The nature of the "massive collection of anecdotal evidence" is not clear. The *B.t.k.* Risk Assessment (Volume III, Appendix F) incorporates a review of not only the relevant public information and studies from peer-reviewed sources, but also unpublished studies examined by the U.S. EPA during the pesticide registration process, and other published or unpublished reports that were available. A number of epidemiology (human health) studies associated with the aerial application of *B.t.k.* for forest pest control (including gypsy moth) were also examined, and were used extensively in the preparation of the *B.t.k.* Risk Assessment. These epidemiology studies are well documented, and show no public health basis for temporarily relocating people to areas outside proposed treatment areas.

Comment

Summary:

Commenter 31 asserted that individuals with preexisting allergies and those who are immunocompromised would be especially vulnerable to *B.t.k.*

Response:

A number of epidemiology studies specific to the application of *B.t.k.* for control of gypsy moth and other tree-defoliating caterpillars were reviewed in the *B.t.k.* Risk Assessment and used extensively in the analysis and quantification of the human health risks to people exposed to *B.t.k.* in treatment areas. In none of these studies was there any evidence that individuals with preexisting allergies or immunocompromised individuals were especially vulnerable. This does not suggest that sensitive individuals would never have a reaction to *B.t.k.* exposure, but the weight of evidence in the epidemiology studies strongly suggests it is not very likely. This issue, however, emphasizes the importance of soliciting public input on proposed projects to identify these issues and concerns so they can be considered during project planning and implementation. Within the *B.t.k.* Risk Assessment a safety factor of 10 was incorporated into the assessment of risk to account for sensitive people within the general population (Volume III, Appendix F, Section 3.4.3). The use of this safety factor of 10 for sensitive individuals is a standard and accepted practice in human health risk assessments. Readers are also referred to comment category e, Comments on Multiple Chemical Sensitivity or Immunocompromised or Sensitive Individuals, for additional information on this subject.

u. Questions, Comments, or Concerns About the Use of Disparlure (18)

Comment

Summary:

One commenter (18) remarked that the apparent persistence of disparlure in the human body, described by E. Alan Cameron 20 years after doing gypsy moth trapping, is cause for concern that has not been addressed in this SEIS.

Response:

This topic is specifically addressed in the Environmental Consequences chapter of this SEIS (Chapter 4, Section 4.6). It references two papers by E. Alan Cameron:

> Cameron, E.A. 1981. On the persistence of disparlure in the human body. Journal of Chemical Ecology 7(2): 313–317.
>
> Cameron, E.A. 1983. Apparent long-term bodily contamination by Disparlure, the gypsy moth (Lymantria dispar) attractant. Journal of Chemical Ecology 9(1): 33–37.

The current literature finds no adverse effects to humans from exposure to disparlure.

v. Questions, Comments, or Concerns About the Use of Gypchek (21, 25)

Comment

Summary:

One commenter (21) recommended that the Forest Service use Gypchek with parasitic wasps and fungus rather than tebufenozide or diflubenzuron.

Response:

Comments were noted. The reader is referred back to the response to comment category i, Recommendations to Use Nontoxic or Less-Toxic Treatments or Minimize Pesticide Use.

In terms of potential unintended risks, Gypchek is clearly preferable to tebufenozide or diflubenzuron. This is discussed at some length in the Risk Comparison (Volume IV, Appendix M); however, Gypchek is produced in very limited quantities every year so a sufficient quantity is not available for broad-scale application in gypsy moth management projects. Further, there are biological and physical (i.e., weather) limitations on the effective use of Gypchek. While other natural control agents like parasitic wasps help to regulate gypsy moth populations, these agents do not play a significant role in controlling gypsy moth when the insect reaches outbreak, and thus damaging, levels. Parasitic wasps are not a factor in areas where slow-the-spread and eradication projects are conducted, because gypsy moth population levels are not high enough to support a significant presence of these agents.

Comment

Summary:

One commenter (25) remarked on the limited data available on Gypchek and requested further testing before it is used.

Response:

Comment noted. The comment is correct in indicating that data gaps exist for Gypchek. This is also true for every agent considered for gypsy moth and, more broadly, for any other pesticide. While data gaps are limitations, and these limitations are often expressed in the risk assessments that have been prepared as part of this SEIS, it is important to appreciate that the minimum information that is available consists of studies required by the U.S. EPA in support of pesticide registration, and that the risk assessments make every effort to include all additional relevant information from the open literature.

Despite these data gaps, Gypchek is an approved treatment for use in gypsy moth projects, and has been used for more than 30 years without documented adverse health incident. It has been through the testing required for registration by the U.S. EPA. The risk assessment for Gypchek (Volume III, Appendix G) covers the results of many tests and studies of human health and ecological effects. The preparers of this SEIS believe the current data is sufficient to continue to make Gypchek available as one of the treatments for gypsy moth projects.

w. Questions or Concerns Related to Nonactive or Inert Ingredients (15, 21, 22, 24, 30, 31, 33)

Comment

Summary:

One commenter (15) remarked that there was no mention of surfactants that may be used for application.

Response:

Surfactants are considered in risk assessments only when the available information suggests that surfactants will substantially contribute to risk. This is the case for some herbicides, such as glyphosate, but this is not the case with agents used to control gypsy moth.

Comment

Summary:

Seven commenters (15, 21, 22, 24, 30, 31, 33) referred to or brought up concerns with regard to the lack of disclosure in the SEIS and to the public about the nonactive ingredients, often called inert ingredients in insecticide formulations.

Response:

The information disclosed in the risk assessments (Volumes III and IV, Appendixes F–K) and the references cited represent the scope of information and data that were available to USDA and its risk assessment contractor. The nonactive components of insecticide formulations, commonly referred to as “inert ingredients,” are confidential and proprietary information that insecticide manufacturers are not required to make public under provisions of the Federal Insecticide, Fungicide, and Rodenticide Act. These data are reviewed, however, by the U.S. EPA during the pesticide registration process to ensure that the nonactive ingredients do not pose a risk to human health and the environment. The insecticide manufacturers provided some information about nonactive ingredients for the human health risk assessments. What is known and what can be said about the nonactive ingredients is discussed in the risk assessments (Volumes III and IV, Appendixes F–K).

x. Public Notification

(7, 16, 17, 21, 24, 30)

Comment

Summary:

A number of commenters (7, 16, 17, 21, 24, 30) addressed the public notification procedures. Their comments included these: little is said about how notification is to be implemented; the advanced warning system does not work; unaware of spraying on a Sunday; last minute notification; notification of spraying occurs but then the treatment is postponed because of weather; people living far from a treatment block are not notified; how would visitors to an area know about the spraying; how would the homeless be notified; and request a toll-free phone number to call for information.

Response:
Developing procedures for notifying the public of pending gypsy moth treatments is strongly encouraged by the Forest Service and APHIS. Gypsy moth managers develop project level procedures in consultation with State and local officials and the public as to the scope of that notification and how it will be accomplished. It is likely to vary from project to project and place to place, based upon the local issues and concerns identified during the project planning process. Some level of public notification of planned treatments is given on all projects; however, that notification might be as simple as an announcement in the newspaper days or weeks ahead of the planned treatments or a toll-free number for people to call, to development of specific procedures for notifying community officials and others the day before treatments are planned. Web-based applications in which people can find their location in relation to planned gypsy moth treatments and then access information about when that area will be treated and with what insecticide are being examined and over time will likely become part of the gypsy moth management program in States. While the Forest Service and APHIS do not prescribe specific public notification procedures, the agencies do strongly support the importance of soliciting public input on proposed projects and developing workable public notification procedures for pending treatments. The section on Public Involvement and Notification in this SEIS (Appendix B, Section B.4) presents additional information on general public involvement and notification procedures.

y. Err on Side of Caution (17, 21, 25, 31)

Comment
Summary:
Several commenters said they agree with the U.S. EPA statement that a “no risk” situation does not exist. One commenter maintained that the Forest Service and APHIS should err on the side of risk-avoidance when human health is jeopardized by toxins sprayed in the air.

Response:
The risk assessments were not prepared by the U.S. EPA; they were prepared for the Forest Service and APHIS by a private risk assessment firm under contract. With regard to comments on “risk avoidance” the commenters appear to be quoting Burges from the *B.t.k.* Risk Assessment (Volume III, Appendix F, Section 3.4.3, p. 3-30). The complete quotation goes on to state: “Registration of a chemical is essentially a statement of usage in which the risks are acceptable. The same must apply to biological agents.” In other words, the U.S. EPA registration of a pesticide indicates that the agency has reviewed the toxicology and environmental data on that material and has determined that the risks to people and the environment are acceptable when used according to the instructions on the pesticide label.

The risk assessments that were prepared for the Forest Service and APHIS for this SEIS represent an independent review of the available toxicological and environmental data on the treatments proposed for use in the USDA National Gypsy Moth Management Program. The risk assessments thoroughly examined the body of available literature on the insecticides, identified potential hazards of these products, and quantified any plausible risks to people associated with how these products would be used in gypsy moth projects. The Forest Service and APHIS have concluded that the risks are minimal and within the range of acceptable risk, for the use of the treatment options. For more information on how exposure can be avoided, readers are referred to the comment responses under populated areas in comment category o, Mitigation Measures.

Comment

Summary:

Several commenters (17, 21, 25, 31) recommended the use of the precautionary principle, and asked that USDA refrain from making determinations about pesticides when there is inadequate information for making a reliable decision.

Response:

In residential applications, members of the general public are likely to be exposed to the treatment material, and pesticide exposure can be a concern. This SEIS has identified risk levels and segments of the population who may have special sensitivities to the pesticide materials. USDA takes these concerns seriously. Areas proposed for treatment and the potential exposure of sensitive individuals are evaluated at the local level before any official decision is made to apply an insecticide to treat gypsy moth. Public involvement early in the project planning process, to identify local issues and concerns, is required by USDA. Notifying the public of pending treatments is also strongly encouraged. Measures to minimize risks and adverse impacts are taken when necessary, and alternatives to insecticide application are evaluated. See also the response to comment category x, Public Notification.

z. Program Questions (17, 22)

Comment

Summary:

Two commenters (17, 22) had questions about the current gypsy moth control program. One commenter asked about the frequency of gypsy moth outbreaks that could result in dermal irritation to people from caterpillar hairs (22). Another commenter asked several questions pertaining to the history of the USDA National Gypsy Moth Management Program, the process for making treatment decisions and informing the public, names of physicians and toxicologists used by USDA to inform the gypsy moth control program, and job descriptions and salaries of each person working in the gypsy moth control program (17).

Response:

The gypsy moth is a permanent resident of all or parts of 19 states and the District of Columbia. The insect has the ability to rapidly increase its population and exhibits episodic outbreaks that cause extensive defoliation. Outbreaks of gypsy moth often occur annually somewhere within its range in the United States. There is always the potential for people to come into contact with the insect, increasing the risk of dermal irritation (dermatitis) in some individuals. The timing and location of these outbreaks are difficult to predict but are directly influenced by environmental conditions (i.e., weather) at the time of egg hatch and larval development (spring), and the presence of natural control agents (parasitoids, virus, fungi).

With regard to questions about the gypsy moth program in general, readers are directed to Appendix B, which presents detailed information about the Gypsy Moth Management Program, including how the public is involved and how notification of pending treatments occurs (Appendix B, Section B.4). Readers are also referred to Appendix E, which provides much detail on the biology of gypsy moth and the history of control programs.

The Forest Service and APHIS and State partners employ a wide variety of highly trained and skilled professional and support personnel to plan and carry out gypsy moth projects. The staff may include entomologists, foresters, biologists, toxicologists, communication specialists, and technicians, and contracting, personnel, and purchasing specialists. Salaries cover a range from junior, “journeyman,” and senior level positions. Often local employees (county, municipal, and township) have a major role in the planning and implementation of gypsy moth projects.

A source of information on job descriptions and salary levels is the U.S. Office of Personnel Management (Web site http://www.opm.gov/, telephone 202–606–1800). Jobs, with descriptions and salaries, can be searched by area of specialty and by agency at the Federal jobs Web site: http://www.usajobs.gov/.

aa. Organic Farmers (34)

Comment

Summary:

One commenter (34) was concerned that the rights of organic growers were not adequately addressed in the draft SEIS and specifically identified this as a concern about the environmental assessment prepared for the 2003 Lincoln County, OR, gypsy moth treatment project.

