United States
Department of
Agriculture

Marketing and
Regulatory
Programs

Animal and
Plant Health
Inspection
Service

Use of LBAM Mating Disruption Pheromone Dispensers in the Light Brown Apple Moth Program in California

Environmental Assessment
September 2010

Use of LBAM Mating Disruption Pheromone Dispenser in the Light Brown Apple Moth Program in California

Environmental Assessment
September 2010

Agency Contact:
Andrea Simao
National Program Manager
Emergency and Domestic Programs
Animal Plant Health Inspection Service
U.S. Department of Agriculture
4700 River Rd. Unit 26
Riverdale, MD 20737

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, sex, religion, age, disability, political beliefs, sexual orientation, or marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA'S TARGET Center at (202) 720–2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326–W, Whitten Building, 1400 Independence Avenue, SW, Washington, DC 20250–9410 or call (202) 720–5964 (voice and TDD). USDA is an equal opportunity provider and employer.

Mention of companies or commercial products in this report does not imply recommendation or endorsement by USDA over others not mentioned. USDA neither guarantees nor warrants the standard of any product mentioned. Product names are mentioned solely to report factually on available data and to provide specific information.

This publication reports research involving pesticides. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

Table of Contents

I. Introduction 1

A. Biology of LBAM 1

B. Moth Pheromones 2

II. Purpose and Need 2

III. Alternatives 3

A. No Action 4

B. Preferred Alternative 5

IV. Environmental Impacts 7

A. No Action 8

B. Preferred Alternative 10

C. Cumulative Effects 11

V. Threatened and Endangered Species 12

VI. Other Considerations 12

VII. List of Agencies and Persons Consulted 14

VIII. References 15

Appendix A. Map of LBAM Population and State Interior Quarantine

Appendix B. APHIS' Involvement With LBAM in the Continental United States

Appendix C. LBAM Pheromone

I. Introduction

Light brown apple moth (LBAM), *Epiphyas postvittana* (Tortricidae), is a tortricid leafroller moth native to Australia, but now widely distributed in New Zealand, the United Kingdom, Ireland, and New Caledonia. LBAM was reported in Hawaii in the late 1800s; however, LBAM's presence in the mainland United States was first confirmed in March 2007 in Alameda County, California. Over the last 3 years, surveys have been conducted in California to determine the extent of the infestation. Nineteen counties have been placed under a Federal quarantine (Alameda, Contra Costa, Los Angeles, Marin, Monterey, Napa, Sacramento, San Benito, San Diego, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Solano, Sonoma, and Yolo). A map of the current LBAM population can be found in appendix A.

LBAM is of concern because it can damage a wide range of crops and other plants, including ornamentals. The list of agricultural crops which could be damaged by this pest includes grapes, citrus, stone fruit (peaches, plums, nectarines, cherries, and apricots), and many others. The complete host list contains well over 1,000 plant species, and more than 250 fruits and vegetables.[1]

California Department of Food and Agriculture (CDFA) and the U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) have been working cooperatively to control LBAM. A brief history of APHIS' involvement in LBAM treatments and environmental documentation can be found in appendix B.

A. Biology of LBAM

The life cycle of LBAM is continuous and does not have a winter resting period (Johnson et al., 2007). However, the colder winter temperatures considerably slow the development of the larval stage (Johnson et al., 2007). The number of LBAM generations produced in a growing season varies from one to more than four, depending on environmental conditions (Danthanarayana, 1983; Mo et al., 2006a). It is estimated that there may be a potential for as many as five generations to occur in some areas of California.

LBAM egg masses can generally be found on the leaves of host plants; however, the egg masses also have been known to occur on the fruit and stems of host plants (Johnson et al., 2007). Once the larvae hatch, they construct a silken shelter and begin feeding on the host plant as they go through up to six stages of growth (Johnson et al., 2007). The larval

[1] The host list is available at: http://www.cdfa.ca.gov/phpps/PDEP/target_pest_disease_profiles/LBAM_HostList.pdf.

stages are the only feeding stages for LBAM. Young larvae are pale yellow, while the mature larvae are pale green (Mo et al., 2006b). The larvae reach approximately three-fourths of an inch (18 millimeters) in length before pupation (Johnson et al., 2007).

Adults emerge after a pupation period of 1 to several weeks and mate soon after emergence (Johnson et al., 2007). Both female and male adults are light brown in color; however, the females are distinguished by a dark spot in the center of the front wings when folded (Johnson et al., 2007). LBAM adults are capable of flying only short distances to find a suitable host. Most moths fly no further than 330 feet (100 meters), although some may fly as far as 2,000 feet (600 meters) (Suckling et al., 1994). The adult life span is 2 to 3 weeks, with longevity influenced by host plant and temperature (Johnson et al., 2007). Female moths generally deposit egg masses containing 20 to 50 eggs (Johnson et al., 2007). Fecundity varies—females have been known to lay up to 1,500 eggs in their lifetime; however, the typical range of eggs per female LBAM is between 118 to 462 (Johnson et al., 2007).

B. Moth Pheromones

Female moths naturally emit pheromones (a chemical attractant) to find a mate. The chemicals that female moths use to attract males are a mixture of compounds that, when combined, are species-specific so they only attract that species of moth. Closely related species may have similar pheromones. Commercial manufacturing of synthetic pheromones has been done for a number of years. These synthetic pheromones are exact replicas of the natural ones. Pheromones are used to trap specific moths and for mating disruption. Mating disruption involves saturation of the area with enough pheromone that the male moth has difficulty locating a female. The mating disruption results in fewer females mating successfully thus lowering the population.

An LBAM-specific pheromone has been developed and can be used for LBAM mating disruption. More information on this pheromone and its toxicity is available in appendix C.

II. Purpose and Need

APHIS is responsible for taking actions to exclude, eradicate, and/or control plant pests under the Plant Protection Act (7 United States Code (U.S.C.) 7701). LBAM is recognized as a pest with the potential to cause damage to agricultural crops and natural resources. Its presence can also have trade implications. Therefore, it is important that APHIS take the steps necessary to control LBAM in California.

CDFA and APHIS have been working cooperatively on an LBAM program since LBAM was identified in Alameda County, California, in March 2007. Since the first detection of LBAM, pheromones have been considered to be a primary tool for use in the LBAM program. Given the increases in LBAM population densities and the extent of contiguous spread of LBAM that has occurred over the past 3 years, APHIS has concluded that eradication is no longer feasible in California. Hence, the LBAM program has shifted its goal from eradication to control and suppression.

A number of tools that could be used in LBAM suppression and control have been examined under a programmatic environmental assessment (EA) prepared by APHIS and an environmental impact report prepared by CDFA. These tools included the use of various formulations of LBAM pheromone, *Bacillus thuringiensis* var. *kurstaki* (Btk), spinosad, a male attractant station, biocontrol with trichogramma wasps, and sterile insect technology. Upon evaluation of different treatment options in relation to the current LBAM infestation, CDFA and APHIS have decided that the treatment methods for LBAM should primarily consist of LBAM pheromone dispensers and possibly sterile insect technology.

There is a need to provide industry with new tools to suppress LBAM populations within the State interior quarantine area (see appendix A). CDFA and APHIS have not funded treatments within the State interior quarantine since 2007. Subsequently, the LBAM population has grown in these areas and the State interior quarantine has continued to expand to surrounding areas.

In addition to control efforts in the State interior quarantine zone, there is also a need to eradicate small populations of LBAM more efficiently. The current process can take from 90 to 120 days to deploy pheromone dispensers after detection of LBAM in a new area outside of any State interior quarantined areas.

This EA has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA) and APHIS' NEPA implementing procedures (7 Code of Federal Regulations (CFR) part 372) for the purpose of evaluating how the proposed action, if implemented, may affect the quality of the human environment.

III. Alternatives

There are two different needs of the LBAM program within California. The map in appendix A identifies the areas within the current State interior quarantine where control efforts may occur. The areas outside the State

interior quarantine areas have the potential to harbor small LBAM populations where eradication efforts may occur.

This EA analyzes the potential environmental consequences of the proposed action to control LBAM with the use of LBAM pheromone dispensers. Two alternatives are being considered: (1) the current isolated population process which has no control efforts within the State interior quarantine (no action alternative), and (2) establishment of a new procedure for the use of LBAM pheromone dispensers within the State of California for treatment of small populations, as well as the distribution of LBAM pheromone dispensers to industry for use in agricultural areas within the State interior quarantined areas (preferred alternative).

A. No Action

1. State Interior Quarantine Areas

Current activities in the State interior quarantine include actions by industry to comply with the Federal and State interior quarantine and voluntary actions by industry to suppress LBAM populations. Under the no action alternative, APHIS would not provide industry with pheromone dispensers. Industry would be limited in the tools available to them to control LBAM. Pheromone dispensers are not available to industry to purchase on their own.

The Federal quarantine requires that all commodities be inspected and found free of LBAM in order to allow movement into another State. Growers are free to use any tools to ensure their commodities are free of LBAM before shipment.

