WASHINGTON STATE UNIVERSITY EXTENSION

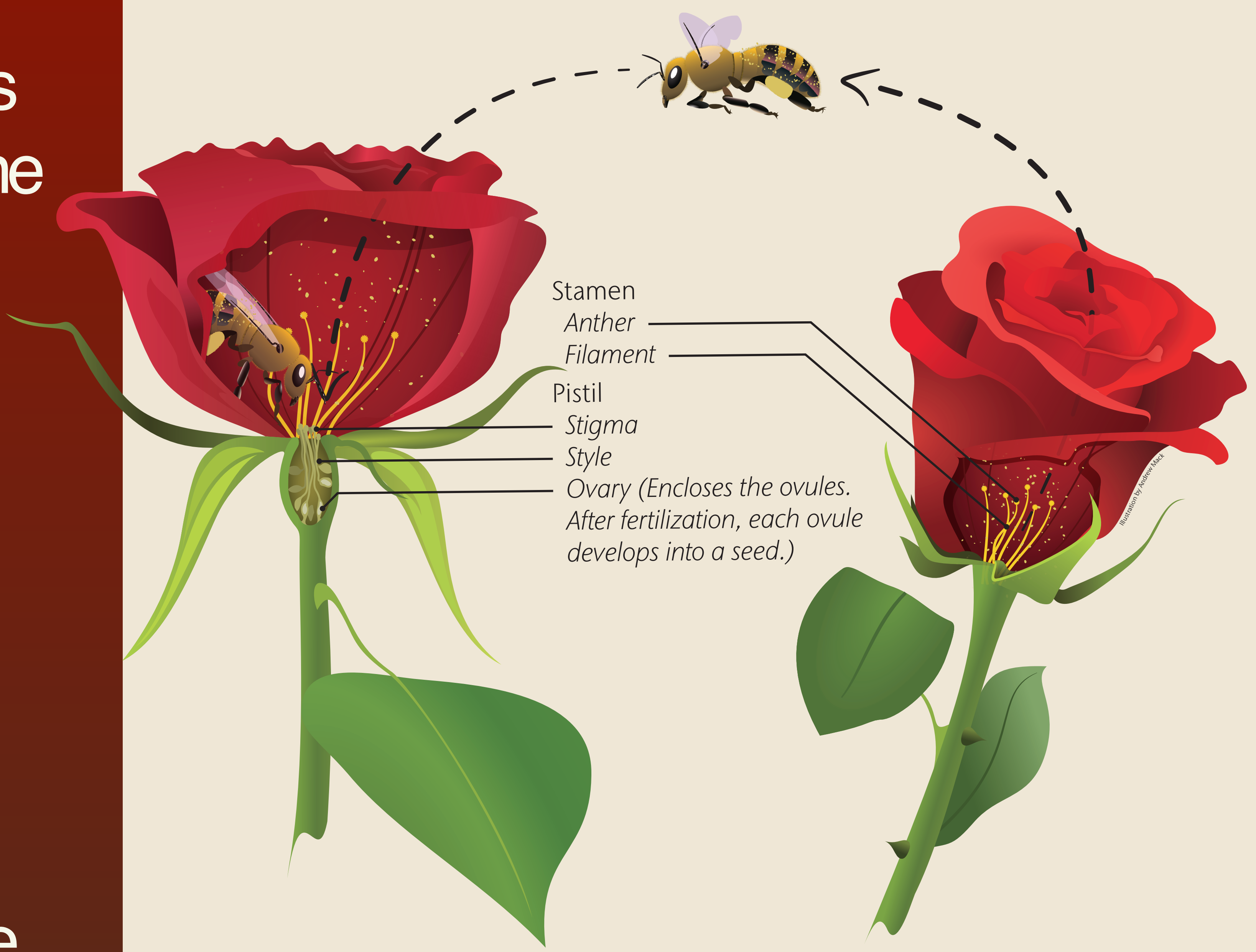
Timothy Lawrence Ph.D.

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



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Pollinating Agents Include:

- Bees and Wasps
- Butterflies and Moths
- Flies
- Beetles
- Birds, Humans and Other Mammals
- Wind and Water

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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

Washington State University Extension

Native Pollinators

Are Perhaps At Greater Risk

Native Pollinators

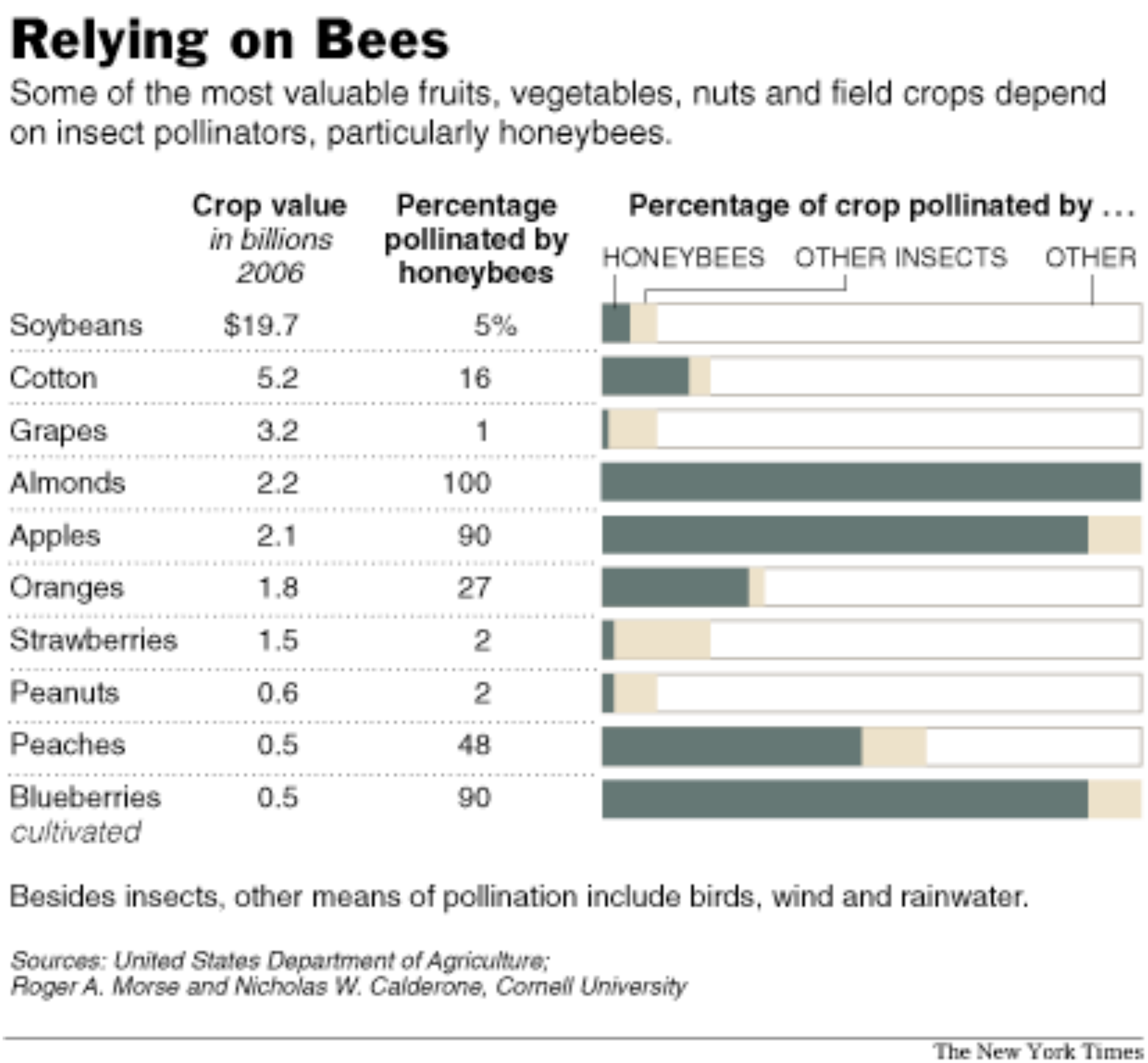
Are Perhaps At Greater Risk

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.