Response:

The decision of which treatments to use in each treatment project is a local decision made after considering issues and concerns and input from the public. If concerns are raised by organic farmers, commercial growers, home gardeners, and others, those concerns will be considered in that decision process (Chapter 2, Section 2.5). Where necessary, mitigating measures can be implemented to help minimize the chances of unintended insecticide exposure of particular areas. The USDA and its partners are concerned about the costs to organic growers, should their organic certification be put at potential risk as a result of the treatments planned in nearby gypsy moth projects. One way to address the concerns of organic farmers and others about the potential exposure of their crops to insecticide residues is for gypsy moth project managers to use the organic formulation of *B.t.k.* in treatment areas. Since 2007 an organic formulation of *B.t.k.* for forestry use has been certified by the Organic Materials Review Institute (OMRI) of Eugene, OR. The certification permits the use of this *B.t.k.* formulation on organic food crops and in food processing. OMRI is a national nonprofit organization that determines which input products are allowed for use in organic production and processing. According to their Web site (http://www.omri.org/OMRI_who.html), OMRI-listed or -approved products may be used in operations that are certified organic under the USDA National Organic Program (http://www.ams.usda.gov/AMSv1.0/nop).

bb. Executive Orders (32)

Comment

Summary:

The U.S. EPA (32) recommended that this SEIS include measures to ensure that Environmental Justice issues pursuant to Executive Order 12898 are addressed.

Response:

Gypsy moth suppression, eradication, and slow-the-spread projects take place in areas where the insect and its host trees are located. Before carrying out planned project officials are required to conduct site-specific environmental analyses, documented in accordance with the National Environmental Policy Act, to identify and address local issues and concerns, including those related to Environmental Justice and other federally and state mandated requirements (e.g., threatened and endangered species consultations). It is through this required site-specific environmental analyses process that all applicable Executive Orders (including that on environmental justice) and all other Federal and State required consultations are conducted and documented.

cc. Acknowledgment of Receiving Document (3, 13)

Comment

Summary:

Two commenters (3, 13) submitted letters simply acknowledging receipt of the draft SEIS and expressing thanks for sending the document.

Response:
No response required.

dd. Editorial Changes (8, 11, 17, 20, 21, 22, 25, 32)

Comment
Summary:
One commenter (8) objected to the use of the term "worst case" in Appendix J (Volume IV), because they thought it conveyed an incorrect message, and suggested instead referring to the worst case as being the "cumulative usage of the highest dosage and shortest interval between treatments. " Another commenter (11) pointed out an error in one of the numerical section headings in Appendix F (Volume III).

Response:
The Tebufenozide Risk Assessment (Volume IV, Appendix J) is a stand-alone document prepared by a risk assessment contractor. The contractor's use of the words "worst case" represents a common concept in risk assessments. As used in Appendix J "worst case" refers to the potential exposure resulting from the maximum application rate permitted by the U.S. EPA. Eliminating the words "worst case" would not change the risk assessment process or the risk outputs for the various treatments. Project managers who are planning gypsy moth projects must familiarize themselves with the risk assessment terminology, assumptions, and outputs, so that they can clearly explain to the public the risks associated with the treatments proposed in gypsy moth projects.

The *B.t.k.* Risk Assessment (Volume III, Appendix F) did have an error; the numerical section heading 3.2.5 should have been 3.2.2. That correction has been made in this final SEIS.

Comment
Summary:
Commenter 11 suggested that Table 2-3 in Chapter 2 be included in the Summary (Volume I).

Response:
The table has been added to the Summary in this Final SEIS.

Comment
Summary:
One commenter (11) suggested that a second table be added to Appendix D, to show plant species by susceptibility index.

Response:
No changes were made to the Plant List in Appendix D. The existing table already contains the susceptibility index for each plant species.

Comment
Summary:
One commenter (20) provided information to update the Mailing List (Chapter 6).

Response:
The Mailing List has been updated for this final SEIS.

Comment
Summary:
One commenter (32) stated that Table 1 (Volume I, Summary) should specify the species from which the most sensitive end point was used for hazard quotient calculations. The commenter also noted that Table 1 did not address potential effects on nontarget Lepidopterans and non-Lepidopteran insects.

Response:
The purpose of Table 1 is to summarize the comparative hazard quotients (HQs) for the effects of gypsy moth treatments on human health and nontarget organisms. The purpose was not to give detailed information on potential effects on specific organisms;

however, where one species was used to calculate an HQ, the species is identified. For example, for nontarget aquatic species, Daphnia are listed in Table 1. When a single species is not referenced in Table 1, then a number of species were used in the calculation of the hazard quotient. Table 1 is a one-page summary of seven comprehensive risk assessments. It is intended to provide a broad overview only. A summary of potential effects on nontarget Lepidopterans can be found in Effects of Treatments (Volume I, Section 8). More detailed information on these potential effects on specific species can be found in Chapter 4, Environmental Consequences. Much more specific information including the endpoints used for HQ calculations is presented in the seven individual risk assessments and the Risk Comparison (Volumes III and IV, Appendixes F–M).

Comment

Summary:

One commenter (22) stated that references needed to be double-checked. Swandeners (1994) and Van Nettens (2000) are in the *B.t.k.* Risk Assessment (Volume III, Appendix F) but are not in the List of Studies Consulted.

Response:

The commenter's reference to "Swandeners 1994" [sic] appears to be referring to several citations of the Swadener (1994) paper. This reference was inadvertently omitted from the *B.t.k.* Risk Assessment (Volume III, Appendix F). The following reference should have been included:

> Swadener, C. 1994. *Bacillus thuringiensis* (*B.t.*). Journal of Pesticide Reform 14(3): 13–20.

Van Netten (2000) is not cited in the *B.t.k.* Risk Assessment (Volume III, Appendix F). Van Netten and others (2000) (emphasis added) is cited in Section 3.1.15, and the citation is included in the List of Studies Consulted on page 5-34. A line space is missing before the citation causing it to blend with the previous citation.

Comment

Summary:

Several commenters expressed concern about the general impacts of pesticides, and called for the banning of pesticides, toxic sprays, and chemical interventions (17, 21, 25).

Response:

No response was necessary. The comments were very broad in nature and well beyond the specific treatments for gypsy moth described in this final SEIS for which public comments were sought.

Appendix D
Plant List

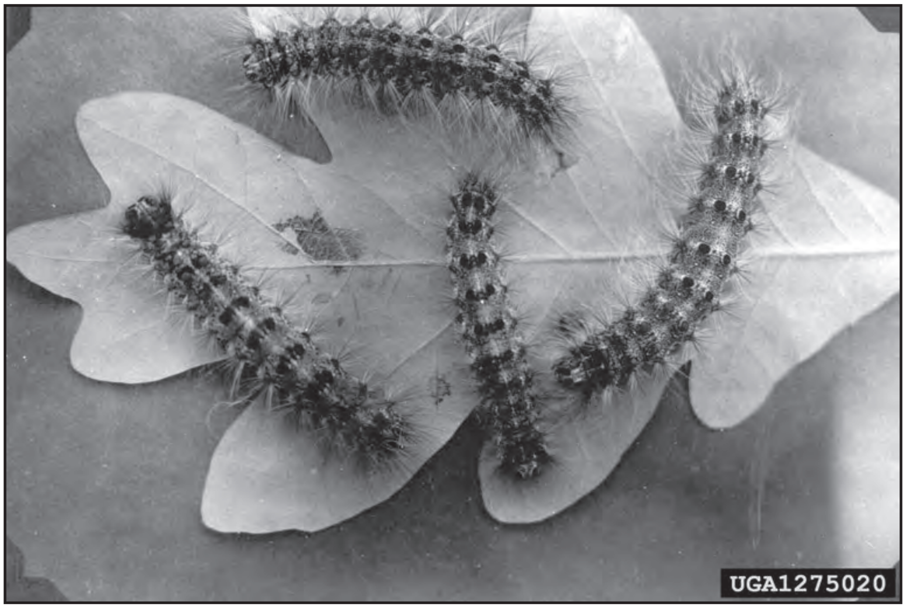


Figure D-1. White oak is one of the gypsy moth caterpillar's preferred foods.

Appendix D Plant List

Figure

This appendix lists the susceptibility of plant species to feeding by gypsy moth caterpillars (Liebhold and others 1995). The susceptibility index, based on preference and weight gain of both European and Asian strains of the gypsy moth, takes into account preference variances between strains. The index numbers provide a general ranking:

1 – Susceptible (these are plants the gypsy moth prefers to eat)

2 – Resistant (although not preferred by the gypsy moth, it will eat these plants)

3 – Immune (these species of plants are not eaten under any circumstances)

The index terms, suggested by Montgomery (1991), indicate the likelihood of plant defoliation. Plant names were selected from several sources (Dirr 1990, Little 1979, Rehder 1951, Taylor 1961, Van Dersal 1938, Viertel 1970).

Genus and species	**Common name**	**Susceptibility index**
Abelia grandiflora	glossy abelia	3
Abies amabilis	Pacific silver fir; silver fir; lovely fir; amabilis fir	2
Abies balsamea	balsam fir; Canada balsam; eastern fir	3
Abies balsamea var. *phanerolepis*	balsam fir; bracted balsam fir	3
Abies bifolia	Rocky Mountain subalpine fir	3
Abies bracteata	bristlecone fir; Santa Lucia fir; silver fir	2
Abies chinensis var. *grandiflora*	Glossy abelia	3
Abies concolor	white fir; concolor fir; silver fir	2
Abies fraseri	Fraser fir; southern balsam fir; southern fir	3
Abies grandis	grand fir; lowland white fir; lowland fir; balsam fir	2
Abies holophylla	needle fir; Manchurian fir	2
Abies lasiocarpa	subalpine fir; alpine fir; balsam fir; white balsam fir; Rocky Mountain fir	2
Abies lasiocarpa var. *arizonica*	corkbark fir	2
Abies lowiana	California white fir; white fir; Sierra white fir	2
Abies magnifica	California red fir; red fir; silvertip; golden fir	2
Abies procera	noble fir; red fir; white fir	2
Acacia baileyana	Bailey acacia; cootamundra wattel	2
Acacia farnesiana	huisache; sweet acacia; Texas huisache; cassie	2
Acacia greggii	Gregg catclaw; catclaw acacia; Texas catclaw; devilsclaw; long-flowered catclaw	2

Genus and species	Common name	Susceptibility index
Acacia longifolia	golden wattle; Sydney golden wattle	2
Acacia spp.	acacia	2
Acacia tortuosa	huisachillo; catclaw; twisted acacia; Rio Grande acacia	2
Acacia wrightii	Wright catclaw; Texas catclaw; Wright acacia	2
Acer barbatum	Florida maple; sugar maple; hammock maple	2
Acer campestre	hedge maple; English field maple	2
Acer circinatum	vine maple	2
Acer dasycarpum	silver maple; cut-leaf maple	2
Acer ginnala	amur maple	3
Acer glabrum	Rocky Mountain maple; dwarf maple; mountain maple; Sierra maple	2
Acer grandidentatum	canyon maple; bigtooth maple; sugar maple; Uvalde bigtooth maple	2
Acer japonicum	fullmoon maple	2
Acer leucoderme	chalk maple; white-bark maple	2
Acer macrophyllum	bigleaf maple; Oregon maple; broadleaf maple	2
Acer negundo	boxelder; ash-leaved maple; boxelder maple; Manitoba maple	2
Acer nigrum	black maple; black sugar maple; hard maple; rock maple	2
Acer palmatum	Japanese maple	2
Acer pensylvanicum	striped maple; moosewood	3
Acer platanoides	Norway maple	2
Acer pseudoplatanus	planetree maple; sycamore maple	2
Acer rubrum	red maple; scarlet maple; swamp maple; soft maple	2
Acer saccharinum	silver maple; soft maple; river maple; silverleaf maple	3
Acer saccharum	sugar maple; hard maple; rock maple	2
Acer spiatum	mountain maple; moose maple	3
Acer tartaricum	tartarian maple; Tartar maple	2
Achras emarginata	wild-dilly	2
Acoelorrhaphe wrightii	paurotis palm	3
Adonica merrillii	Manila palm	3
Aesculus californica	California buckeye	3
Aesculus glabra	Ohio buckeye; fetid buckeye; stinking buckeye; American horsechestnut	2