The State interior quarantine requires growers and nurserymen within this area to abide by certain restrictions in order to move commodities outside the quarantine. Commodities must be declared free of LBAM either by inspection or the use of an approved treatment. CDFA quarantine restrictions can be found at http://pi.cdfa.ca.gov/pqm/manual/ pdf/419.pdf. The list of approved chemical treatments can be found at http://phpps.cdfa.ca.gov/LBAM/LBAM%20Approved%20Treatments/currently%20posted/LBAMApprovedTreatments.pdf.

As the State interior and Federal quarantine grows, as a result of the increased population and natural spread of LBAM, more and more nurseries and growers will be subject to these quarantine restrictions.

2. Small Population Areas

Under the no action alternative, APHIS would continue with the current process to treat outlying areas known in this document as small LBAM population areas. After detection of a male LBAM in a new area, a treatment boundary is defined and a draft finding of no significant impact (FONSI) is prepared that identifies a 200-meter treatment area around each find in which LBAM pheromone dispensers are to be applied at a

rate of 250 per acre. The draft FONSI is made available to the public for a 30-day comment period. Upon conclusion of the comment period, APHIS analyzes any comments received and makes a determination as to whether a FONSI is appropriate. If a FONSI is determined to be appropriate, notification and treatments commence after the FONSI is signed. Based on APHIS' previous experience, this process can take between 90 to 120 days to complete after the initial LBAM detection in the area. This time delay between the initial find and commencement of treatments can be reduced by eliminating the FONSI process without negatively impacting the public notification.

Once the FONSI is signed, the LBAM pheromone dispensers (see figure 1) are applied to trees and shrubs (see figure 2) in the treatment area for up to 1 year. The LBAM pheromone dispensers are replaced after 6 months. At the conclusion of the treatment, the LBAM pheromone dispensers are removed and disposed of according to label directions.

Figure 1. An LBAM pheromone dispenser.

B. Preferred Alternative

Under the preferred alternative, pheromone dispensers would be distributed to industry within the State interior quarantine, and a new process for small population areas would be implemented which would allow for faster deployment of pheromone dispensers.

1. State Interior Quarantine Areas

Under the preferred alternative, industry would still have to comply with Federal and State interior quarantine restrictions for interstate and intrastate movement of host material, as discussed under the no action alternative. APHIS would provide LBAM pheromone dispensers to

Figure 2. Application of a pheromone dispenser in the LBAM program.

California County Agriculture Commissioners to distribute to growers and nurserymen who request them. The distributions would begin in fall 2010 and would continue until the supply of LBAM pheromone dispensers is depleted (approximately 3 to 5 years, depending on demand).

The LBAM pheromone dispensers would be applied by industry according to the label instructions at a rate 250 per acre and would be replaced every 6 months. This would add a new tool for industry to use in their efforts to suppress LBAM on their properties.

2. Small Population Areas

Under the preferred alternative, APHIS is proposing a new process for treating newly detected small population areas outside the State interior quarantine. The placement of pheromone dispensers would be the same as under the no action alternative; however, APHIS would no longer prepare and publish individual site-specific FONSIs for each treatment area. Instead, a treatment notification would be published on APHIS' Web site. Notification of public meetings and notices to any residents affected will be provided according to CDFA's current practices.

As in the no action alternative, the LBAM pheromone dispensers will be in the treatment areas for up to 1 year and would be replaced at the 6-month interval. Once treatment has concluded, the LBAM pheromone dispensers will be removed.

IV. Environmental Impacts

LBAM pheromone dispensers would be used under both the no action alternative and the preferred alternative. The effects and risks of these types of pheromones is found in appendix C. A summary of the appendix is outlined below.

The pheromone is suspended within a plastic casing (known as a dispenser) that is clipped to a tree or a shrub, or sticks when there are no trees or shrubs in the area (refer to figures 1 and 2 above). The LBAM pheromone is slowly released into the surrounding air attracting male LBAM in search of females for mating purposes.

The mixture of pheromone chemicals that a female emits is species-specific, meaning it attracts the target species but not other species; however, closely related species of moths may also be attracted (Pheronet, 2010).

The LBAM pheromone contains a blend of two chemicals that provide the species specificity to ensure attraction of the male LBAM for reproduction. LBAM pheromone has been known to be slightly attractive to other torticids and one pyralid species moth.

The pheromone itself is not known to be detectable by humans or animals. It is sensitive to ultraviolet light and breaks down easily in terrestrial and aquatic environments. It is unlikely to cause any effects to nontarget insects, mammals, aquatic species, or humans based on its low toxicity (see appendix B). Although some closely related species may be attracted to the pheromone, the pheromone itself is not likely to cause any noticeable effects. In addition, because it is contained within a plastic dispenser, pheromone chemical exposure to humans and wildlife will be minimal. The LBAM pheromone dispenser will not be applied near or over water sources (creeks, rivers, streambeds, or lakes) limiting any potential for the chemical to get into an aquatic environment. However, if the pheromone dispenser were to accidentally get into water, the pheromone would not be expected to impact aquatic resources due to its low toxicity and solubility in water. The dispensers will be removed from the treatment site at intervals of 6 months. Pheromone potency can begin to decline at about this time and their collection will prevent litter from accumulating. The applicator will ensure that each dispenser has been collected. Since the beginning of the LBAM pheromone dispenser treatments in 2007, all dispensers have been recovered from all completed treatment areas.

A. No Action

Under the no action alternative, the environmental effects are mainly attributed to the increases in LBAM populations throughout California.

1. State Interior Quarantine

Under the no action alternative, the growers would not have the ability to use LBAM mating disruption pheromone dispensers as part of their integrated pest management plan to manage LBAM. Growers and nursery personnel would have to rely on other chemical and nonchemical means to suppress LBAM populations.

Since 2007, CDFA and APHIS have monitored LBAM populations in California, and have documented the continual expansion of LBAM within regulated areas and into new areas in California. Average California trap catches have steadily increased from 0.1 moth/trap/month in June 2007 to 0.2 moths/trap/month in April 2008, and 0.4 moths/trap/month in April 2009 (APHIS, 2010).

As has happened in the past, when the LBAM population increases, the quarantine will also expand thereby adding costs to industry. The California Nursery Growers Commission/Nursery Growers Association estimated that the procedures to meet compliance could increase producer costs by $2,250 to $4,570 per acre annually (APHIS, 2010). These additional costs above current non-LBAM pest management costs are associated with the use of chemical applications, pheromone dispensers, and monitoring of the premises (APHIS, 2010).

In addition to interstate and intrastate commodity restrictions, there have also been restrictions on international trade. After detection of the moth in California, the government of Canada outlined new regulatory controls restricting the importation into Canada of fresh fruits and vegetables and cut flowers from quarantined counties in California. Similar restrictions have been imposed by Mexico, and may be adopted soon by other countries, such as China (APHIS, 2010).

There is a threat that LBAM populations could damage crops and nursery stock. In 2009, two organic caneberry fields in Santa Cruz County, California, were found to be heavily infested with LBAM. The moth population had increased rapidly and the organic-certified pest management practices were insufficient to control LBAM. Over $1 million in losses were incurred by the growers (APHIS, 2010).

In addition, there is a potential that LBAM could cause damage to shrubs and trees in natural areas. Of the eight species of Tortricidae causing moderate-to-severe damage to Monterey pine (*Pinus radiata* D. Don) in Australia, LBAM is the most common. Neumann & Marks deemed LBAM an important defoliator “sometimes associated with significant

damage to seedlings and trees of…conifers" in New South Wales, South Australia, and Victoria. They reported larvae damaged needles and terminal buds of *P. radiata* in nurseries and young plantations. The moth is also among the most important tortricid pests of conifers in New Zealand and, in addition is found on plantation eucalyptus there. In New Zealand, LBAM is found on *P. radiata* and other *Pinus* spp., Douglas fir, and *Picea* spp. Larvae use the stems and apical buds of the leading shoots of conifers as winter-feeding and refuge sites. The bud is destroyed and the apical few centimeters of the leader hollowed out; damage results in a malformed stem or multiple leaders. On pines, larvae web needles together to form tubular shelters; feeding damages needles, flowers, and green cones. In New Zealand, LBAM has been found to be about as abundant in *P. radiata* plantation forests as it was in fruit orchards (APHIS, 2010).

The moth's introduction into the continental United States puts at risk native American plant taxa determined by the U.S. Department of the Interior's Fish and Wildlife Service to be in danger of extinction (50 CFR §17.12, 2005). At least 70 of these species, subspecies, or varieties were identified as potential or actual hosts of LBAM, based on the moth's known host range. The list includes 26 species, subspecies, or varieties, on which the moth has been recorded since its introduction into California, and which, therefore, are under increased threat of extinction (APHIS, 2010).

2. Small Population Areas

Under the no action alternative, the current process can delay the treatment of small populations. The smaller the population the more effective mating disruption is as an eradication tool (Fischer et al., 1985; Webb et al., 1990; Carde and Minks, 1995). Therefore, delays in treatment that allow the LBAM population to expand will result in a decrease in the effectiveness of mating disruption.

