



Timothy Lawrence Ph.D.



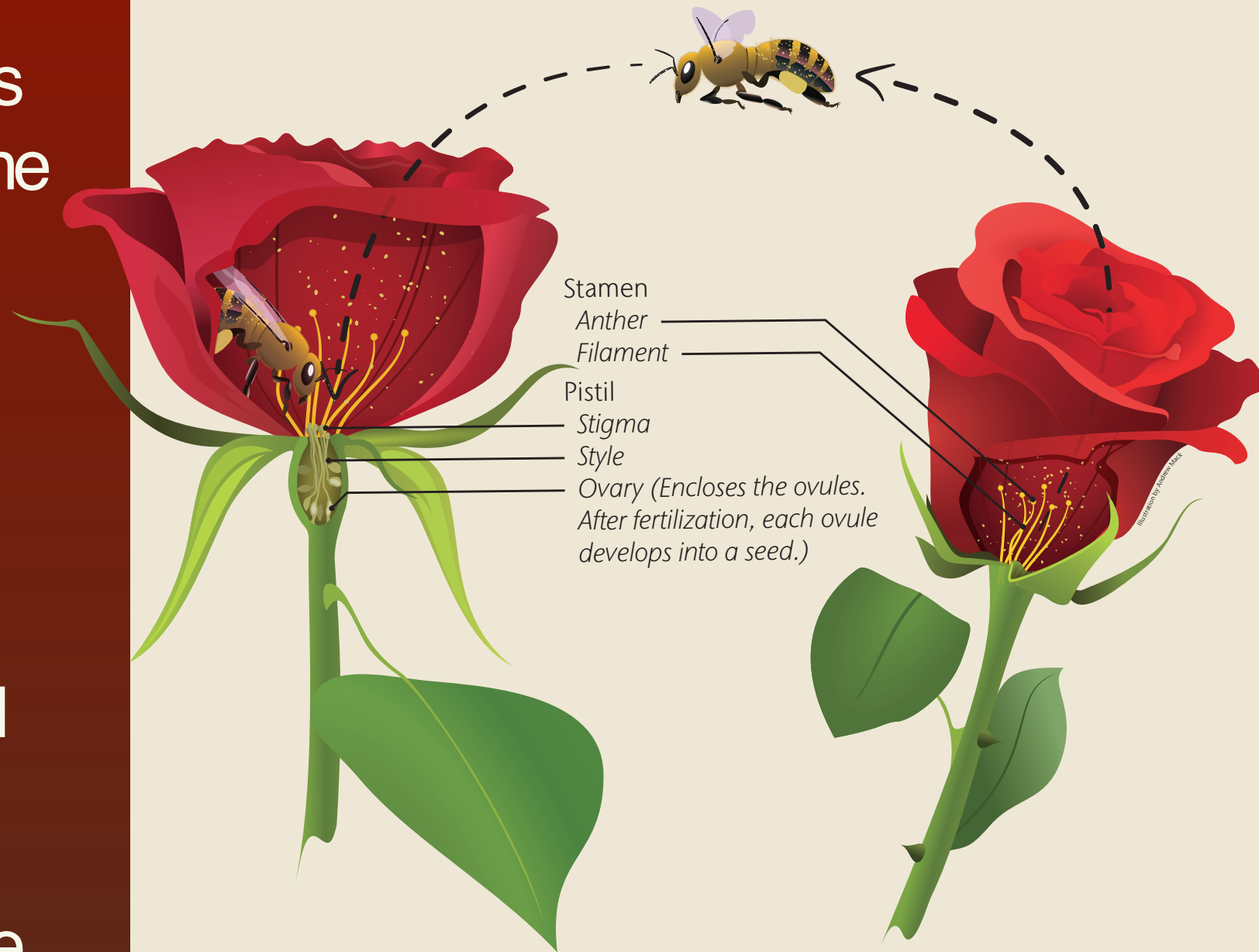
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Pollinator Protection  
March 19, 2015  
2015

# Pollinators

Any organisms that:

- provide pollination services by moving pollen from one plant or flower to another
- effect fertilization of host plants by various mechanisms
- promote host plant seed production
- pollinators may be native or introduced





# Pollinating Agents Include:

Bees and Wasps

Butterflies and Moths

Flies

Beetles

Birds, Humans and Other  
Mammals

Wind and Water



# What Makes A Good Pollinator? and present a single idea.

- Hairy Bodies
- Pollen Carrying Devices
- Chewing & Lapping Mouthparts
- Vision - Acuity & UV Sensitivity
- Floral Constancy - Pollinator Fidelity







Native  
Pollinators

Are Perhaps At Greater Risk





Native  
Pollinators

Are Perhaps At Greater Risk

# Bees and Flies Most Prominent

Pollination Importance Value

Honey bee	15.55
Bumblebee	11.54
Muscidae (fly)	0.0073
Coleoptera (beetle)	0.0012
Syrphidae (hoverfly)	0.0001
Formicidae (ants)	0.0001

PIV= Visitation rate+pollen carrying capacity+  
consistency+ pollination effectiveness





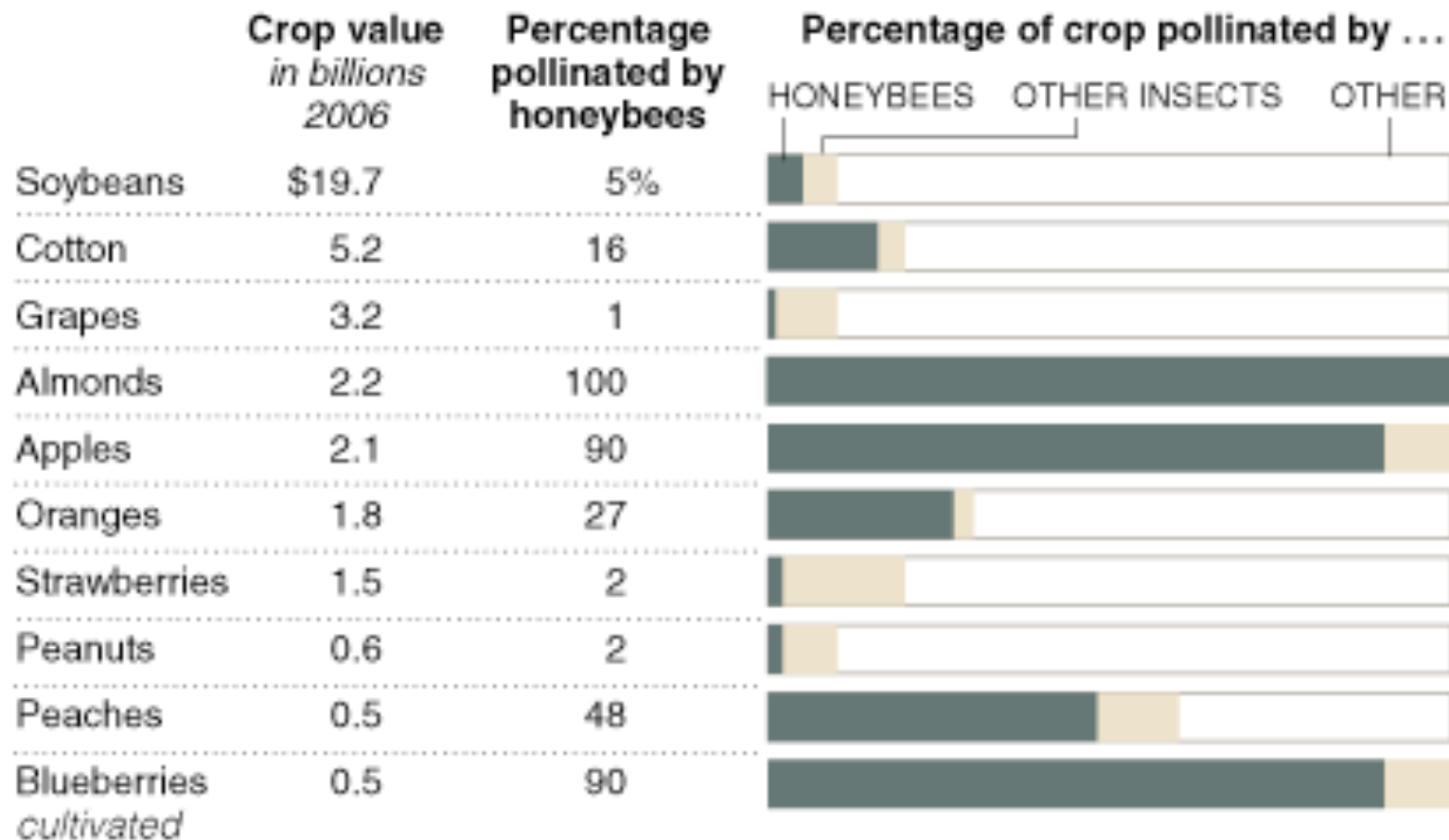




# Value of the Bee's as Pollinators

## Relying on Bees

Some of the most valuable fruits, vegetables, nuts and field crops depend on insect pollinators, particularly honeybees.



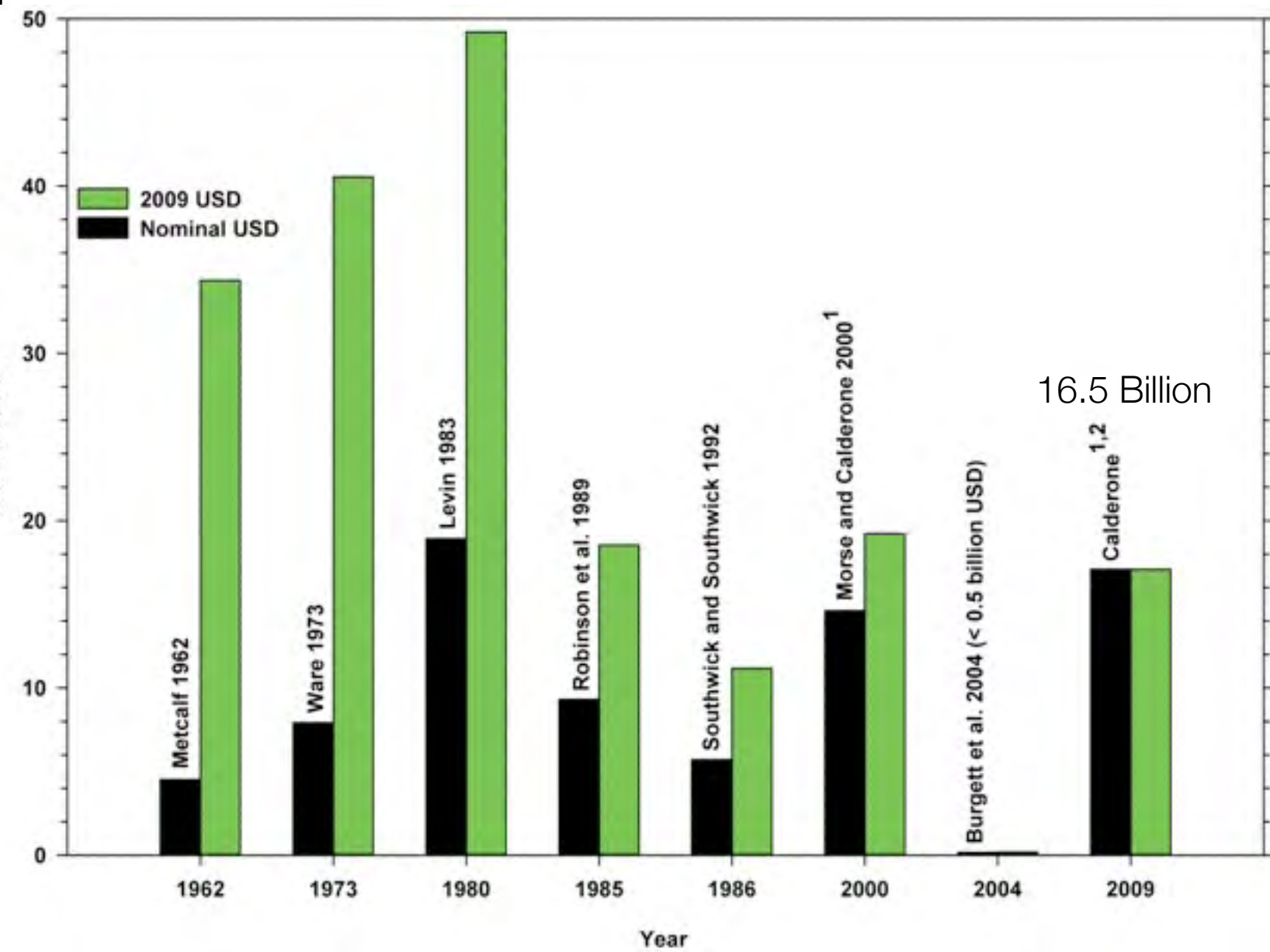
Besides insects, other means of pollination include birds, wind and rainwater.