Genus and species	Common name	Susceptibility index
Aesculus hippocastanum	horsechestnut; common horsechestnut	3
Aesculus octandra	yellow buckeye; sweet buckeye; big buckeye	3
Aesculus sylvatica	painted buckeye; dwarf buckeye; Georgia buckeye	2
Ailanthus altissima	ailanthus; tree of heaven; Chinese tree-of-heaven; copaltree	2
Albizia julibrissin	silktree; mimosa; mimosa-tree; powderpuff-tree	3
Aleurites fordii	tung-oil-tree; tungtree	2
Alnus maritima	seaside alder	1
Alnus oblongifolia	Arizona alder; Mexican alder; New Mexican alder	1
Alnus rhombifolia	white alder; Sierra alder	2
Alnus rubra	red alder, Oregon alder, western alder, Pacific Coast alder	1
Alnus rugosa	speckled alder; smooth alder; tag alder; gray alder; hoary alder; hazel alder	1
Alnus serrulata	hazel alder; smooth alder; common alder; tag alder; black alder	2
Alnus sinuata	Sitka alder; mountain alder, wavyleaf alder	2
Alnus tenuifolia	mountain alder; thinleaf alder; river alder	1
Alvaradoa amorphoides	Mexican alvaradoa	2
Amelanchier alnifolia	western serviceberry; saskatoon serviceberry; serviceberry; juneberry; western shadbush	2
Amelanchier arborea	downy serviceberry; Allegheny serviceberry; shadblow; apple shadbush	2
Amelanchier canadensis	thicket serviceberry; oblongleaf juneberry	2
Amelanchier laevis	Allegheny serviceberry; downy serviceberry; smooth serviceberry	2
Amelanchier spp.	serviceberry	2
Amphitecna latifolia	black calabash	3
Amyris elemifera	torchwood; candlewood; sea amyris	2
Annona glabra	pond-apple; alligator-apple	2
Aralia spinosa	devils-walkingstick; Hercules-club; prickly-ash; angelica-tree	3
Arbutus arizonica	Arizona madrone; madrona; Arizona madrono	2
Arbutus menziesii	Pacific madrone; madrone; madrona	1
Arbutus texana	Texas madrone; madrona	2

Genus and species	Common name	Susceptibility index
Arbutus unedo	strawberry madrone; strawberrytree	2
Ardisia escallonioides	marlberry; marbleberry	2
Ardisia japonica	Japanese ardisia; marlberry	3
Arecastrum romanzoffianum	queen palm	3
Asimina triloba	pawpaw; common pawpaw; pawpaw apple; false-banana	2
Avicennia nitida	black-mangrove; blackwood	2
Betula alba	European white birch; white-barked canoe birch; cut-leaved birch	2
Betula alleghaniensis	yellow birch; gray birch; silver birch; swamp birch	3
Betula caerulea	blueleaf birch	1
Betula eastwoodiae	Yukon birch	1
Betula lenta	sweet birch; black birch; cherry birch	2
Betula nigra	river birch; red birch; black birch; water birch	1
Betula occidentalis	water birch; red birch; black birch; spring birch; paper birch	2
Betula papyrifera	paper birch; canoe birch; white birch; silver birch	1
Betula pendula	European birch; European white birch; cut-leaf weeping birch; blueleaf birch	1
Betula populifolia	gray birch; grey birch; white birch; wire birch; fire birch; oldfield birch	1
Betula pumila	swamp birch; bog birch	1
Betula verrucosa	European white birch	1
Bourreria ovata	Bahama strongback; Bahama strongbark; strongback	3
Broussonetia papyrifera	paper mulberry; common paper mulberry	3
Bumelia lanuginosa	gum bumelia; woolly buckthorn; chittamwood; swiftwig-gum; gum elastic; buckthorn	2
Bursera simaruba	gumbo-limbo; West-Indian-birch; gum-elemi	2
Callitris glaucophylla	white cypress-pine	3
Calocedrus decurrens	incense-cedar	3
Calycanthus floridus	common sweetshrub; Carolina allspice; hairy (Caroline) allspice	3
Calyptranthes pallens	pale lidflower; spicewood; white spicewood	2
Calyptranthes zuzygium	myrtle-of-the-river, spicewood	2
Canella winterana	canella; cinnamonbark; wild-cinnamon	2

Genus and species	Common name	Susceptibility index
Canotia holacantha	canotia; Mohave thorn; crucifixion-thorn	2
Capparis cynophallophora	Jamaica caper; capertree; Jamaica capertree	2
Caragana arborescens	peatree; peashrub; Siberian peashrub; Siberian pea tree	2
Carica papaya	papaya; pawpaw	2
Carpinus caroliniana	American hornbean	2
Carya aquatica	water hickory; bitter pecan; swamp hickory; bitter water hickory	2
Carya cordiformis	bitternut hickory; bitternut; swamp hickory; pignut; pignut hickory	2
Carya floridana	scrub hickory; Florida hickory	2
Carya glabra	pignut hickory; pignut	2
Carya illinoensis	pecan; sweet pecan	2
Carya laciniosa	shellbark hickory; big shellbark hickory; king nut hickory; big shagbark hickory	2
Carya leiodermis	pignut hickory; swamp hickory	2
Carya myristiciformis	nutmeg hickory; swamp hickory; bitter water hickory	2
Carya ovalis	red hickory; small pignut; sweet pignut	2
Carya ovata	shagbark hickory; shellbark hickory; upland hickory; scalybark hickory	3
Carya pallida	sand hickory; pignut hickory; pale hickory; pallid hickory	2
Carya spp.	hickory	2
Carya texana	black hickory; bitter pecan; Buckley hickory; pignut hickory	2
Carya tomentosa	mockernut hickory; mockernut; white hickory; whiteheart hickory	2
Caryota urens	toddy palm; white palm; fishtail palm; wine palm	3
Castanea dentata	American chestnut; chestnut	2
Castanea ozarkensis	Ozark chinkapin; Ozark chestnut	2
Castanea pumila	Allegheny chinkapin	2
Castanopsis chrysophylla	giant chinkapin; golden chinkapin; giant evergreen chinkapin	1
Casuarina equisetifolia	horsetail casuarina; beefwood; Australian pine; horsetail-tree	2
Casuarina stricta	coast beefwood	2
Catalpa bignonioides	southern catalpa; common catalpa; catawba; Indian-bean; cigartree	3

Genus and species	Common name	Susceptibility index
Catalpa speciosa	northern catalpa; hardy catalpa; western catalpa; catawba	3
Catalpa spp.	catalpa; hardy catalpa	3
Ceanothus arboreus	feltleaf ceanothus; island myrtle; Catalina ceanothus	3
Ceanothus integerrimus	deer brush	3
Ceanothus maritimus	ceanotus	2
Ceanothus spp.	ceanothus	3
Ceanothus thysiflorus	blueblossom; blue-myrtle; blue-brush; blueblossom ceanothus	3
Cedrus atlantica	atlas cedar	2
Cedrus deodara	deodar cedar	2
Cedrus libani	Cedar of Lebanon	2
Celtis laevigata	sugarberry; southern hackberry; Mississippi hackberry; Texas sugarberry	3
Celtis occidentalis	hackberry; northern hackberry; sugarberry; nettletree	3
Celtis tenuifolia	Georgia hackberry; dwarf hackberry; upland hackberry	3
Cephalanthus occidentalis	buttonbush; buttonball bush; honey-balls; globeflowers	2
Cercidium floridum	blue paloverde; Texas paloverde; paloverde	2
Cercidium microphyllum	yellow paloverde; littleleaf hornbeam; foothill paloverde; littleleaf paloverde	2
Cercis canadensis	eastern redbud; redbud; Judas tree	3
Cercis occidentalis	California redbud; western redbud; Arizona redbud	3
Cercocarpus betuloides	birchleaf cercocarpus; birchleaf mountain-mahogany; alderleaf cercocarpus	2
Cercocarpus breviflorus	hairy cercocarpus; Wright mountain-mahogany; hairy mountain-mahogany	2
Cercocarpus intricatus	little leaf mountain-mahogany	2
Cercocarpus ledifolius	curlleaf cercocarpus; mountain-mahogany; curlleaf mountain-mahogany	2
Cercocarpus montanus	alderleaf cercocarpus; alderleaf mountain-mahogany; mountain-mahogany; true mountain-mahogany	2
Cereus giganteus	saguaro; giant cactus; pitahaya	2
Chamaecyparis lawsoniana	Port-Orford-cedar; Port-Orford white-cedar; Oregon-cedar; Lawson cypress	3
Chamaecyparis nootkatensis	Alaska-cedar; Nootka cypress; Alaska yellow-cedar; Sitka cypress	3

Genus and species	Common name	Susceptibility index
Chamaecyparis thyoides	Atlantic white-cedar; Atlantic cedar; white-cedar; southern white-cedar	3
Chilopsis linearis	desert-willow; desert catalpa	3
Chionanthus virginicus	fringetree; fringe tree; old-mans-beard	2
Chrysobalus icaco	cocoplum	2
Chrysophyllum oliviforme	satinleaf	2
Cinnamonum camphora	camphor-tree	1
Citharexylum fruticosum	fiddlewood; Florida fiddlewood	2
Citrus aurantifolia	lime; key lime	2
Citrus limon	lemon	3
Citrus sinensis	orange; navel orange; sweet orange	2
Cladrastis lutea	yellow-wood	2
Clethra alnifolia	sweet pepperbush; summersweet clethra	3
Clethra spp.	clethra; pepperbush	3
Cliftonia monophylla	buckwheat-tree; titi; black titi	2
Coccoloba diversifolia	pigeon-plum; doveplum; tie-tongue	2
Coccoloba uvifera	seagrape; grape-tree	2
Coccothrinax argentata	Florida silverpalm; Biscayne-palm; brittle thatch; thatchpalm	3
Cocos nucifera	coconut; coconut palm	3
Colubrina reclinata	soldierwood	2
Conocarpus erectus	button-mangrove; buttonwood; silver buttonwood	2
Cordia sebestena	geiger-tree	3
Cornus alternifolia	alternate-leaf dogwood; blue cornel	3
Cornus drummondii	roughleaf dogwood	3
Cornus florida	flowering dogwood; dogwood; cornel; boxwood	2
Cornus nuttallii	Pacific dogwood; flowering dogwood; mountain dogwood	3
Cornus racemosa	gray dogwood	3
Cornus rugosa	roundleaf dogwood; roundleafed cornel	3
Cornus spp.	dogwood; cornel	3
Cornus stolonifera	red-osier dogwood; American dogwood; redstem dogwood; kinnikinnik	3
Corylus americana	American hazelnut; American filbert; wild hazelnut	1

Genus and species	Common name	Susceptibility index
Corylus avellana	European hazelnut; European filbert	1
Corylus avena		1
Corylus cornuta	beaked hazelnut; beaked filbert; western hazelnut	2
Corylus rostrata	beaked hazelnut	1
Cotinus obovatus	American smoketree; smoketree; chittamwood; yellowwood	1
Cotoneaster pyracantha	firethorn; everlasting thorn	1
Cowania mexicana	cliffrose; Stansbury cliffrose; quininebush	2
Crataegus berberifolia	barberry hawthorn; bigtree hawthorn; barberryleaf hawthorn	1
Crataegus boyntonii	Biltmore hawthorn; Boynton hawthorn	1
Crataegus brachycantha	blueberry hawthorn; blue haw; pommette blue	1
Crataegus coccinea	scarlet hawthorn; scarlet haw	1
Crataegus crus-galli	cockspur hawthorn; hog-apple; cockspur-thorn; Newcastle thorn	1
Crataegus douglasii	black hawthorn; Douglas hawthorn; river hawthorn	1
Crataegus induta	downy hawthorn; turkey hawthorn	1
Crataegus intricata	Biltmore hawthorne	1
Crataegus marshallii	parsley hawthorn; parsley-leaf hawthorn	1
Crataegus mollis	downy hawthorn	1
Crataegus monogyna	oneseed hawthorn; singleseed hawthorn; English hawthorn; European hawthorn	2
Crataegus opaca	riverflat hawthorn; English hawthorn; May hawthorn; May haw; apple haw	1
Crataegus oxyacantha	English hawthorn	1
Crataegus pedicellata	scarlet hawthorn	1
Crataegus pruinosa	frosted hawthorn; waxy-fruit thorn	1
Crataegus pyracantha	firethorn; white thorn	1
Crataegus saligna	willow hawthorn	1
Crataegus spathulata	littlehip hawthorn; small-fruit hawthorn; pasture hawthorn	1
Crataegus spp.	hawthorn	1
Cunninghamia lanceolata	China fir; blue Chinese fir	3
Cupressocyparis leylandii	Leyland cypress	3
Cupressus arizonica	Arizona cypress	3

