Light Brown Apple Moth in Nurseries

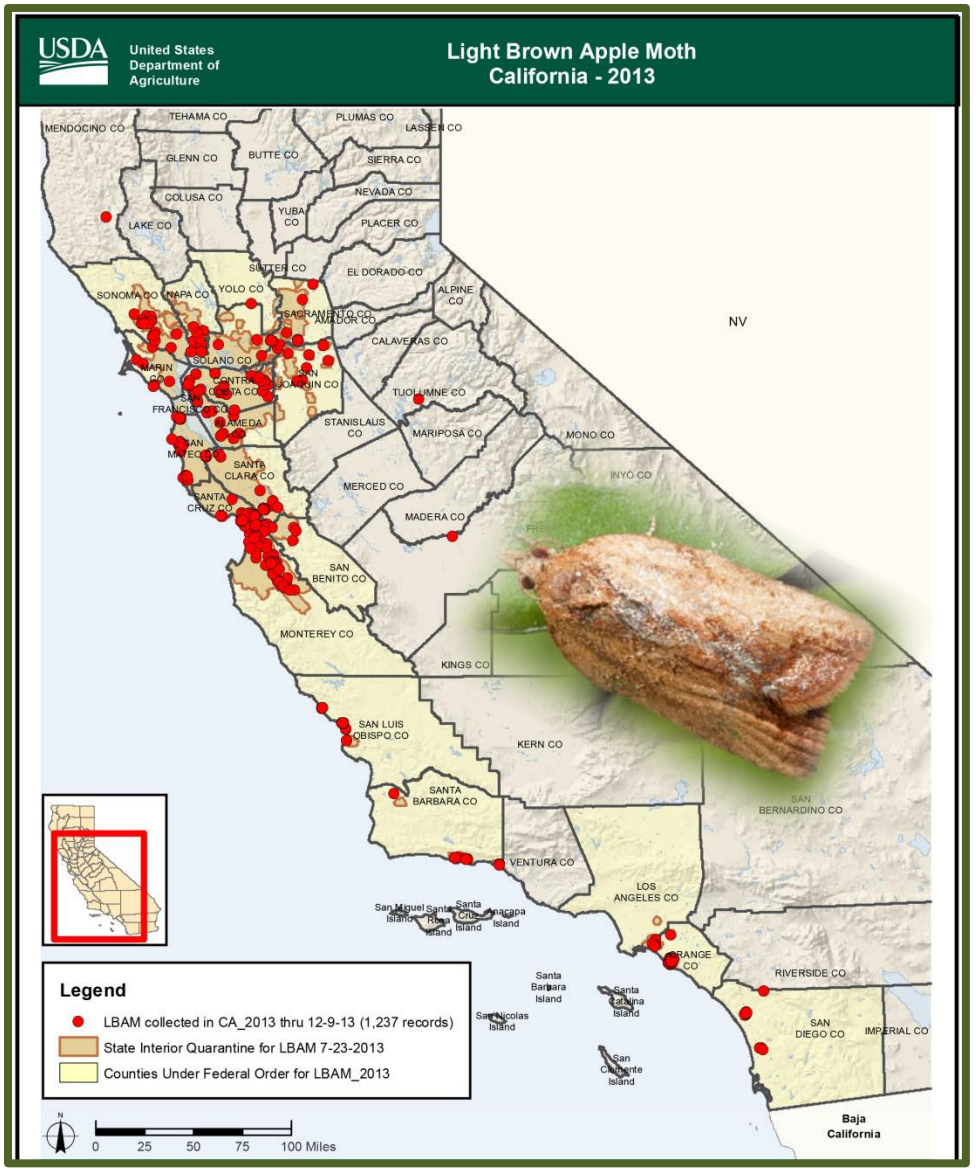
Steve Tjosvold
University of California
Cooperative Extension

February 5, 2013
Current Invasive Issues
UC Davis

Funding: CDFA / USDA Specialty Crop Block Grant

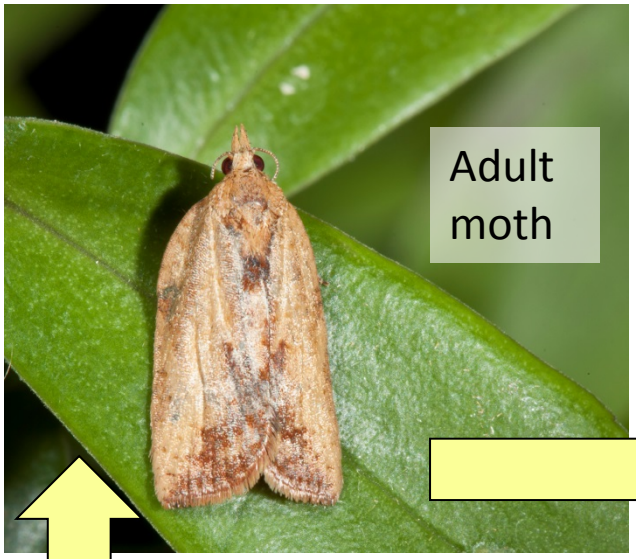
Light Brown Apple Moth (LBAM)

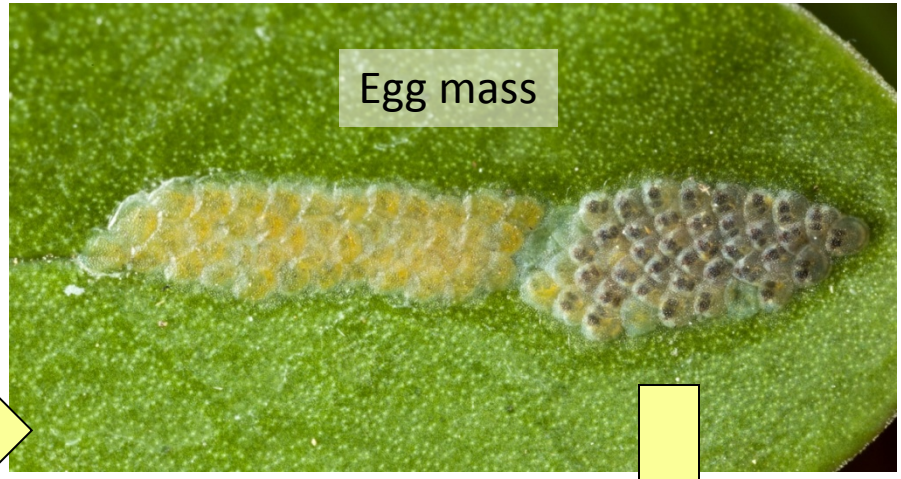
- Invasive pest from Australia detected in Alameda Co. in March 2007
- Favored by cooler coastal climates (20 counties)
- Broad host range (Established in natural areas and landscapes)
- Production loss due to regulatory closures
- Great increase in pesticide use in nurseries