Sources: United States Department of Agriculture;  
Roger A. Morse and Nicholas W. Calderone, Cornell University





# Value of the Honey Bee



# Partial List Of Plants Pollinated By Bees



Alfalfa Seed	Macadamia nuts
Almonds	Nectarines
Apples	Onions
Asparagus	Peaches
Avocados	Pears
Blueberries	Plums/Prunes
Boysenberries	Pumpkins
Broccoli	Rapeseed
Cantaloupe	Raspberries
Carrots	Soybeans
Cauliflower	Squash
Celery	Strawberries
Cherries	Sugar Beets
Citrus	Sunflowers
Cotton	Watermelons
Cranberries	
Cucumbers	
Honeydew	
Kiwifruit	
Legume Seed	
Loganberries	



# Alternative Pollinators





# Man/Bee Relationship

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Up to 1500 AD

- Bee Hunting - 7,000 BC
- Bee Robbing

1500 to 1851

- Rudimentary Bee Management
- Beginning Of The Keeping of Bees
- Understanding of Bee Biology & Techniques in Keeping Bees Alive







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 EXTENSION

# Lorenzo Lorraine Langstroth

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1851

## Discovery of “Bee Space”

The bee space left between the hive and the frames in which the combs were built; they did not build comb across the space, and the frames were, therefore, truly moveable





# Bee Space





# Bee Space - 5/16 to 5/8





# Moses Quinby (1810-1875)

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First Commercial Beekeeper in  
the United States

Operated 1200 Colonies in St.  
Johnsville, New York 1830-1875

Wrote “The Mysteries of Bee-  
Keeping Explained: Being a  
Complete Analysis of the Whole  
Subject”



M. QUINBY,

Author of “*The Mysteries of Bee-Keeping.*”

This writer is mentioned pages 139, 147, 148, 150, 151, 152, 153, 157, 160,  
168, 189, 363, 471.



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# Modern Beekeeping

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Big Business - 2.3 Million Hives\*

- Pollination
- Honey Production
- Package Bees and Queens
- Other Products
  - Pollen
  - Royal Jelly
  - Cosmetics
  - Venom

\*Ag Marketing Resource Center



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# Almond Production

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Leading Agricultural Export in California\*

Nearly 800,000 acres of almonds

- 680,000 bearing acres
- 115,000 non-bearing acres
- 26,724 new acres planted each year

85% of the worlds production of almonds come from California

\*By Value







# Honey Bee Migration

50% of all colonies in the US move to California for Almond Pollination



# California Almond Pollination Demand

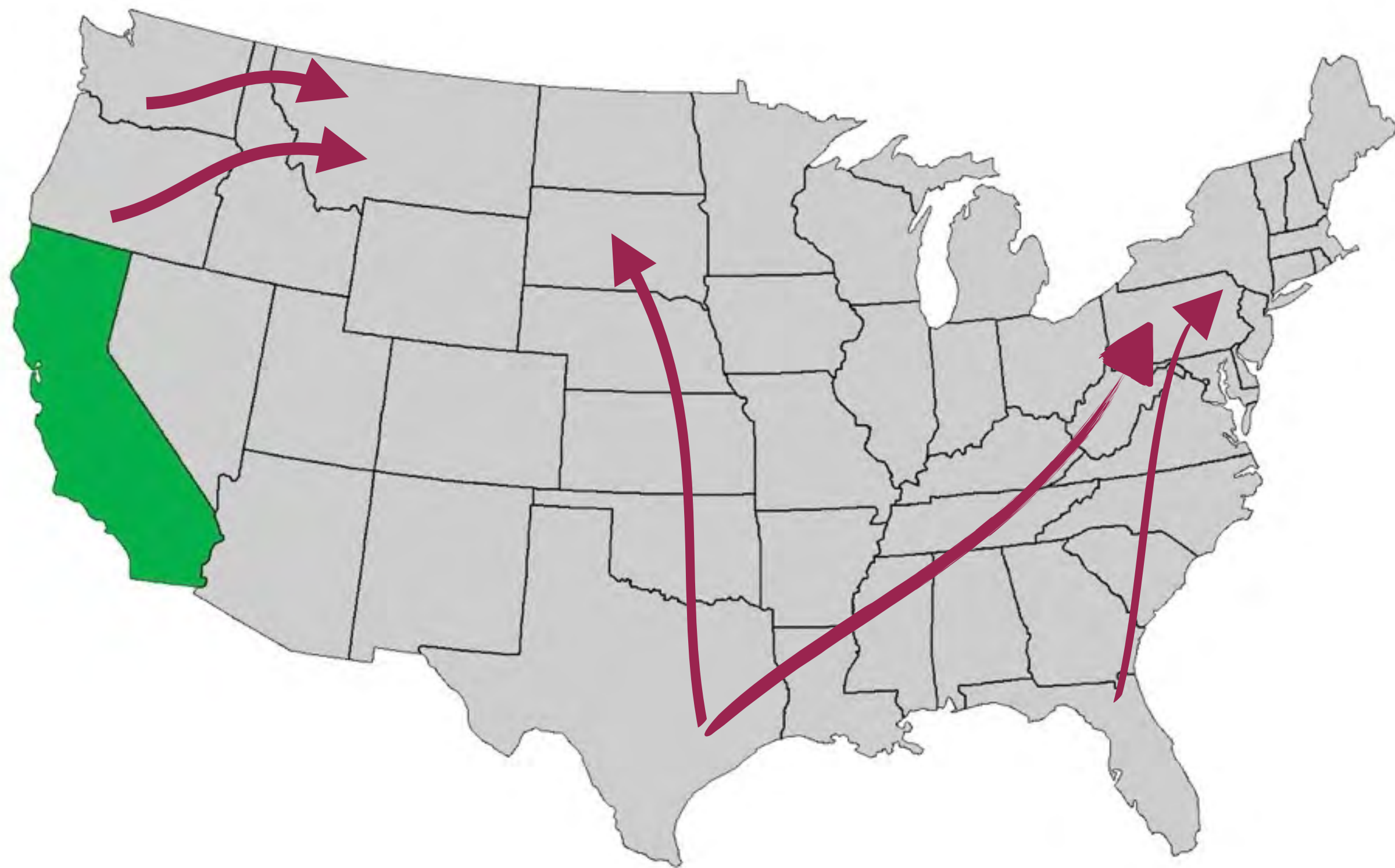
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- 1.6 to 2.0 million hives needed for pollination
- Average 2013 Price for Pollination \$160 (Range \$135 to \$200)











# Colony Collapse Disorder

- Viruses

- P

OPEN ACCESS Freely available online



## Colony Collapse Disorder: A Descriptive Study

Dennis vanEngelsdorp<sup>1,2</sup>, Jay D. Evans<sup>3</sup>, Claude Saegerman<sup>3</sup>, Chris Mullin<sup>2</sup>, Erik Haubruge<sup>4</sup>, Bach Kim Nguyen<sup>4</sup>, Maryann Frazier<sup>2</sup>, Jim Frazier<sup>2</sup>, Diana Cox-Foster<sup>2</sup>, Yanping Chen<sup>5</sup>, Robyn Underwood<sup>2</sup>, David R. Tarpy<sup>6</sup>, Jeffery S. Pettis<sup>5</sup>

<sup>1</sup> Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania, United States of America, <sup>2</sup> Department of Entomology, The Pennsylvania State University, University Park, Pennsylvania, United States of America, <sup>3</sup> Department of Infectious and Parasitic Diseases, Epidemiology and Risk analysis applied to the Veterinary Sciences, University of Liege, Belgium, <sup>4</sup> Department of Functional and Evolutionary Entomology, Gembloux Agricultural University, Gembloux, Belgium, <sup>5</sup> United States Department of Agriculture (USDA) – Agricultural Research Service (ARS) Bee Research Laboratory, Beltsville, Maryland, United States of America, <sup>6</sup> Department of Entomology, North Carolina State University, Raleigh, North Carolina, United States of America

### Abstract

**Background:** Over the last two winters, there have been large-scale, unexplained losses of managed honey bee (*Apis mellifera* L.) colonies in the United States. In the absence of a known cause, this syndrome was named Colony Collapse Disorder (CCD) because the main trait was a rapid loss of adult worker bees. We initiated a descriptive epizootiological study in order to better characterize CCD and compare risk factor exposure between populations afflicted by and not afflicted by CCD.

**Methods and Principal Findings:** Of 61 quantified variables (including adult bee physiology, pathogen loads, and pesticide levels), no single measure emerged as a most-likely cause of CCD. Bees in CCD colonies had higher pathogen loads and were co-infected with a greater number of pathogens than control populations, suggesting either an increased exposure to pathogens or a reduced resistance of bees toward pathogens. Levels of the synthetic acaricide coumaphos (used by beekeepers to control the parasitic mite *Varroa destructor*) were higher in control colonies than CCD-affected colonies.

**Conclusions/Significance:** This is the first comprehensive survey of CCD-affected bee populations that suggests CCD involves an interaction between pathogens and other stress factors. We present evidence that this condition is contagious or the result of exposure to a common risk factor. Potentially important areas for future hypothesis-driven research, including the possible legacy effect of mite parasitism and the role of honey bee resistance to pesticides, are highlighted.

Citation: vanEngelsdorp D, Evans JD, Saegerman C, Mullin C, Haubruge E, et al. (2009) Colony Collapse Disorder: A Descriptive Study. PLOS ONE 4(8): e6481. doi:10.1371/journal.pone.0006481

FOOT WORTH STAR-TELEGRAM ETT HULN



- Nutriti

- Parasitic

- Stress



## Summary

Category	High	Low	Loss	% Loss
10,000+ Hives	40,272	26,252	14,020	35%
6,000 - 10,000 Hives	19,200	9,100	10,100	53%
4,000 - 6,000 Hives	4,200	3,000	1,200	29%
2,000 - 4,000 Hives	9,092	6,148	2,944	32%
1,000 - 2,000 Hives	5,992	4,226	1,766	29%
Below 1,000 Hives	7,584	4,244	3,340	44%
<b>TOTAL</b>	<b>86,340</b>	<b>52,970</b>	<b>33,370</b>	<b>39%</b>

Washington State  
Beekeepers

2009-2010





Varroa destructor

Single Biggest Issue



# Introduction

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- Smuggled (Pocket Importation)
- Hitchhiked (Container Shipping)
- Migration (African Bees)





# Introduction

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- Smuggled (Pocket Importation)
- Hitchhiked (Container Shipping)
- Migration (African Bees)





# Beekeepers Opinions

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“When the mites came along, we thought we had problems. But this mess makes mites look like a Sunday school picnic.”

“Our scientists are working their heads off on a little bit of nothing.”

"What it basically does is it causes bees to get immune-deficiency disorder."





# Beekeepers Opinions

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“Our scientists are working their heads off on a little bit of nothing.”

"What it basically does is it causes bees to get immune-deficiency disorder."

“What are we going to do when all the stuff we have been using illegally stops working?”

“... these ----- scientists don't know what's going on out here in the real world they need to get their heads out of their --- and get out into the trenches to figure out what's going on”







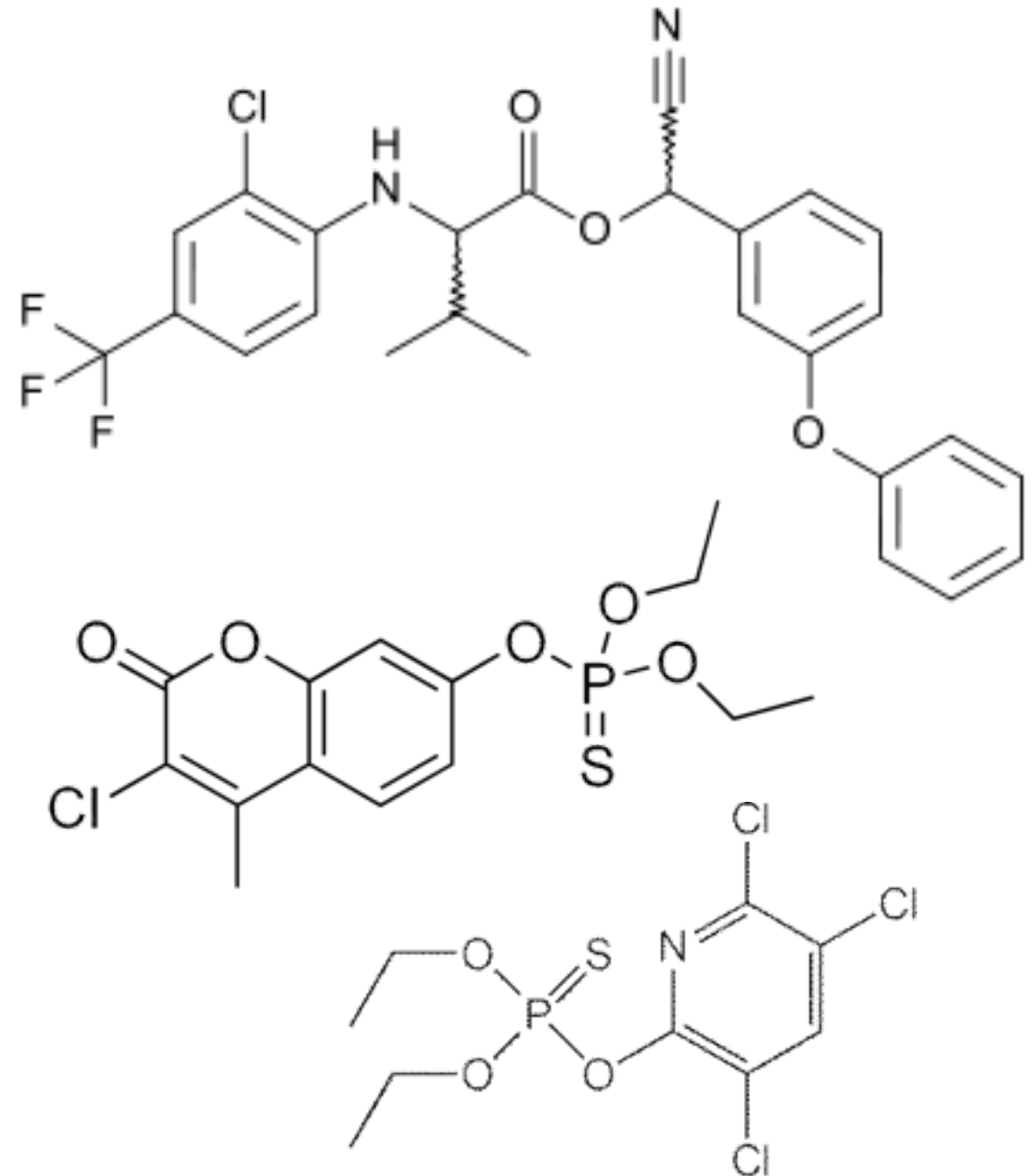
In Hive Use Of Chemicals



# Most Commonly Found Chemicals found in Honey Bee Comb

- Fluvalinate (Apistan®)
- Coumaphos (Checkmite+®)
- Coumaphos Oxon\*
- Chlorpyrifos (Dursban®, Lorsban®)
- 2, 4 Dimethylpheny formamide\*\*