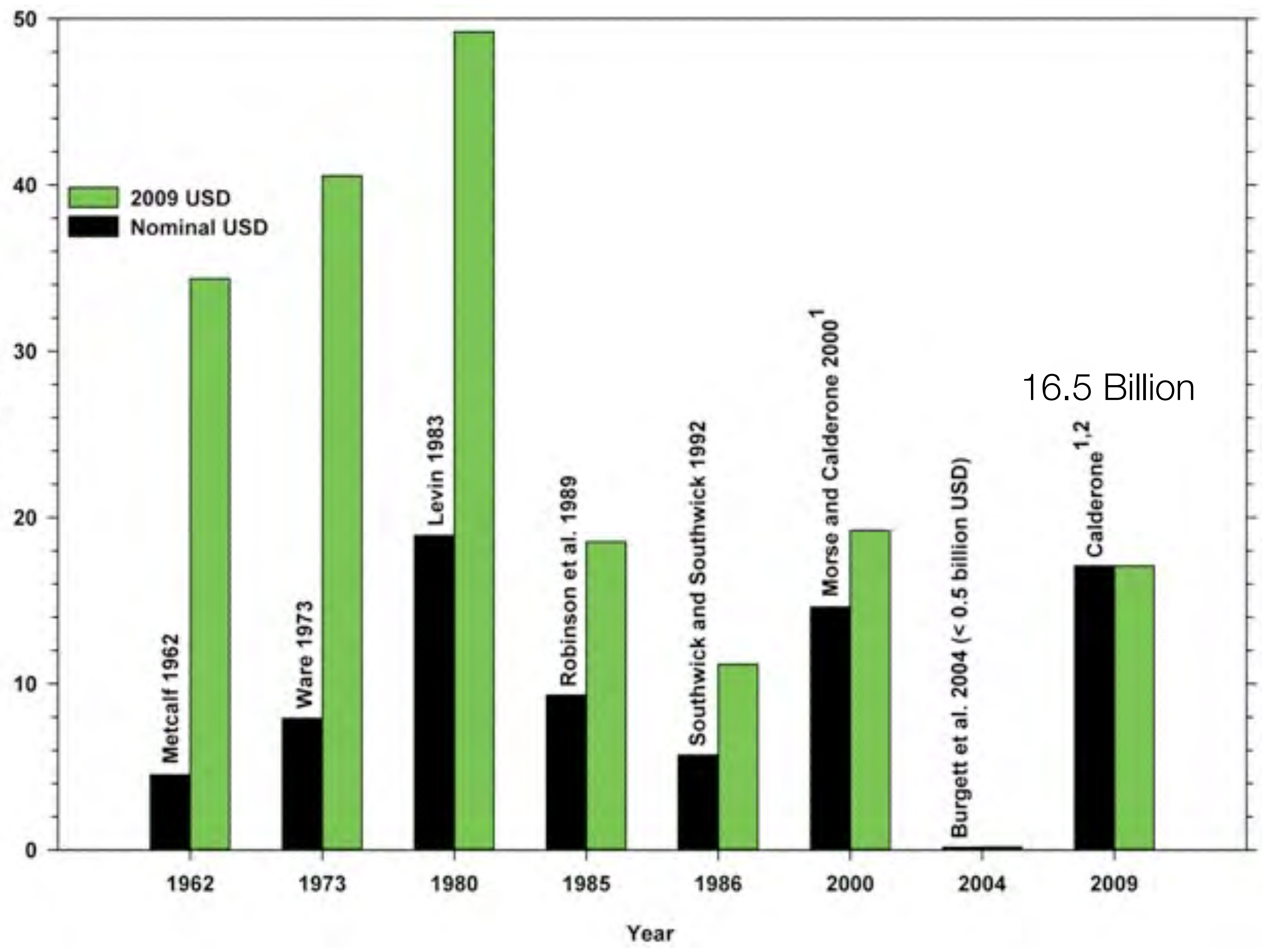
	Crop value *in billions 2006*	Percentage pollinated by honeybees
Soybeans	$19.7	5%
Cotton	5.2	16
Grapes	3.2	1
Almonds	2.2	100
Apples	2.1	90
Oranges	1.8	27
Strawberries	1.5	2
Peanuts	0.6	2
Peaches	0.5	48
Blueberries *cultivated*	0.5	90

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

The New York Times

Value of the Honey Bee



Partial List Of Plants Pollinated By Bees

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

Alternative Pollinators

Man/Bee Relationship

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

Lorenzo Lorraine Langstroth

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)

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, [illegible], 168, 189, 363, 471.

Modern Beekeeping

Big Business - 2.3 Million Hives*

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

*Ag Marketing Resource Center

Modern Beekeeping

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Almond Production

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

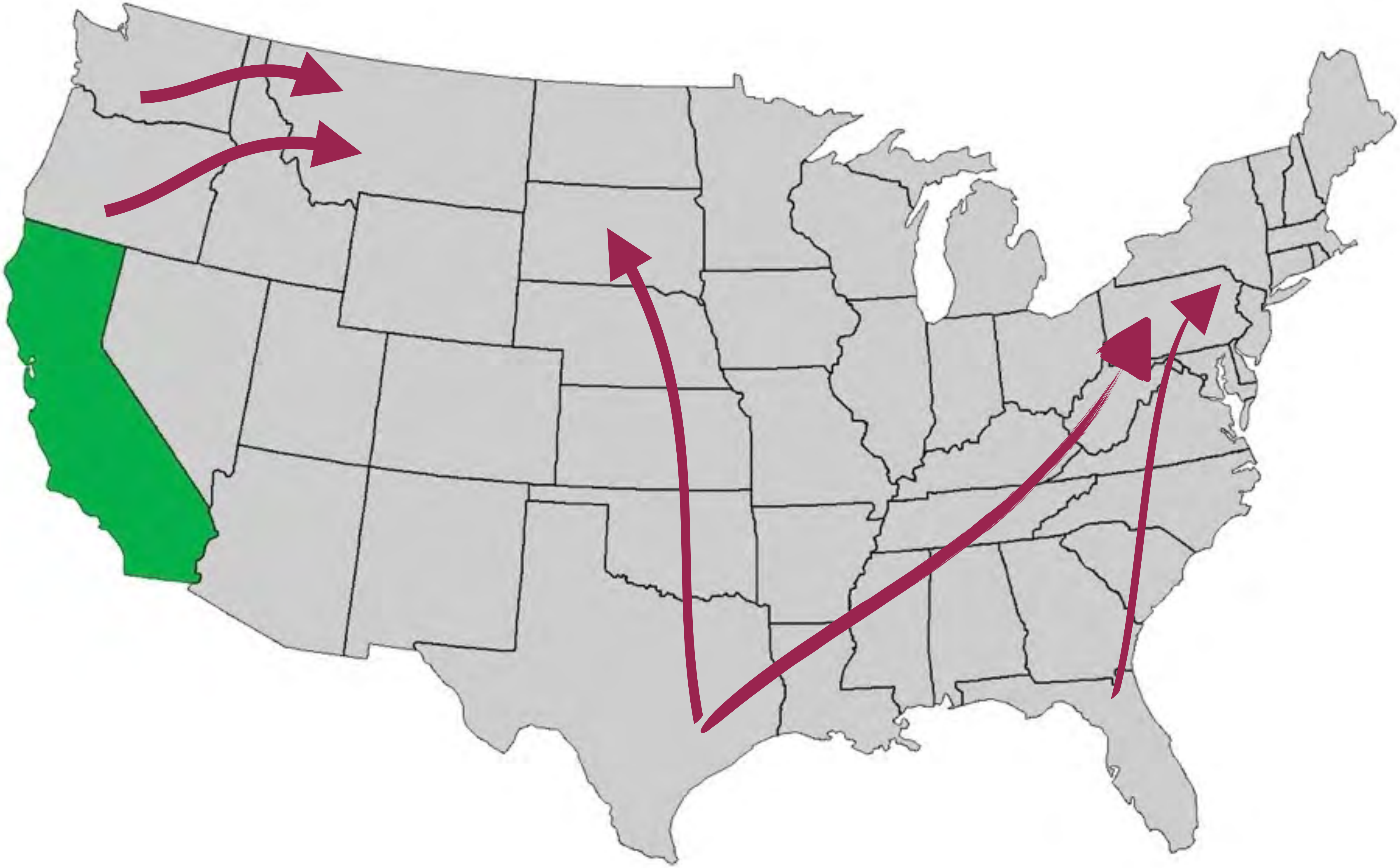
Honey Bee Migration

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

California Almond Pollination Demand

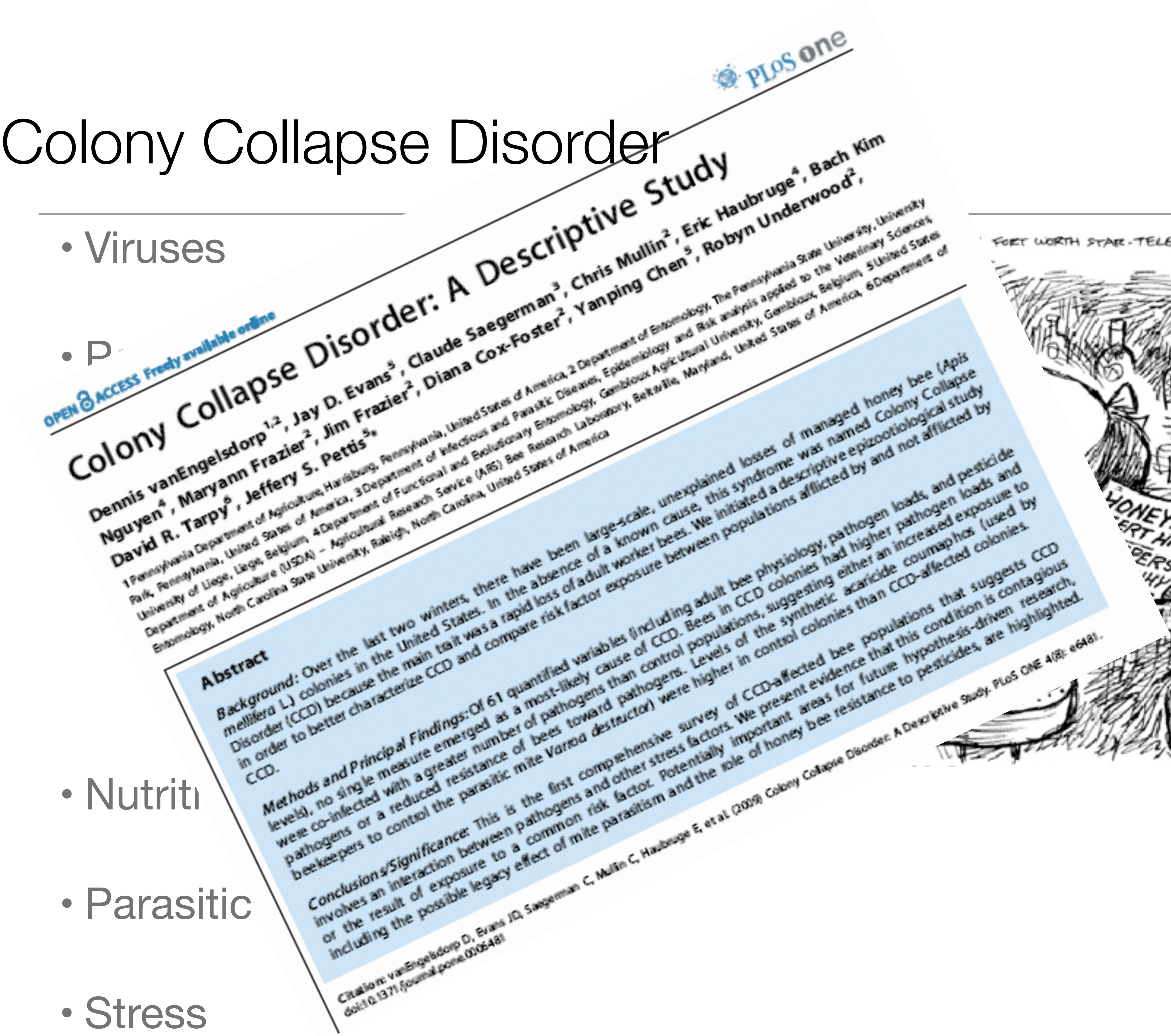
• 1.6 to 2.0 million hives needed for pollination