The current process (preparation of site-specific FONSIs followed by a 30-day public comment period, evaluation of the comments, and the signing of the FONSI) has resulted in the preparation of 45 individual site-specific FONSIs for 95 individual treatment sites. Since 2007, the public comment process has only yielded a total of 14 comments from three commenters.[2] Rather than providing pertinent information relative to potential risk, the comments were questions regarding how LBAM pheromone dispensers work and how the dispensers are applied. These comments could have been obtained through another public process, such as public meetings that are held by CDFA prior to treatments. Thus far, after preparing 45 FONSIs for LBAM dispenser treatments, no relevant information has been obtained that would justify the delay in treatments

[2] San Jose treatment area, June 2008—available at http://www.aphis.usda.gov/plant_health/ea/downloads/lbam-fonsi-sanjose-6-08.pdf.

caused by the current process (the generation of the FONSI and the 30-day public comment period). The delay caused by the comment period is especially onerous when it is obvious that delays allowing populations to increase also decrease the efficacy of mating disruption.

The LBAM program has completed 95 different treatment areas with the use of LBAM pheromone dispensers. All LBAM pheromone dispensers have been recovered and no environmental impacts have been observed or reported. From the program's experience with the LBAM pheromone dispenser use in small population areas, there are no significant impacts.

B. Preferred Alternative

1. State Interior Quarantine Areas

LBAM mating disruption pheromone dispensers would be made available to growers and nursery personnel to use on their properties within State interior quarantine areas. This could reduce the use of traditional chemical pesticides by providing growers and nursery personnel with an additional tool to use in helping control the LBAM populations and helping slow the natural spread of LBAM. The LBAM pheromone dispensers would be made available to individual growers at 6-month intervals for as long as the dispensers are available. It is estimated that the current supply of dispensers would last from 3 to 5 years, depending upon demand.

Although this program would provide a large number of LBAM pheromone dispensers, they would be distributed throughout the State interior quarantine and would only be applied on the individual properties of the growers and nurseries. This program could continue for several years, depending upon the demand for LBAM pheromone dispensers. If there is low demand for LBAM pheromone dispensers, the areas that receive dispensers could be treated year after year, resulting in reduced LBAM populations in those specific areas. If there is high demand for LBAM pheromone dispensers, the dispensers may only be available for a few LBAM life cycles, thus limiting the effects on the LBAM populations in those areas.

Studies have shown that moth populations can be successfully controlled using pheromones for mating disruption. Generally, studies show that the smaller the population at the start of the program, the greater the chance of success in suppressing moth populations. Pheromones used to control oriental fruit moth showed decreased numbers of moths trapped, reduced fruit and shoot damage, and less successful mating (Vickers et al., 1985). Another study showed fewer trap catches and less pink bollworm damage to cotton bolls in areas using pheromone dispensers when compared to conventionally treated areas (Staten et al., 1987). In addition, each year of pheromone use further suppresses the population. In a 5-year study conducted in the State of Washington, fruit damage by codling moth was

60 to 97 percent lower in the last year of the study than in the first year for all but one site (Brunner et al., 2002).

There is a potential to disrupt the mating of some native tortricids and one species of pyralid as they have been collected during monitoring efforts in California using traps containing LBAM pheromone. The species collected are common and widespread, and any potential population level effects to these species would be localized to areas of treatment and not expected to have negative impacts on the population over their entire range.

2. Small Population Areas

Under the preferred alternative, APHIS would be allowed to treat small populations as soon as they are detected. The environmental effects would be the same as those described under the no action alternative. The only difference would be that the new process would allow for a more rapid deployment of LBAM pheromone dispensers. Being able to treat LBAM as soon as detected allows for mating disruption to occur earlier, thus resulting in a greater potential to lower LBAM populations in these areas. Removing the current process of preparing a FONSI and allowing for a 30-day public comment period would not result in any negative impacts. All comments that have been received as a result of the LBAM pheromone dispenser FONSIs have been questions regarding how LBAM pheromone dispensers work and how they are applied. These comments could have been obtained through another public process.

A change in the process used to deploy LBAM pheromone dispensers would allow for a faster deployment of pheromone dispensers, and there would be no environmental effects.

C. Cumulative Effects

Cumulative effects from potential LBAM pheromone dispenser use are expected to be negligible due to the specificity of the pheromone to LBAM and its minimal risk to human health and the environment. The impacts are limited to LBAM and potential minor impacts to some tortricids and one pyralid species that have been attracted to LBAM pheromone baited traps.

The European grapevine moth (EGVM) has recently been found in Napa, Sonoma, and other areas of California. There is an active EGVM program which uses pheromone dispensers and chemicals as part of its eradication strategy. Currently, the EGVM program consists of voluntary pesticide treatments in vineyards. These chemicals would also aid in decreasing LBAM populations because they are not species specific. In addition, industry has been supplied with EGVM pheromone dispensers; however, the EGVM pheromone dispensers should not affect the LBAM program because in field studies EGVM pheromone dispensers placed in traps

baited for LBAM showed that there was no impact on LBAM moth captures (ITWG, 2010). There is no data to suggest the tortricids and pyralid attracted to LBAM pheromone are also attracted to EGVM pheromone.

Other programs utilize pheromones in traps; nevertheless, because of the low levels of pheromones and the specificity of pheromones used in these traps, it is unlikely that these would interfere with the LBAM program.

V. Threatened and Endangered Species

Section 7 of the Endangered Species Act (ESA) and ESA's implementing regulations require Federal agencies to ensure that their actions are not likely to jeopardize the continued existence of federally listed threatened and endangered species or result in the destruction or adverse modification of critical habitat.

APHIS has determined that deployment of pheromone dispensers in agricultural areas by nurserymen and growers will have no effect on federally listed species or designated critical habitat in agricultural areas of California.

This determination is based on the evidence that the pheromone dispensers themselves do not pose any direct risks to the species. Physical disturbance to listed species through deployment and replacement of dispensers would not occur because dispensers would be used in lands that are already highly disturbed by agricultural activities, such as tilling, pesticide application, and harvesting. Listed butterflies and other insects would not be affected by the pheromone because it is specific to LBAM.

For treatment of small LBAM populations outside the State interior quarantine areas in California, APHIS will work with the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) to ensure that treatment activities do not adversely affect listed species or their designated and proposed critical habitats. No treatments will occur until APHIS has completed a determination of effects on listed species and their habitats and, if necessary, a section 7 consultation with FWS and/or NMFS has been concluded.

VI. Other Considerations

Executive Order (EO) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," focuses Federal attention on the environmental and human health conditions of minority and low-income communities, and promotes community access to public information and public participation in matters relating to human

health or the environment. This EO requires Federal agencies to conduct their programs, policies, and activities that substantially affect human health or the environment in a manner so as not to exclude persons and populations from participation in or benefiting from such programs. It also enforces existing statutes to prevent minority and low-income communities from being subjected to disproportionately high or adverse human health or environmental effects. APHIS has determined that the environmental and human health effects from the proposed use of LBAM pheromone dispensers are minimal and are not expected to have disproportionate adverse effects to any minority or low-income populations.

EO 13045, "Protection of Children from Environmental Health Risks and Safety Risks," acknowledges that children, as compared to adults, may suffer disproportionately from environmental health and safety risks because of developmental stage, greater metabolic activity levels, and behavior patterns. This EO (to the extent permitted by law and consistent with the agency's mission) requires each Federal agency to identify, assess, and address environmental health risks and safety risks that may disproportionately affect children. A low potential for exposure and low toxicity of LBAM pheromone dispensers minimizes any potential risk to children.

VII. List of Agencies and Persons Consulted

California Department of Food and Agriculture
Plant Health and Pest Prevention Services
1220 N Street
Sacramento, CA 95814

U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine
Emergency and Domestic Programs
4700 River Road, Unit 26
Riverdale, MD 20737

U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine
Emergency and Domestic Programs
4700 River Road, Unit 150
Riverdale, MD 20737

U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Policy and Program Development
Environmental and Risk Analysis Services
4700 River Road, Unit 149
Riverdale, MD 20737

U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine
9550 Micron Avenue
Sacramento, CA 95827

VIII. References

APHIS—See U.S. Department of Agriculture, Animal and Plant Health Inspection Service

Brunner, J., Welter, S., Calkins, C., Hilton, R., Beers, E., Dunley, J., Buskirk, P.V., (2002). Mating disruption of codling moth: a perspective from the Western United States. International Organisation for Biological and Integrated Control of Noxious Animals and Plants–Western Palaearctic Regional Section Bulletin 25(9), 11–21.

Carde, R. T., and Minks, A.K., 1995. Control of moth pests by mating disruption: successes and constraints. Annual Review of Entomology 1995. 40: 559–580.

Danthanarayana, W., 1983. Population ecology of the light brown apple moth, *Epiphyas postvittana* (Lepidoptera: Tortricidae). J. Animal Ecology. 52:1–33.