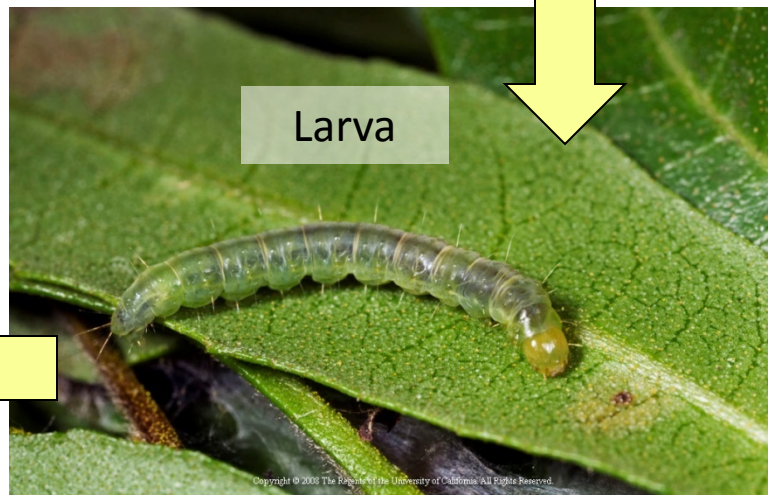


December, 2013

LBAM life stages and cycle

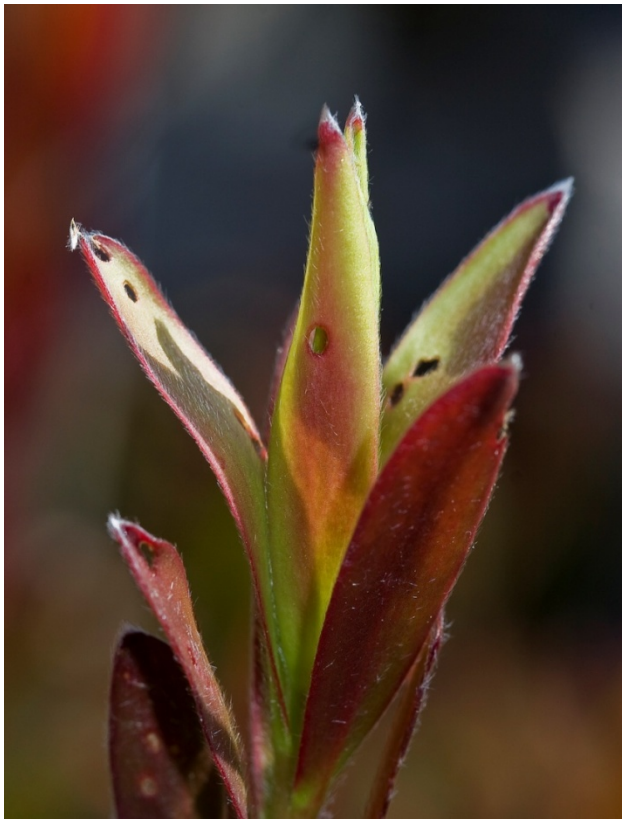






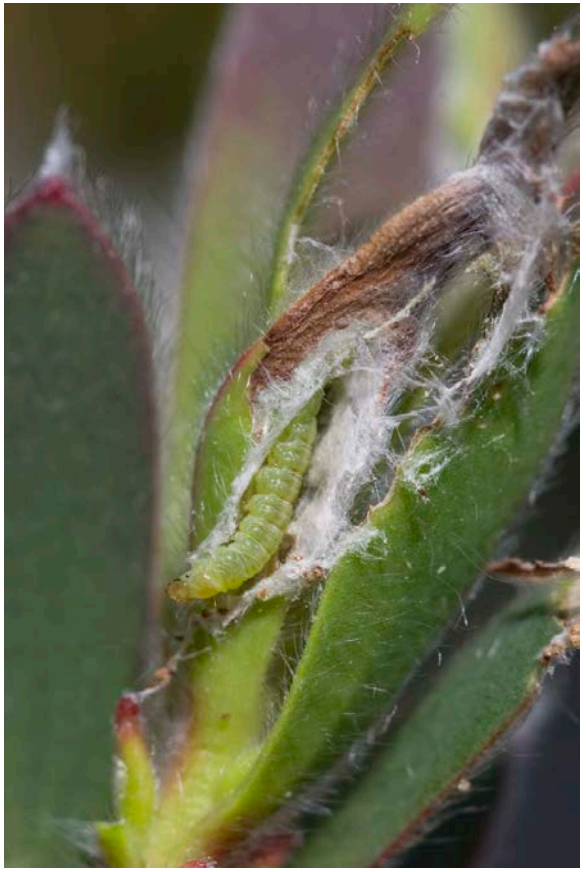
No diapause, development continues 45 ^{o}F to 88 ^{o}F. Nearly 4 life cycles in Watsonville