•Average 2013 Price for Pollination $160 (Range $135 to $200)



Colony Collapse Disorder

- Viruses
- P
- Nutriti
- Parasitic
- Stress



PLoS one

OPEN ACCESS Freely available online

Colony Collapse Disorder: A Descriptive Study

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

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

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%
TOTAL	**86,340**	**52,970**	**33,370**	**39%**

Washington State Beekeepers

2009-2010

Varroa destructor

Single Biggest Issue

Introduction

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

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

Beekeepers Opinions

“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?"

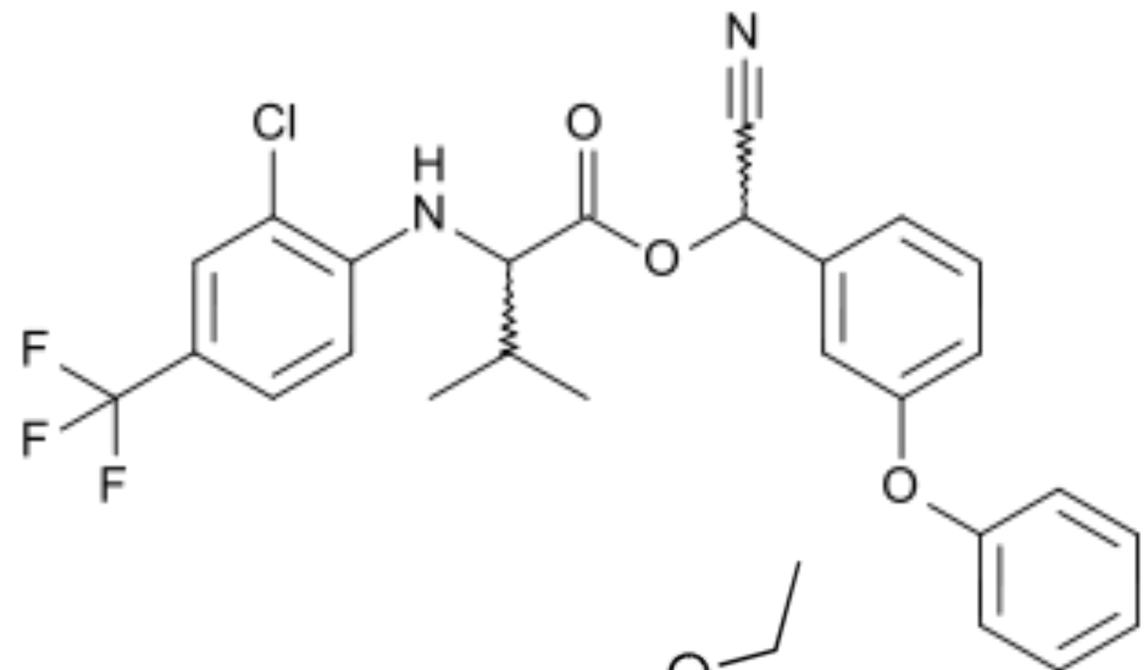
"... these ----- scientists don't know what's going on out here in the real world they need to get their heads out of their --- and get out into the trenches to figure out what's going on"

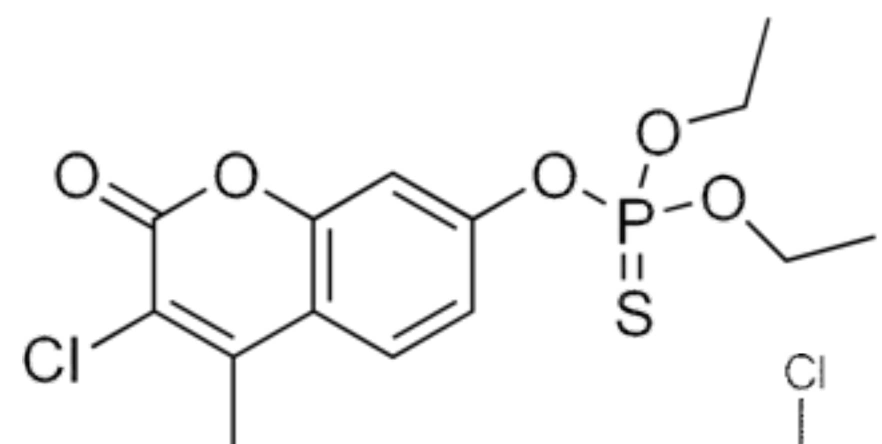


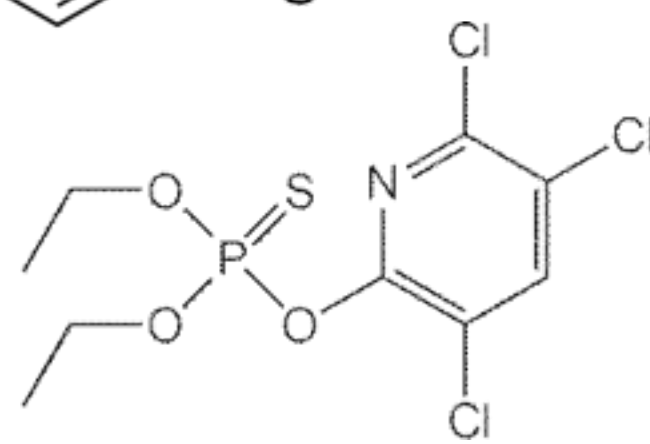
In Hive Use Of Chemicals

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[¶]	Max Detection (ppb)			95%tile (ppb)			Wax (ppb)[$]		Pollen (ppb)[$]		Bee (ppb)[$]	
		Wax	Pollen	Bee	Wax	Pollen	Bee	(ppb)	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