Fisher, M.E., Van Den Driessche, P., and Barclay, H.J., 1985. A density dependent model of pheromone trapping. Theoretical Population Biology 27: 91–104.

ITWG—See International Technical Working Group

International Technical Working Group, 2010. Final report of the international technical working group for the European grape vine moth (EGVM) in California. February 10, 2010. 10 pages.

Johnson, M.W., Pickel, C., Strand, L., Varela, L., Wilen, C., Bolda, M., Flint, M., Lam, W., Frankie, K., and Zalom, F., 2007. Light brown apple moth in California: quarantine, management, and potential effects. UC statewide IPM program: light brown apple moth. [Online.] Available: http://www.ipm.ucdavis.edu/PDF/PUBS/lbam091207.pdf. [2007, July 17]. 28 pg.

Mo, J., Glover, M., Munro, S., and Beattie, G.A., 2006a. Evaluation of mating disruption for control of light brown apple moth (Lepidoptera: Tortricidae) in citrus. J. Economic Entomol. 99(2):421–426.

Mo, J., Glover, M., Munro, S., and Beattie, G.A., 2006b. Development of *Epiphyas postvittana* (Lepidoptera: Tortricidae) on leaves and fruit of orange trees. J. Econ. Entomol. 99(2):1321–1326.
Pheronet Database, 2010. [Online]. Available: http://www.phero.net/index.html [2010, Aug. 30].

Staten, R.T., Flint, H.M., Weddle, R.C., Quintero, E., Zarate, R.E., Finnell, C.M., Hernandes, M., Yamamoto, A., 1987. Pink bollworm (Lepidoptera: Gelechiidae): Large-scale field trials with a high-rate gossyplure formulation. J. of Econ. Entomol. 80(6), 1267–1271.

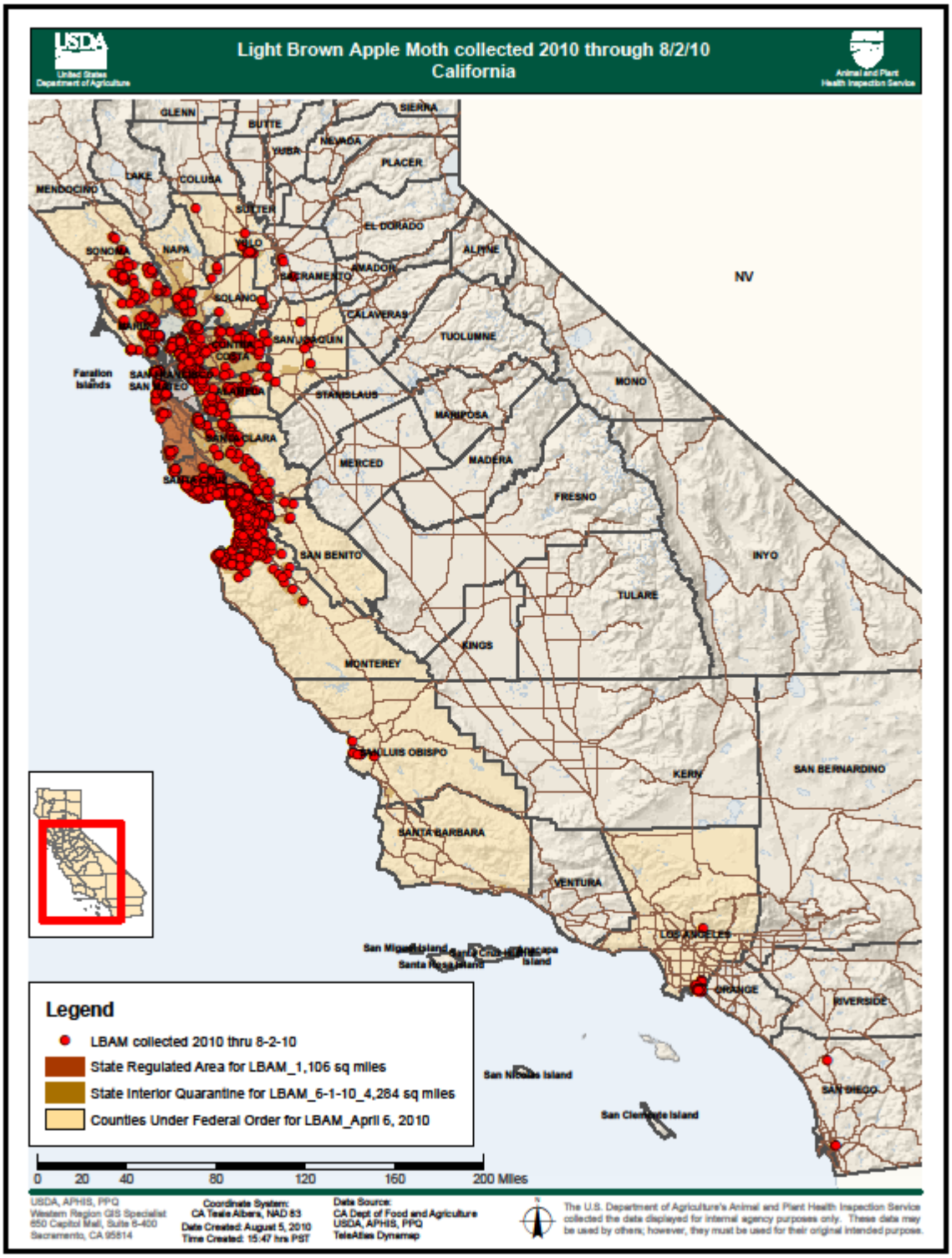
Suckling D.M., Brunner, J.F., Burnip, G.M., Walker, J.T.S., 1994. Dispersal of *Epiphyas postvittana (*Walker) and *Planotortrix octo Dugdale* (Lepidoptera: Tortricidae) at a Canterbury, New Zealand orchard. NZ J Crop Hort Sci 22: 225–34.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, 2010. Draft APHIS response to petitions for the reclassification of light brown apple moth [*Epiphyas postvittana* (Walker)] as a Non-Quarantine Pest. January 2010.

Vickers, R.A., Rothschild, G.H.L., Jones, E.L., (1985). Control of the oriental fruit moth, *Cydia molesta* (Busck) (Lepidoptera: Torticidae), at a district level by mating disruption with synthetic female pheromone. Bulletin of Entomological Research 75(4), 625–634

Webb, R.E., Leonhardt, B.A., Plimmer, J.R., Tatman, K.M., Boyd, V.K., Cohen, D.L., Schwalbe, D.L., and Douglas, L.W., 1990. Effect of racemic disparlure released from grids of plastic ropes on mating success of gypsy moth (Lepidoptera: Lymantriidae) as influenced by dose and by population density. J. Econ. Entomol. 83:910–916.

Appendix A. Map of LBAM Population and State Interior Quarantine



Appendix B. APHIS' Involvement with LBAM in the Continental United States

In February 2007, LBAM was found near Berkeley in Alameda County, California. On March 16, 2007, the Agriculture Research Service Systematic Entomology Laboratory in Washington, DC, confirmed the identification of the original detection as LBAM. In response, pheromone-baited traps were placed in Alameda and Contra Costa Counties to determine if LBAM populations existed in the area. Trapping was soon expanded to other counties. On April 20, 2007, the California Department of Food and Agriculture (CDFA) established a quarantine area of at least 182-square miles in Alameda, Contra Costa, San Francisco, Marin, and Santa Clara Counties.

A. Federal Quarantine

The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) first issued a Federal quarantine Order on May 2, 2007, requiring trapping, inspection, and certification of all nursery stock and host commodities from quarantine areas. The quarantine areas continue to be modified as needed. The current quarantine includes the counties of Alameda, Contra Costa, Los Angeles, Marin, Monterey, Napa, San Benito, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Solano, Sonoma, and Yolo. The quarantine area will continue to expand if LBAM is identified in new counties.

B. Isolated Populations

CDFA and APHIS started treatment of small populations in June 2007. The first environmental assessment (EA) was drafted to include isolated population treatments in Napa and Sonoma with both pheromone dispensers (formerly known as twist ties) and *Bacillus thuringiensis* var. *kurstaki* (Btk). This EA was revised in July 2007 to include other pheromone dispenser treatment areas; however, individual treatments were required to have a posting of a FONSI on the APHIS' Web site and a 30-day public comment period. Forty-five FONSIs have been drafted since July 2007 for 95 individual treatment sites in Alameda, Contra Costa, Los Angeles, Marin, Napa, San Diego, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Solano, Sonoma, and Yolo. All FONSIs are available on the APHIS Web site at http://www.aphis.usda.gov/plant_health/ea/lbam.shtml,

C. Aerial Treatments

In an attempt to disrupt LBAM mating, aerial applications of a microencapsulated formulation of LBAM pheromone were made on four consecutive nights (beginning on the night of September 9 and ending in the early morning hours of September 13, 2007) to treat the Seaside, Marina, Sand City, Del Rey Oaks, Monterey, and Pacific Grove areas of Monterey County, California. The total treatment area was approximately 36,500 acres. A second treatment of the microencapsulated pheromone was applied to the same treatment area and concluded on October 27, 2007. An environmental document, Treatment of Light Brown Apple Moth in the Seaside Area in California, Environmental Assessment, July 2007, was prepared for this treatment and a

FONSI was signed September 7, 2008. Both of these documents are available on the APHIS Web site at http://www.aphis.usda.gov/plant_health/ea/lbam_archive.shtml.