Foliar Damage



Leaves chewed

Leaves distorted



Leaves bound together with silk-like webs

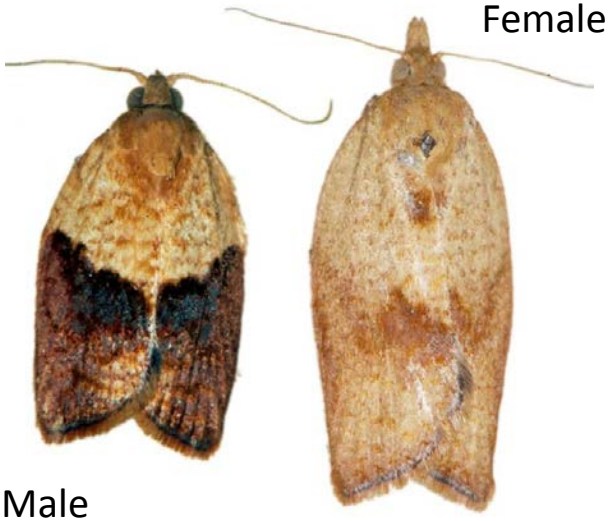
Fruit Damage

Family: Tortricidae

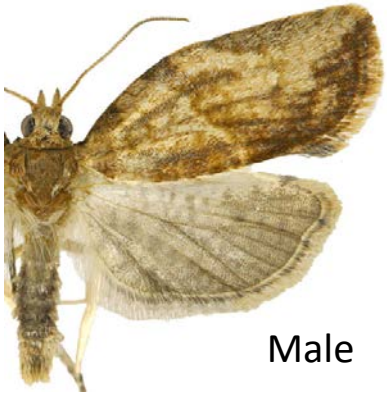
Leafroller adults

- Wings bell-shaped
- Protruding mouthparts
- Antennae threadlike
- 0.25-1.25 in. wingspan
- Gray, tan, or brown with dark bands, mottled areas, metallic spots

LBAM

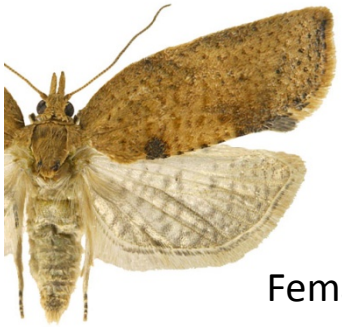


Males : ≈ 8 mm (0.3 in.)
Female: ≈ 10 mm (0.4 in.)


Male


Male

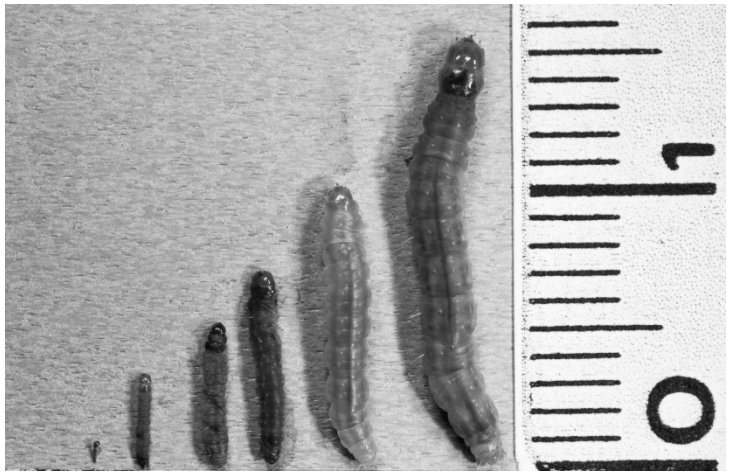

Male


Female

Photos: T. M. Gilligan & M. E. Epstein, CSU, CDFA, USDA/APHIS/PPQ/CPHST

LBAM Larvae Field Identification

- 5 or 6 larva instars. Range in size from 2 mm to 18 mm (up to 0.75 inch)
- Light to medium green body
- Light yellow-brown head
- White hairs and light legs.
- Body darker on top.
- 3 distinct darker bands running the length of the body
- Prothorax shield light green-brown
- Pre-spiracular pinaculum (3 hairs) and anal comb (7 or 8 prongs)



Not LBAM

DNA testing of suspected LBAM larvae is often necessary for identification in official detections

HOST PLANTS

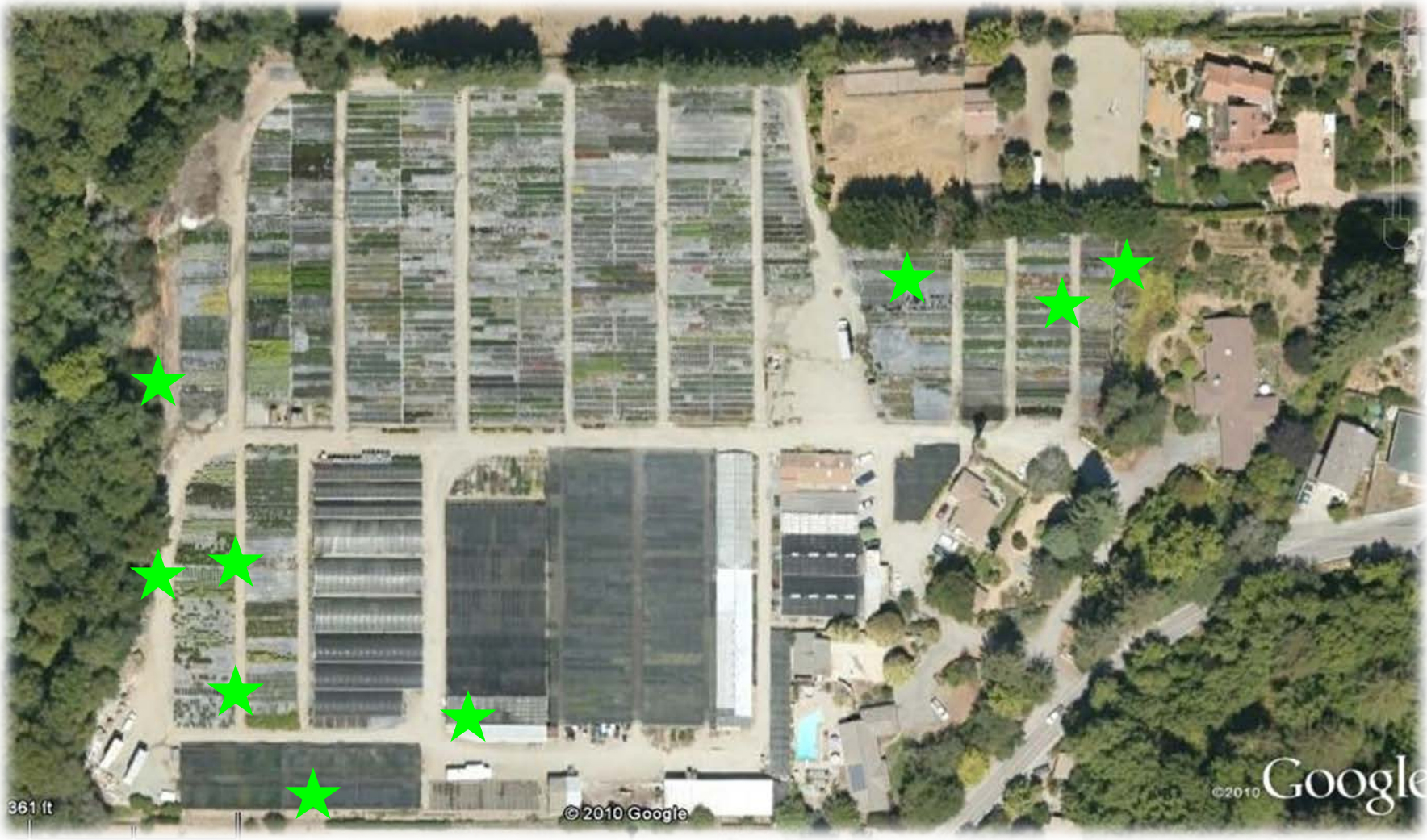
545 plant species, 363 genera, and 121 families*
Herbaceous plants preferred over woody plants
Common: many weeds, ornamentals, and berry crops