Genus and species	Common name	Susceptibility index
Cupressus bakeri	Baker cypress; Siskiyou cypress; Modoc or MacNab cypress	3
Cupressus goveniana	Gowen cypress	3
Cupressus guadalupensis	Guadalupe cypress; Forbes' cypress; Tecate cypress	3
Cupressus macrocarpa	Monterey cypress	3
Cupressus sargentii	Sargent cypress	3
Cydonia japonica	common flowering quince; dwarf Japanese quince; Japan quince	2
Cydonia vulgaris	quince	2
Cyrilla racemiflora	swamp cyrilla; swamp ironwood; leatherwood	2
Dalea spinosa	smokethorn; smoketree; indigobush	2
Diospyros texana	Texas persimmon; black persimmon; Mexican persimmon	3
Diospyros virginiana	persimmon; common persimmon; eastern persimmon; possumwood	3
Dipholis salicifolia	willow bustic; bustic; willow-leaf bustic; cassada	2
Drypetes lateriflora	Guiana-plum	3
Elaeagnus angustifolia	Russian-olive; oleaster	3
Elaeagnus hortensis	oleaster	2
Elliottia racemosa	elliottia; southern plume	2
Enallagma latifolia	black-calabash	3
Eriobotrya japonica	loquat; loquat tree	2
Erythrina herbacea	southeastern coralbean; eastern coralbean; Cherokee-bean	2
Ethretia anacua	anaqua	3
Eucalyptus botryiodes	bastard mahogany; bangalay	2
Eucalyptus camaldulensis	longbeak eucalyptus; camal eucalyptus; redgum	2
Eucalyptus camphora	eucalyptus	3
Eucalyptus cinerea	silver dollar eucalyptus	1
Eucalyptus diversifolia	eucalyptus	3
Eucalyptus globulus	bluegum eucalyptus; Tasmanian bluegum; bluegum	2
Eucalyptus gunnii	cider gumtree	1
Eucalyptus leucoxylon	white ironbark	2
Eucalyptus polyanthemos	redbox eucalyptus; redbox-gum; Australian beech; silver dollar gum	2

Genus and species	Common name	Susceptibility index
Eucalyptus pulchella	white peppermint	2
Eucalyptus rudis	desert gum	2
Eucalyptus sideroxylon	red ironbark	2
Eucalyptus spp.	eucalyptus; gum-tree	2
Eucalyptus tereticornis	horncap eucalyptus	2
Euonymus atropurpureus	eastern burningbush; burningbush; eastern wahoo; strawberry-bush	2
Euonymus europaeus	European spindletree; European enonymus	2
Euonymus japonicus	Japanese euonymus; evergreen euonymus	2
Euonymus occidentalis	western burningbush; wahoo; western wahoo	2
Euonymus verrucosa	spindle tree	2
Exostema caribaeum	princewood; Caribbean princewood	2
Exothea paniculata	inkwood; butterbough	2
Fagus grandifolia	American beech; beech	2
Fagus sylvatica	European beech	2
Fatsia japonica	Japanese fatsia; Japanese aralia	3
Ficus aurea	Florida strangler fig; golden fig; strangler fig; wild fig	2
Ficus benjamina	Java fig; Java willow; Benjamin fig	3
Ficus carica	fig; common fig	2
Ficus elastica	India-rubber fig; rubber plant; India rubber tree	2
Ficus lyrata	fiddle-leaf fig	2
Firmiana platanifolia	Chinese parasoltree	2
Forestiera acuminata	swamp-privet; forestiera; common adelia; whitewood	3
Fraxinus americana	white ash; Biltmore ash; Biltmore white ash	3
Fraxinus anomala	singleleaf ash; dwarf ash	3
Fraxinus caroliniana	Carolina ash; water ash; Florida ash; pop ash; swamp ash	3
Fraxinus cuspidata	fragrant ash; flowering ash	3
Fraxinus excelsior	European ash	2
Fraxinus greggii	Gregg ash; littleleaf ash; dogleg ash	3
Fraxinus latifolia	Oregon ash	3
Fraxinus nigra	black ash; swamp ash; basket ash; brown ash; hoop ash; water ash	3
Fraxinus pennsylvanica	green ash; red ash; Darlington ash; white ash; swamp ash; water ash	3

Genus and species	**Common name**	**Susceptibility index**
Fraxinus profunda	pumpkin ash; red ash	3
Fraxinus quadrangulata	blue ash	3
Fraxinus spp.	ash	3
Fraxinus texensis	Texas ash	3
Fraxinus velutina	velvet ash; Arizona ash; desert ash; Modesto ash; leatherleaf ash; smooth ash; Toumey ash	3
Garrya fremontii	Fremont silktassel; silk-tassel	3
Gaultheria shallon	salal; shallon	2
Ginkgo biloba	ginkgo; maidenhair tree	3
Gleditsia aquatica	waterlocust	3
Gleditsia texana	honeylocust; Texas honeylocust	3
Gleditsia triacanthos	honeylocust; sweet-locust; thorny-locust	3
Gordonia lasianthus	loblolly-bay; tan bay; gordonia; bay; holly-bay	2
Grevillea 'noellii'	grevillea	3
Grevillea robusta	silk-oak; silky oak	3
Guaiacum sanctum	roughbark lignumvitae; holywood lignumvitae; lignumvitae	2
Guettarda elliptica	elliptic-leaf velvetseed; Everglades velvetseed; velvetseed	2
Guettarda scabra	roughleaf velvetseed	2
Gyminda latifolia	falsebox; false boxwood; West Indies falsebox	2
Gymnanthes lucida	oysterwood; crabwood	3
Gymnocladus dioicus	Kentucky coffeetree; coffeetree	3
Hakea spp.		2
Halesia carolina	Carolina silverbell; silver bell; snowdrop-tree; opossum-wood	3
Hamamelis virginiana	witch-hazel; common witch-hazel; southern witch-hazel	1
Heteromeles arbutifolia	toyon; Christmas berry; California-holly; hollyberry	2
Hibiscus rosa-sinensis	Chinese hibiscus	2
Hibiscus tiliaceus	sea hibiscus; mahoe; tree hibiscus	2
Hippomane mancinella	manchineel	3
Ilex aquifolium	English holly	3
Ilex cassine	dahoon; dahoon holly; Alabama dahoon; Christmas-berry	3
Ilex coriacea	large gallberry; tall inkberry; gallberry; bay-gallbush	3
Ilex decidua	possumhaw; deciduous holly; winterberry	3
Ilex glabra	inkberry; gallberry	3

Genus and species	Common name	Susceptibility index
Ilex krugiana	tawnyberry holly; Krug holly; southern holly	3
Ilex montana	mountain winterberry; mountain holly	3
Ilex opaca	American holly; holly; white holly	3
Ilex verticillata	common winterberry; black-alder; winterberry	3
Jasminum nudiflorum	winter jasmine	3
Juglans californica	southern California walnut; California walnut; California black walnut	2
Juglans cinerea	butternut; white walnut; oilnut	2
Juglans hindsii	northern California walnut; Hinds walnut; California black walnut	2
Juglans major	Arizona walnut; Arizona black walnut	2
Juglans microcarpa	little walnut; Texas walnut; Texas black walnut; river walnut	2
Juglans nigra	black walnut; eastern black walnut; American walnut	2
Juniperus ashei	Ashe juniper; mountain-cedar; rock-cedar; post-cedar; Mexican juniper	3
Juniperus californica	California juniper	3
Juniperus coahuilensis	redberry juniper; roseberry	3
Juniperus communis	common juniper; dwarf juniper; prostrate juniper	3
Juniperus deppeana	alligator juniper; checker-bark juniper; western juniper	3
Juniperus erythrocarpa	redberry juniper; red-fruited juniper	3
Juniperus flaccida	drooping juniper; weeping juniper; Mexican drooping juniper	3
Juniperus monosperma	oneseed juniper; cherrystone juniper; West Texas juniper	3
Juniperus occidentalis	western juniper, Sierra juniper	3
Juniperus osteosperma	Utah juniper; bigberry juniper	3
Juniperus pinchotii	Pinchot juniper; redberry juniper	3
Juniperus scopulorum	Rocky Mountain juniper; Rocky Mountain cedar; redcedar; Colorado redcedar	3
Juniperus silicicola	southern redcedar; redcedar; sand-cedar; coast juniper	3
Juniperus virginiana	eastern redcedar; redcedar; red juniper; savin	3
Krugiodendron ferreum	leadwood; black-ironwood	2
Laguncularia racemosa	white-mangrove; white buttonwood; buttonwood	2
Larix decidua	European larch	1
Larix laricina	tamarack; eastern larch; American larch; Alaska larch; hackmatack	1

Genus and species	Common name	Susceptibility index
Larix lyallii	subalpine larch; alpine larch; timberline larch; tamarack	1
Larix occidentalis	western larch; hackmatack; Montana larch; mountain larch	1
Leitneria floridana	corkwood	2
Lindera benzoin	spicebush	3
Liriodendron tulipifera	yellow-poplar; tuliptree; tulip-poplar; white-poplar	3
Lithocarpus densiflorus	tanoak; tan oak; tanbark-oak	1
Lyonia ferruginea	tree lyonia; staggerbush; titi; rusty lyonia	2
Lyonothamnus floribundus	Lyontree; Catalina-ironwood; lyonothamnus; Santa-Cruz-ironwood	2
Lysiloma bahamensis	Bahama lysiloma	2
Maclura pomifera	Osage-orange; bodark; bodock; bowwood; hedge-apple; horse-apple	3
Magnolia acuminata	cucumbertree; cucumber magnolia; mountain magnolia	3
Magnolia ashei	Ashe magnolia; sandhill magnolia	3
Magnolia fraseri	Fraser magnolia; mountain magnolia; earleaf cucumbertree	3
Magnolia grandiflora	southern magnolia; evergreen magnolia; bull-bay; big-laurel	3
Magnolia macrophylla	bigleaf magnolia; umbrella-tree; large-leaf cucumbertree	3
Magnolia pyramidata	pyramid magnolia; southern cucumbertree; mountain magnolia	3
Magnolia soulangeana	saucer magnolia; rustica rubra	3
Magnolia tripetala	umbrella magnolia; umbrella-tree; elkwood	3
Magnolia virginiana	sweetbay; swampbay; southern sweetbay; laurel magnolia	3
Malus angustifolia	southern crab apple; narrowleaf crab apple; wild crab apple	1
Malus coronaria	sweet crab apple; American crab apple; wild crab	1
Malus diversifolia	Oregon crab apple; Pacific crab apple; western crab apple; wild crab apple	1
Malus glabrata	sweet crab apple; Biltmore crab apple; wild crab	1
Malus ioensis	prairie crab apple; wild crab apple; Iowa crab	1
Malus spp.	apple	1
Melaleuca decussata	lilac melaleuca	1
Melaleuca quinquenervia	cajeput-tree; punktree; bottlebrush	2
Melia azedarach	chinaberry; umbrella chinaberry; chinatree; pride-of-India	2
Mespilus germanica	medlar; showy mespilus; European medlar	2

Genus and species	Common name	Susceptibility index
Metasequoia glyptostroboides	dawn redwood	2
Metopium toxiferum	Florida poisontree; poisonwood; West Indies poisontree	1
Morus alba	white mulberry; silkworm mulberry; weeping mulberry	3
Morus alba var. *tatarica*	Russian mulberry	3
Morus nigra	black mulberry	3
Morus rubra	red mulberry; moral	3
Morus tartarica	Tartarian mulberry	2
Mustichodendro foetidissimum	false mastic	2
Myrica californica	Pacific bayberry; California bayberry; Pacific waxmyrtle; western waxmyrtle; California waxmyrtle	2
Myrica cerifera	southern bayberry; southern waxmyrtle; bayberry; candleberry	2
Nyssa aquatica	water tupelo; tupelo-gum; cotton-gum; sourgum	3
Nyssa ogeche	Ogeechee tupelo; sour tupelo-gum; Ogeechee-lime; sour tupelo	3
Nyssa sylvatica	black tupelo; blackgum; sourgum; pepperidge; tupelo	3
Nyssa sylvatica var. *biflora*	swamp tupelo; blackgum; swamp blackgum	3
Olea europaea	olive; common olive	3
Olneya tesota	tesota; desert ironwood; Arizona-ironwood	2
Osmanthus americana	devilwood; wild-olive	3
Ostrya knowltonii	Knowlton hophornbeam; western hophornbeam; wolf hophornbeam	2
Ostrya virginiana	eastern hophornbeam; hophornbeam; American hophornbeam; hornbeam; leverwood	1
Oxydendrum arboreum	sourwood; sorrel-tree; lily-of-the-valley-tree	2
Parkinsonia aculeate	Jerusalem-thorn; horsebean; Mexican paloverde	2
Paulownia tomentosa	royal paulownia; empress-tree; princess-tree; paulownia	3
Paurotis wrightii	paurotis-palm; paurotis	3
Persea americana	avocado; zutano avocado; alligator-pear	2
Persea borbonia	redbay; shorebay	2
Photinia arbutifolia	toyon; Christmas berry	2