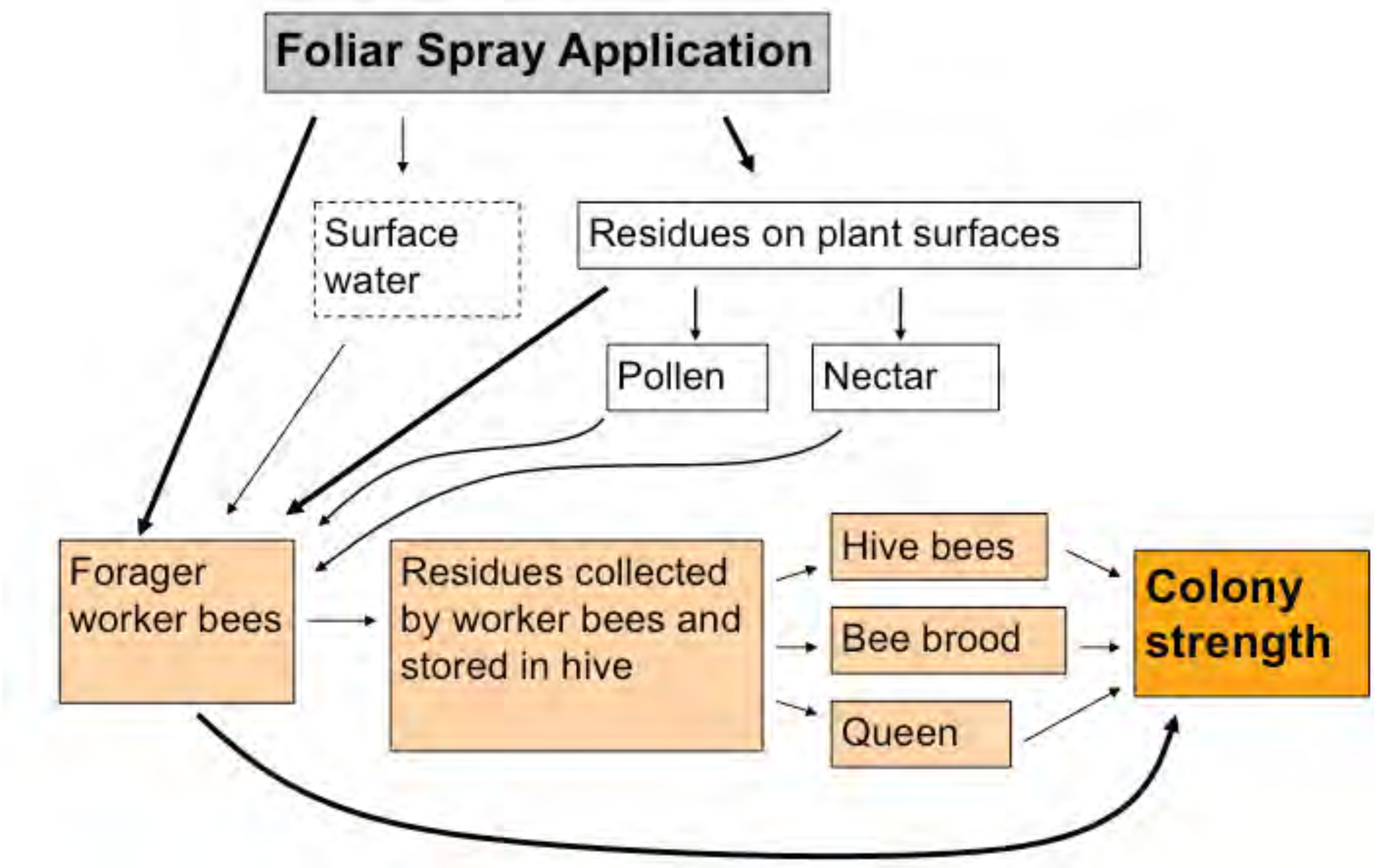
Agricultural Pesticides

A total of 121 pesticides found

Agricultural and Landscape Pesticides

Field Applied

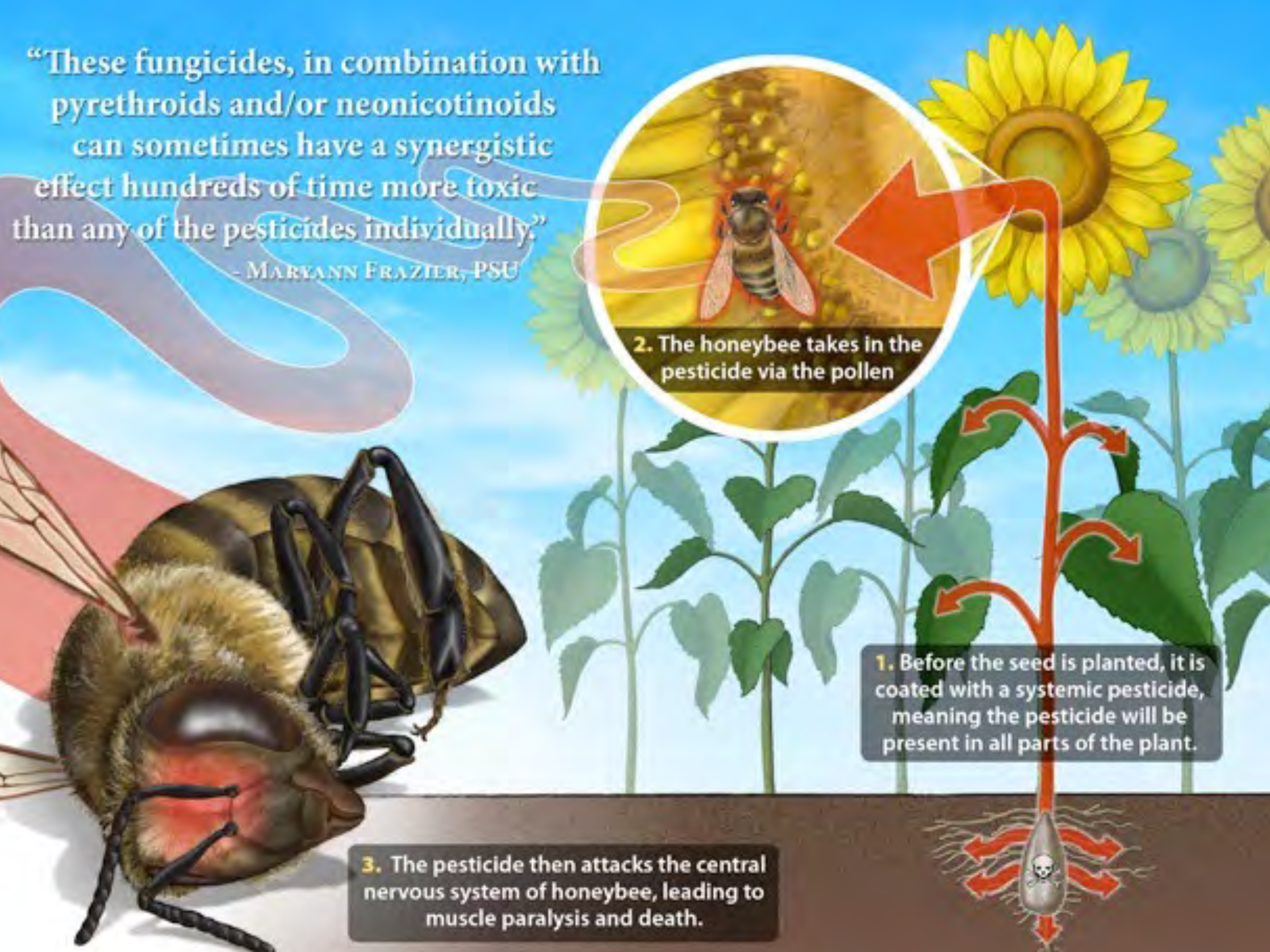


Risk to Honey Bees

Foliar Spray Application

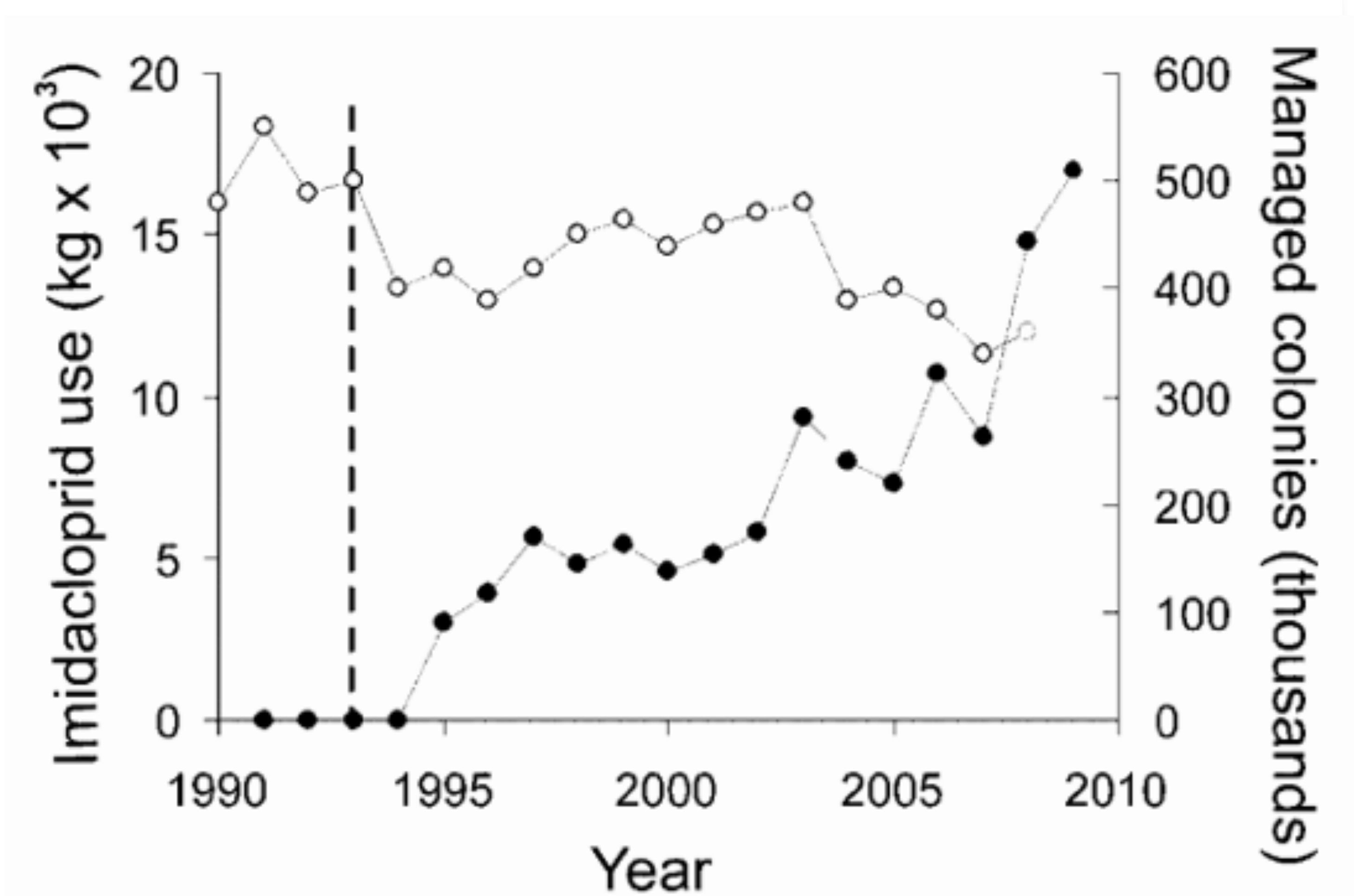
Agricultural and Landscape Pesticides

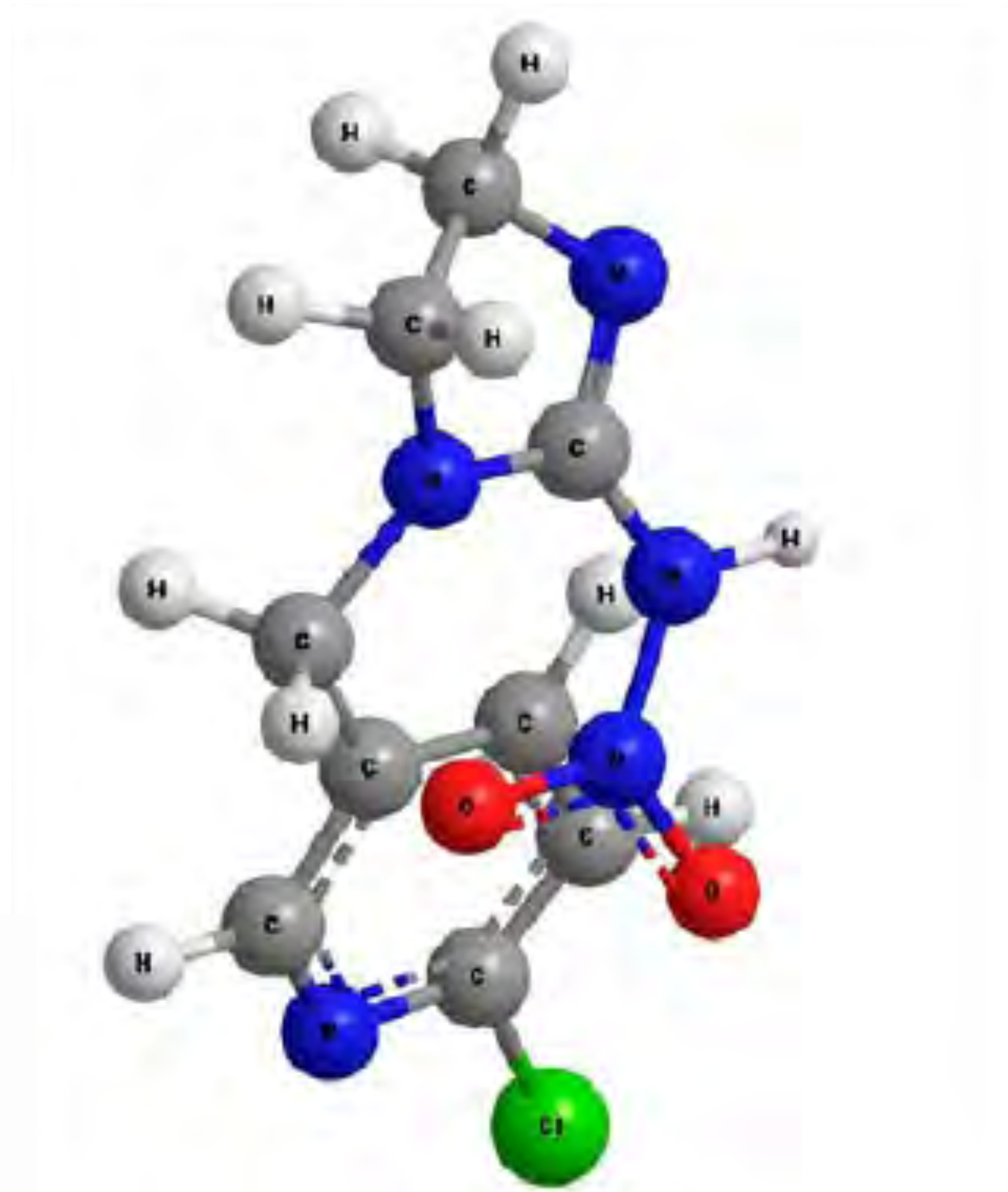
Systemic

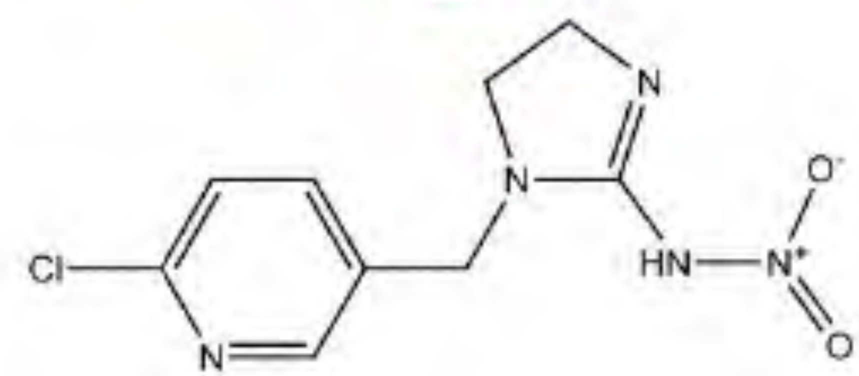

"These fungicides, in combination with pyrethroids and/or neonicotinoids can sometimes have a synergistic effect hundreds of time more toxic than any of the pesticides individually."
- Maryann Frazier, PSU
2. The honeybee takes in the pesticide via the pollen
1. Before the seed is planted, it is coated 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

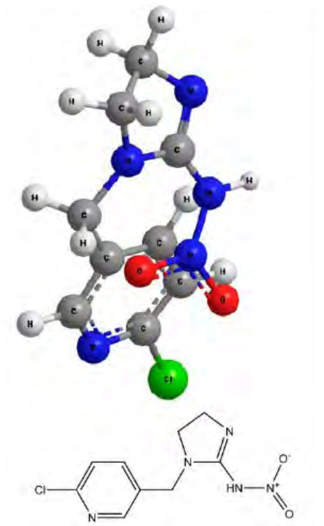
- Imidacloprid
- Clothianidin
- Thiamethoxam
- Thiacloprid
- Acetamiprid
- Dintefuran