Adiantum sp., *Aguilegia* sp., *Amaranthus* sp., *Arbutus* sp., apple (*Malus domestica*, *Malus* spp.), apricot (*Prunus armeniaca*), *Artemesia* sp., *Astartea* sp., *Aster* sp., avocado (*Persea americana*), *Baccharis* sp., black alder/European alder (*Alnus glutinosa*), blackberry and raspberry (*Rubus* spp.), black poplar (*Populus nigra*), blueberry (*Vaccinium sp.*), *Boronia* sp., *Brassica* sp., *Breynia* sp., broad bean (*Vicia faba*), broadleaf dock (*Rumex obtusifolius*), *Bursaria* sp., butterfly bush (*Buddleia* sp.), *Calendula* sp., *Callistemon* sp., camellia (*Camellia japonica*), *Campsis* sp., capeweed (*Arctotheca calendula*), *Cassia* sp., *Ceanothus* sp., Chinese gooseberry (*Actinidia chinensis*), *Choisya* sp., chrysanthemum (*Chrysanthemum* sp.), citrus (*Citrus* spp.), *Clematis* sp., *Correa* sp., cotoneaster (*Cotoneaster* sp.), *Clerodendron* sp., clover (*Trifolium repens*, *Trifolium* sp.), *Cupressus* sp., curled dock (*Rumex crispus*), currant (*Ribes* sp.), *Cydonia* sp., *Dahlia* sp., *Datura* sp., *Daucus* sp., *Dodonaea* sp., *Eriobotrya* sp., *Eriostemon* sp., *Escallonia* sp., eucalyptus (*Eucalyptus* sp.), euonymus (*Euonymus* sp.), fat-hen (*Chenopodium album*), *Forsythia* sp., *Fortunella* sp., fox's brush (*Centranthus* spp.), *Gelsemium* sp., *Genista* sp., *Gerbera* sp., gorse (*Ulex europaeus*), grape (*Vitis vinifera*, *Vitis* sp.), *Grevillea* sp., *Hardenbergia* sp., hawthorn (*Crataegus* sp.), hebe (*Hebe* spp.), *Helichrysum* sp., hop (*Humulus lupulus*), horn of plenty (*Feijoa sellowiana*), ivy (*Hedera helix*, *Hedera* spp.), jasmine (*Jasminum* spp.), *Juglans* sp., kiwifruit (*Actinidia deliciosa*), *Lathyrus* sp., *Lavendula* sp., *Leucodendron* sp., *Leptospermum* sp., *Linus* sp., litchi (*Litchi chinensis*), *Lonicera* sp., alfalfa (*Medicago sativa*), *Lupinus* sp., *Lycopersicum* sp., *Macadamia* sp., malabar ebony (*Diospyros* sp.), *Mangifera* sp., *Melaleuca* sp., *Mentha* sp., *Mesembryanthemum* sp., *Michelia* sp., *Monotoca* sp., montbretia (*Crocosmia* sp.), *Myoporum* sp., oak (*Quercus* sp.), *Oxalis* sp., *Parthenocissus* sp., peach (*Prunus persica*), pear (*Pyrus* sp.), *Pelargonium* sp., *Persoonia* sp., *Petroselinum* sp., persimmon (*Diospyros kaki*), *Philadelphus* sp., *Photinia* sp., *Pittosporum* sp., pine (*Pinus* muricata, *P.* radiata, Pinus sp.), plantain / ribwort (*Plantago lanceolata*), *Platysace* sp., *Polygala* sp., *Polygonum* sp., poplar and cottonwood (*Populus nigra*, *Populus* sp.), potato (*Solanum tuberosum*), privet (*Ligustrum vulgare*, *Ligustrum* sp.), *Pteris* sp., *Pulcaria* sp., *Pyllanthus* sp, *Pyracantha* sp., *Ranunculus* sp., *Raphanus* sp., *Reseda* sp., raspberry and boysenberry (*Rubus idaeus*, *Rubus* sp.), rose (*Rosa* sp.), *Salvia* sp., *Senecio* sp., Scotch broom (*Cytisus scoparius*), *Sida* sp., *Sisymbrium* sp., *Smilax* sp., *Sollya* sp., St. John's wort (*Hypericum perforatum*), strawberry (*Fragaria* sp.), *Tithonia* sp., *Trema* sp., *Triglochin* sp., *Urtica* sp., *Viburnum* sp., *Vinca* sp., wattle (*Acacia* sp.), willow (*Salix* sp.).

*E.G. Brokerhoff, et.al. (2011)