\* Metabolite of Coumaphos  
\*\* Metabolite of Amitraz





Total Pesticide*	CLASS#	Samples Analyzed			% with Detections			LD50 <sup>†</sup>	Max Detection (ppb)			95%tile (ppb)			Wax (ppb) <sup>‡</sup>		Pollen (ppb) <sup>‡</sup>		Bee (ppb) <sup>‡</sup>	
		Wax	Pollen	Bee	Wax	Pollen	Bee		Wax	Pollen	Bee	Wax	Pollen	Bee	Mean	SEM	Mean	SEM	Mean	SEM
Fluvalinate	PYR	259	350	140	98.1	88.3	83.6	15860	204000	2670	5860	28703	294	1623	7329.5	956.9	83.9	11.2	299.0	79.7
Coumaphos	OP	259	350	140	98.1	75.4	60.0	46300	94131	5828	762	11555	730	135	3363.4	511.8	137.4	25.4	30.5	8.4
Chlorpyrifos	OP	258	350	140	63.2	43.7	8.6	1220	890	830	11	33	127	1	15.5	4.8	23.3	4.8	0.3	0.1
Chlorothalonil	FUNG	258	280	140	49.2	52.9	7.1	1110000	53700	98900	878	1545	10380	3	525.0	225.2	1593.5	473.5	7.2	6.3
Amitraz	FORM	177	247	125	61.6	31.2	6.4	750000	46060	1117	13780	4700	181	6	1080.7	327.1	32.5	7.3	107.2	104.2
Pendimethalin	HERB	176	247	140	27.8	45.7	4.3	665000	84	1730	28	11	71	0	3.0	0.7	20.4	7.3	0.7	0.3
Endosulfan	CYC	258	350	140	39.1	36.6	3.6	78700	132	157	9	22	33	0	5.5	1.0	6.0	1.0	0.2	0.1
Fenpropathrin	PYR	258	350	140	17.1	18.0	2.9	500	200	170	37	30	12	0	4.2	1.0	2.7	0.7	0.5	0.3
Esfenvalerate	PYR	258	350	140	16.7	11.7	5.7	2240	56	60	9	11	3	1	1.5	0.3	0.9	0.3	0.2	0.1
Atrazine	S HERB	208	350	140	13.9	20.3	0.7	980000	31	49	15	8	17	0	1.1	0.3	2.8	0.4	0.1	0.1
Methoxyfenozide	IGR	208	350	140	18.8	8.3	2.1	1000000	495	128	21	89	11	0	15.3	3.9	2.9	0.8	0.2	0.2
Azoxystrobin	S FUNG	258	350	140	15.5	15.1	0.0	1120000	278	107	0	7	17	0	2.4	1.1	3.2	0.6	0.0	0.0
Bifenthrin	PYR	258	350	140	12.8	5.1	1.4	150	56	13	12	6	0	0	1.3	0.4	0.2	0.1	0.1	0.1
Trifluralin	HERB	176	247	125	12.5	3.6	0.0	685000	36	14	0	1	0	0	0.5	0.2	0.1	0.1	0.0	0.0
Aldicarb	S CARB	208	350	140	10.6	6.0	0.0	3730	693	1342	0	217	92	0	27.8	7.9	31.2	8.4	0.0	0.0
Carbendazim	S FUNG	208	350	140	10.1	4.6	0.7	500000	133	149	14	11	0	0	2.3	0.8	0.9	0.5	0.1	0.1
Boscalid	S FUNG	208	350	140	10.1	0.9	0.0	1550000	388	962	0	80	0	0	11.1	3.1	2.8	2.7	0.0	0.0
Dicofol	OC	258	350	140	10.1	8.0	3.6	370000	21	143	4	5	3	0	0.7	0.2	1.9	0.6	0.1	0.0
Iprodione	FUNG	208	350	140	6.7	0.3	0.0	1020000	636	10	0	136	0	0	18.2	5.8	0.0	0.0	0.0	0.0
Norflurazon	S HERB	208	350	140	6.3	5.1	0.0	1630000	38	108	0	2	2	0	0.4	0.2	1.5	0.5	0.0	0.0
Pyrethrins	PYR	208	350	140	6.3	0.9	0.0	1480	222	62	0	22	0	0	5.3	1.7	0.4	0.2	0.0	0.0
Oxyfluorfen	HERB	258	350	140	6.2	2.0	1.4	1000000	34	5	5	3	0	0	0.7	0.2	0.0	0.0	0.1	0.0
Methidathion	OP	258	350	140	5.8	4.0	5.0	2010	79	33	32	4	0	0	0.9	0.3	0.9	0.2	0.8	0.3
Fenbuconazole	S FUNG	176	247	125	5.7	5.7	0.0	1490000	183	264	0	11	0	0	3.1	1.3	4.6	1.6	0.0	0.0
Cyprodinil	S FUNG	208	350	140	5.3	4.3	2.9	3320000	106	344	19	4	0	0	1.8	0.8	3.9	1.6	0.4	0.2
Cyhalothrin	PYR	258	350	140	5.0	10.9	2.1	790	17	28	2	0	2	0	0.3	0.1	0.4	0.1	0.0	0.0
Cypermethrin	PYR	258	350	140	5.0	7.1	6.4	1350	131	49	26	1	3	2	1.6	0.7	0.8	0.2	0.6	0.3

# Agricultural Pesticides

A total of 121 pesticides found

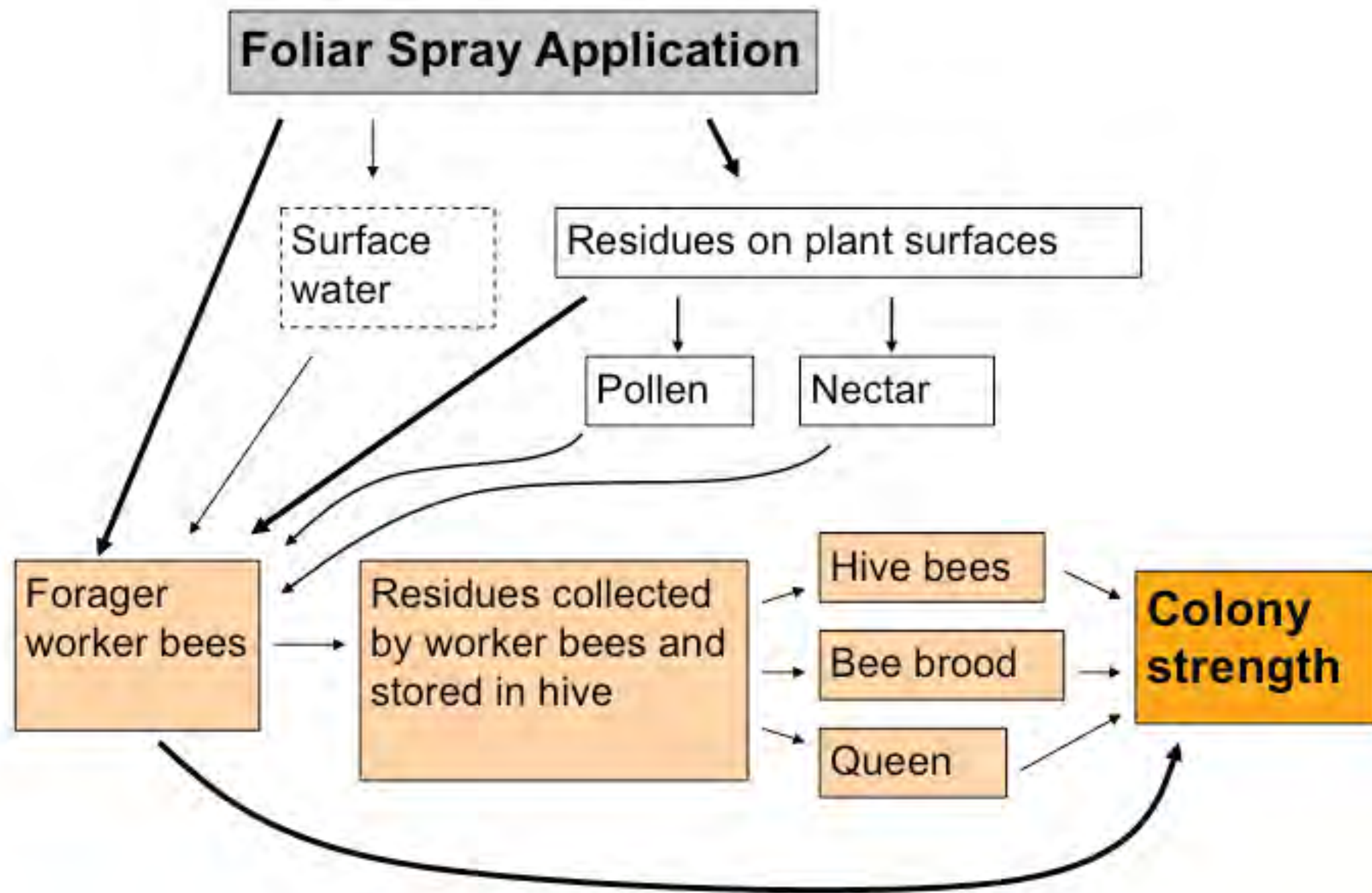




# Agricultural and Landscape Pesticides

Field Applied





Risk to  
Honey Bees

Foliar Spray Application





Agricultural and  
Landscape Pesticides

Systemic



“These fungicides, in combination with pyrethroids and/or neonicotinoids can sometimes have a synergistic effect hundreds of time more toxic than any of the pesticides individually.”

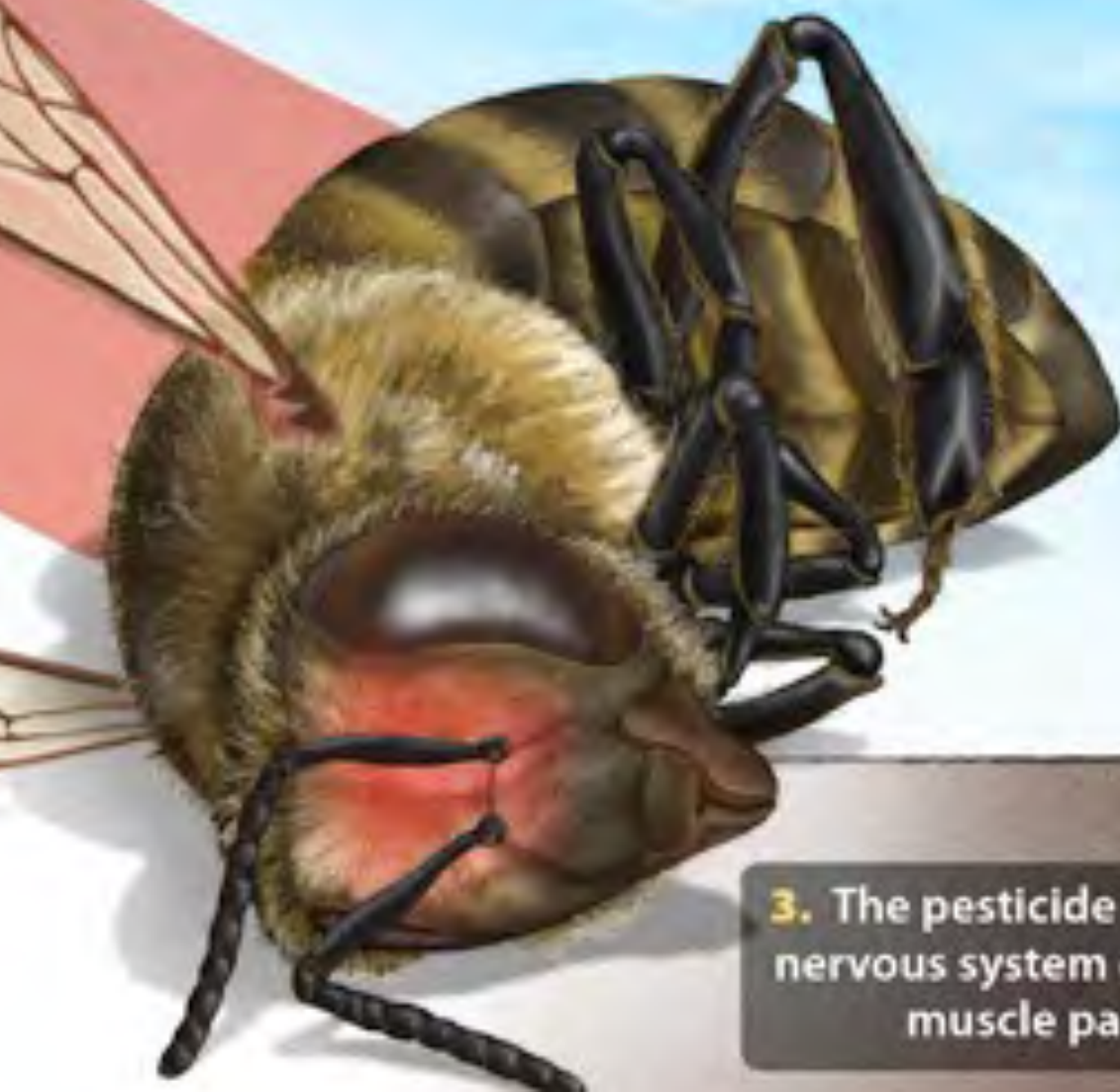
- MARYANN FRAZIER, PSU



2. The honeybee takes in the pesticide via the pollen

1. Before the seed is planted, it is coated with a systemic pesticide, meaning the pesticide will be present in all parts of the plant.