Genus and species	Common name	Susceptibility index
Photinia glabra	Japanese photinia	2
Photinia serrulata	Chinese photinia: Chinese medlar	2
Photinia spp.	toyon; photinia	3
Picea abies	Norway spruce	2
Picea breweriana	Brewer spruce; weeping spruce	2
Picea engelmannii	Engelmann spruce; Columbian spruce; mountain spruce; silver spruce; white spruce	2
Picea glauca	white spruce; skunk spruce; Canadian spruce; cat spruce	2
Picea mariana	black spruce; bog spruce; swamp spruce; shortleaf black spruce	2
Picea polita	tigertail spruce	2
Picea pungens	blue spruce; Colorado blue spruce; Colorado spruce; silver spruce	2
Picea rubens	red spruce; yellow spruce; West Virginia spruce; eastern spruce	2
Picea sitchensis	Sitka spruce; coast spruce; tideland spruce; yellow spruce	2
Picea spp.	spruce	2
Picramnia pentandra	bitterbush; Florida bitterbush	2
Pinckneya pubens	pinckneya; fevertree; Georgia-bark; fever-bark	2
Pinus albicaulis	whitebark pine; scrub pine; white pine	2
Pinus aristata	bristlecone pine; hickory pine; foxtail pine	2
Pinus attenuata	knobcone pine	2
Pinus balfouriana	foxtail pine	2
Pinus banksiana	jack pine; scrub pine; gray pine; black pine; Banksian pine	2
Pinus cembroides	Mexican pinyon; nut pine; Mexican stone pine	2
Pinus clausa	sand pine; scrub pine; spruce pine	2
Pinus contorta	lodgepole pine; shore pine; beach pine	2
Pinus coulteri	Coulter pine; bigcone pine; pitch pine	2
Pinus discolor	border pinyon	2
Pinus echinata	shortleaf pine; shortleaf yellow pine; yellow pine	2
Pinus edulis	pinyon; two-leaf pinyon; two-needle pinyon	2
Pinus elliottii	slash pine; yellow slash pine; swamp pine; pitch pine	2
Pinus engelmannii	Apache pine; Arizona longleaf pine	2
Pinus flexilis	limber pine; white pine; Rocky Mountain white pine	2

Genus and species	Common name	Susceptibility index
Pinus glabra	spruce pine; cedar pine; Walter pine; bottom white pine	2
Pinus halepensis	Aleppo pine	2
Pinus jeffreyi	Jeffrey pine; western yellow pine; bull pine; black pine; ponderosa pine	2
Pinus lambertiana	sugar pine; California sugar pine	2
Pinus leiophylla var. *chihuahuana*	Chihuahua pine; yellow pine	2
Pinus longaeva	intermountain bristlecone pine	2
Pinus monticola	western white pine; mountain white pine; Idaho white pine; silver pine	2
Pinus mugo	mugo pine; mountain pine; Swiss mountain pine	2
Pinus muricata	bishop pine; prickle-cone pine; Santa Cruz Island pine	2
Pinus nigra	Austrian pine; European black pine	2
Pinus palustris	longleaf pine; swamp pine; longleaf yellow pine; southern yellow pine	3
Pinus pinea	Italian stone pine	3
Pinus ponderosa	ponderosa pine; western yellow pine; yellow pine	2
Pinus ponderosa var. *arizonica*	Arizona pine; Arizona ponderosa pine; yellow pine	2
Pinus pungens	Table Mountain pine; mountain pine; hickory pine	2
Pinus quadrifolia	Parry pinyon; four-needle pinyon; nut pine	2
Pinus radiata	Monterey pine; insignis pine	2
Pinus resinosa	red pine; Norway pine	2
Pinus rigida	pitch pine	3
Pinus sabiniana	Digger pine; bull pine; gray pine	2
Pinus serotina	pond pine; marsh pine; pocosin pine	2
Pinus spp.	Pine	2
Pinus strobiformis	southwestern white pine; Mexican white pine; border white pine	2
Pinus strobus	eastern white pine; northern white pine; white pine	2
Pinus sylvestris	Scotch pine; Scots pine	2
Pinus taeda	loblolly pine; oldfield pine; shortleaf pine	2
Pinus thunbergiana	Japanese black pine	3

Genus and species	Common name	Susceptibility index
Pinus torreyana	Torrey pine; Del Mar pine; Soledad pine	2
Pinus virginiana	Virginia pine; Virginia scrub pine; spruce pine; Jersey pine; scrub pine; poverty pine	2
Pinus washoensis	Washoe pine	2
Piscidia piscipula	Florida fishpoison-tree; Jamaica-dogwood; Florida fishfuddletree	2
Pistacia texana	Texas pistache; American pistachio; wild pistachio	1
Pistacia vera	pistachio	1
Planera aquatica	water-elm; planertree	2
Platanus orientalis	Oriental planetree	2
Platanus racemosa	California sycamore; western sycamore; California planetree	3
Platanus wrightii	Arizona sycamore; Arizona planetree	3
Populus alba	white poplar; silver poplar	2
Populus angustifolia	narrowleaf cottonwood; black cottonwood; mountain cottonwood; narrowleaf poplar	1
Populus balsamifera	balsam poplar; balm; balm-of-Gilead; bam; tacamahac	1
Populus deltoides	eastern cottonwood; eastern poplar; southern cottonwood	2
Populus fremontii	Fremont cottonwood; cottonwood	2
Populus grandidentata	bigtooth aspen; largetoothed aspen; aspen; poplar; popple	1
Populus heterophylla	swamp cottonwood; black cottonwood; river cottonwood	1
Populus nigra var. *italica*	Lombardy poplar	1
Populus palmeri	eastern cottonwood; eastern poplar; Palmer cottonwood	1
Populus sargentii	plains cottonwood; great plains cottonwood; sargent cottonwood	1
Populus spp.	cottonwood; poplar	1
Populus tremuloides	quaking aspen; trembling aspen; golden aspen	1
Populus trichocarpa	black cottonwood; western balsam poplar; cottonwood; balsam cottonwood	1
Populus wislizenii	Rio Grande cottonwood; valley cottonwood	1
Prosopis juliflora	honeylocust; mesquite; algaroba	2
Prosopis pubescens	screwbean mesquite; screwbean	2
Prunus alleghaniensis	Allegheny plum; sloe plum; sloe; Allegheny sloe; northern sloe	2

Genus and species	Common name	Susceptibility index
Prunus americana	American plum; wild plum; red plum; river plum; yellow plum	2
Prunus angustifolia	Chickasaw plum; sand plum	2
Prunus avium	mazzard; common sweet cherry; English cherry	2
Prunus caroliniana	Carolina laurelcherry; laurel cherry; cherry-laurel	2
Prunus domestica	garden plum; plum; Damson plum	2
Prunus emarginata	bitter cherry; quinine cherry; wild cherry	2
Prunus fremontii	desert apricot	2
Prunus glandulosa	flowering almond; dwarf flowing almond; almond cherry; wild peach	2
Prunus hortulana	Hortulan plum	2
Prunus japonica	Japanese plum	2
Prunus laurocerasus	cherry laurel; English laurel	2
Prunus lyonii	Catalina cherry	2
Prunus maritima	beach plum	2
Prunus mexicana	Mexican plum; bigtree plum; inch plum	2
Prunus munsoniana	wildgoose plum; Munson plum	2
Prunus myrtifolia	West Indies cherry; myrtle laurel cherry; laurelcherry	2
Prunus nigra	Canada plum; red plum; horse plum; wild plum	2
Prunus padus	European bird-cherry; black serviceberry	2
Prunus pensylvanica	pin cherry; wild red cherry; fire cherry; northern pin cherry; pigeon cherry; bird cherry	3
Prunus persica	peach; nectarine; heavenly white nectarine; Tilton apricot	2
Prunus pissardi	purple-leaved prune	2
Prunus pumila	sand cherry	2
Prunus serotina	black cherry; wild black cherry; rum cherry; mountain black cherry	2
Prunus spinosa	sloe; blackthorn	2
Prunus spp.	cherry; plum	2
Prunus subcordata	Klamath plum; Sierra plum; Pacific plum; western plum; wild plum	2
Prunus umbellata	flatwoods plum; black sloe; hog plum; sloe	2
Prunus virginiana	chokecherry; common chokecherry; black chokecherry; California chokecherry	2

Genus and species	Common name	Susceptibility index
Pseudophoenix sargentii	buccaneer-palm; Florida cherrypalm; Sargent cherrypalm	3
Pseudotsuga macrocarpa	bigcone Douglas-fir; bigcone-spruce; hemlock	2
Pseudotsuga menziesii	Douglas-fir; red-fir; Oregon-pine; Douglas-spruce	2
Psidium guajava	guava; common guava; guayaba	2
Ptelea trifoliata	hoptree; common hoptree; wafer-ash	2
Punica granatum	pomegranate	2
Pyracantha coccinea	scarlet firethorn; everlasting thorn; fire thorn	2
Pyrus angustifolia	narrowleaf crab apple	1
Pyrus arbutifolia	red chokecherry; red chokeberry; chokeberry	2
Pyrus communis	pear	2
Pyrus fusca	Oregon crab apple	1
Pyrus malus	wild apple; common apple	1
Quercus agrifolia	coast live oak; California live oak	1
Quercus alba	white oak; stave oak	1
Quercus arizonica	Arizona white oak; Arizona oak	1
Quercus austrina	Durand oak; Durand white oak; bluff oak	1
Quercus bicolor	swamp white oak	1
Quercus chapmanii	Chapman oak; Chapman white oak; scrub oak	1
Quercus chrysolepis	canyon live oak; California live oak; canyon oak; goldcup oak; live oak; maul oak	1
Quercus cinerea	bluejack oak	1
Quercus coccinea	scarlet oak; black oak; Spanish oak	1
Quercus douglasii	blue oak; California blue oak; iron oak; mountain white oak; mountain oak	1
Quercus durandii	Durand oak; Durand white oak; bluff oak; white oak	1
Quercus ellipsoidalis	northern pin oak; jack oak; black oak; Hill oak	1
Quercus emoryi	Emory oak; black oak; blackjack oak	1
Quercus engelmannii	Engelmann oak; evergreen white oak; mesa oak; Engelmann spruce	1
Quercus falcata	southern red oak; Spanish oak; water oak; red oak	1
Quercus gambelii	Gambel oak; Rocky Mountain white oak; Utah white oak; white oak	1

Genus and species	Common name	Susceptibility index
Quercus garryana	Oregon white oak; Oregon oak; Garry oak; post oak; white oak; Brewer oak; shin oak	1
Quercus grisea	gray oak; Arizona gray oak	1
Quercus hemisphaerica	laurel oak; Darlington oak	1
Quercus hypoleucoides	silverleaf oak; white-leaf oak	1
Quercus ilicifolia	bear oak; scrub oak	1
Quercus imbricaria	shingle oak; laurel oak	1
Quercus incana	bluejack oak; cinnamon oak; sandjack; bluejack; shin oak; turkey oak	1
Quercus kelloggii	California black oak; black oak; Kellogg oak	1
Quercus laevis	turkey oak; Catesby oak; scrub oak	1
Quercus laurifolia	laurel oak; Darlington oak; diamond-leaf oak; swamp laurel oak	1
Quercus lobata	valley oak; California white oak; valley white oak; water oak	1
Quercus lyrata	overcup oak	1
Quercus macrocarpa	bur oak; mossy cup oak; blue oak; mossy-overcup oak; scrub oak	1
Quercus margaretta	sand post oak; small post oak; dwarf post oak; post oak	1
Quercus marilandica	blackjack oak; blackjack; barren oak; black oak; jack oak	1
Quercus michauxii	swamp chestnut oak; basket oak; cow oak	1
Quercus muehlenbergii	chinkapin oak; yellow chestnut oak; chestnut oak; rock chestnut oak	1
Quercus myrtifolia	myrtle oak; scrub oak	1
Quercus nigra	water oak; possum oak; spotted oak	1
Quercus nuttallii	Nuttall oak; red oak; Red River oak; pin oak	1
Quercus oblongifolia	Mexican blue oak	1
Quercus oglethorpensis	Oglethorpe oak	1
Quercus pagoda	cherrybark oak; swam red oak; bottomland red oak	1
Quercus palustris	pin oak; swamp oak; water oak; swamp Spanish oak; Spanish oak	1
Quercus phellos	willow oak; pin oak; peach oak; swamp willow oak	1
Quercus prinus	chestnut oak; basket oak; rock chestnut oak; rock oak; tanbark oak	1
Quercus rubra	northern red oak; red oak; common red oak; gray oak; eastern red oak; mountain red oak	1