Eradication in Nurseries is Difficult

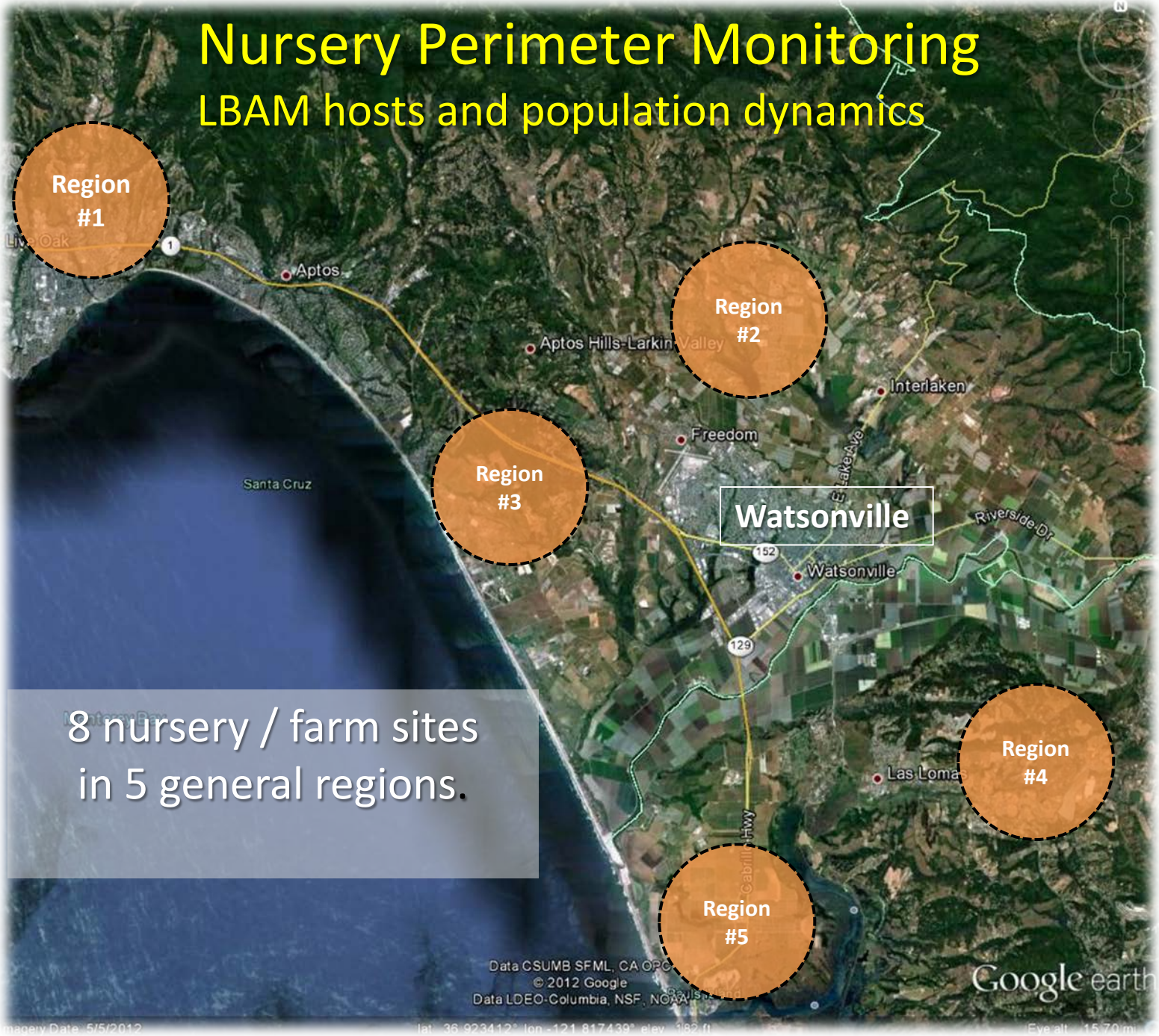
LBAM can be introduced from surroundings