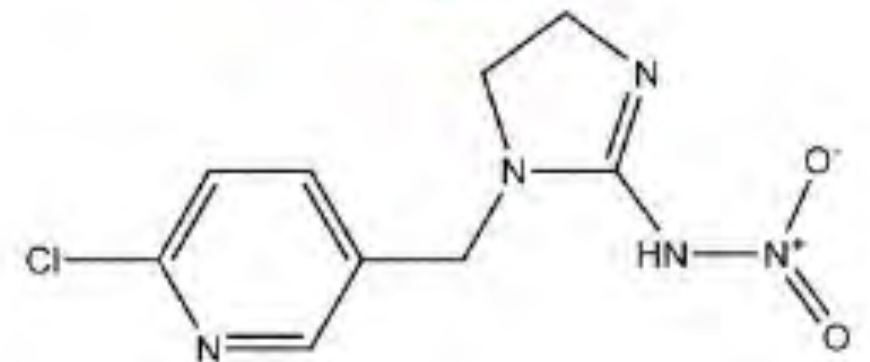
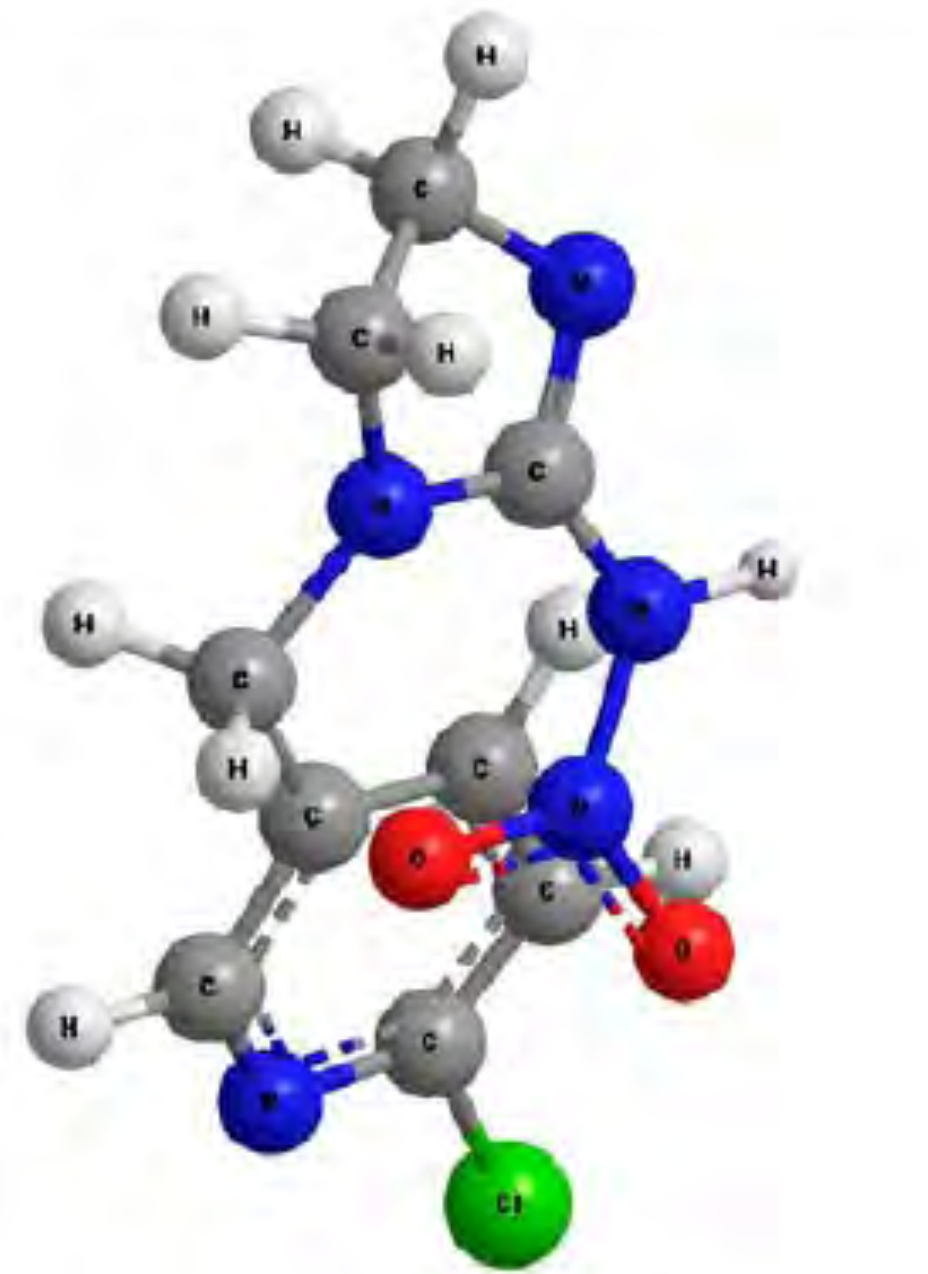
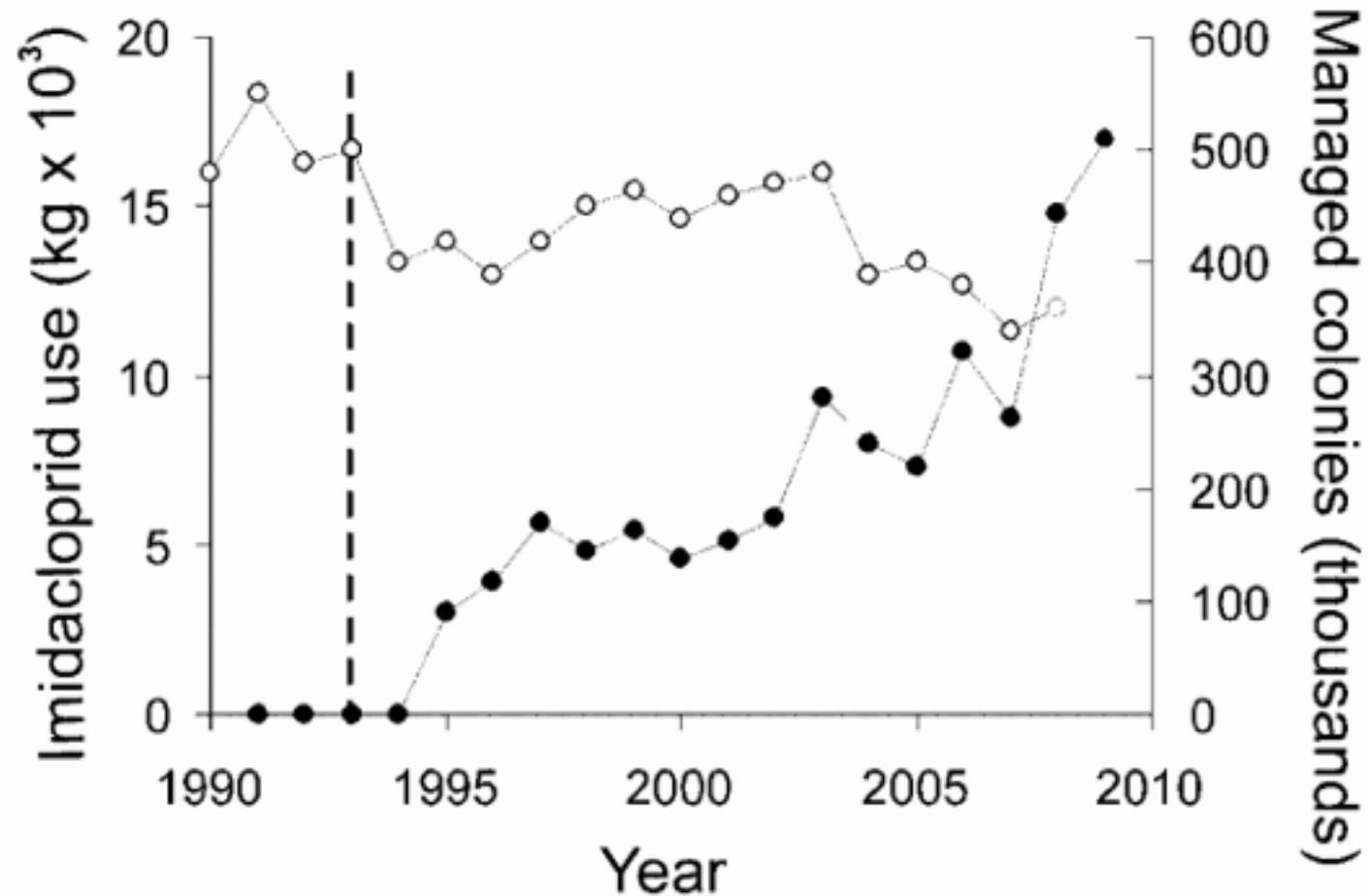
3. The pesticide then attacks the central nervous system of honeybee, leading to muscle paralysis and death.





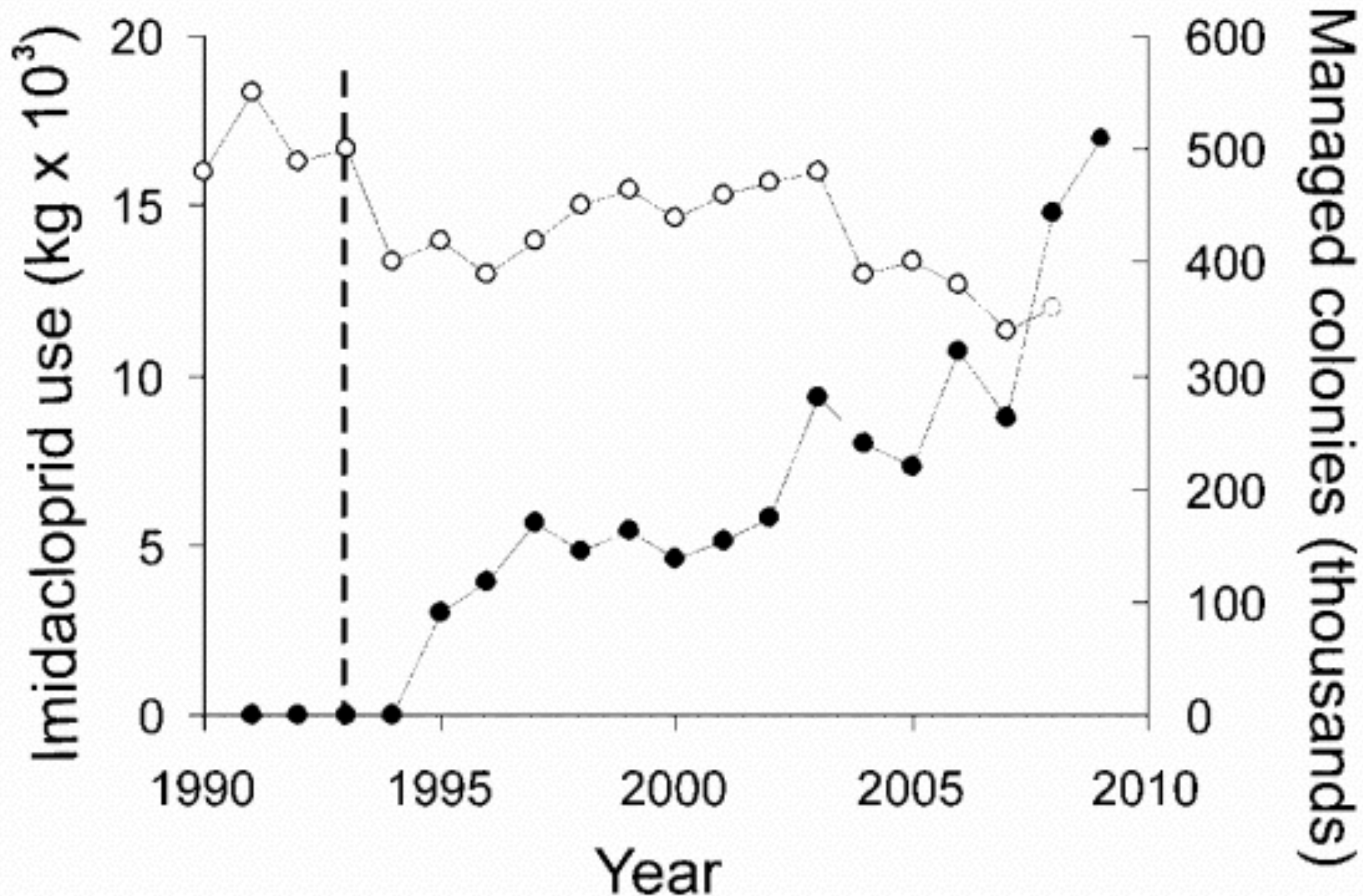
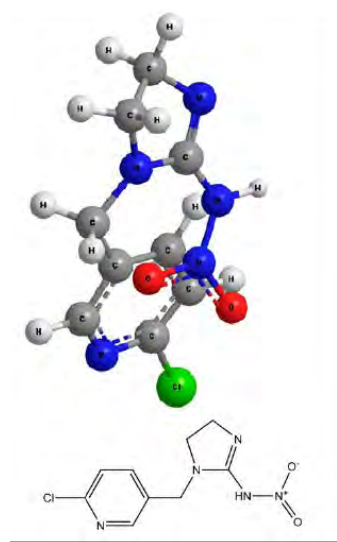
# Neonicotinoids