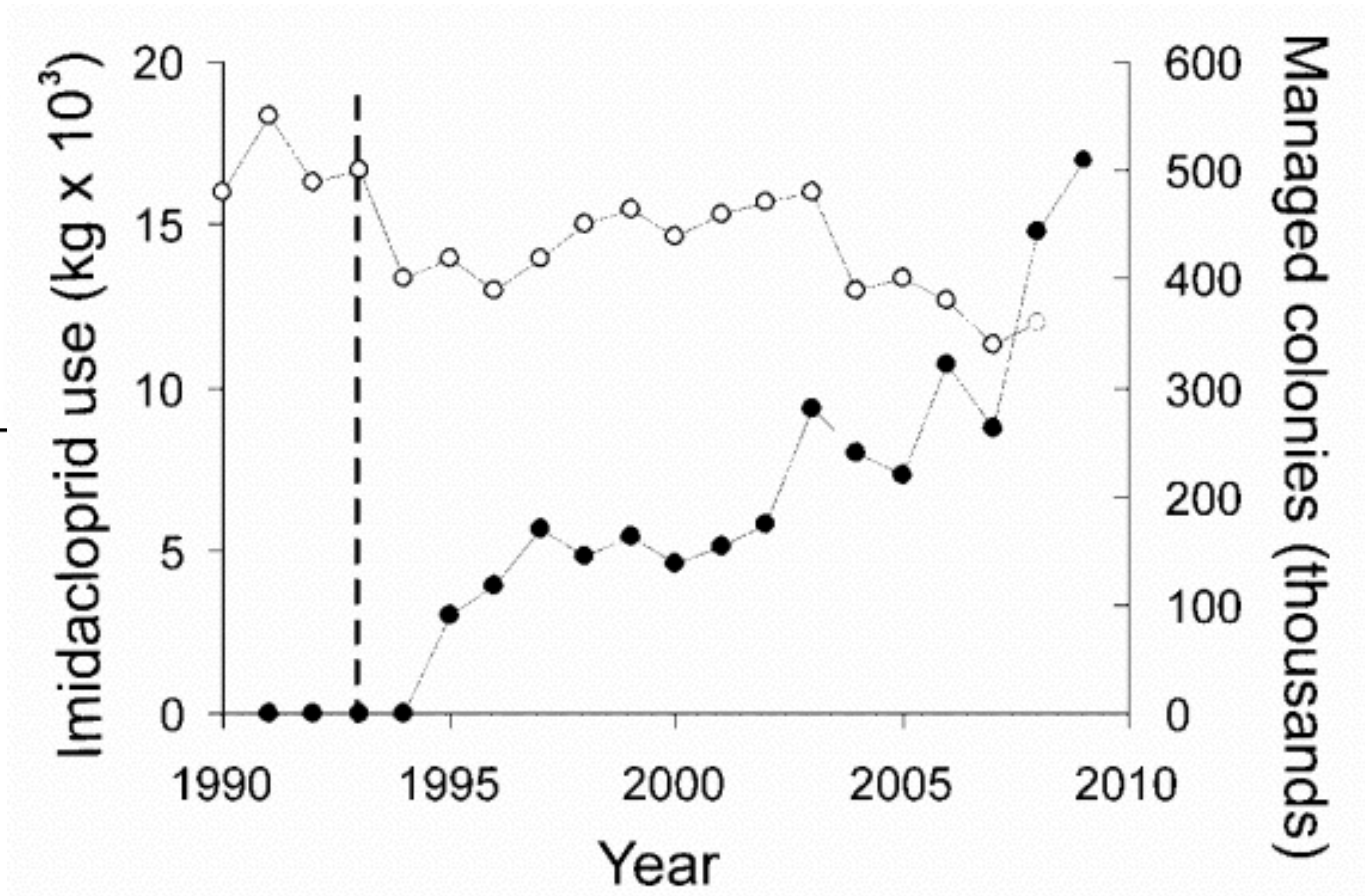






Imidacloprid



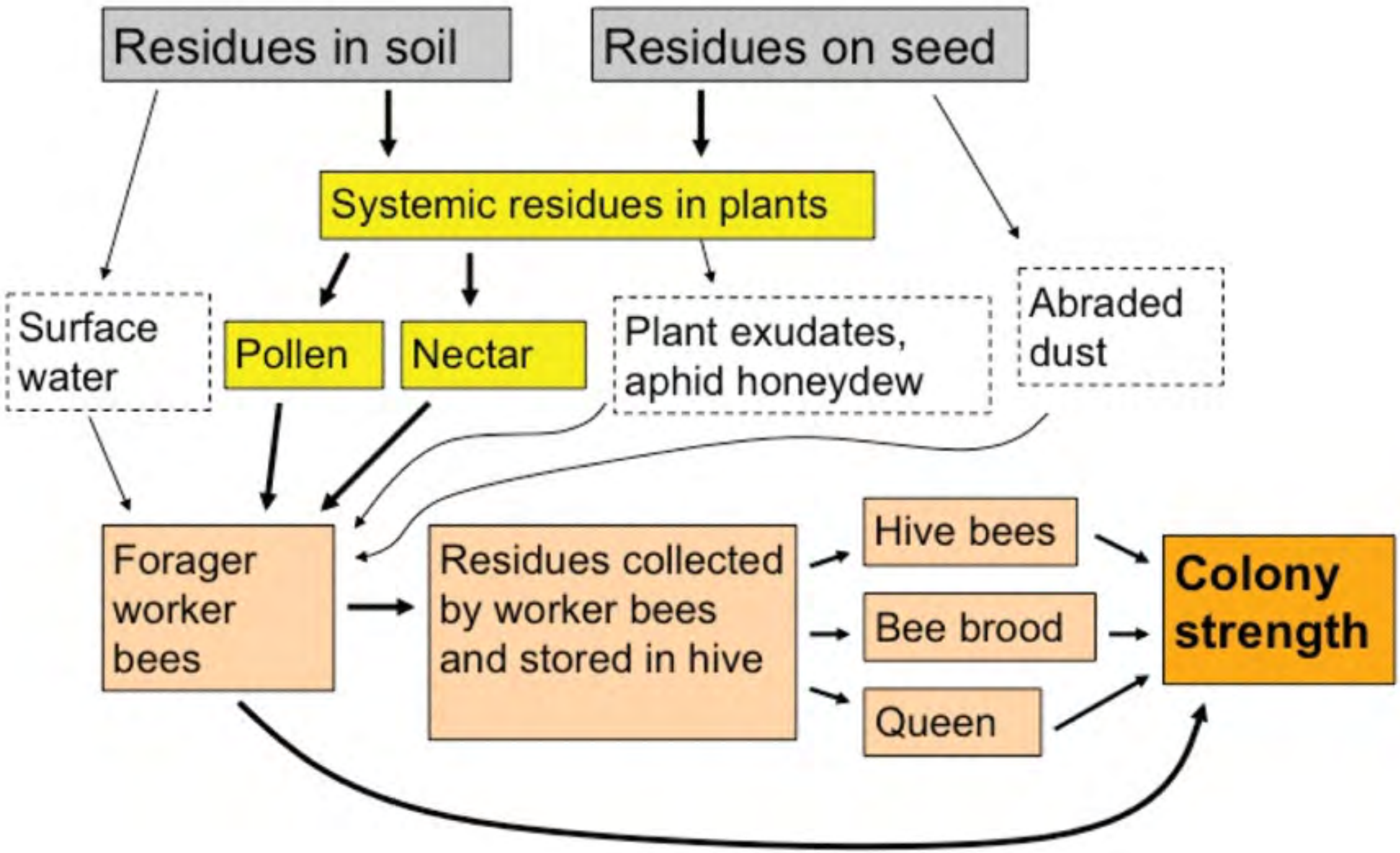


Imidacloprid

- Imidacloprid
- Clothianidin
- Thiamethoxam
- 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