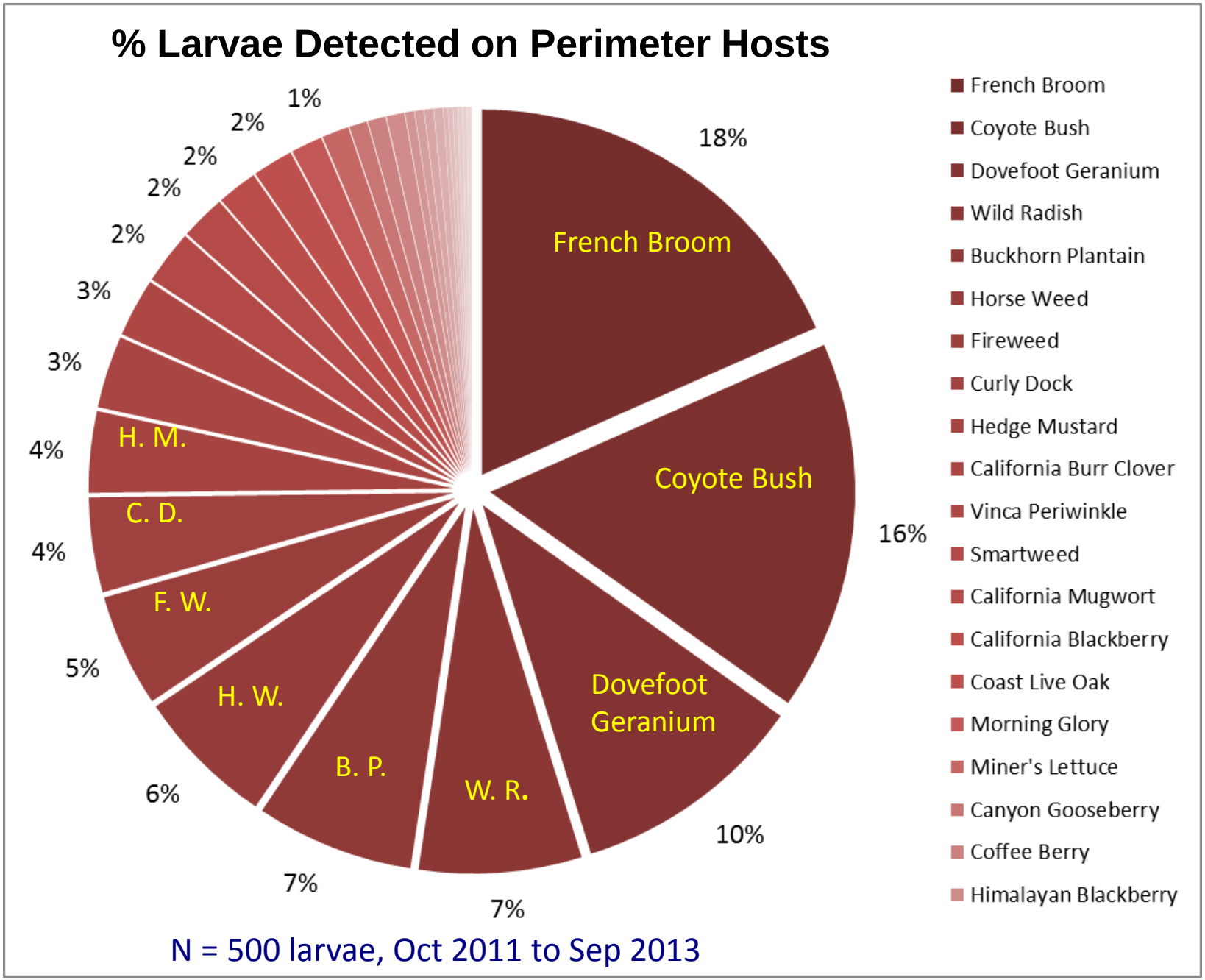


USDA official detections Mar 2010 to Sept 2010

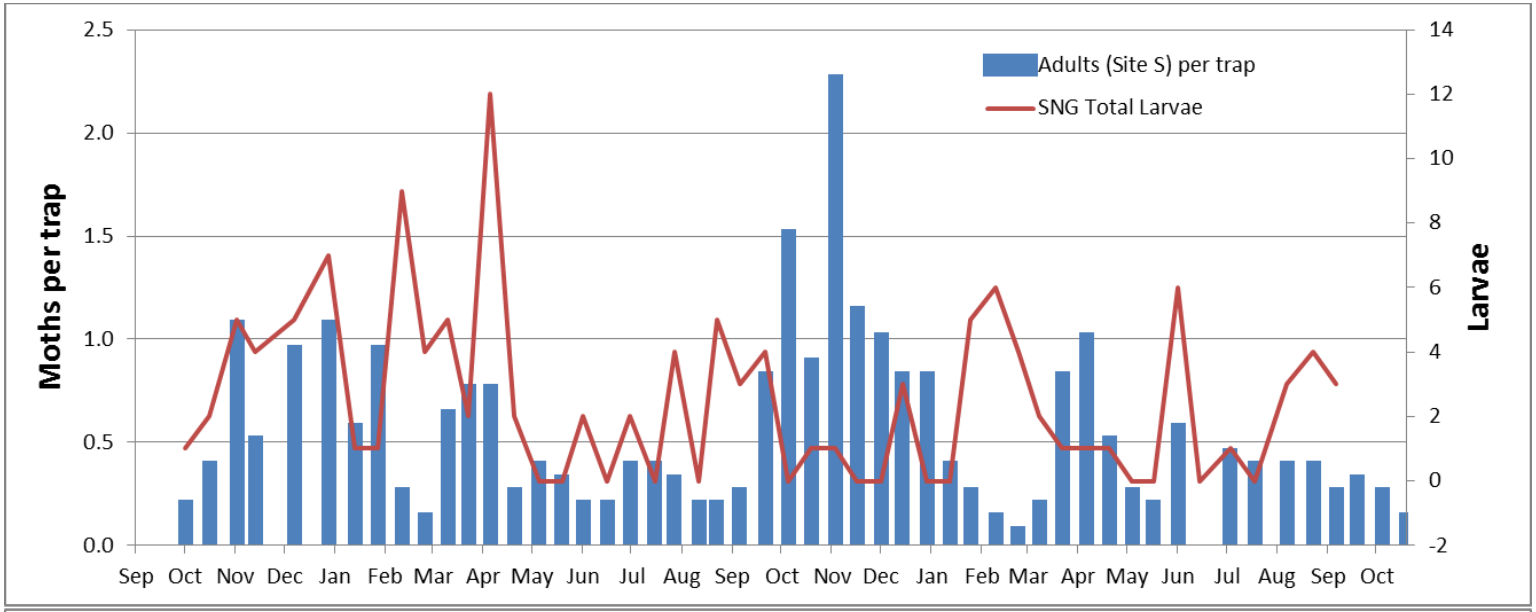
LBAM Larvae Detection in Raspberries (1 A)

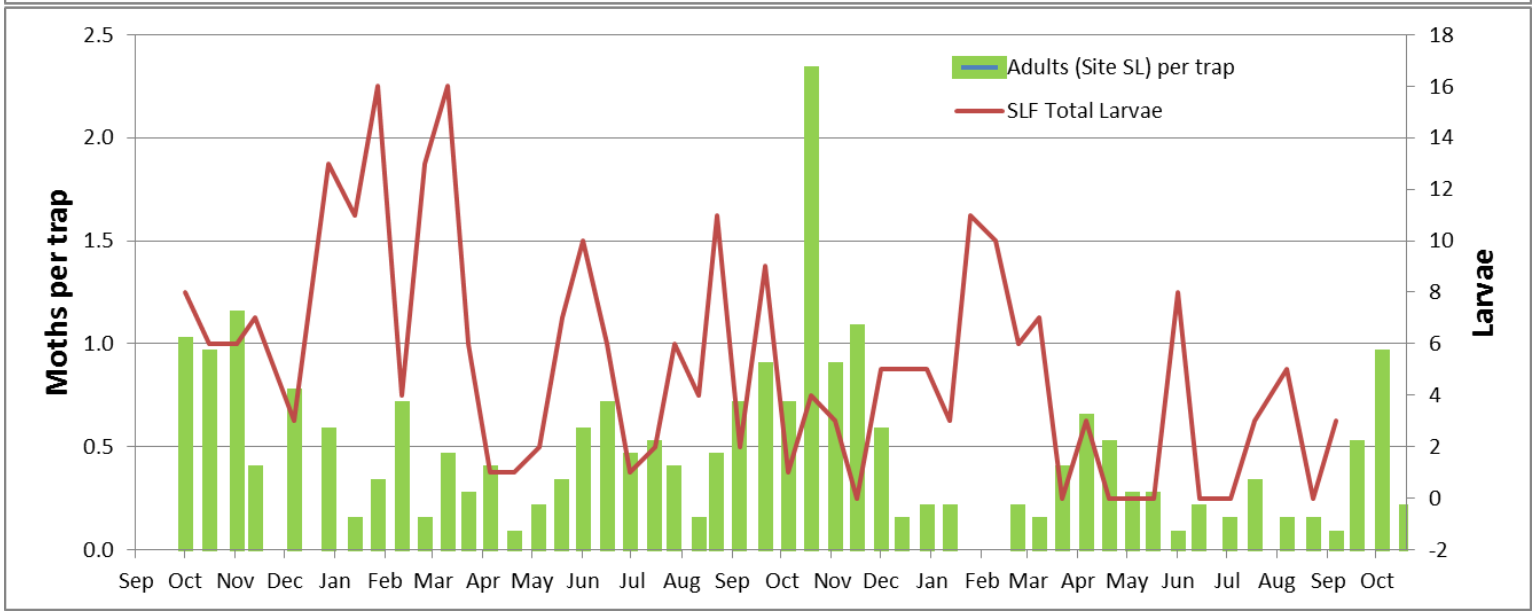
RED number of leaf rolls
BLUE number of larvae