- Imidacloprid
- Clothianidin
- Thiamethoxam
- Thiacloprid
- Acetamiprid
- Dintefuran



Imidacloprid





# Imidacloprid

- Imidacloprid
- Thiamethoxam
- Clothianidin
- Thiacloprid

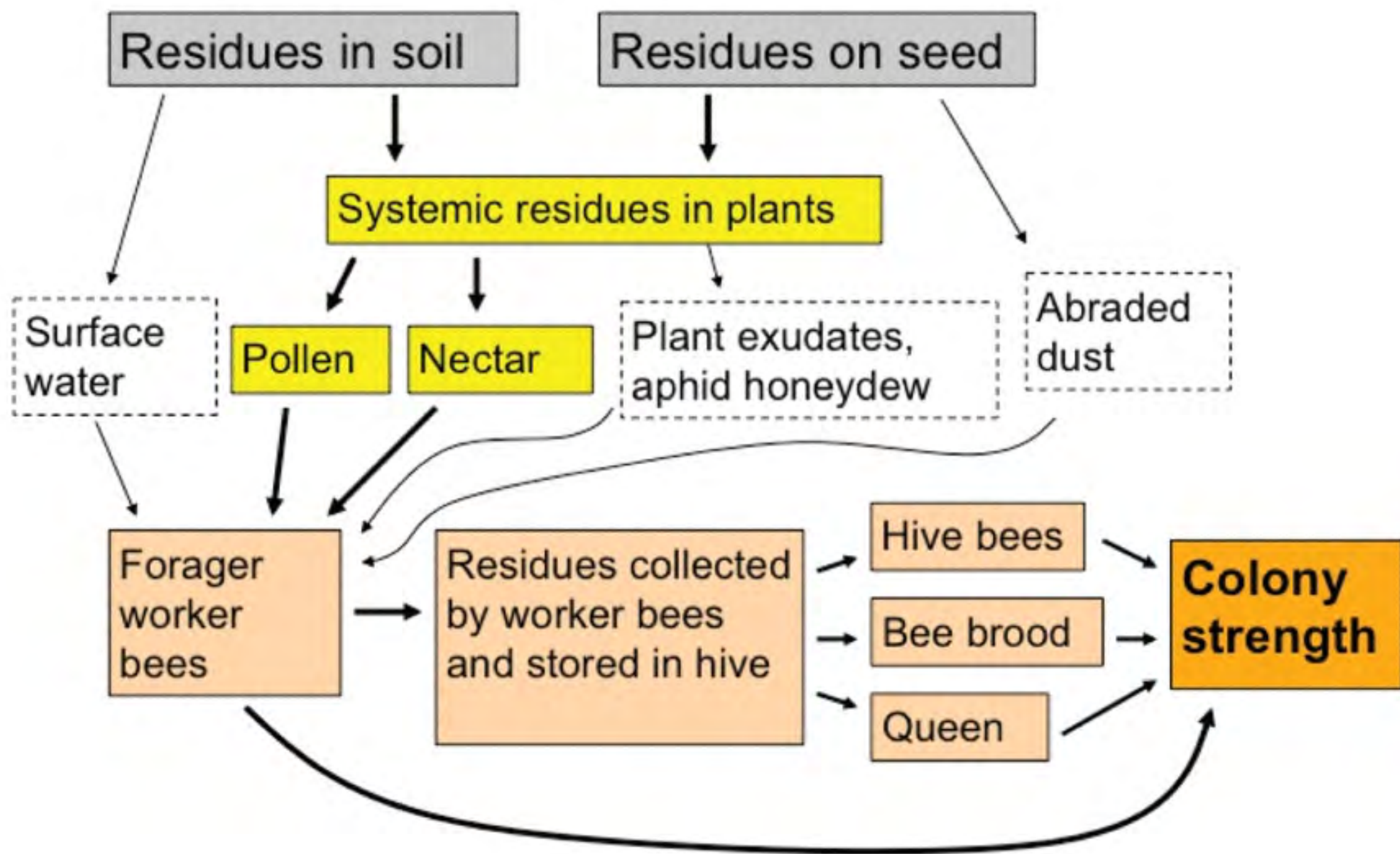


# Why Neonicotinoids?

- Low mammalian toxicity
- Very effective
- Lower dose than OP's and other classes of pesticides
- More than 465 products containing neonicotinoids are approved for use in the State of Washington
- 150 approved for home and garden







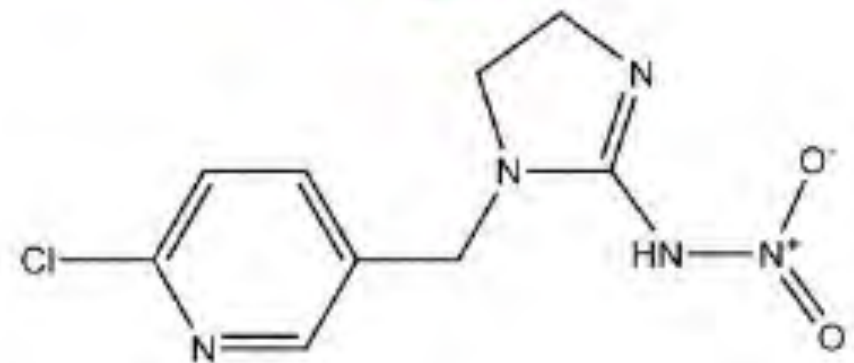
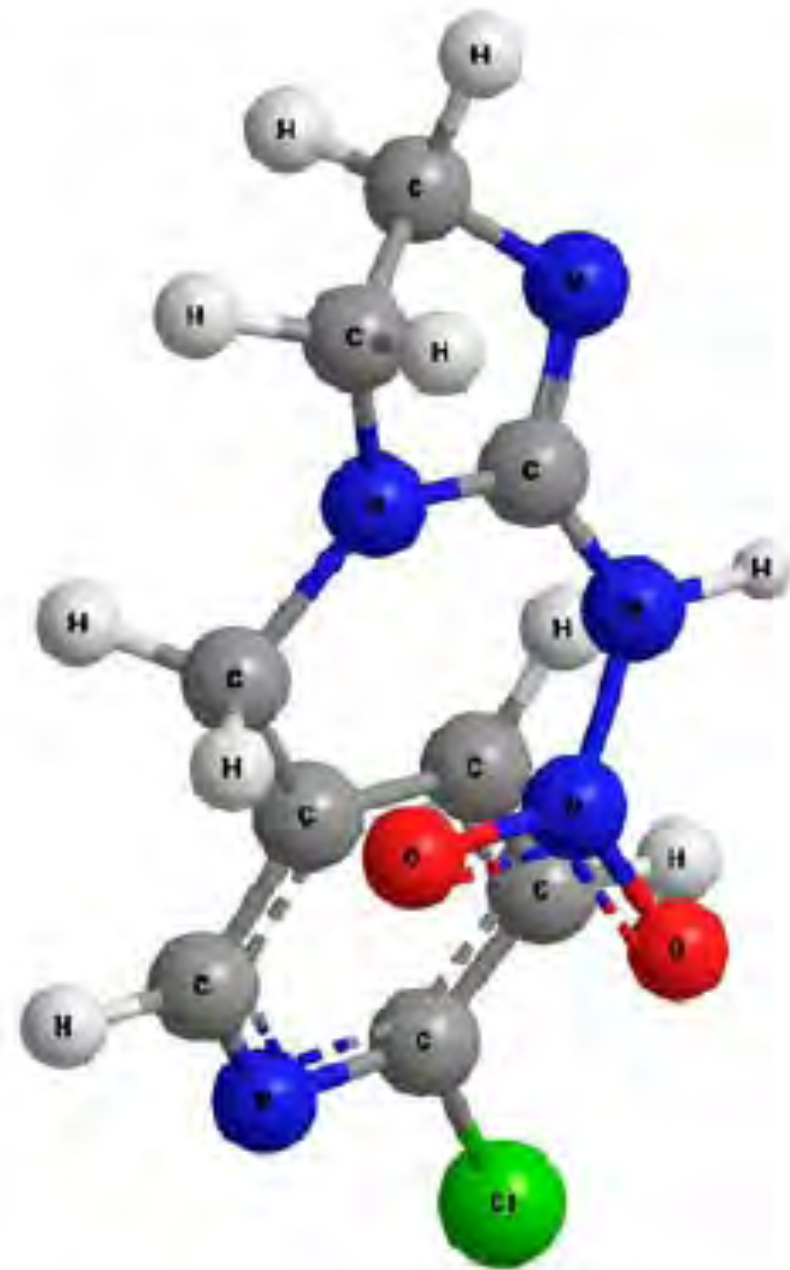
Risk to  
Honey Bees

Systemic Pesticide Application



# Neonicotinoids

- Imidacloprid
  - alters learning behavior
  - motor activity
  - memory
  - reduces brood production
  - foraging activity
- Clothianidin
  - impairs foraging behavior
- Thiamethoxam
  - decreases sucrose sensitivity
  - memory
- Acetamiprid
  - impairs activity
  - memory
  - sucrose sensitivity



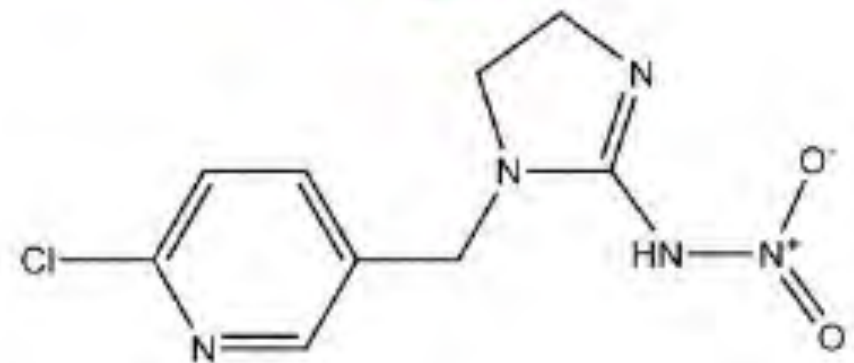
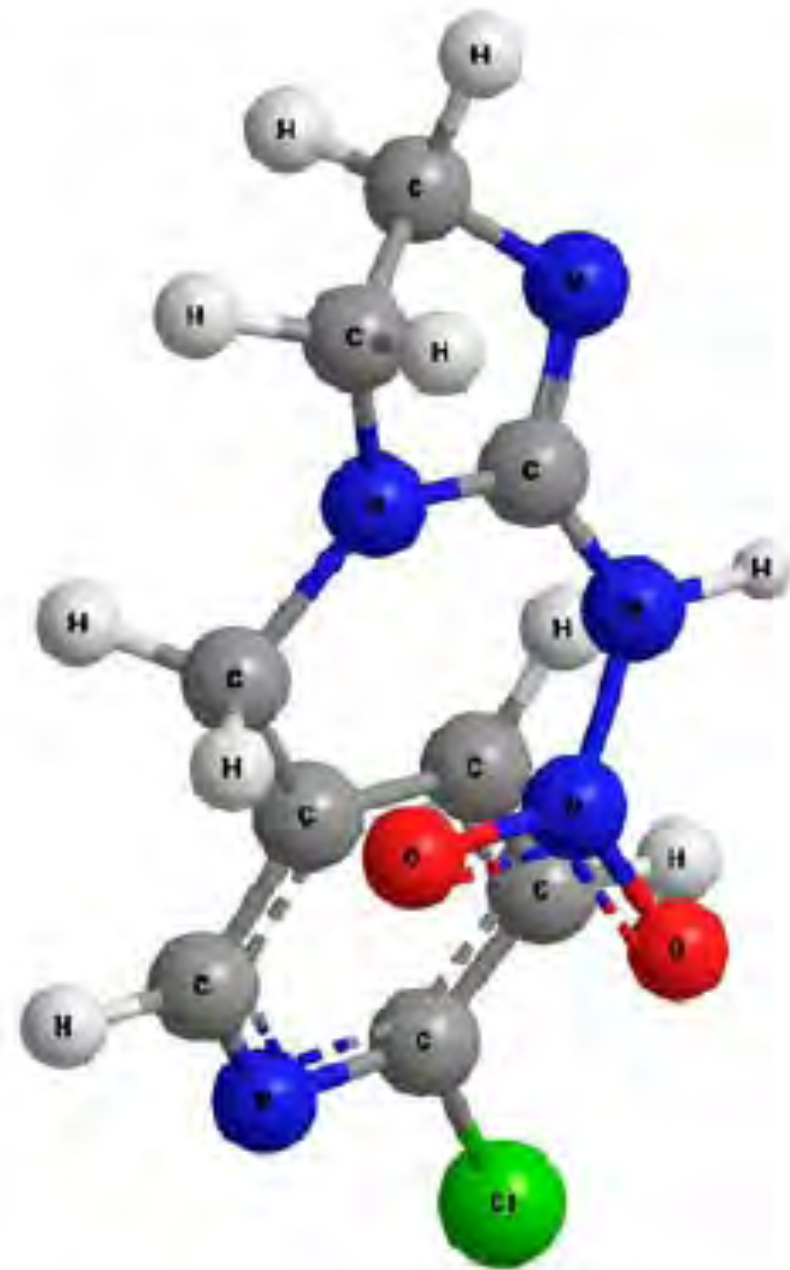
## Sub-Lethal Effects\*