Santa Cruz (in Santa Cruz County), the North Salinas, Boronda, Prunedale, and Royal Oaks areas of northern Monterey County also received one aerial application of the microencapsulated pheromone in November, 2007. These applications concluded on November 11, 2007. The total treatment area was approximately 52,000 acres. An environmental assessment for this treatment was prepared in September, 2007 titled Treatment Program for Light Brown Apple Moth in Santa Cruz and Northern Monterey Counties, California Environmental Assessment, September 2007. A FONSI was signed on November 2, 2007. Both of these documents are available on the APHIS Web site at http://www.aphis.usda.gov/plant_health/ea/lbam_archive.shtml.

There have not been any other areas treated with aerial pheromone since the LBAM program started. Since November 2007, the LBAM program has focused on treating small population areas outside the main population centers with LBAM mating disruption pheromone dispensers.

D. Programmatic Document

In February 2008, a programmatic EA was prepared to examine different formulations of pheromone, Btk, spinosad, male attractant stations, and trichogramma wasps. Upon review of the public comments received and evaluation of the needs of the program, it was determined that further evaluation and study was needed before a program could be outlined. This document was never finalized and no FONSI was signed. To date, there is no defined comprehensive LBAM program, although APHIS anticipates developing a plan at some point in the future.

E. Sterile Insect Technology Research

In 2009, APHIS prepared an EA for the study of sterile insect technology for use in the LBAM program in Napa and Sonoma. This study is still ongoing and further study is needed before SIT can be incorporated into the LBAM program.

Appendix C. LBAM Pheromone

Introduction

The light brown apple moth (LBAM) pheromone belongs to a group of compounds known as straight chain lepidopteran pheromones (SCLP) that serve as a chemical cue attracting male moths to females of the same species for reproduction. Lepidopteran pheromones are typically a unique mixture of short chain hydrocarbons with one of several functional groups (ie., acetate, alchohol, and aldehyde). In the case of LBAM, the female emits a pheromone that contains a blend of two acetate based hydrocarbons (E-11-Tetradecen-1-yl acetate and (E,E)-9,11-Tetradecadien-1-yl acetate) that provides the species specificity to ensure attraction of the male LBAM for reproduction (Bellas et al., 1983). The identification and synthesis of these types of pheromones have been successfully used as a means to provide species-specific suppression of target insect populations including LBAM (Suckling and Shaw, 1992; Suckling and Shaw, 1995; Suckling et al., 2007; Carde and Minks, 1995; Plettner, 2002; Welter et al., 2005; Witzgall et al., 2008). This type of insect control acts by releasing a synthetic version of the naturally produced pheromone into the atmosphere which can reduce reproduction by either creating false plumes that male moths will follow, mask or camouflage the natural plumes released by the female moths, or through decreased sensitivity of male moths to the pheromone due to high background concentrations (Stelinski, 2007). Release of synthetic pheromone into target areas will be implemented using the formulation, Isomate® LBAM-Plus, which is a dispenser that contains the LBAM pheromone. Dispensers are attached to a tree or other object by hand at a rate of 250 per acre where the LBAM pheromone can volatilize into the atmosphere for approximately 180 days before removal and replacement with a new dispenser.

Current registration data requirements for SCLP in the United States, Canada and Europe are less than conventional insecticides (OECD, 2002; EPA, 2007). The reduced data requirements are based on similarities in toxicity, exposure and environmental fate that suggest that these types of pheromones pose minimal risk to human health and the environment. Due to these similarities in fate and effects, regulatory agencies have adopted a structure activity relationship approach for SCLP (Weatherston and Minks, 1995). This assessment summarizes the range of toxicity data for the LBAM pheromone, as well as other acetate-based SCLP, and describes the potential environmental risk to terrestrial and aquatic organisms.

Effects Analysis

A. Terrestrial

The reported acute toxicity values for the LBAM pheromone show low oral, dermal and inhalation toxicity based on information provided in the material safety data sheet (Pacific Biocontrol, 2007). Dermal and oral median lethality dose values (LD_{50}) are greater than 2 and 5 g/kg, respectively, while the inhalation median lethality concentration value (LC_{50}) is reported as greater than 5.26 mg/L. Available acute mammalian toxicity data for approximately 10 structurally similar lepidopteran pheromones suggest that these types of compounds would be considered practically nontoxic with median lethal oral dose values ranging from greater than

5 grams per kilogram (g/kg) to greater than 34.6 g/kg. Acute dermal toxicity is also considered low with LD_{50} values ranging from greater than 2 g/kg to 20.25 g/kg based on study results from nine acetate based straight chain lepidopteran pheromones (Touhey 1990; Inscoe and Ridgway, 1992). Inhalation hazards are also low based on results compiled from three studies that show that the LC_{50} values range from 3.3 to 33.2 milligrams per liter (mg/L) (Touhey, 1990; Inscoe and Ridgway, 1992; Weatherston and Stewart, 2002). Chronic toxicity data is limited for SCLP since the U.S. Environmental Protection Agency (EPA) waives these types of studies because of their low acute toxicity and the low potential for long-term exposure. Available subchronic and developmental mammalian toxicity studies have shown no mutagenic, carcinogenic, or developmental effects for all tested pheromones (Touhey, 1990; EPA, 1996). Daughtrey et al. (1990) dosed rats daily 5 days per week for 13 weeks with tridecyl acetate at doses ranging from 0.1 to 1.0 g/kg/day. The calculated no observable effect level was found to be 0.1 g/kg/day based on a slight increase in liver weight which is consistent with long-term dosing of chemicals and is not specific to this group of pheromones.

LBAM pheromone toxicity to birds has not been characterized based on a review of the available literature. However, from acute avian studies that have been conducted using similar SCLP, the toxicity to birds is considered to be low. Acute oral LD_{50} values for bobwhite quail are reported to be greater than 2 g/kg while mallard values range from greater than 2 g/kg to greater than 10 g/kg (Weatherston and Stewart, 2002).

Nontarget toxicity data for terrestrial invertebrates is limited to acute studies with the honey bee for the LBAM technical material and a formulation not proposed for use in the program. Ingestion and contact exposures to a 0.1 or 1.0% concentration of the technical material and a microencapsulated formulation did not result in any mortality or changes in food consumption at either concentration (Monheit et al., 2008). The lack of toxicity or sublethal effects at doses above those considered environmentally relevant suggests low acute toxicity. Toxicity to other terrestrial invertebrates is expected to be low based on the mode of action for how these types of compounds work, their species specificity, and their low toxicity to the honey bee and other taxa. The use of insect pheromones is designed to alter insect behavior therefore any nontarget terrestrial invertebrate impacts would be expected to be sublethal in nature. Sublethal impacts to other lepidopteran, such as butterflies, are not expected because of the specificity of the combination of pheromone that is present in the Isomate® LBAM-Plus dispenser. The production of mating pheromones is recognized as a process that is species-specific to attract potential males for reproduction purposes (Roelofs, 1995; Plettner, 2002; Howard and Bloomquist, 2005). The E-11 acetate molecule makes the pheromone specific to leafrollers and some closely related families while the pairing of the E-11 with the E-9 acetate provides specificity to LBAM (Bellas et al., 1983). Due to the amount of pheromone common to some other moths in the mixture there is a possibility that moths that communicate using E-11 tetradecenyl acetate could be affected; however, the frequency of occurrence would be minor compared to LBAM due to the additional pheromone component. This is supported by surveillance trap data for LBAM that has been collected in California. Native moths collected in LBAM sticky traps include six species (*Henricus umbrabasanus, Archips argyrospilus, Clepsis peritana, Clepsis fucana, Argyrotaenia franciscana, Platynota stultana*) of moths from the family Tortricidae and one species (*Achyra occidentalis*) from the family Crambidae which in some cases is considered a subfamily within the Pyralidae family (CDFA, 2007). The collection

of this group of moths is consistent with available pheromone data that suggests this group, as well as species from other closely related families, can be attracted to structurally similar pheromones (Pheronet 2010). The collection of other non-target insects in some of the surveillance traps may be more of a function of trap design, placement and color than a response to the pheromone itself. Trap color, placement and design as well as other factors not related to the pheromone itself have been shown to influence the collection of nontarget invertebrates (Mitchell et al., 1989; Gross and Carpenter, 1991; Clare et al., 2000). These types of impacts would not be expected with the use of dispensers since no trap is being used in the dispersion of the pheromone.