Genus and species	Common name	Susceptibility index
Quercus shumardii	Shumard oak; Shumard red oak; spotted oak; Schneck oak; Schneck red oak; southern red oak	1
Quercus spp.	oak	1
Quercus stellata	post oak; iron oak	1
Quercus suber	cork oak	1
Quercus undulata	Rocky Mountain shin oak; wavyleaf oak	1
Quercus velutina	black oak; yellow oak; quercitron oak; yellow-bark oak; smooth-bark oak	1
Quercus virginiana	live oak; Virginia live oak	1
Quercus wislizenii	interior live oak; highland live oak; Sierra live oak	1
Rapanea guianensis	Guiana rapanea	2
Reynosia septentrionalis	darling-plum; red-ironwood	2
Rhamnus caroliniana	Carolina buckthorn; Indian-cherry; yellow buckthorn; tree buckthorn; yellowwood	3
Rhamnus cathartica	European buckthorn; common buckthorn; European waythorn	3
Rhamnus frangula	glossy buckthorn; alder buckthorn	3
Rhamnus purshiana	cascara buckthorn; cascara; cascara sagrada; bearberry; chittam; coffeetree	2
Rhizophora mangle	mangrove; red mangrove	2
Rhus copallina	shining sumac; dwarf sumac; winged sumac; wing-rib sumac; flameleaf sumac	2
Rhus corallina	mountain sumac	1
Rhus cotinus	smoketree; common smoketree	2
Rhus glabra	smooth sumac; scarlet sumac; common sumac; Rocky Mountain sumac; red sumac	1
Rhus integrifolia	lemonade sumac; sourberry; lemonade-berry; mahogany sumac	2
Rhus typhina	staghorn sumac; velvet sumac	1
Ribes uva-crispa	English gooseberry	2
Robinia neomexicana	New Mexico locust; New Mexican locust; southwestern locust	3
Robinia pseudoacacia	black locust; common locust; yellow locust; white locust	3
Robinia spp.	locust	2

Genus and species	Common name	Susceptibility index
Robinia viscosa	clammy locust	3
Rosa bracteata	Macartney rose	2
Rosa eglanteria	sweetbriar; sweetbriar rose	2
Rosa setigera	prairie rose; climbing prairie rose	2
Rosa spp.	rose	1
Roystonea elata	Florida royalpalm; Cuban royalpalm; royalpalm	3
Sabal palmetto	cabbage palmetto; common palmetto; Carolina palmetto; palmetto; cabbage-palm	3
Salix alaxensis	feltleaf willow	1
Salix alba	white willow; European white willow	1
Salix alba var. *tristis*	golden weeping willow	1
Salix amygdaloides	peachleaf willow; peachleaved willow; almond willow; peach willow; southwestern peach willow	1
Salix babylonica	weeping willow; Babylon weeping willow; Napolean willow	2
Salix bonplandiana	Bonpland willow; Toumey willow; red willow; polished willow	1
Salix caroliniana	Coastal Plain willow; Ward willow; southern willow; Harbison willow	1
Salix cordata	heartleaf willow; heart-leaved willow	1
Salix discolor	pussy willow; glaucous willow; silvery pussy willow	1
Salix eriocephala	pussy willow	1
Salix fragilis	crack willow; brittle willow; snap willow	1
Salix hookerana	Hooker willow; coast willow; Yakutat willow; bigleaf willow	1
Salix interior	sandbar willow; coyote willow; acequia willow; basket willow; gray willow; sandbar willow	1
Salix laevigata	Bondpland willow; red willow; Toumey willow; polished willow	1
Salix lasiandra	Pacific willow; whiplash willow; black willow; red willow; western black willow; yellow willow	1
Salix lasiolepis	arroyo willow; white willow	1
Salix lucida	shining willow; shiny willow	1
Salix mackenzieana	Mackenzie willow	1
Salix nigra	black willow; swamp willow; Goodding willow; western black willow; Dudley willow	1
Salix pentandra	laurel willow; bay willow; bayleaf willow	2

Genus and species	Common name	Susceptibility index
Salix scouleriana	Scouler willow; fire willow; black willow; mountain willow; Nuttall willow	1
Salix spp.	willow	1
Salix taxifolia	yewleaf willow; yew willow	1
Salix viminalis	basket willow; osier; common osier; silky osier	1
Sambucus callicarpa	Pacific red elder; Pacific elder; coast red elder; redberry elder; red elderberry	2
Sambucus canadensis	American elder; common elderberry; common elder; blackberry elder	3
Sapindus drummondii	western soapberry; wild chinatree; cherioni	2
Sapindus marginatus	wingleaf soapberry; Florida soapberry	2
Sapindus saponaria	wingleaf soapberry; Florida soapberry; southern soapberry; Mexican soapberry; wild chinatree	2
Sapium sebiferum	tallowtree; Chinese tallowtree	3
Sassafras albidum	sassafras; white sassafras	2
Schinus molle	California peppertree	1
Sequoia sempervirens	redwood; coast redwood; California redwood	2
Sequoiadendron giganteum	giant sequoia; sequoia; bigtree; Sierra redwood	2
Sideroxylon foetidissimum	false-mastic; mastic; wild-mastic; wild-olive	2
Simarouba glauca	paradise-tree; bitterwood	2
Sophora affinis	Texas sophora; coralbean; pink sophora; Eves-necklace	3
Sophora japonica	Japanese pagoda-tree	3
Sophora secundiflora	mescalbean; frigolito; coralbean; Texas-mountain-laurel	2
Sorbus americana	American mountain-ash; mountain-ash; roundwood	1
Sorbus aucuparia	European mountain-ash; Rowan-tree	1
Spiraea bumalda	Bumalda spirea; spirea	3
Stewartia koreana	Korean stewartia; stewartia	3
Stewartia ovata	mountain stewartia; mountain-camellia; angel-fruit stewartia	2
Swietenia mahagoni	West Indies mahogany; mahogany	2
Symphoricarpos albus	snowberry; waxberry; common snowberry	3
Symplocos tinctoria	sweetleaf; horse-sugar; common sweetleaf; yellowwood	2
Tamarix parviflora	small-flower tamarisk	2
Taxodium distichum	baldcypress	3

Genus and species	Common name	Susceptibility index
Taxodium mucronatum	Montezuma baldcypress; Mexican cypress	3
Taxus brevifolia	Pacific yew; western yew	3
Taxus floridana	Florida yew	3
Thrinax microcarpa	key thatchpalm; silvertop palmetto; prickly thatch; brittle thatch; brittle thatch palm	3
Thrinax parviflora	Jamaica thatchpalm	3
Thuja occidentalis	northern white-cedar; white-cedar; eastern arborvitae; American arborvitae; eastern white-cedar	3
Thuja orientalis	oriental arborvitae; Chinese arborvitae	3
Thuja plicata	western redcedar; giant western arborvitae; Pacific redcedar; giant-cedar; arborvitae; canoe-cedar	3
Tilia americana	American basswood; American linden; basswood	1
Tilia caroliniana	Carolina basswood; Florida basswood; basswood; Carolina linden; Florida linden	1
Tilia cordata	littleleaf linden; small-leaved linden; small-leaved European linden	1
Tilia europaea	European linden	1
Tilia floridana	Florida basswood; Carolina basswood	1
Tilia heterophylla	white basswood; beetree; linden; beetree linden	1
Torreya californica	California torreya; California-nutmeg	3
Torreya taxifolia	Florida torreya; stinking-cedar	3
Torrubia longifolia	longleaf blolly; Brace blolly roundleaf blolly; beeftree; beefwood	2
Toxicodendron vernix	poison-sumac; poison-dogwood; poison-elder; thunderwood	1
Trema micrantha	Florida trema	2
Tsuga canadensis	eastern hemlock; Canadian hemlock; Canada hemlock; hemlock spruce; common hemlock	2
Tsuga caroliniana	Carolina hemlock	2
Tsuga heterophylla	western hemlock; Pacific hemlock; west coast hemlock	2
Tsuga mertensiana	mountain hemlock; black hemlock; alpine hemlock; hemlock spruce	2
Ulmus alata	winged elm; wahoo elm; cork elm; wahoo	2
Ulmus americana	American elm; white elm; water elm; soft elm; Florida elm	2
Ulmus campestris	English elm; European elm	2
Ulmus crassifolia	cedar elm; basket elm; red elm; southern rock elm	2

Genus and species	Common name	Susceptibility index
Ulmus glabra	Scotch elm; wych elm	2
Ulmus montana	Scotch elm	2
Ulmus parvifolia	Chinese elm; lacebark	2
Ulmus pumila	Siberian elm; Asiatic elm; dwarf Asiatic elm; Pekin elm	2
Ulmus racemosa	rock elm; cork elm	2
Ulmus rubra	slippery elm; red elm; gray elm; soft elm	3
Ulmus serotina	September elm; red elm	2
Ulmus spp.	elm	2
Ulmus thomasii	rock elm; cork elm	2
Umbellularia californica	California-laurel; California-bay; Oregon-myrtle; Pacific-myrtle; pepperwood; spice-tree	3
Vauquelinia californica	Torrey vauquelinia; Arizona-rosewood	2
Veitchia merrillii	Manila palm	3
Viburnum acerifolium	mapleleaf viburnum; dockmackie; maple-leaved arrowwood	3
Viburnum ellipticum	western blackhaw; oval-leafed viburnum	2
Viburnum lantana	wayfaringtree	2
Viburnum opulus	European cranberrybush; highbush cranberry; cranberry tree	3
Viburnum prunifolium	blackhaw; stagbush; sweethaw	2
Viburnum pubescens	downy viburnum; hairy nannyberry; downy arrowwood	2
Viburnum rhytidophyllum	leatherleaf viburnum	2
Viburnum spp.	viburnum; wayfaringtree	3
Viburnum tomentosum	doublefile viburnum	3
Washingtonia filifera	California washingtonia; California-palm; fanpalm; California fanpalm; desert-palm	3
Ximenia americana	tallowwood; hogplum	3
Zanthoxylum americanum	common prickly-ash; toothache-tree; northern prickly-ash; prickly ash	2
Zanthoxylum clava-herculis	Hercules-club; pepperbark; southern prickly-ash; toothache-tree; tingle-tongue	2
Zanthoxylum fagara	lime prickly-ash; wild-lime-tree; wild-lime	2
Zanthoxylum flavum	West Indies satinwood; yellowheart; satinwood; yellowwood	2

Appendix E
Biology, History, and Control Efforts for the Gypsy Moth

Figure E-1. Small hand sprayers were used to apply DDT in 1945 (Gill, MA).

Appendix E Biology, History, and Control Efforts for the Gypsy Moth

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This appendix describes the progression of control efforts that paralleled the spread of the gypsy moth from 1869 to 2005 in the United States *(Figure E-2)*. Biological information includes coverage of its life cycle, differences between the European and Asian strains, and the four population phases and host plants.

E.1 About the Gypsy Moth.

The following information is provided to facilitate better understanding of the insect, the problems it creates, and treatments.

Life Cycle.

Producing one generation per year, the gypsy moth goes through four life stages: egg, larva, pupa, and adult moth *(Figures E-3, E-4, E-5, E-6)*.

After mating, the female gypsy moth deposits eggs in a well-defined mass, containing from a few hundred to a thousand eggs, typically in a protected area such as a bark crevice, on the underside of a branch, or in leaf litter. She coats the eggs with hairs from her abdomen, giving the egg mass a furry appearance and buff color.

Though the embryos within the eggs develop into caterpillars in 4 to 6 weeks, the caterpillars remain in the eggs during winter. Survival and hatching success depend on a combination of time and temperature requirements. A prolonged period of chilling and sufficient time for subsequent incubation are necessary for egg hatch the following spring (Giese and Casagrande 1981).