\* >0.20 ppb



# Neonicotinoids

- Imidacloprid
  - Clothianidin
  - Thiamethoxam
  - Thiacloprid
  - Acetamiprid
  - Dintefuran
- Field Realistic Doses of Imidacloprid
    - No effect on rates of mortality
    - Reduced expected performance in adult honey bees by 10-20%
  - It does not appear there is sufficient evidence, currently, to suggest the presence of trace dietary neonicotinoids is, in itself, the cause of Colony Collapse Disorder



## Imidacloprid



Toxicity Group	Precautionary Statement if Extended Residual Toxicity is Displayed	Precautionary Statement if Extended Residual Toxicity is not Displayed
<b>I</b> Product contains any active ingredient with an acute LD50 of 2 micrograms/bee or less	This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.	Product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting treatment area.
<b>II</b> Product contains any active ingredient(s) with acute LD50 of greater than 2 micrograms/bee but less than 11 micrograms/bee.	This product is toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product if bees are visiting the treatment area.	This product is toxic to bees exposed to direct treatment. Do not apply this product while bees are actively visiting the treatment area.
<b>III</b> All others.	No bee caution required.	No bee caution required.

Bee Toxicity of Your Chemical

Know It!






EPA Pollinator Protection



# THE NEW EPA BEE ADVISORY BOX

On EPA's new and strengthened pesticide label to protect pollinators



**PROTECTION OF POLLINATORS**

**APPLICATION RESTRICTIONS** EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.

Look for the bee hazard icon in the Directions for Use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.

**This product can kill bees and other insect pollinators.** Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar.

Bees and other insect pollinators can be exposed to this pesticide from:

- Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications.
- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.

When Using This Product Take Steps To:

- Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
- Minimize drift of this product on to beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives can result in bee kills.

Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at: <http://pesticidestewardship.org/pollinatorprotection/pages/default.aspx>

Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency. For contact information for your state/tribe, go to [www.epa.gov](http://www.epa.gov). Pesticide incidents can also be reported to the National Pesticide Information Center at [www.npic.orst.edu](http://www.npic.orst.edu) or directly to EPA at [beekills@epa.gov](mailto:beekills@epa.gov).

Alerts users to separate restrictions on the label. These prohibit certain pesticide use when bees are present.

The new bee icon helps signal the pesticide's potential hazard to bees.


Makes clear that pesticide products can kill bees and pollinators.

Bees are often present and foraging when plants and trees flower. EPA's new label makes it clear that pesticides cannot be applied until all petals have fallen.

Warns users that direct contact and ingestion could harm pollinators. EPA is working with beekeepers, growers, pesticide companies, and others to advance pesticide management practices.

Highlights the importance of avoiding drift. Sometimes, wind can cause pesticides to drift to new areas and can cause bee kills.

The science says that there are many causes for a decline in pollinator health, including pesticide exposure. EPA's new label will help protect pollinators.



**Read EPA's new and strengthened label requirements: <http://go.usa.gov/jHH4>**

EPA Pollinator Protection





## Neonicotinoid Pesticides and Honey Bees



WASHINGTON STATE UNIVERSITY EXTENSION FACT SHEET • FS122E

field class of insecticides has become important for use  
 agriculture and home landscapes. There are currently  
 than 465 products containing neonicotinoids (often  
 "neonics") approved for use in the state of Washington.  
 Approximately 150 are approved for use in the home

## Introduction

## Introduction

Recently, concern has been raised regarding the impact of a common class of pesticides known as neonicotinoids (specifically, Figure 1) and native bee populations. Many people feel the decline in honey bee populations known as Colony Collapse Disorder (CCD) is directly linked to the increased use of these products.

In this paper, we will discuss the use of neonicotinoids as pesticides on commercial bee populations. Finally, we will discuss the relationship between honey bees and CCD.

In this paper, we will discuss the use of honey bees as indicators in honey bee populations. Finally, we will review what is currently known about the relationship between neonicotinoid pesticides and honey bees.



Figure 1. Honey bee on apple blossom. Bees are an important component of Washington's seven-billion-dollar apple industry. Much of the food we eat is dependent on honey bees for pollination. Photo courtesy of MIA Wiman, Oregon State University.

## What are Neonicotinoids?

## What are Neonicotinoids?

new class of insecticides has become important for use in agriculture and home landscapes. These are currently more than 400 products containing isoxanthoxanols (often called "diectics") approved for use in the state of Washington. Approximately 150 are approved for use in the home or garden.

Neem extracts are relatively safe for use around people, animals, and the environment (Mohamed 2008; Tomizawa 2004). Because of their effectiveness and relative safety, neem extracts have become one of the fastest growing classes of pesticides used in agriculture as well as in home and garden products (Joshi and Nauen, 2008).

### Bee Exposure

**Bee Exposure**

In laboratory experiments, researchers have documented several neonicotinoid products that are toxic to bees. Depending on the amount of exposure to neonicotinoids, sub-lethal effects of neonicotinoids include impaired learning behavior, short- and long-term memory loss, reduced fecundity (density and reproductive rate), and altered foraging behavior and motor activity of the bees. Researchers have documented similar issues with other pesticides including some products used by beekeepers to control Varroa, a parasitic mite of the honey bee. Neonicotinoids have also been implicated, along with some fungicides, in either depressing bees' immune systems or increasing their susceptibility to biological infections (Pillai et al., 2012; Pettit et al., 2013).

Exposure levels from dust created during planting of neonicotinoid-treated seed are known to have a devastating lethal impact on honey bees. However, this mode of exposure can be avoided and more work needs to be done

Authors/Date	Pesticide(s)	Species	Swarming	Application	Exposure Route
Cresswell et al. 2012	neonics	<i>A. mellifera</i>	n/a	oral	n/a
Significance:	Neonics not implicated in decline.				
Comments:	A review using epidemiological				
data et al. 2013	pyrethroids, pyrethroids, pyrethroids	<i>A. mellifera</i>	n/a	oral	n/a

Author(s)/Date	Neonic(s)	Species	Setting	Application	Exposure Range	Effects Tested
Cresswell et al. 2012	Neonics	A. mellifera	n/a	oral	n/a	Effects Tested: causal to decline
Significance:	Neonics not implicated to decline.					
Comments:	A review using epidemiology criteria.					
Idol et al. 2013	thiamethoxam, propiconazole	B. terrestris	lab	oral	thiamethoxam (7, 1.0 ug/kg); propiconazole (21, 230 mg/kg)	colony initiation, food consumption
Significance:	thiamethoxam: no larvae; propiconazole: no population effect.					
Comments:	Both reduced food consumption.					
Henry et al. 2012	thiamethoxam	A. mellifera	field	oral	1.34 ng/bee	homing success (homing)
Significance:	Differences in post exposure homing failure between treated and control.					
Comments:	Author's note: This field realistic rate doubles the probability of forager death on any given day.					
Krupke et al. 2012	various neonics and fungicides: clothianidin, imidacloprid, thiamethoxam, metolachlor, azoxystrobin, tri	A. mellifera	field/lab	n/a	0 to 32 ppb soil, 4 to 13,000 ppm in tank, 0.4 ppb in field pollen, 0.08 ppb returning forager pollen, etc.	n/a
Significance:	Showed possible routes of exposure from planting and plant expression; found at higher levels in dead and dying bees.					
Comments:	Indicated possible side effect of seed treatments.					
Laycock et al. 2012	imidacloprid	B. terrestris	lab	oral	imidacloprid variable, 0 to 125 ug/l	ovary development, fecundity
Significance:	Dose-dependent decline in fecundity: 1 ug/l reduced fecundity by 1/3; no effect on ovary development except at highest dosage.					
Comments:	Fecundity reduction at "environmentally realistic" dosages.					
Morimoto 2013	clothianidin, imidacloprid, dinotefuran, thiamethoxam	A. mellifera	lab/field	topical	variable (0.5 to 0.625 LD50)	behavioral/foraging success
Significance:	clothianidin/imidacloprid at 0.1 LD50 and greater; dinotefuran at 0.25 LD50, imidacloprid = N.S.					
Comments:	2 neonics, 1 pyrethrin, 1 organophosphate (OP).					
Schmider et al. 2012	imidacloprid, clothianidin	A. mellifera	field	n/a	imidacloprid 0.15 to 4 ng/bee; clothianidin 0.05 to 2 ng/bee	foraging
Significance:	Not at "field relevant" doses. imidacloprid > 0.5 ng/l, clothianidin > 1.5 ng/l reduced foraging and longer flight times.					
Comments:	Sub-lethal foraging effects.					
Wol et al. 2012	various neonics: imidacloprid, clothianidin, thiamethoxam, fipronil	A. mellifera	field/lab	n/a	Washed planter around dust, caged bees, etc. foraging bees over their planting showed mean clothianidin = 1.2-1.4 ng/bee; thiamethoxam 126-302 ng/bee	
Significance:	Similar to Krupke study. High exposure of bees possible during planting.					
Comments:	Used as seed treatments. Fipronil banned in France following evidence of bee kill during planting.					
imidacloprid	B. terrestris	lab/field	oral pollen and sugar water		Pollen 6 ug/kg, 12 mg/kg (low and high); sugar water 7 ug/kg, 14 ug/kg (low and high)	growth rate, queen production
Significance:	Difference in number of queens produced: control = 13.7, low 2.0 and high 1.4 queens.					
Comments:	Authors: trace levels of neonics can have a string of negative consequences for queen production.					



# Is London's pollution crippling bees' ability to smell?

by Martin Stew: ITV Weather Presenter - last updated Thu 3 Oct 2013

Honeybees rely on their incredible sense of smell and ability to learn and memorise floral odours. Essentially their sense of smell is the homing device they use to find floral food.



Bee collecting nectar from a flower *Credit: Press Association*

Research published today in Scientific Reports warns that air pollution from diesel fumes can affect that delicate sense. London has some of the worst air pollution levels in Europe. Honeybees use the whole range of chemicals found in a floral blend to discriminate between different blends, and the results suggest that some chemicals in a blend may be more important than others.