The specificity of pheromones to insects of the same species is not solely related to the unique chemical structure of a given insect pheromone. In the case of lepidopteran pheromones, the chemical structure of each pheromone, and its blend, is a critical component in selecting for species specificity and is evident in the LBAM pheromone where there are two components of the pheromone with a mixture ratio that is unique to LBAM. The use of a primary component in lepidopteran pheromones to attract a specific group of Lepidoptera with the addition of other smaller components in the blend at a specific ratio has been recognized as a means of maximizing species specificity for reproduction (Ando et al. 2004; Baker, 1989; Rumbo et al., 1993; McDonough et al., 1993; Wyatt, 2003; Stelinski et al., 2007). Secondly, the species-specific nature of pheromones is evident in the receiving structure that elicits a response in the male insect (Roelofs, 1995). The specialized sensory systems in male moths, as well as the physical structure of the antennae further increase species specificity when compared to other insects, such as butterflies. Other lepidopterans, such as butterflies, have very different antennae structures, as well as reproductive behavior patterns, that further reduce the potential for moth SCLP to affect butterfly behavior and reproduction (Myers, 1972; Rutowski, 1991; Wyatt, 2003).

B. Aquatic

Available aquatic toxicity data for the technical active ingredient demonstrates that acute and chronic toxicity is low for aquatic invertebrates and fish (table 1). All standardized studies listed in the below tables were conducted by the California Department of Fish and Game (CDFG) (CDFG, 2009a–g). Other studies testing the technical LBAM pheromone have shown no effects at 12 or 24 µg/L when using *Ceriodaphnia dubia* or the fathead minnow (Werner et al., 2007).

Additional toxicity testing conducted using the formulation, Isomate® LBAM-Plus, show low acute and chronic toxicity to aquatic invertebrates, fish and algae (CDFG, 2009h-n) (table 2). Aquatic exposures to the dispensers were conducted by cutting the dispensers into 10 cm sections adding a volume of water to obtain the desired concentration and then shaking for 6 hours. This type of exposure is not expected since the dispensers will not be cut into pieces but will be attached to vegetation and other structures and then collected after approximately 180 days and replaced with new dispensers.

Fish toxicity values obtained from the LBAM studies are similar to those that have been reported for other SCLP. Acute toxicity testing using other SCLP show that the range of toxicity values is greater than 100 mg/L to 540 mg/L for the bluegill sunfish and greater than 100 mg/L to 270 mg/L for the rainbow trout (Weatherston and Minks, 1995). Other SCLP toxicity studies

report acute EC_{50} values for aquatic invertebrates such as the freshwater cladoceran ranging from 1.20 to 6.80 mg/L (Weatherston and Minks, 1995; Rosa et al., 2006).

Table 1. Toxicity of LBAM Technical Pheromone to Select Aquatic Species.

Test Organism	Exposure Duration	LC_{50}/EC_{50} (mg/L)	LOEC[2] (mg/L)	NOEC[3] (mg/L)
Ceriodaphnia dubia	96 hours	>262.4	>262.4	262.4
Ceriodaphnia dubia[1]	7 days	120.19	100.0	50.0
Rainbow trout	96 hours	>262.4	>262.4	262.4
Fathead minnow	96 hours	>328.0	>328.0	328.0
Fathead minnow[1]	7 days	>200	>200	200
Bullfrog tadpoles	96 hours	>114.8	>114.8	114.8
Selanastrum capricornutum	96 hours	1.48	1.17	<1.17

[1] Response based on effects to reproduction.
[2] Lowest observable effects concentration.
[3] No observable effects concentration.

Table 2. Toxicity of the Formulation Isomate® LBAM-Plus to Select Aquatic Species.

Test Organism	Exposure Duration	LC_{50}/EC_{50} (mg/L)	LOEC (mg/L)	NOEC (mg/L)
Ceriodaphnia dubia	96 hours	>187	>187	187
Ceriodaphnia dubia[1]	7 days	>187	93.75	46.88
Rainbow trout	96 hours	>187	>187	187
Fathead minnow	96 hours	>187	>187	187
Fathead minnow[1]	7 days	>187	23.44	11.72
Bullfrog tadpoles	96 hours	>27.41	>27.41	27.41
Selanastrum capricornutum	96 hours	>137.2	12.84	3.14

[1] Response based on effects to reproduction.

Exposure Analysis

A. Terrestrial

Exposure to terrestrial organisms is expected to be minimal based on the previously described application method and fate of SCLP in the environment. In terrestrial environments exposure can occur via dietary or inhalation exposure. Dietary exposure can occur through the ingestion of the dispenser by mammals and birds, however, this type of exposure is not expected because dispensers are attached to trees and other objects and would have to be physically removed and then ingested to receive any type of dose. Another route of dietary exposure that could occur is through the ingestion of food items in the area of treatment. Based on the volatility and other physical properties of the pheromone significant residues are not expected on food items that

mammals, birds, reptiles and terrestrial insects might consume. The lack of residues has been documented for similar pheromones on different commodities (Spittler et al., 1992).
Due to the volatile nature of insect pheromones another route of potential exposure could be from inhalation. As a conservative method to quantify exposure, the maximum amount of pheromone available in 300 dispensers was assumed to be discharged into a confined area that is one hectare in size and two meters tall. Based on the maximum amount of active ingredient allowed on the label (37.52 g a.i./ac) results in a rate of 92.67 g a.i./ha after converting the rate from acres to hectares. Based on the above assumptions the maximum amount of pheromone available for inhalation would be 4.61 mg/m^3. This estimate is highly conservative since the dispensers are designed to act as a barrier to allow passive diffusion of the pheromone into the surrounding environment over time (Brown et al., 1992; McDonough, 1992; Mayer and Mitchell, 1998). Diffusion rates for individual dispensers are typically in the low nanogram range but have been reported to be as high as 10 µg/dispenser/hour for SCLP (Mayer and Mitchell 1998). This value is considered above what would be expected from the use of dispensers in this program since they are removed after 180 days and smaller amounts of pheromone would need to be emitted to provide sufficient efficacy before replacing the dispensers. However, when using this upper limit value and a maximum number of dispensers in the confined area as described above, the resulting exposure level is 0.44 mg/ m^3. This value is approximately an order of magnitude below the previously calculated exposure value with an assumption of instantaneous discharge of all pheromone. Mean daily release rates for LBAM from dispensers have been reported at 264 mg/ha based on the use of 1000 dispensers per hectare. When this is converted to cubic meters based on the confined space as described above it results in an exposure concentration of 0.0132 mg/m^3 (Suckling et al., 2007). This value is still highly conservative since the pheromones would not be confined to the small closed area defined in this exposure assessment. These concentrations would not be constant since the release rate will decrease over time resulting in pulsed exposures (Mayer and Mitchell, 1998). Also, the above assumes that the pheromone would not degrade which is a highly conservative assumption based on available data for SCLP. Degradation and slower release rates from the dispensers over time would result in long term concentrations well below the nanogram range until the dispensers are replaced approximately every 180 days. Measured aerial pheromone concentrations in the field from placement of dispensers at recommended rates have been shown to range from the upper picogram to low nanogram level per cubic meter for *Pectinophora gossypiella* and *Cydia pomonella*, as well as other moth species (Suckling et al, 1999; Stelinksi et al., 2004).

Based on the above maximum exposure level for instantaneous discharge of all pheromone, species-specific inhalation doses were calculated for several surrogate species representing various inhalation rates for certain nontarget wild mammals, birds and reptiles (table 3) (EPA, 1993; Birchard et al., 1984). In cases where there was a range of inhalation values the highest value was used to maximize the dose.

Table 3. Species-Specific Inhalation Dose of Isomate® LBAM-Plus for Nontarget Mammals, Birds, and Reptiles.

Species	Inhalation Rate (m^3/day)	Maximum Inhalation Dose (mg/m^3)	Species Specific Inhalation Dose (mg/day)
Deer Mouse	0.025	4.61	0.12
Cottontail	0.63	4.61	2.90
Red Fox	2.0	4.61	9.22
Belted Kingfisher	0.094	4.61	0.43
Western Gull	0.48	4.61	2.21
Bald Eagle	1.43	4.61	6.60
Garter Snake	4.2×10^{-5}	4.61	1.93×10^{-4}

B. Aquatic

SCLP exhibit chemical and physical properties that suggest the probability of contamination of aquatic habitats would be very low. In addition, the proposed formulation, dispensers, further reduces the possibility of contamination from runoff or drift. The primary method of off-site transport for most conventional pesticides is volatilization, drift and runoff. The proposed method of application for pheromones in this program involves the use of dispensers that will be attached to trees and other structures by hand allowing release of the pheromone over time. This method of application and formulation type will eliminate drift and runoff as a mechanism of off-site transport. The chemical will volatilize into the air since this is the natural mechanism of communication between female and male moths for reproduction purposes. Pheromone is expected to be dispersed primarily within the areas of treatment although changes in weather conditions will result in some fraction of the pheromone moving outside of treated areas. Pheromones similar to the one proposed for use in this program report low solubility values in water. Most SCLP are considered insoluble in water with reported solubility values in the low part per billion range. An actual solubility value for the LBAM pheromone does not appear to be available however solubility and stability studies with the technical material and formulation suggest very low solubility based on analytical recovery data collected as part of the expanded ecological toxicity testing that was conducted on this pheromone and associated formulations (CDFG, 2009o). Reported analytical recoveries based on nominal concentrations for the technical material and dispensers ranged from 16 to 420%. The high variability reported in this study supports results that would be expected for a chemical that is not miscible in water at the range of nominal concentrations selected for analysis.