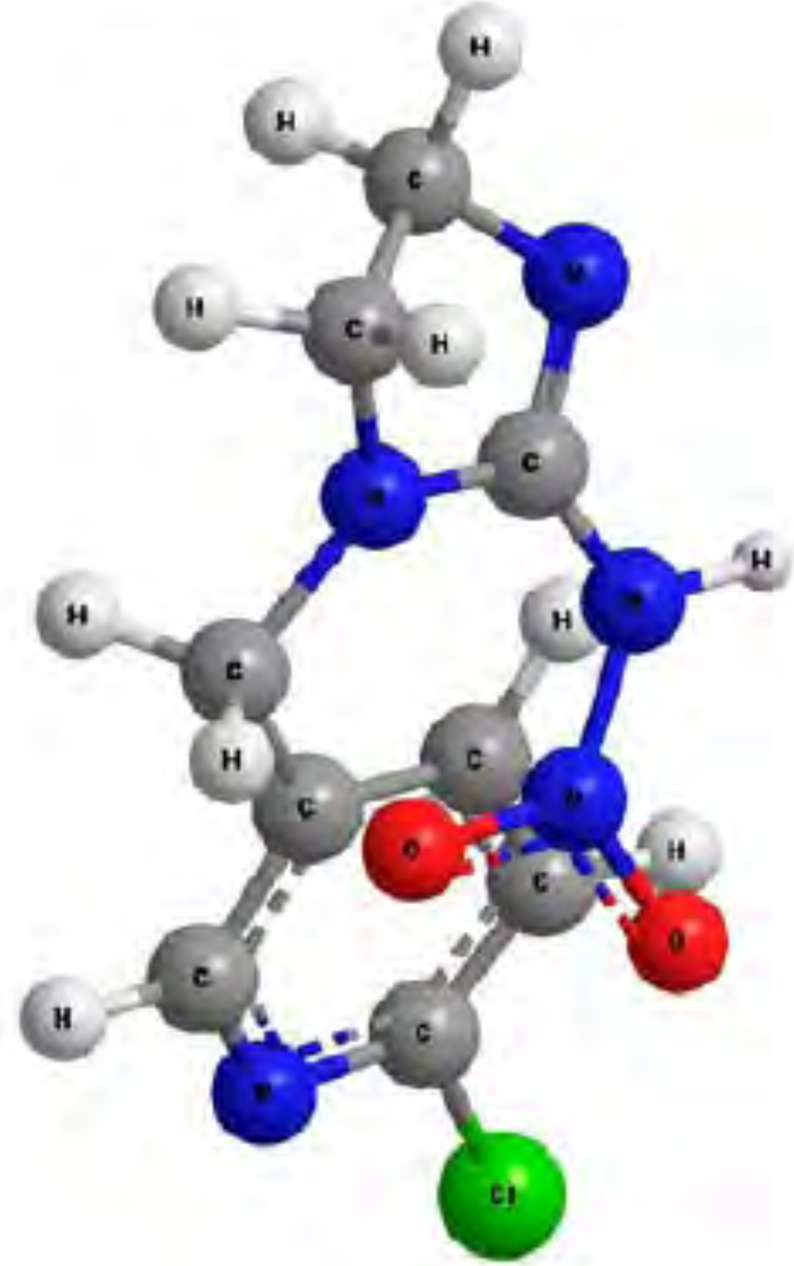


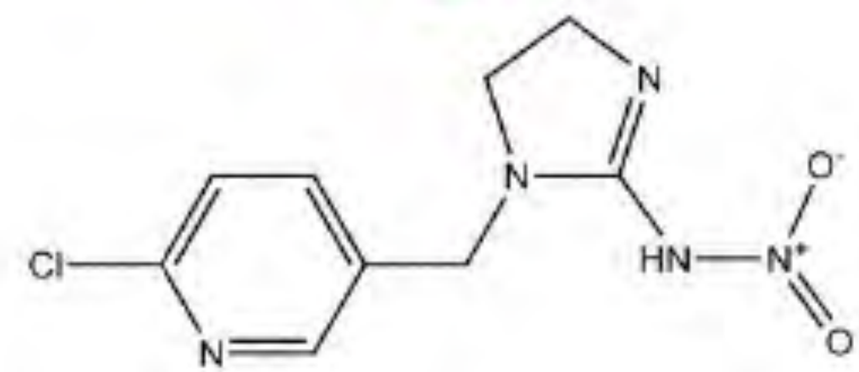
Risk to Honey Bees

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*

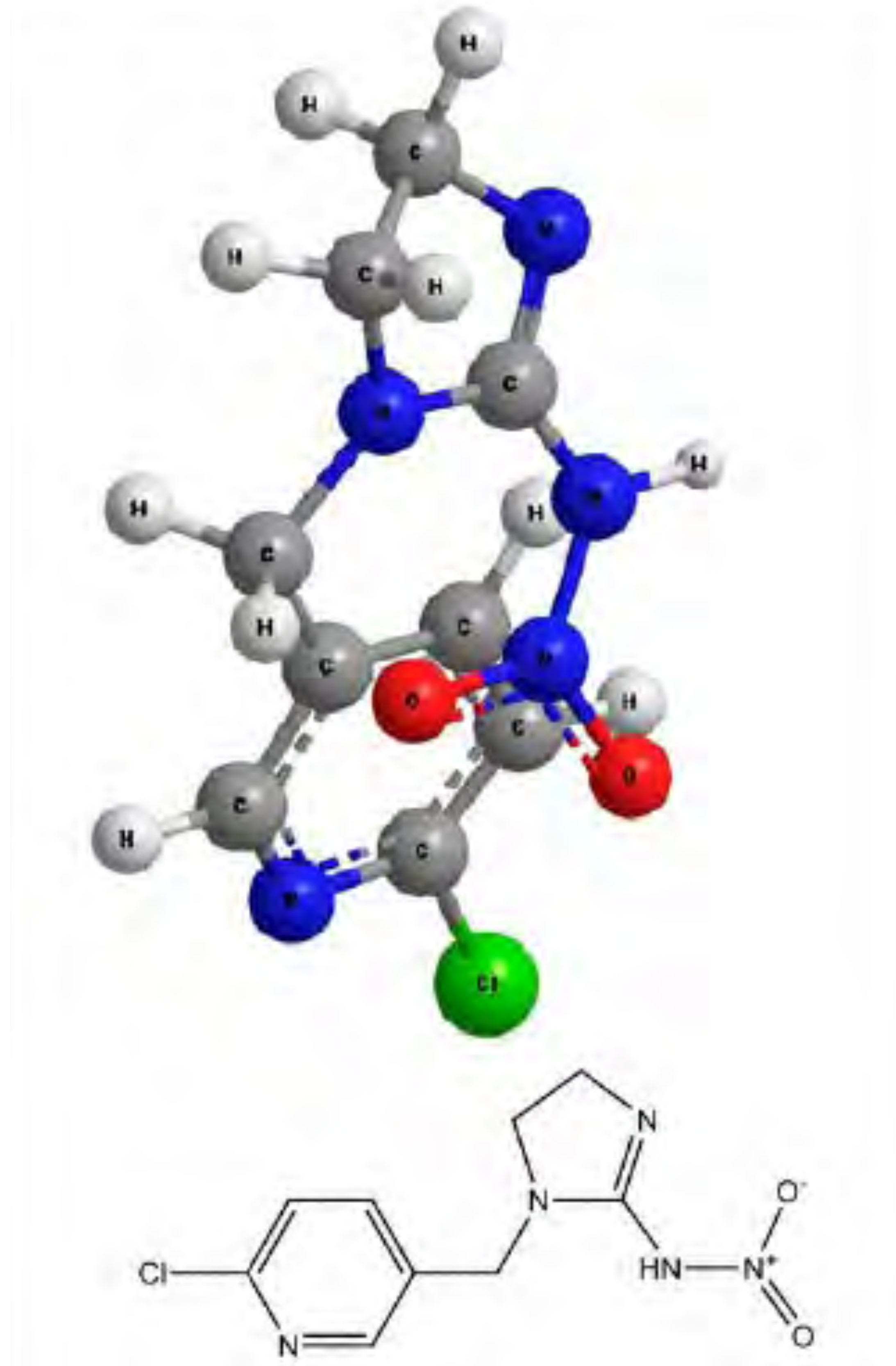
* >0.20 ppb

Neonicotinoids

- Imidacloprid
- Thiacloprid
- Clothianidin
- Acetamiprid
- Thiamethoxam
- 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



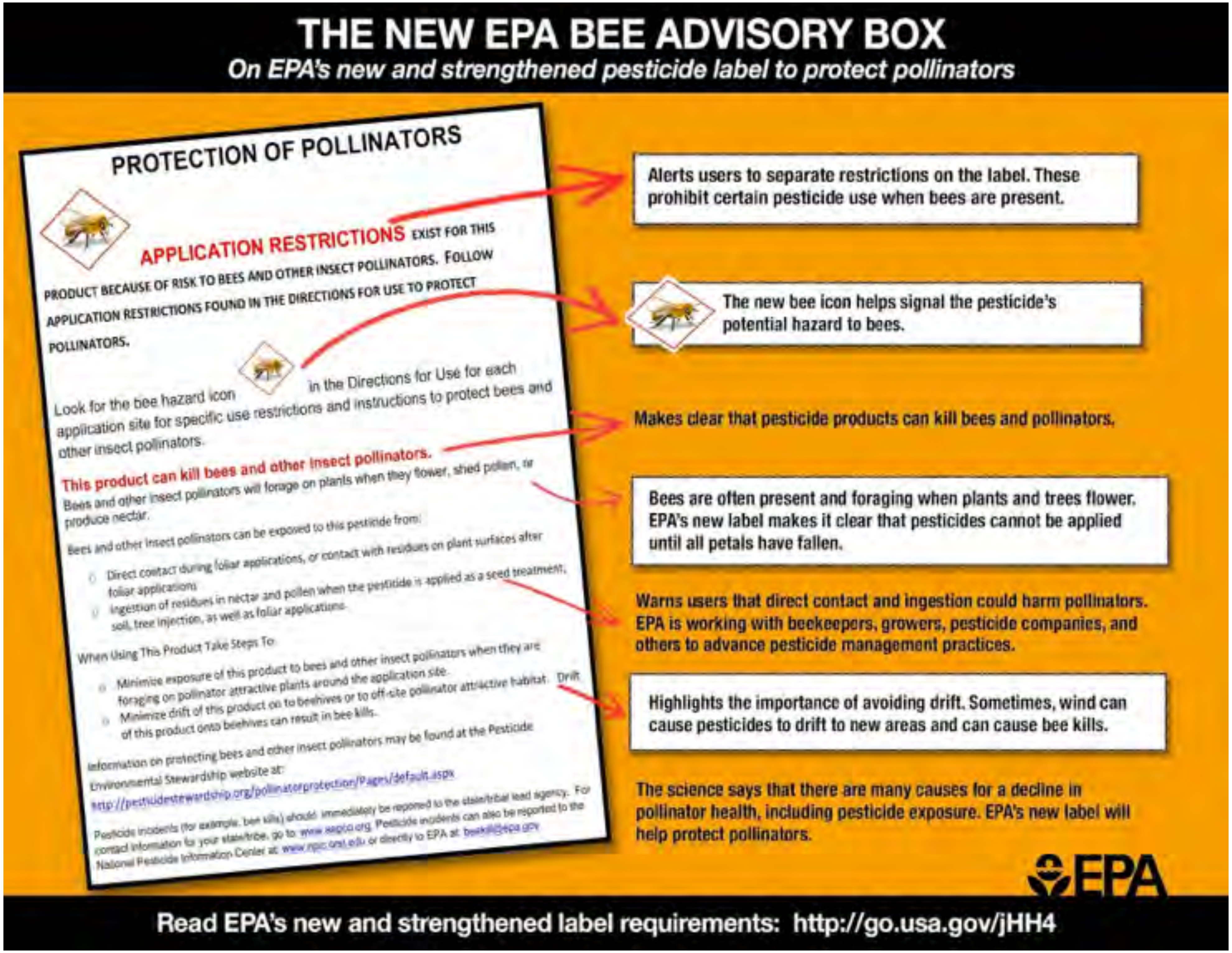
Imidacloprid

Toxicity Group	Precautionary Statement if Extended Residual Toxicity is Displayed	Precautionary Statement if Extended Residual Toxicity is not Displayed
I 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.
II 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.
III All others.	No bee caution required.	No bee caution required.