## Study eyes selenium impacts to honey bees

Posted on October 4, 2013 by Bob Berwyn

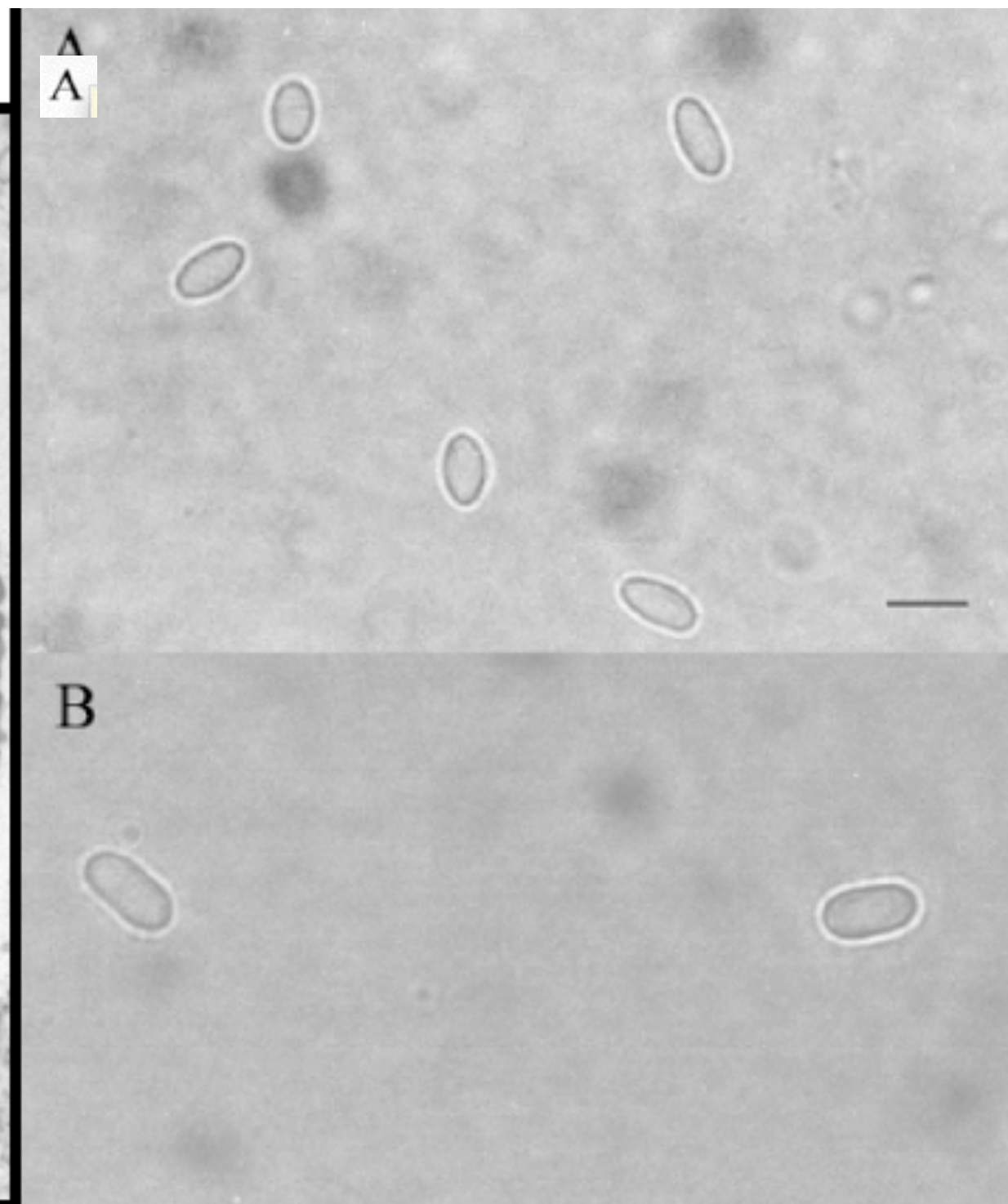
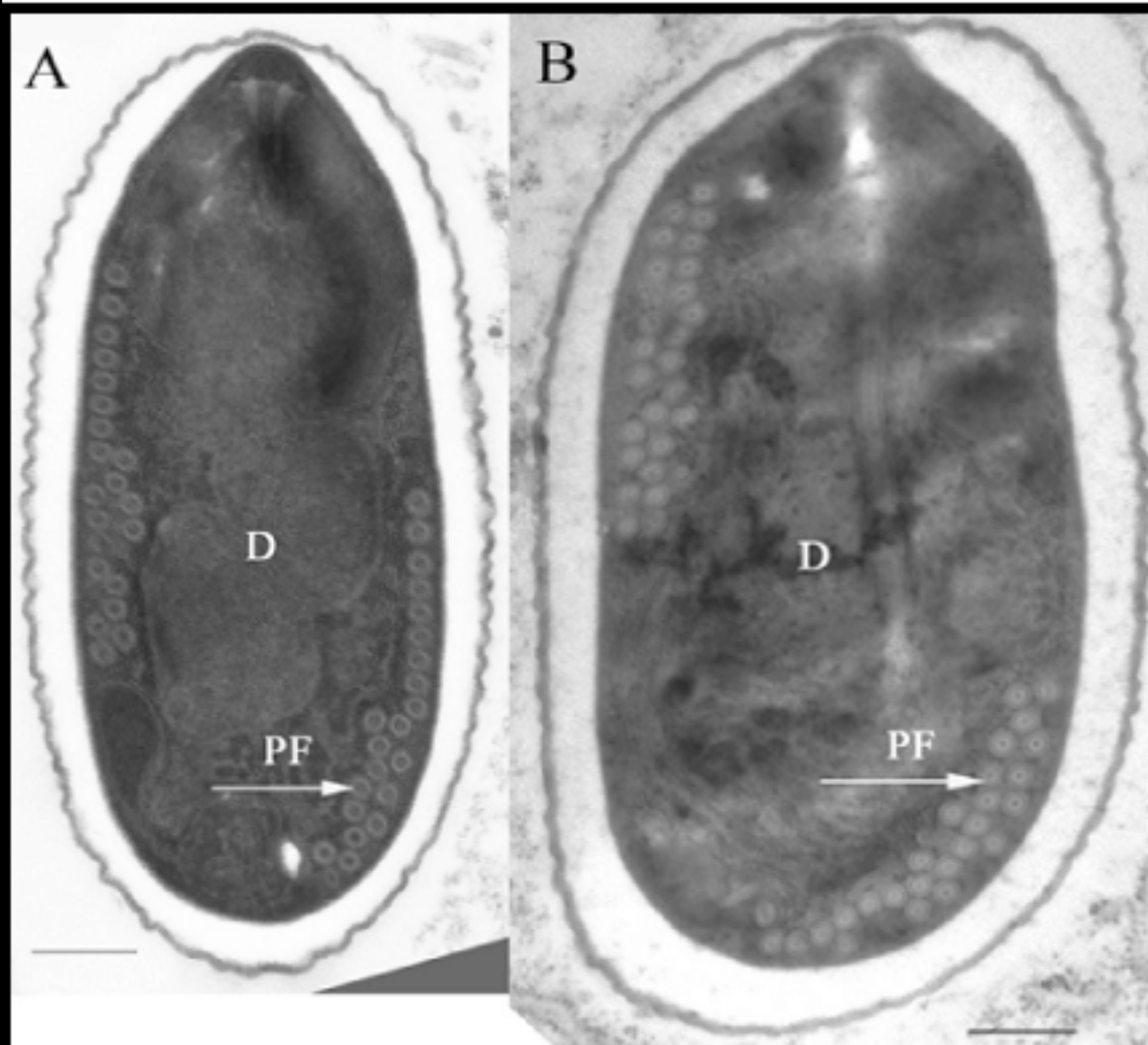
*Exposure can lead  
to mortality,  
California  
researchers say*

**By Summit Voice**

FRISCO — Along with pesticides, heavy metals may also be contributing to the decline of [honey bees](#) in some regions, according to







*Microsporidians*

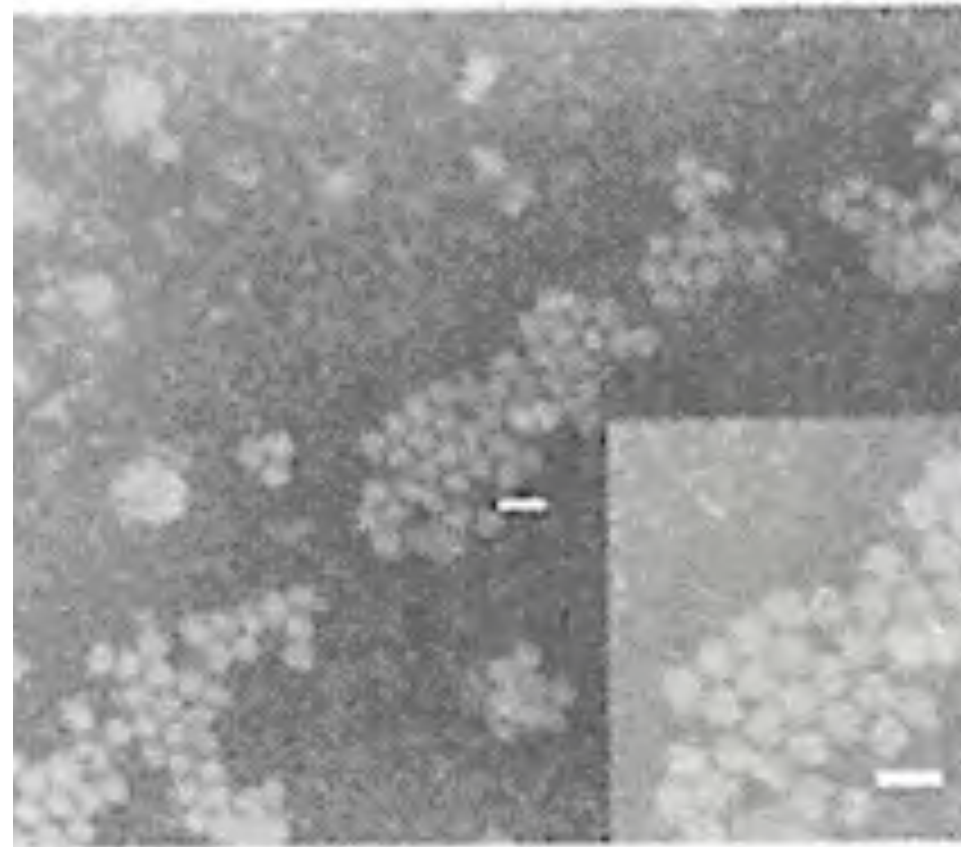
*Nosema ceranae* (a)  
*Nosema apis* (b)



# Viruses

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- Chronic paralysis
- Cloudy wing
- Israeli Acute Paralysis
- Acute paralysis
- Black Queen
- Deformed wing
- Kashmir bee virus
- Sac Brood
- Slow paralysis
- Bee virus X & Y
- Filamentous





# Monoculture Agriculture

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- Loss of nutritional diversity
- Heavy reliance on honey bees for pollination
- Intense use of chemicals to control undesirable pests and diseases









# Industrial Beekeeping





# Major Causes of Bee Poisoning

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- Insecticides are applied when bees are foraging
- Insecticides are applied to blooming weeds
- Insecticides drift onto blooming plants adjacent to the target crop
- Bees Collect insecticide pollen or nectar from non-target plants or plants treated with pesticides





# What You Can Do!

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- Do not spray or apply pesticides when flowers are present
- Do not spray when bees are present
- Avoid spray drift to standing water
- Avoid applying systemics to flowering plants





# What You Can Do!

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- Available Free - [pubs.wsu.edu](http://pubs.wsu.edu)





# Change In The Mindset Of The Farming Community

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- Avoid Spraying During Bloom - Still a good recommendation
- Develop Products Or Strategies That Reduce The Impact On Pollinators





# Change In The Mindset Of The Farming Community

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- Avoid Spraying During Bloom - Still A Good Recommendation
- Develop Products Or Strategies That Reduce The Impact On Pollinators
- Select For Increased Nectar & Pollen Production To Increase Nutrition & Attraction
- Promote Natural Vegetation and Pollinator Habitat

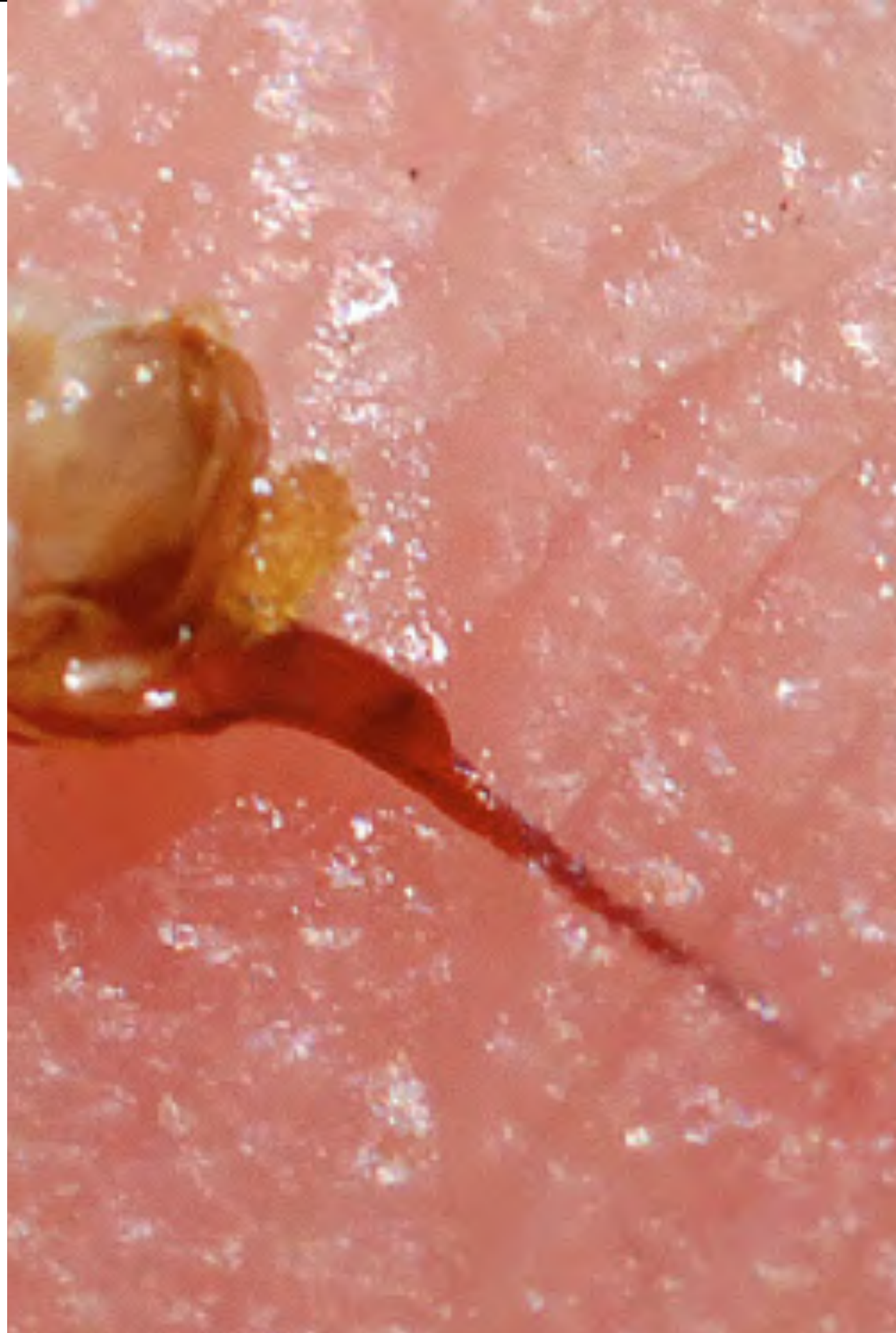




# What Needs To Happen

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- Continue to Seek Short Term Solutions
  - Detection
  - Treatment
- Aggressively Fund & Implement Long Term Strategies
  - Breeding Programs
- Research On The Interactions of Various Stressors
- Development Of Non-Chemical Management Strategies
- Expanded Outreach Education
- Stop Pandering To The Industry