Risk Characterization

The risk of pheromones to aquatic and terrestrial organisms was determined by assessing the relationship between the effects and exposure data for each group of non-target organisms. For terrestrial nontarget wildlife a risk quotient (RQ) value was determined for each group of organisms by taking the lowest available acute and chronic toxicity value and comparing it to the estimated environmental concentration. This was done for terrestrial organisms to determine

potential risk; however, aquatic risk was not evaluated using the same methods since the application and chemical properties of insect pheromones eliminate the potential for exposure.

A. Terrestrial

Risk from oral ingestion of pheromone dispensers to non-target mammals and birds is not expected due to the lack of exposure and low toxicity values that have been determined for SCLP. Dispensers would have to be consumed for any sort of substantial exposure to occur which is unlikely since multiple dispensers would have to be physically removed and completely ingested to receive a large dose of pheromone.

Inhalation risk to non-target mammals and birds is expected to be extremely low for a range of animals based on the available toxicity data and the highly conservative exposure scenario that was defined in the exposure analysis. Using the maximum exposure value and comparing it to the lowest inhalation toxicity value results in extremely low RQ values (table 4). These values are consistent with inhalation risks that have been estimated for other species using the same LBAM formulation (CDFA, 2010).

Table 4. Species-Specific Inhalation Risk Quotient Values for Nontarget Mammals, Birds, and Reptiles Exposed to Isomate® LBAM-Plus.

Species	Species Specific Inhalation Dose (mg/day)	Inhalation Toxicity Value (mg/m^3)	Risk Quotient (RQ)
Deer Mouse	0.12	3000	4.0×10^{-5}
Cottontail	2.90	3000	9.6×10^{-4}
Red Fox	9.22	3000	3.1×10^{-3}
Belted Kingfisher	0.43	3000	1.4×10^{-4}
Western Gull	2.21	3000	7.4×10^{-4}
Bald Eagle	6.60	3000	2.2×10^{-3}
Garter Snake	1.93×10^{-4}	3000	6.4×10^{-8}

As a means of comparison, EPA OPP establishes levels of concern (LOC) for non-listed and listed mammals, birds and reptiles where RQ values below the LOC make the presumption of no risk (EPA, 2004). No LOC have been established for inhalation risk however for federally listed mammals, birds and reptiles the acute dietary LOC is 0.1 which is a minimum of two orders of magnitude above the calculated RQ values that were estimated for this assessment. In reality the risk would be much less since the pheromone will be discharged over a period of at least 180 days and would begin to degrade once it passes across the dispenser. In addition the pheromone would not be confined to the small area that was defined in the exposure analysis but would diffuse into the surrounding environment. Uncertainty in the inhalation risk to birds and reptiles is largely based on the assumption that mammalian inhalation toxicity is similar for all groups. The low inhalation toxicity of SCLP to mammals with the extremely low risk that was calculated for animals based on overly conservative assumptions of exposure indicates that if birds and reptiles are more sensitive to inhalation of insect pheromones that they would have to be several orders of magnitude more sensitive for any risk to occur under the exposure assumptions in this

risk assessment. From an exposure perspective this would seem unlikely since reptiles in general have lower inhalation rates when compared to mammals, and birds would have greater mobility reducing their exposure when compared to mammals. In addition actual concentrations measured in the field are in the picogram to nanogram per cubic meter range therefore acute and chronic toxicity would have to be 3 $X10^9$ to 3 X 10^{12} less than what has been demonstrated in acute mammalian tests for any effects to occur to any terrestrial vertebrates.

B. Aquatic

The direct and indirect risk to aquatic organisms from the use of pheromone dispensers is expected to be extremely low based on the available toxicity data, the chemical fate of these types of pheromones and the proposed use pattern. Toxicity testing demonstrates lethal and sublethal responses at concentrations above the highest values tested for most test organisms. Sublethal impacts from exposure to the technical active ingredient and proposed formulation were observed in green algae within the range of doses selected for that study. However, all toxicity values are above the solubility limits of these types of chemicals, therefore any measured response is above concentrations that could occur in an aquatic environment. The method of application and low use rates for the LBAM pheromone further reduces the risk of direct and indirect impacts to aquatic organisms. As previously mentioned the pheromone will be applied by hand as a dispenser. Dispensers are placed on trees and other objects for a period of 180 days before they are removed and replaced with new dispensers. Label prohibitions regarding placement and disposal of dispensers in water will further reduce the possibility of contamination of aquatic sites. Application rates are also low using the proposed method of application. Dispensers are placed at a rate of approximately 250 per acre with each dispenser containing 125.07 mg/dispenser. Approximately 31.27 g/acre of pheromone will be released into the atmosphere over the lifespan of the dispenser in the environment. Under a very unrealistic exposure scenario where all of the pheromone is discharged simultaneously the resulting concentration in a one acre body of water one foot deep would be 25 µg/L assuming miscibility in water. Under this unrealistic exposure scenario the active ingredient from all dispensers ranging from 125 to 7,480 acres would have to be discharged simultaneously to reach the NOEC values for algae and acute aquatic invertebrates/fish, respectively.

Summary

The LBAM pheromone as well as similar acetate based SCLP pose minimal risk to terrestrial and aquatic organisms based on the available information. The method of application, the selective nature of the pheromone, their low toxicity and use rates provide evidence that direct and indirect risks to nontarget organisms are not expected under labeled use.

References

Ando, T., Inomata, S. and M. Yamamoto. 2004. Lepidopteran sex pheromones. Topics in Curr. Chem. 239:51-96.

Baker, T.C. 1989. Sex pheromone communication in the Lepidopera: new research progress. Experientia. 45: 248-262.

Bellas, T.E., Bartell, R.J., and Hill, A., 1983. Identification of two components of the sex pheromone of the moth, *Epiphyas postvittana* (Lepidoptera, Tortricidae). J. Chem. Ecology. 9(4):503–512.

Birchard, G.F., Black, C.P., Schuett, G.W. and V. Black. 1984. Influence of pregnancy on oxygen consumption, heart rate and hematology in the garter snake: implications for the "cost of reproduction" in live bearing reptiles. Comp. Biochem. Physiol. 77(3):519-523.

Brown, D.F., Knight, A.L., Howell, J.F., Sell, C.R., Krysan, J.L. and M. Weiss. 1992. Emission characteristics of a polyethylene pheromone dispenser for mating disruption of codling moth (Lepidoptera: Tortricidae). J. Econ. Entomol. 85(3):910-917.

CDFA – See California Department of Food and Agriculture

California Department of Food and Agriculture. 2010. Programmatic environmental impact report: light brown apple moth eradication program. Appendix F: Ecological Risk Assessment 226 pp.

CDFG – See California Department of Fish and Game

California Department of Fish and Game. 2009a. Chronic Toxicity of LBAM disruptor technical to algae, *Selenastrum capricornutum*. Pesticide Investigations Laboratory Report P-2542.a. 11 pp.

California Department of Fish and Game. 2009b. Acute toxicity of LBAM disruptor technical to cladoceran *Ceriodaphnia dubia*. Pesticide Investigations Laboratory Report P-2542.b. 11 pp.

California Department of Fish and Game. 2009c. Acute toxicity of LBAM disruptor technical to fathead minnow, *Pimephales promelas*. Pesticide Investigations Laboratory Report P-2542.c. 11 pp.

California Department of Fish and Game. 2009d. Chronic Toxicity of LBAM disruptor technical to *Ceriodaphnia dubia*. Pesticide Investigations Laboratory Report P-2542.d. 11 pp.

California Department of Fish and Game. 2009e. Chronic Toxicity of LBAM disruptor technical to fathead minnow, *Pimephales promelas*. Pesticide Investigations Laboratory Report P-2542.e. 11 pp.

California Department of Fish and Game. 2009f. Acute toxicity of LBAM disruptor technical to rainbow trout, *Oncorhynchus mykiss*. Pesticide Investigations Laboratory Report P-2542.f. 10 pp.

California Department of Fish and Game. 2009g. Acute toxicity of LBAM disruptor technical to bullfrog tadpoles (*Rana catesbeina*). Pesticide Investigations Laboratory Report P-2542B.g. 10 pp.

California Department of Fish and Game. 2009h. Chronic toxicity of LBAM Isomate ties to fathead minnow, *Pimephales promelas*. Pesticide Investigations Laboratory Report P-2544.a. 11 pp.

California Department of Fish and Game. 2009i. Acute toxicity of LBAM Isomate ties to cladoceran, *Ceriodaphnia dubia*. Pesticide Investigations Laboratory Report P-2544.b. 11 pp.

California Department of Fish and Game. 2009j. Acute toxicity of LBAM Isomate ties to fathead minnow, *Pimephales promelas*. Pesticide Investigations Laboratory Report P-2544.c. 11 pp.