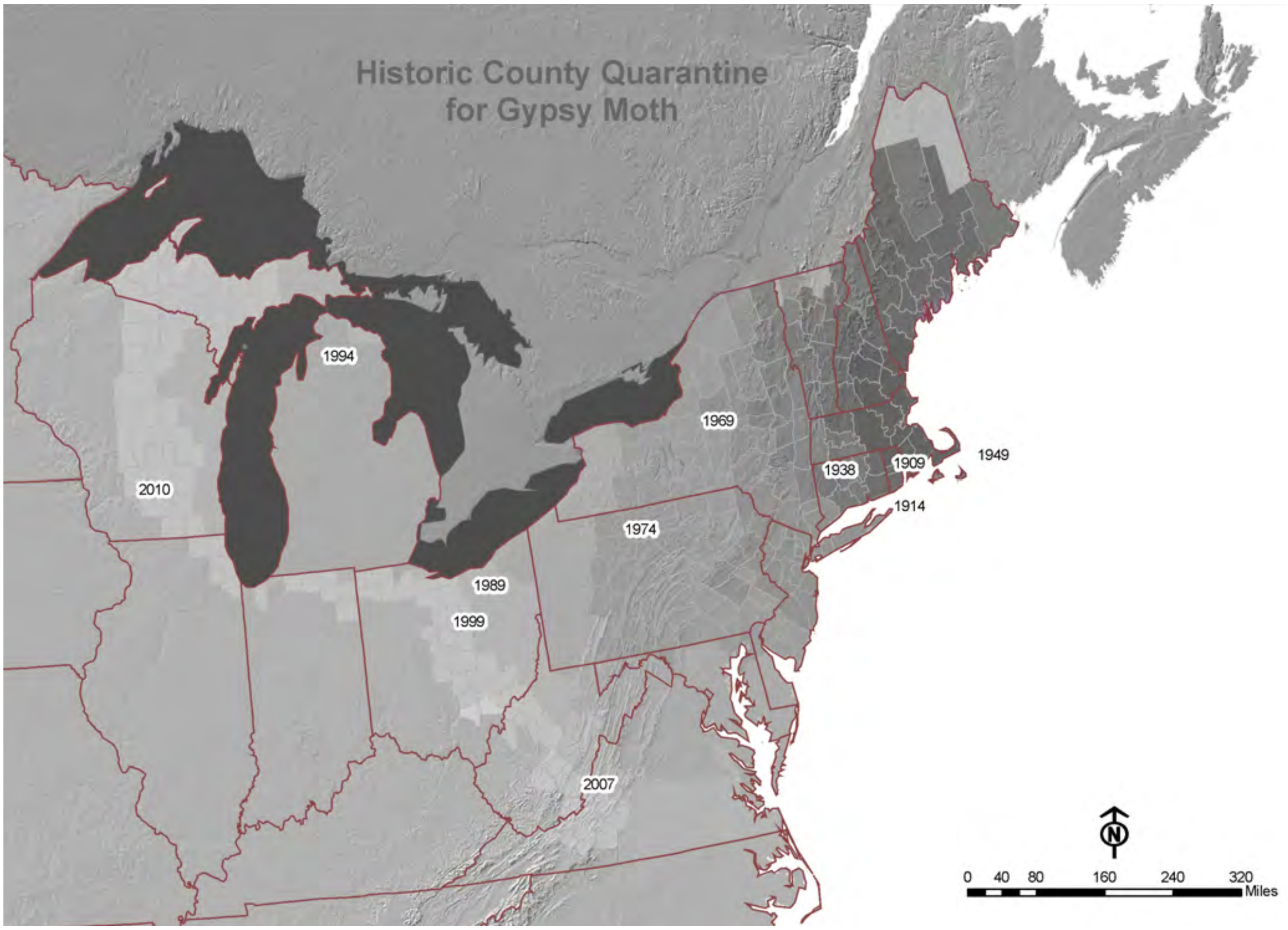

Figure E-2. A historic county quarantine map shows the spread of the gypsy moth from 1909 to 2010 (USDA APHIS 2011).

Figure E-3. Female gypsy moths add hairs from their abdomens to their egg masses.

Figure E-4. The gypsy moth catepillar (larva) develops pairs of distintive red and blue spots as it grows.

Figure E-5. The gypsy moth pupa lasts for about 2 weeks.

Figure E-6. The gypsy moth adult male (left) and female (right) are visibly different.

Coinciding with the appearance of spring leaves, eggs laid the previous year hatch (during April and May in the Middle Atlantic States), and caterpillars climb multiple varieties of trees, bushes, and other objects, spinning a thread of silk from which they hang freely. A phenomenon termed “ballooning,” by which the wind carries them to new locations, relocates most caterpillars before they begin feeding. Caterpillars may balloon several times before they settle and begin feeding on foliage (Nichols 1980).

The small caterpillars move into the tree canopy where they feed on leaves for the next 6 to 8 weeks. Caterpillars grow from one-tenth of an inch (3 mm) to as large as 3½ inches (90 mm) by going through a series of growth stages called instars. A molt (shedding of the outer layer) precedes each instar stage; the discarded "skins" can cause respiratory problems for some people. Male caterpillars grow through five instars, females through six; an additional instar is not uncommon (Doane and McManus 1981).

The caterpillars develop distinctive markings on their ash-colored bodies as they grow--a yellow stripe down the back, with rows of five blue spots followed by six red spots on both sides of the yellow stripe. Their excrement, called frass, can create health risks; large populations of caterpillars excrete so much frass it sounds like rain falling through the leaves. Frass in runoff water can also pollute lakes and streams, threatening fish (Sharpe 1982).

Caterpillars typically feed at night to avoid predators, though feeding may occur at any time of the day when caterpillar populations explode and competition for food increases. The feeding caterpillar is the life stage targeted in most gypsy moth treatment projects because of the potential for defoliation.

When population levels are low, caterpillars move down the tree during the day and rest in protected areas under tree bark and in crevices, returning to the tree canopy to feed at night. When populations are elevated and competition for foliage high, caterpillars remain in the tree canopy and feed night and day. After stripping the foliage of the host tree, the caterpillars descend, crawling in search of new food sources (McManus and others 1989).

Following the last instar (June and July in the Middle Atlantic States), caterpillars find any available protected spot in trees, on buildings, and even on the ground, entering their pupal stage over the next 2 days. Approximately 2 weeks later, adult moths emerge.

Male gypsy moths appear first, followed several days later by the females. The egg-laden females emit a pheromone, attracting males for mating. The female moths then deposit their egg masses, beginning the cycle anew the following spring.

European and Asian Strains.

The European strain of the gypsy moth became established in North America from a single introduction of closely related individuals, and genetic studies have shown little variation within or between populations (Wallner 1992). In North America, the European strain is also called the North American strain.

The common reference to "the Asian strain" of the gypsy moth actually refers to several strains, which display considerable variability. The most notable variances are the female's flying abilities (some females of the Asian strain are strong fliers, capable of flights exceeding 18 miles [28.9 km]) and the capacity to establish in a broad range of hosts (Wallner 1992).

The European and Asian strains of the gypsy moth are similar in appearance; however, behavioral differences between them are significant, particularly the inability of the European strain female to fly (Wallner 1992). Females of the Asian strain are attracted to light and more likely to deposit their eggs near light sources, thus potentially increasing the social "nuisance" factor usually associated with the gypsy moth (Hofacker 1994).

The Asian strain feeds on some hosts that are only marginally acceptable to the European strain, increasing their potential to establish themselves and cause even more extensive defoliation than their European cousins (USDA APHIS 1992).

Other differences between the European and Asian strains are minor *(Table E-1)*. The most reliable method for distinguishing between the strains, other than the flight of the female, is genetic testing .

Prior to the first known introductions of the Asian strain in 1991, eradication actions were singularly focused against the European strain. Efforts against

Table E-1. Differences between the European and Asian strains of the gypsy moth, by life stage and cause of mortality (adapted from Wallner 1992, p. 2).

Life Stage	**European Strain (North America)**	**Asian Strain (Siberia, Russia, Far East)**
Caterpillars	First instars disperse	First and second instars disperse
	Color uniform	Color highly variable
	Main hosts: oak, birch, poplar, willow, alder	Main hosts: oak, larch, birch, willow
	Early instars feed in the canopy at night and move to resting sites during the day.	Early instars feed in the canopy at night and remain on the host during the day.
Pupae	Pupates in protected spots in bark crevices, in leaf litter	Pupates on foliage
Adult Females	Flightless	Strong flier, attracted to light
Egg Masses	On tree trunks, rocks, leaf litter	On foliage, tree trunks, rocks, objects near lights
Cause of Mortality	Virus, *B.t.*, fungus, parasites, various predators	Virus, *B.t.*, fungus, microsporidia, parasites and predators

the European strain, then and now, are conducted outside the generally infested area. Because of the flight capabilities of the Asian strain and the expanded potential host range, USDA policy is to eradicate moths exhibiting characteristic traits or genetic markers consistent with the Asian strain wherever feasible—even if they are detected inside the area quarantined for the European (or North American) strain.

Knowledge of the time, location, and extent of an introduction is required to trigger eradication of the Asian strain in the generally infested area. In cases where deductive, circumstantial, or investigative information can be developed about an introduction of uncertain origin, eradication may also be conducted. The goal is to eradicate gypsy moths that exhibit traits characteristic of the Asian strain in a specific area wherever it may occur (within or outside the generally infested area).

Treatments available are the same for both strains, but the timing of application differs. Eradication of the European strain begins with a detection survey that locates isolated infestations, followed by a delimiting survey confirming the presence of established populations and determining the approximate size and geographic extent of the infestation (see Appendix B for survey descriptions). Treatment ensues at the conclusion of the delimiting survey; time from detection to initial treatment is 1 to 2 years.

Treatment for the Asian strain begins the year after detection, as an isolated infestation of the Asian strain could spread significantly because of the female's flight capability, resulting in the need for an even larger eradication project. The treatment area is determined using the best information available. After treatment delimiting surveys are conducted throughout and significantly beyond the treated area.

Population Phases.

Populations of the gypsy moth periodically build to high levels for one or more years, then collapse and remain at low levels for varying periods of time before increasing again. These changes in population levels pass through four phases (Doane and McManus 1981, USDA Forest Service 1989):

Innocuous Phase.

Populations are low and stable. Predation by small mammals and birds and parasitism by other insects appear to keep populations low (Campbell 1976, Elkinton and Leibhold 1990). This phase was undoubtedly the major contributing factor in the 1900 decision to cancel the eradication program.

Release Phase.

Populations build rapidly. While not fully understood, mild winters followed by warm, dry springs and summers may increase survival and lead to population expansion and increase (Campbell and Sloan 1977c).

Outbreak Phase.

Populations reach high levels, and feeding causes widespread moderate-to-heavy defoliation of susceptible hosts. Although predation and parasitism of caterpillars continue, the impact on gypsy moth populations is minor. As the outbreak progresses, the gypsy moth virus--a naturally occurring nucleopolyhedrosis virus--or a fungus (*Entomophaga maimaiga*) may begin to build in the population and contribute to its collapse (Campbell and Sloan 1977c).

Decline Phase.

Populations collapse from overpopulation, starvation, infection by the virus or fungus and decreased reproduction. Males frequently outnumber females in these populations; the other phases exhibit approximately equal numbers of males and females.

Host Plants.

Caterpillars of the European strain eat foliage from a wide variety of trees and shrubs. They prefer oaks, apple, sweetgum, speckled alder, basswood, gray and white birch, poplar, willow and hawthorn (McManus and others 1989). All instars feed on these species; later instars feed on some additional tree species shunned by early instars, such as cottonwood, hemlock, southern white cedar, and the pines and spruces in the eastern United States. The gypsy moth usually does not feed on some plants, including rhododendron, laurel, dogwood, and yellow poplar, although during an outbreak gypsy moth caterpillars will feed on almost all vegetation (McManus and others 1989). Appendix D provides the gypsy moth's feeding preferences for over 700 plant species.

The Asian strain exhibits a broader range of preferred hosts than does the European strain (USDA APHIS 1992). Studies show the Asian strain thrives with greater vigor than the European strain on many of the hosts species present in the United States, with the largest variability in growth rate observed on conifers (Wallner 1994).

E.2 1869 to 1910: Biological Controls Fail.