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## Honeybee CAP



**Date Funded:** 2008

**Amount:** \$4 million

**Duration:** 4 years

**Objective:** Restore large and diverse populations of managed bee pollinators across the United States to sustain natural and agricultural plant communities.

**Why?** Bee pollination is responsible for \$15 billion in added crop value each year. Colony Collapse Disorder (CCD) became an issue in

the winter of 2006-2007 when an estimated 25 percent of the beekeepers in the United States reported substantial losses of adult bees from their hives.

**Impact:** By looking into the causes of CCD and other diseases affecting bee populations, researchers will be able to improve the overall health of this agriculturally important insect. The team plans to develop best management practice guides that provide practical answers for beekeepers and growers of crops that rely on bees for pollination.

**Participants:** University of Georgia, lead institution

Connecticut Agricultural  
Experiment Station

Cornell University

Kentucky State University

Michigan State University

North Carolina State  
University

Pennsylvania State  
University

Purdue University

University of California-  
Riverside

University of Maine

University of Massachusetts

University of Minnesota

University of Nebraska

University of Tennessee

USDA Agricultural Research  
Service

Washington State University





# Habitats for Pollinators

- Protect existing natural areas
- Department of Transportation
  - Roadside beautification
- Conservation Reserved Enhancement Program (CREP)
- Reclaimed areas
- Marginal or unused areas
- Riparian or Marshy areas

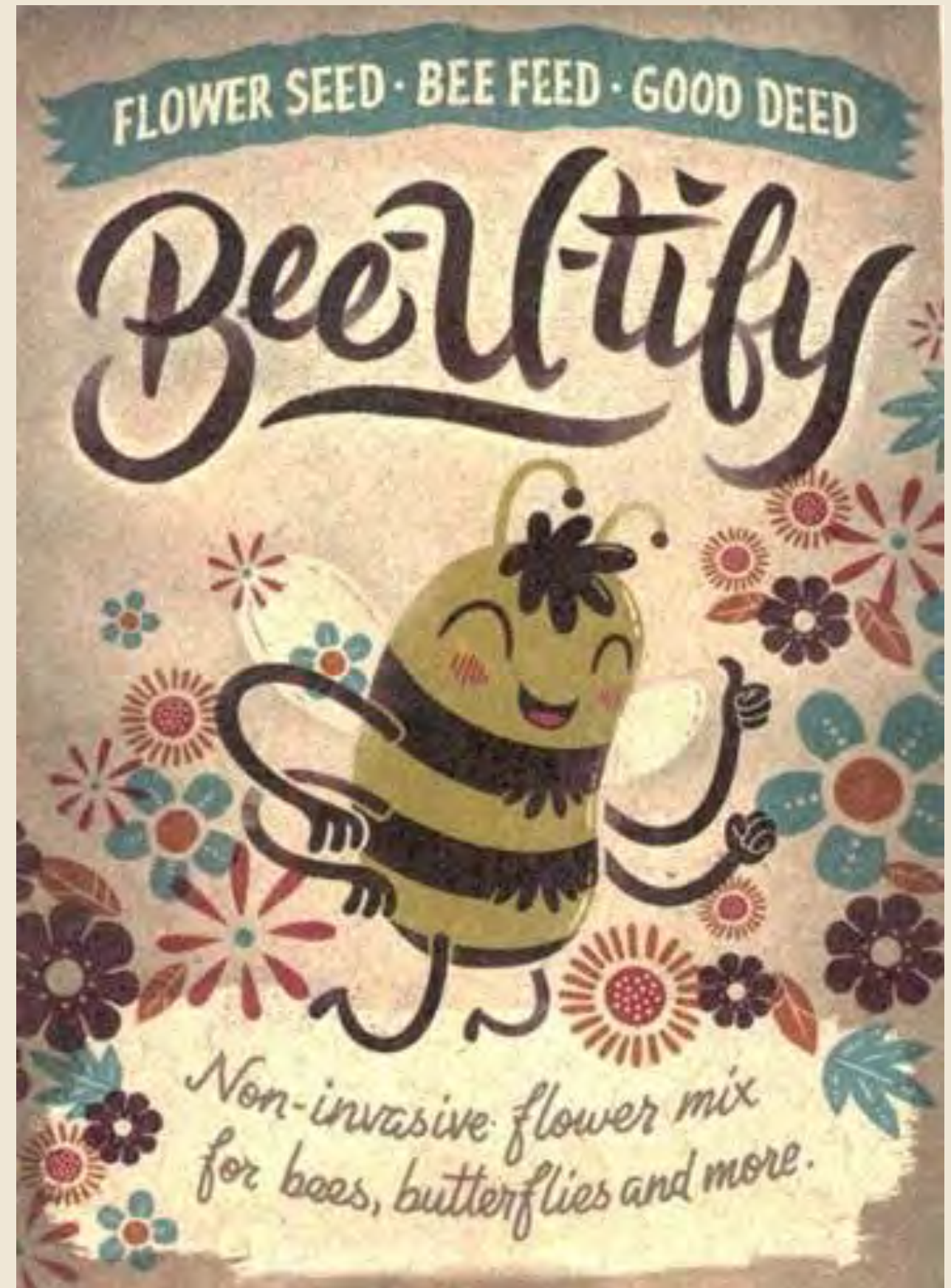


# Washington State Noxious Weed Control Board

Very Nice - THANK YOU!

A good first step

But more needs to be done







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*Review*

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## The Potential Conservation Value of Non-Native Species

MARTIN A. SCHLAEPFER,<sup>\*†</sup> DOV F. SAX,<sup>‡</sup> AND JULIAN D. OLDEN<sup>§</sup>

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<sup>†</sup>INRA, Ecologie et Santé des Ecosystèmes, 35042 Rennes, France

<sup>‡</sup>Department of Ecology and Evolutionary Biology, 80 Waterman Street, Brown University, Providence, RI 02912, U.S.A.

<sup>§</sup>School of Aquatic and Fishery Sciences, University of Washington, Box 355020, Seattle, WA 98195, U.S.A.

**Abstract:** *Non-native species can cause the loss of biological diversity (i.e., genetic, species, and ecosystem diversity) and threaten the well-being of humans when they become invasive. In some cases, however, they can also provide conservation benefits. We examined the ways in which non-native species currently contribute to conservation objectives. These include, for example, providing habitat or food resources to rare species, serving as functional substitutes for extinct taxa, and providing desirable ecosystem functions. We speculate that non-native species might contribute to achieving conservation goals in the future because they may be more likely than native species to persist and provide ecosystem services in areas where climate and land use are changing rapidly and because they may evolve into new and endemic taxa. The management of non-native species and their potential integration into conservation plans depends on how conservation goals are set in the future. A fraction of non-native species will continue to cause biological and economic damage, and substantial uncertainty surrounds the potential future effects of all non-native species. Nevertheless, we predict the proportion of non-native species that are viewed as benign or even desirable will slowly increase over time as their potential contributions to society and to achieving conservation objectives become well recognized and realized.*



# Value and Benefits of Pollinator Programs



- Enhances aesthetic pleasures of pollinator-friendly areas
- Develops general community awareness of native flora and fauna
- Provides abundant food and seed crops
- Encourages conservation of pollinators
- Provides educational opportunities



# Things To Consider With Bee Gardens

Abundance

Sequence

Diversity

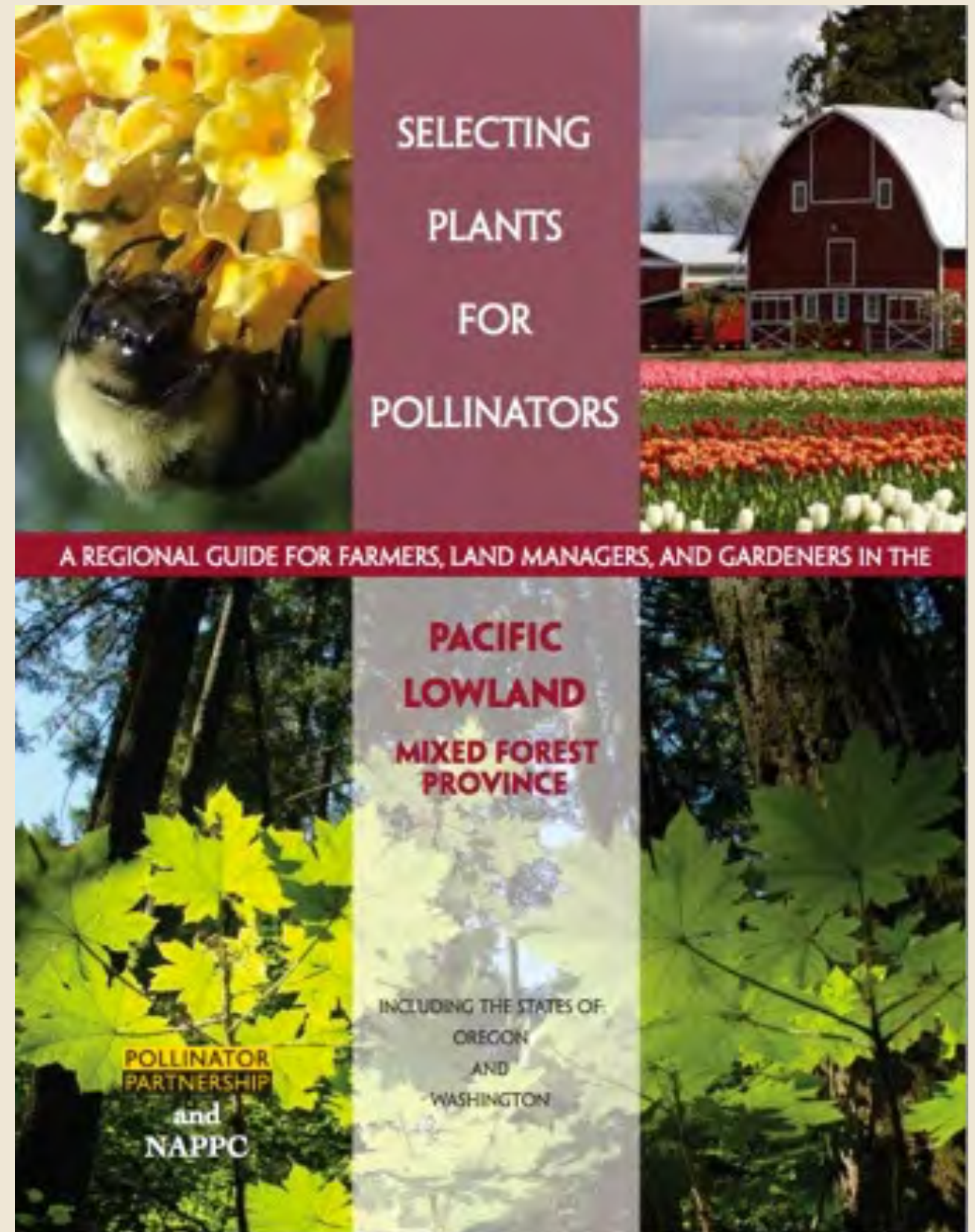
Pesticide Use





# Resources for Selecting Plants

[www.pollinator.org](http://www.pollinator.org)





# Resources for Selecting Plants



[www.pollinator.org](http://www.pollinator.org)



**Thanks!**  
**Questions?**