California Department of Fish and Game. 2009k. Chronic Toxicity of LBAM Isomate ties to cladoceran, *Ceriodaphnia dubia*. Pesticide Investigations Laboratory Report P-2544.d. 11 pp.

California Department of Fish and Game. 2009l. Chronic Toxicity of LBAM Isomate ties fathead minnow, *Pimephales promelas*. Pesticide Investigations Laboratory Report P-2544.e. 11 pp.

California Department of Fish and Game. 2009m. Acute toxicity of LBAM Isomate ties to rainbow trout, *Oncorhynchus mykiss*. Pesticide Investigations Laboratory Report P-2544.f. 11 pp.

California Department of Fish and Game. 2009n. Acute toxicity of LBAM Isomate ties to bullfrog tadpoles (*Rana catesbeina*). Pesticide Investigations Laboratory Report P-2544.g. 10 pp.

California Department of Fish and Game. 2009o. Solubility and stability studies for seven light brown apple moth (LBAM) formulations and adjuvant. 33 pp.

California Department of Food and Agriculture. 2007. Memo to Environmental Advisory Task Force, Subject: Response to LBAM Task Force Issues and Concerns, November 26, 2007. 3 pp.
Carde, R.T. and A.K. minks. 1995. Control of moth pests by mating disruption: successes and constraints. Annu. Rev. Entomol. 40:559-585.

Clare, G., Suckling, D.M., Bradley, S.J., Walker, J.T. S., Shaw, P.W., Daly, J.M., McLaren, G.F. and C.H. Wearing. 2000. Pheromone trap colour determines catch of non-target insects. New Zealand Plant Protection 53:216-220

Daughtrey, W.C., Smith, J.H, Hinz, J.P., and Biles, R.W., 1990. Subchronic toxicity evaluation of tridecyl acetate in rats. Fund. Appl. Toxicol. 14:104–112.

EPA –See Environmental Protection Agency.

Environmental Protection Agency 2007. Biopesticide Registration Document. Straight Chain Lepidopteran Pheromones (SCLP). Office of Pesticide Programs. Biopesticides and Pollution Prevention Division. 57 pp.

Environmental Protection Agency. Office of Pesticide Programs. 2004. Technical overview of ecological risk assessment. http://www.epa.gov/oppefed1/ecorisk_ders.

Environmental Protection Agency. 1996. Reregistration eligibility decision (RED) Tridecenyl Acetates. 51 pp.

Environmental Protection Agency. 1993. Wildlife Exposure Factors Handbook. Volume I of II. EPA/600/R-93/187a. Office of Research and Development, Washington, D.C.

Gross, H.R. and J. E. Carpenter. 1991. Role of the fall armyworm (Lepidoptera: Noctuidae) pheromone and other factors in the capture of bumblebees (Hymenoptera: Apidae) by universal moth traps. Environ. Entomol. 20: 377-381.

Howard, R.W. and G.J. Bloomquist. 2005. Ecological, behavioral, and biochemical aspects of insect hydrocarbons. Annu. Rev. Entomol. 50:371-393.
Inscoe, M.N. and R.L. Ridgway. 1992. Non-target effects of lepidopteran sex attractant pheromones. BCPC Monograph No. 51, Pheromones and Behavior-Modifying Chemicals. 49-59.

Mayer, M.S. and E.R. Mitchell. 1998. Rapid measure of sex pheromone emission from plastic rope dispensers: example of utility in sexual communication disruption of the diamondback moth, *Plutella xylostella*. Phytoparasitica 26(2): 1-9.

McDonough, L.M., Davis, H.G., Chapman, P.S. and C.L. Smithhisler. 1993. Response of male codling moths (*Cydia pomonella*) to components of conspecific female sex pheromone glands in flight tunnel tests. J. Chem. Ecology. 19(8): 1737-1748.

Mitchell, E.R., H.R. Agee, and R.R. Heath. 1989. Influence of pheromone trap colour and design on capture of male velvetbean caterpillar and fall armyworm moths (Lepidoptera: Noctuidae). J. Chem. Ecol. 15: 1775-1784.

Monheit, S., Mussen, E.C. and M.L. Johnson. 2008. Effects of contact and oral exposure to formulated CheckMate® LBAM-F and unformulated LBAM mating pheromones on honey bees, *Apis mellifera* (Hymenoptera: Apidae). Final Report. 8 pp.

Morse, D. and E. Meighen. 1986. Pheromone biosynthesis and role of functional groups in pheromone specificity. J. Chem. Ecol. 12(2): 335-351.

Myers, J. 1972. Pheromones and courtship behavior in butterflies. Am. Zoologist. 12:545-551.
OECD. 2002. OECD Series on Pesticides: Number 12: Guidance for Registration Requirements for Pheromones and Other Semiochemicals Used for Arthropod Pest Control. 25 pp.

Pacific Biocontrol. 2007. Material safety data sheet for Isomate® LBAM Plus. 2pp.

Pheronet Database 2010. Accessed August 30, 2010. http://www.phero.net/index.html.

Plettner, E. 2002. Insect pheromone olfaction: new targets for the design of species-selective pest control agents. Current Med. Chem. 9: 1075-1085.

Roelofs, W.L. 1995. Chemistry of sex attraction. Proc. Natl. Acad. Sci. 92:44-49.

Rosa, E., Barata, C. Damasio, J., Bosch, M.P. and A. Guerrero. 2006. Aquatic ecotoxicity of a pheromonal antagonist in *Daphnia magna* and *Desmodesmus subspicatus*. Aq. Toxicol. 79:296-303.

Rumbo, E.R., Deacon, S.M. and L.P. Regan. 1993. Spatial discrimination between sources of pheromone and an inhibitor by the light-brown apple moth, *Epiphyas postvittana*. J. Chem. Ecol. 19(5): 953-962.

Rutowski, R.L. 1991. The evolution of male mate-locating behavior in butterflies. The American Naturalist. 138(5): 1121-1139.

Spittler, T.D., Leichtweis, H.C. and P. Kirsch. 1992. Exposure, fate and potential residues in food of applied lepidopteran pheromones. BCPC Mono. No. 51: 93-108.

Stelinski, L.L. 2007. On the physiological and behavioral mechanisms of pheromone-based mating disruption. Pestycydy. (3-4), 27-32.

Stelinksi, L.L., Gut, L.J., Pierzchala, A.V. and J.R. Miller. 2004. Field observations quantifying attraction of four tortricid moths to high dosage pheromone dispensers in untreated and pheromone-treated orchards. Entomologia Experimentalis et Applicata 113:187-196.

Suckling, D.M., Daly, J.M., Chen, X. and G. Kang. 2007. Field electroantennogram and trap assessments of aerosol pheromone dispensers for disrupting mating in *Epiphyas postvittana*. Pest Manag. Sci. 63:202-209.

Suckling, D.M., Green, S.R., Gibb, A.R. and G. Karg. 1999. Predicting atmospheric concentration of pheromone in treated apple orchards. J. Chem. Ecology 25(1):117-139.

Suckling, D.M. and P.W. Shaw. 1995. Large-scale trials of mating disruption of lightbrown apple moth in Nelson, New Zealand. New Zealand J. Crop Hortic. Sci. 23:127-137.

Suckling, D.M. and P.W. Shaw. 1992. Conditions that favor mating disruption of *Epiphyas postvittana* (Lepidoptera: Tortricidae). Environ. Entomol. 21(5):949-956.

Tohey, J.G. 1990. "A review of the current basis for the United States Environmental Protection Agency's policies for the regulation of pheromones and other semiochemicals, together with a review of the available relevant data which may impact the assessment of risk for these classes of chemicals. Part No. 1, Straight Chain Alcohols, Acetate Esters and Aldehydes". (Unpublished report, 474 pp.).

Weatherston, I. and A.K. Minks. 1995. Regulation of semiochemicals – global aspects. Integrated Pest Management Reviews. 1:1-13.

Weatherston, I. and R. Stewart. 2002. Regulatory issues in the commercial development of pheromones and other semiochemicals. Use of pheromones and other semiochemicals in integrated production. IOBS wprs Bulletin Vol. 25: 1-10.

Welter, S.C., Pickel, C., Millar, J., Cave, F., Van Steenwyk, R.A. and J. Dunley. 2005. Pheromone mating disruption offers selective management options for key pests. California Agriculture 59(1):16-22.

Werner, I., Deanovic, L.A., and Markiewicz, D., 2007. Toxicity of Checkmate® and *Epiphyas postvittana* pheromone to *Ceriodaphnia dubia* and fathead minnow (*Pimephales promelas*) larvae. UC-Davis. Unpublished Report. 9 pp.

Witzgall, P., Stelinski, L., Gut, L. and D. Thomson. 2008. Codling moth management and chemical ecology. 53: 502-522.

Wyatt, T.D. 2003. Pheromones and animal behavior. Communication by smell and taste. Ch. 1: Animals in a chemical world. Pp 1-22. Cambridge University Press, United Kingdom.