The European strain of the gypsy moth was considered a curiosity when it first escaped around 1869 from an insectary in Medford, Massachusetts. Public perception of the moth as a problem developed two decades later as the gypsy moth population exploded; citizens soon realized the consequences of allowing the moths to remain uncontrolled:

> In the summer of 1889 it [the gypsy moth] threatened to overrun Medford, Massachusetts. The startled townspeople discovered caterpillars in astounding numbers, swarming through trees, eating leaves, and coating the ground below with

> droppings. People swept insects from their sidewalks, porches, and clothes; carried umbrellas to ward off droppings and falling caterpillars; and even wore face nets. The town, unable to deal with the situation, appealed to the state for aid. The striking nature of the infestation and its occurrence in an urban area brought quick response from the commonwealth, and an ambitious effort to deal with the pest was begun. (Dunlap 1980, p. 118)

Gypsy moth, initially assumed native, was first identified as an exotic pest in 1889 (Weseloh 2003c). Control methods included destroying egg masses, burning infested trees and shrubs, banding trees to trap caterpillars, and spraying insecticides. Paris green (copper aceto-arsenate), the first gypsy moth insecticide, was replaced with lead arsenate in 1893 (McManus and McIntyre 1981).

Massachusetts discontinued efforts to eradicate the gypsy moth in 1900, mistakenly considering the project fully successful. The actual reason for the diminished presence of the pest was its entry into the innocuous phase, one of four periodic population phases. A second outbreak in 1906 prompted the Federal government to take action to eliminate the non-native insect. Eradication proved impossible; gypsy moth was already widespread.

Entomologists with the (then) USDA Bureau of Entomology initiated studies to determine the life cycle of the insect and identify natural enemies from Europe for use against the pest. Introduction of identified natural enemies failed to stop the moths, and these biological control efforts were deemed failures. Funding reductions affected even basic research activities:

> Biological control proved to be much more difficult than either the scientists or the public had anticipated. Importing and establishing the moth's natural enemies was neither simple nor inexpensive. Some of the parasites immediately died in the new environment, others refused to breed, and still others vanished without a trace when released. Some survivors were found to be preying on the moth, but with no noticeable effect on its population. (Dunlap 1980, p. 121).

E.3 1911 to 1939: Chemical Insecticides Gain Favor.

The Bureau of Entomology issued a report in 1911, stating the parameters of effective use of biological controls against the gypsy moth in the United States:

> . . . all fifty of the moth's known European predators [would have to be imported and established], which would require long-term studies of the ecology of the moth and its enemies. (Dunlap 1980, p. 121)

The public, as well as scientists and politicians, quickly realized the successful use of biological controls would require extensive research and funding:

> With the end of hope that natural enemies would control the moth, both state and federal workers fell back on a piecemeal approach. They sought to reduce damage in highly visible and economically important areas—roadsides and towns. (Dunlap 1980, p. 123)

The gypsy moth spread throughout New England. By 1914, the generally infested area included the southern half of New Hampshire, Rhode Island, eastern Connecticut, southern Vermont, and the eastern half of Massachusetts (McManus and McIntyre 1981). The use of chemical insecticides evolved as the favored form of control:

> Their popularity was due in part to … the public's desire for an immediate [visible] solution to [gypsy moth] problems and its reluctance to invest in long-term research that did not promise a certain or immediate return. Chemicals…gave immediate and gratifying visible results. Best of all, they could be used by individual landowners or towns without regard to coordination with other people or jurisdictions…
>
> In forest spraying, however, chemicals proved ineffective. Better equipment and sprays now made roadside and urban spraying practical…[while] skyrockets and aerial bombs proved interesting but impractical. Spraying from planes or autogiros [early helicopters] seemed promising…[but] the hazards of tall trees, crosswinds, and irregular terrain made spraying difficult, but the most important factor was economic: American forests had too low a return per acre to justify the expense and repeated sprayings that were necessary to control the moth.
>
> The same economic calculations also doomed another, ecological, control method [that of silvicultural…] replacing stands of susceptible or favored food species with those that were most resistant to the moth's attacks or less palatable. Unfortunately, this approach, like extensive forest spraying, presupposed a relatively high return per acre, and nothing came of it. (Dunlap 1980, p. 123-124)

The United States Department of Agriculture (USDA), in cooperation with the infested States and Canada, established a barrier zone in 1923, extending from the Canadian border along the Hudson River and Champlain Valleys to Long Island. Gypsy moth infestations east of this barrier were designated for treatment by the States; infestations to the west for eradication. The first major infestation west of the barrier zone occurred in Pennsylvania in 1932. Six years later, the New England hurricane of September 21, 1938, spread the gypsy moth hundreds of miles into new territory. In the following year the barrier zone had become generally infested.

E.4 1940 to 1957: DDT Gets Widespread Use.

Consideration and experimentation of new insecticide controls occurred both before and during World War II. Experimental use of cryolite as a gypsy moth insecticide in Pennsylvania in the 1940s proved ineffective; the most promising new insecticide was a synthetic organic chemical, dichloro-diphenyl-trichlorethane (DDT):

> Even before the end of World War II, American and Canadian scientists were using experimental lots of the new chemical for aerial spraying on northern forests to test DDT against the gypsy moth and the spruce budworm. The results were astounding. Less than a pound of DDT per acre killed almost all the caterpillars, but it did not, apparently, cause any significant damage to wildlife. (Dunlap 1980, p. 124)

Experimental use of DDT in Pennsylvania proved more effective than cryolite, leading to the erroneous conclusion that successful eradication of gypsy moth in the State occurred by 1948. Undetected infestations, however, led to further outbreaks and continued spread (Nichols 1961).

Gypsy moth infestations proliferated in the 1950s, and another barrier zone was set up through the Adirondack plateau in an attempt to prevent spread to the south and west. However, detection of the insect in previously uninfested areas occurred by the mid-1950s. New Jersey, New York, Pennsylvania, and Michigan reported populations, initiating a major Federal effort to eradicate the gypsy moth:

> The first phase, to begin in the spring of 1957, involved aerial spraying to eliminate outlying populations of the moth in New York, Pennsylvania, and Michigan. If these were successful, a second phase would follow, wiping out the main body in New England… The moth's periodic outbreaks caused serious but local damage, and there was no urgent demand to quell the latest one. The only clear rationale was the availability of DDT…
>
> Spraying began in April 1957 and lasted until June, covering more than 3 million acres in the Northeast with DDT. It brought a storm of criticism from the populace, from scientists, and from local and state officials. Some objected to the nuisance; cars dotted with scum or pools covered with layers of oil [from the carrier used to spray the DDT]. Other effects were more serious: dairy farmers complained that DDT fell on their pastures and passed into the milk, contaminating it. Organic farmers on Long Island also protested, for the sprays rendered their crops unsuitable for the special markets… The program also met legal challenge, the first serious environmental litigation against a pest control program…it [proved to be] too controversial for officials and bureaus whose budgets depended on public goodwill. (Dunlap 1980, p. 124-125)

E.5 1958 to the Mid-1980s: Safer Treatments Needed.

During its use, DDT application for gypsy moth control totaled over 12 million acres (4.9 million ha) of forest in nine northeastern States and Michigan (U.S. EPA 1975). Questions concerning the non-target effects of DDT led to its replacement by the carbamate, carbaryl, in the late 1950s. DDT use came to an end soon after publication of Rachel Carson's book *Silent Spring*, in 1962. The Forest Service stopped using DDT in its Eastern Region (Paananen and others 1987). Although considered safer than DDT, in certain formulations carbaryl demonstrated toxicity to honeybees (USDA 1985).

Between 1970 and 1981, suppression of gypsy moth outbreaks was accomplished with aerial applications of broad-spectrum insecticides, including carbaryl and the organophosphate trichlorfon and, to a lesser degree, acephate. These broad-spectrum, nerve-poison insecticides killed not only gypsy moth caterpillars, but many other immature and adult insects in treated areas.

The initiation of research efforts to find effective means of gypsy moth control began in the 1970s, including the use of the gypsy moth nucleopolyhedrosis virus (NPV) and *Bacillus thuringiensis* var. *kurstaki* (*B.t.k.*) as biological control agents. Gypchek, registered in 1978, is an insecticide made from NPV. The insect growth-regulator, diflubenzuron, also registered in 1978, offered an attractive alternative with fewer effects on non-target organisms than other chemical insecticides.

The USDA increased exploration for foreign parasites and predators of the gypsy moth in 1971, also funding research on a synthetic pheromone (disparlure) and gypsy moth population dynamics and environmental effects (McManus and McIntyre 1981). Results of this and other research led to the development of non-insecticidal methods, such as mass trapping, mating disruption and the sterile insect technique for use in gypsy moth projects.

Attempts to eliminate the gypsy moth from the United States were abandoned in the 1970s and a two-phase management approach adopted: suppression of outbreaks in the generally infested area and eradication of isolated infestations resulting from inadvertent transport of the insect by people into the uninfested area.

Diflubenzuron and *B.t.k.* largely replaced carbaryl and trichlorfon as the insecticides of choice in cooperative gypsy moth suppression projects by the mid-1980s. Cooperative suppression projects last used trichlorfon in 1984 and carbaryl in 1987 (USDA Forest Service 1994d). Use of broad-spectrum chemical insecticides in cooperative eradication projects ceased in 1989 (USDA APHIS 1992).

E.6 Mid-1980s to the Present: Adoption of Integrated Pest Management.

Integrated pest management (IPM) became the standard approach to gypsy moth suppression and eradication in the 1980s, and continues to this writing. This approach employs the use of various management practices, including the application of chemical and biological insecticides and utilization of non-insecticidal methods.

Up to this point, controls against high-density populations of the gypsy moth were employed in relatively small treatment blocks. Three successive studies began attempts to keep low-density populations from expanding over geographic areas of increasing size.

The Forest Service led Federal, State, and county agencies in an IPM study of a five-county area in Maryland from 1983 to 1987 (Reardon and others 1993). Using geographic information system (GIS) computer technology to collect and store data, this first study accomplished advances in the operational use of controls specific to gypsy moth. An improved formulation of the nucleopolyhedrosis virus (Gypchek) resulted, as well as the first release of sterile eggs.

The second study, conducted in 38 counties along the Appalachian Mountains in Virginia and West Virginia, began in 1987 and concluded in 1992 (USDA Forest Service 1989). Researchers successfully minimized damage in the project area, reducing adverse environmental effects using gypsy-moth-specific treatments in an IPM approach, demonstrating the technical feasibility of slowing the spread of the gypsy moth (USDA Forest Service 1994e).

The third study, a 5-year pilot project started in 1992, utilized the same concepts and methodologies in four States (Virginia, West Virginia, North Carolina, and Michigan), to determine the operational and economic feasibility of a nationwide program to slow the spread of the gypsy moth.

Building upon these three field studies, development and improvement of methods for IPM continued on a national scale for the gypsy moth and for all major forest pests. Participants included the Forest Service National Center for Forest Health Management and other units of the Forest Service, APHIS, Agricultural Research Service and Cooperative State Research, Education, and Extension Service.

Following the issuance of the 1995 Final Environmental Impact Statement "Gypsy Moth Management in the United States: a cooperative approach" and the subsequent signing of the 1996 Record of Decision, USDA implemented a program that included eradication, suppression, and slow-the-spread (STS) projects to control the gypsy moth. An STS pilot project concluded in 1999, leading to the first full-scale projects using STS methodologies operationally in 2000. Eradication, suppression, and STS strategies continue to comprise the USDA National Gypsy Moth Management Program.

E.7 1991 to the Present: Asian Strain Creates Additional Concern.

The Asian strain of the gypsy moth, found for the first time in the United States in 1991, is of concern because females have the ability to fly. This mobility poses the possibility of the Asian strain spreading at an even faster rate than does the European strain. Between 1991 and 2009 Asian gypsy moth has been detected, monitored, and in most cases treated, in a number of States:

California 2003, 2005–2007, 2009
Idaho 2004
North Carolina 1993
Oregon 1991, 2000, 2006
Texas 2005
Washington 1991, 1993–1997, 1999

Isolated infestations of the European strain continue to be a problem outside the generally infested area, usually resulting from inadvertent movement of gypsy moth life stages on articles such as cars, campers, outdoor furniture, and nursery stock. Port-of-entry activities to prevent all gypsy moth strains from entering the United States are ongoing (Appendix B). Surveys using pheromone traps continue nationally to detect introduction and determine if eradication is necessary.

Pesticide Precautionary Statement

Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key--out of the reach of children and animals--and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency, consult your county agricultural agent or State extension specialist to be sure the intended use is still registered.

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