Nursery Perimeter Monitoring
LBAM hosts and population dynamics
Region #1
Region #2
Region #3
Region #4
Region #5
Watsonville
8 nursery / farm sites in 5 general regions.
Aptos
Aptos Hills-Larkin Valley
Interlaken
Freedom
Santa Cruz
Watsonville
Las Loma
Riverside Dr
Data CSUMB SFML, CA OPC
© 2012 Google
Data LDEO-Columbia, NSF, NOAA
Google earth

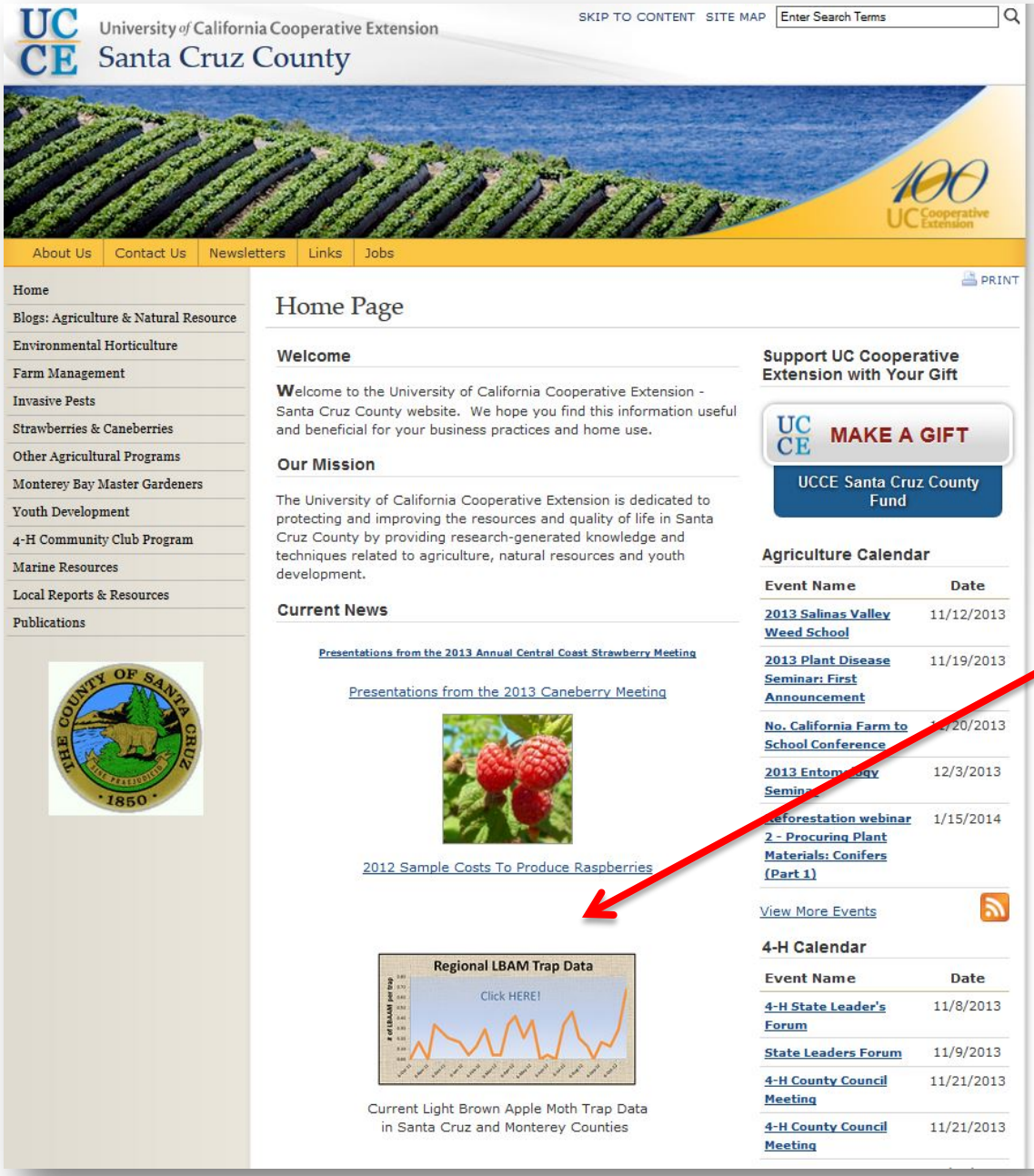

% Larvae Detected on Perimeter Hosts
18%
16%
10%
7%
7%
6%
5%
4%
4%
3%
3%
2%
2%
2%
1%
French Broom
Coyote Bush
Dovefoot Geranium
W. R.
B. P.
H. W.
F. W.
C. D.
H. M.
French Broom
Coyote Bush
Dovefoot Geranium
Wild Radish
Buckhorn Plantain
Horse Weed
Fireweed
Curly Dock
Hedge Mustard
California Burr Clover
Vinca Periwinkle
Smartweed
California Mugwort
California Blackberry
Coast Live Oak
Morning Glory
Miner's Lettuce
Canyon Gooseberry
Coffee Berry
Himalayan Blackberry
N = 500 larvae, Oct 2011 to Sep 2013

Moth and Larvae Numbers (2 of 8 Sites)





2011 2012 2013



UCCE Santa Cruz home page

http:// cesantacruz.ucanr.edu

LBAM Parasitoids Indigenous in California

Trichogramma platneri and *T. fasciatum*
Egg parasitoids

Meteorus trachynotus
Larval parasitoid

Enytus eureka
Larval parasitoid

Slide adapted from: Nick Mills, UC Berkeley

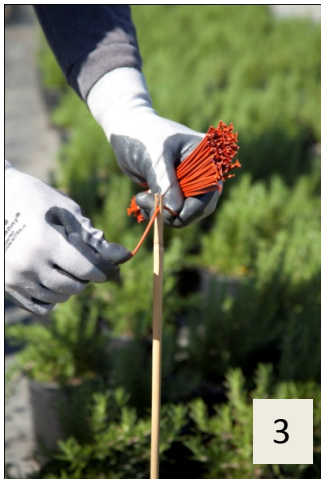
Biological Control

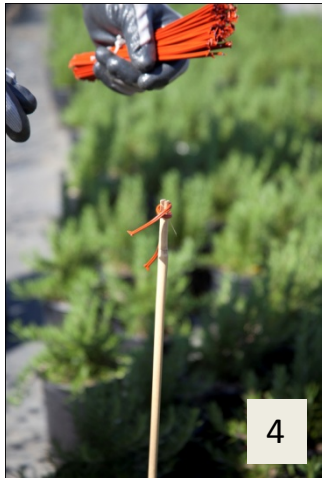
Augment biological control with releases of commercially available *Trichogramma platneri* at nursery perimeters or within nursery.

Bill Roltsch, CDFA

Isomate® LBAM Plus

Application in Nurseries





300 twist ties per Acre = 13 X 13 foot square

Insecticide Control and Residual Activity

Treatment	% Control	Residual
Dipel (Bacillus thuringiensis) Provaunt (indoxacarb)	61 to 93 %	1 week
Conserve (spinosad)	82 to 100 %	1 to 2 weeks
Acelpryn (chlorantraniliprole) Enfold (emmamectin benzoate)	77 to 100 %	2 to 3 weeks
Intrepid (methoxyfenozide) Scimitar (lambda-cyhalothrin)	94 to 100 %	3 to 4 weeks
Pure Spray Green (horticultural oil)	74 to 85 %	+ / -
Dimilin (difluobenzuron)	Not effective	

Treatments at maximum labeled rate. Dyne-Amic surfactant added. Results based on survival to adulthood (2 repeated experiments). **% Control:** treatments applied after egg laying. **Residual**: treatments applied before egg laying.

“Today light brown apple moth is successfully managed ….through a combination of biological control and threshold-based applications of selective insecticides”

from

New Zealand lessons…….

California Agriculture Vol 64 No.1

REVIEW ARTICLE

New Zealand lessons may aid efforts to control light brown apple moth in California

by Lucia G. Varela, James T.S. Walker, Peter L. Lo and David J. Rogers

New Zealand's major fruit industries are dependent upon producing high-quality crops for export with a very low incidence of pest damage. Light brown apple moth was an economically important pest within the fruit sector in the 1960s through the 1980s, and it developed resistance to broad-spectrum insecticides. The increase in its pest status focused research on biological control, and existing native natural enemies were augmented with new introductions from Australia in the late 1960s. By the early 1990s, this effort resulted in substantially reduced leafroller populations and fruit damage. The implementation of integrated pest management (IPM) programs in the New Zealand fruit sector in the mid- to late 1990s practically eliminated the use of broad-spectrum organophosphate insecticides, further enhancing natural control. Today light brown apple moth is successfully managed in IPM and organic programs through a combination of biological control and threshold-based applications of selective insecticides.

The recent discovery of light brown apple moth, a leafroller, in California may affect the management of fruit crops, and because it is a quarantine pest in some markets, the discovery has already had implications for domestic and export trade in produce and nursery stock.

In New Zealand, light brown apple moth, *Epiphyas postvittana* (Walker) (Lepidoptera: Tortricidae), was first reported in 1891 (Hudson 1928). It became a major pest, primarily of pome fruit (apples and pears) and berry fruit, and a minor pest of grapes, citrus, stone fruit and kiwi fruit. The number of acres planted to pome and berry fruit — the crops most affected by light brown apple moth — is similar in New Zealand and California (table 1).

Jack Kelly Clark

In New Zealand, light brown apple moth is controlled by parasitoids and selective insecticides.

New Zealand went through a phase from the 1960s to 1980s when light brown apple moth caused major fruit damage; in apple crops this averaged from 8% to 26% and as high as 48% (Collyer and van Geldermalsen 1975). Control programs were based on frequent applications of broad-spectrum insecticides. This led to the development of resistance to organochlorines in the early 1960s (Collyer and van Geldermalsen 1975) and organophosphates by the early 1980s (Suckling et al. 1984; Suckling and Khoo 1990).

Over the last two decades, the pest status of light brown apple moth in New Zealand apples has shifted significantly. Damage has decreased to typically less than 2% in unsprayed trees (fig. 1). The decline in fruit damage is associated with lower leafroller density, which in turn is attributed to two key factors: (1) the introduction in the 1960s and subsequent spread of parasitoids attacking pupal and late larval stages of light brown apple moth and (2) the change in fruit production programs from frequent applications of broad-spectrum insecticides to less-intensive spraying with selective products.

By using a combination of natural control and selective insecticides, New Zealand growers are able to control light brown apple moth and meet the export standards of more than 60 countries that import a variety of fruit crops. In the 1980s, organophosphate insecticides were sprayed in six to nine applications each season on pome fruit crops for a variety of pests. Over the last decade, use of organophosphate insecticides has declined by 97%, while the frequency of insecticide applications has declined by approximately 50% (Manktelow et al. 2005). The insecticides now used are selective. The incidence of light brown apple moth fruit damage has declined, as has the larval incidence in crops.

In recent U.S. Department of Agriculture preclearance inspections of New Zealand apples grown using the Integrated Fruit Production program, the rejection rate of export consignments for the presence of light brown apple moth was typically less than 1%. A consignment is rejected if one or more larva is detected in 20,000 individually inspected fruit.

Biology and damage

The light brown apple moth's biology was previously described in *California Agriculture* (Varela et al. 2008). In New Zealand, this insect reportedly feeds on 265 different host plant species

TABLE 1. Planted area of light brown apple moth fruit-crop hosts

Crop	New Zealand*	California†
	acres (hectares)	
Pome fruit	23,539 (9,526)	36,500 (14,771)
Berry fruit	5,913 (2,393)	7,400 (2,994)
Strawberries	420 (170)	35,500 (14,366)
Grapes	72,518 (29,347)	789,000 (319,297)
Citrus	4,532 (1,834)	251,500 (101,778)
Stone fruit	5,669 (2,294)	243,800 (98,662)
Kiwi fruit	30,112 (12,186)	4,000 (1,619)

* Plant & Food Research Fresh Facts 2008.
† USDA NASS 2008.