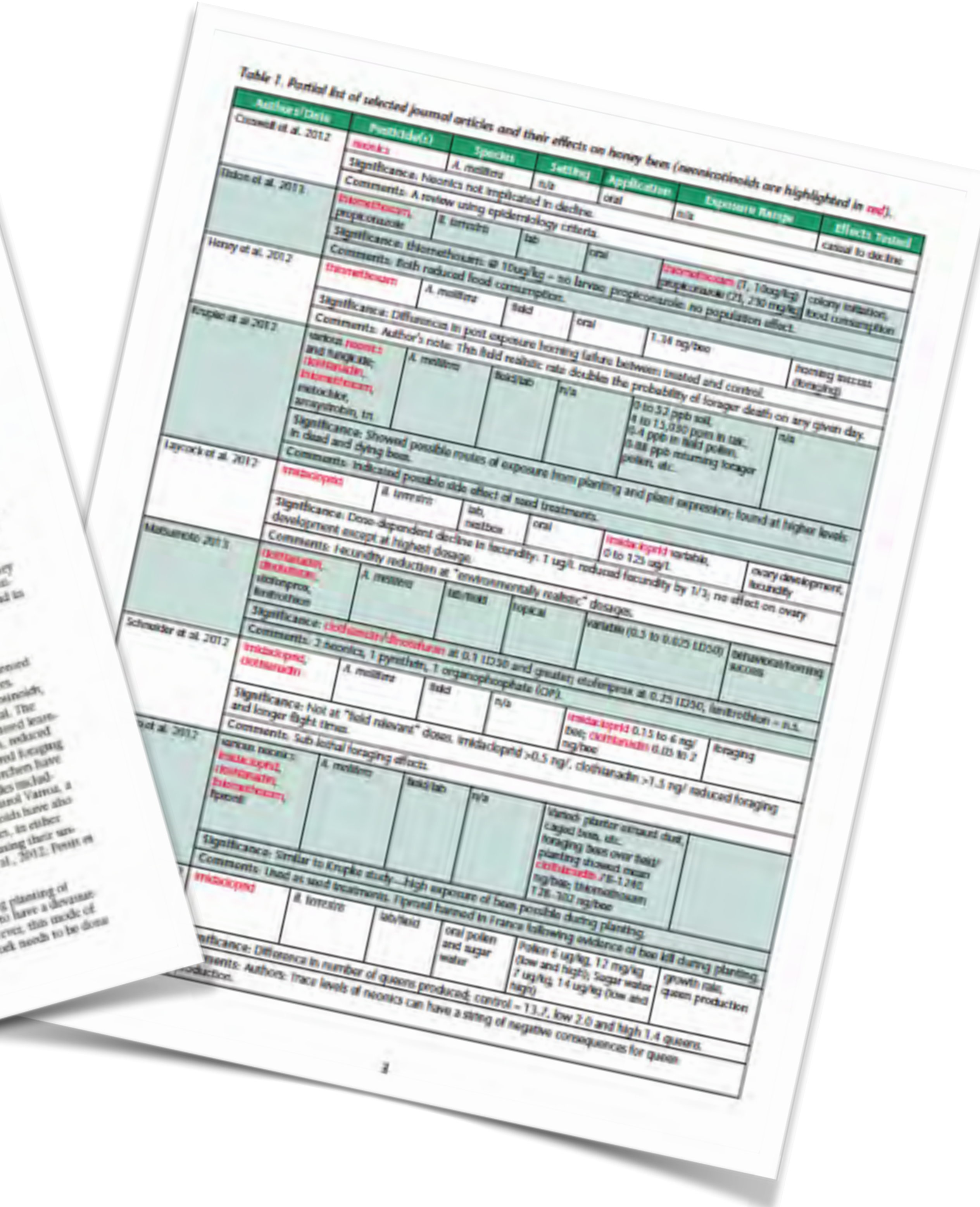
Bee Toxicity of Your Chemical

Know It!

EPA Pollinator Protection



EPA Pollinator Protection



http://cru.cahe.wsu.edu/CEPublications/FS122E/FS122E.pdf

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.

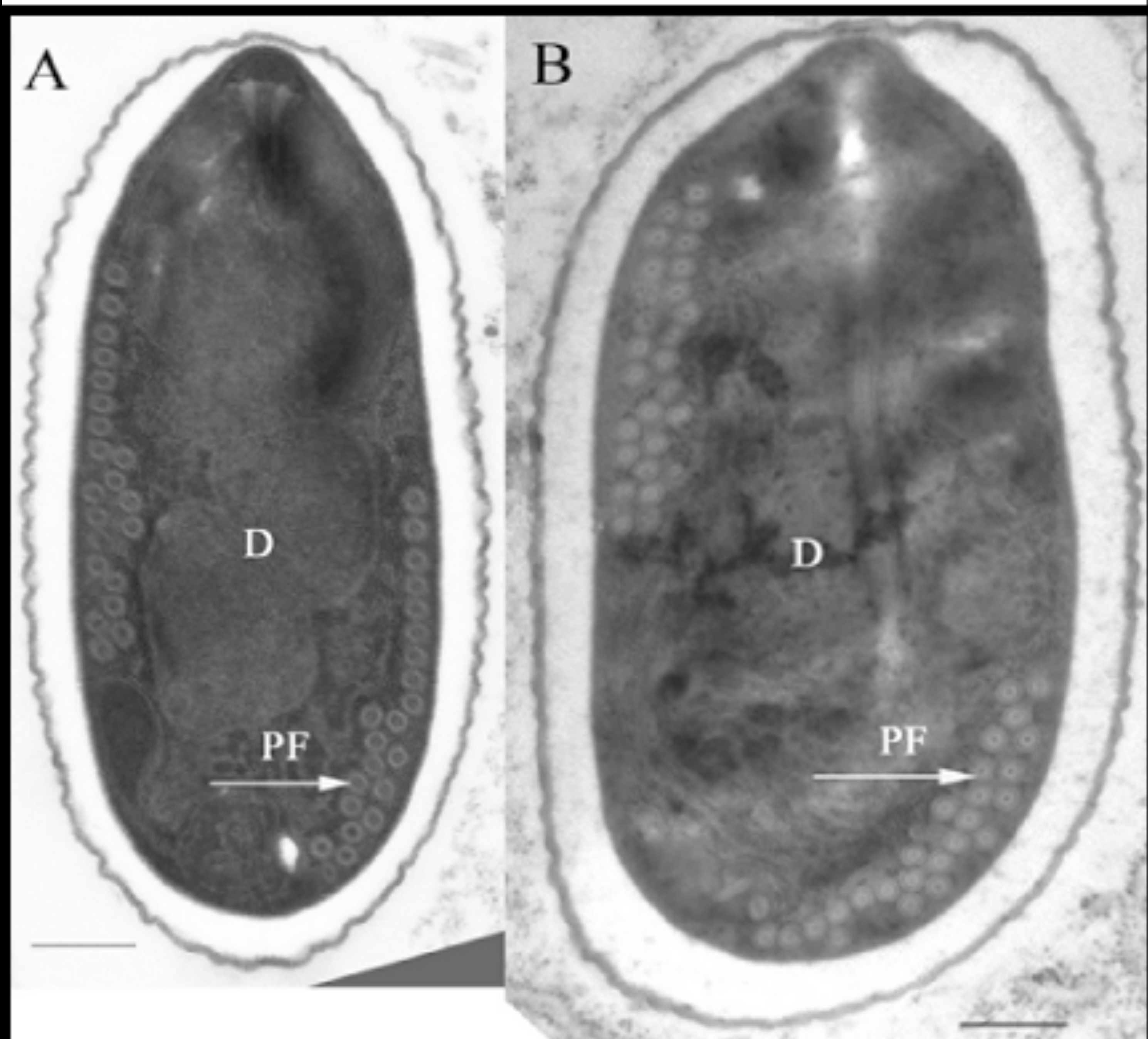
Study eyes selenium impacts to honey bees

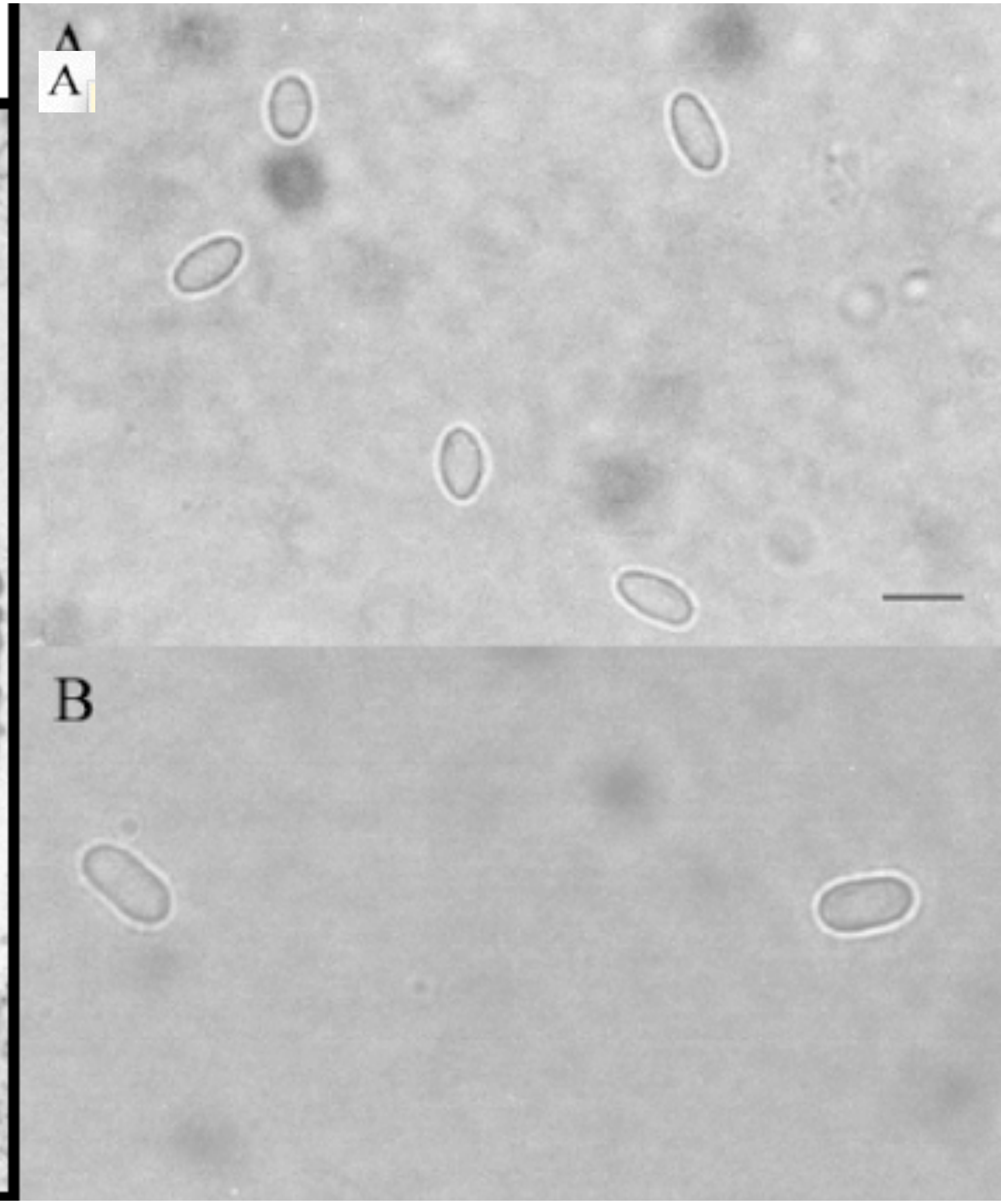
Posted on October 4, 2013 by Bob Berwyn

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



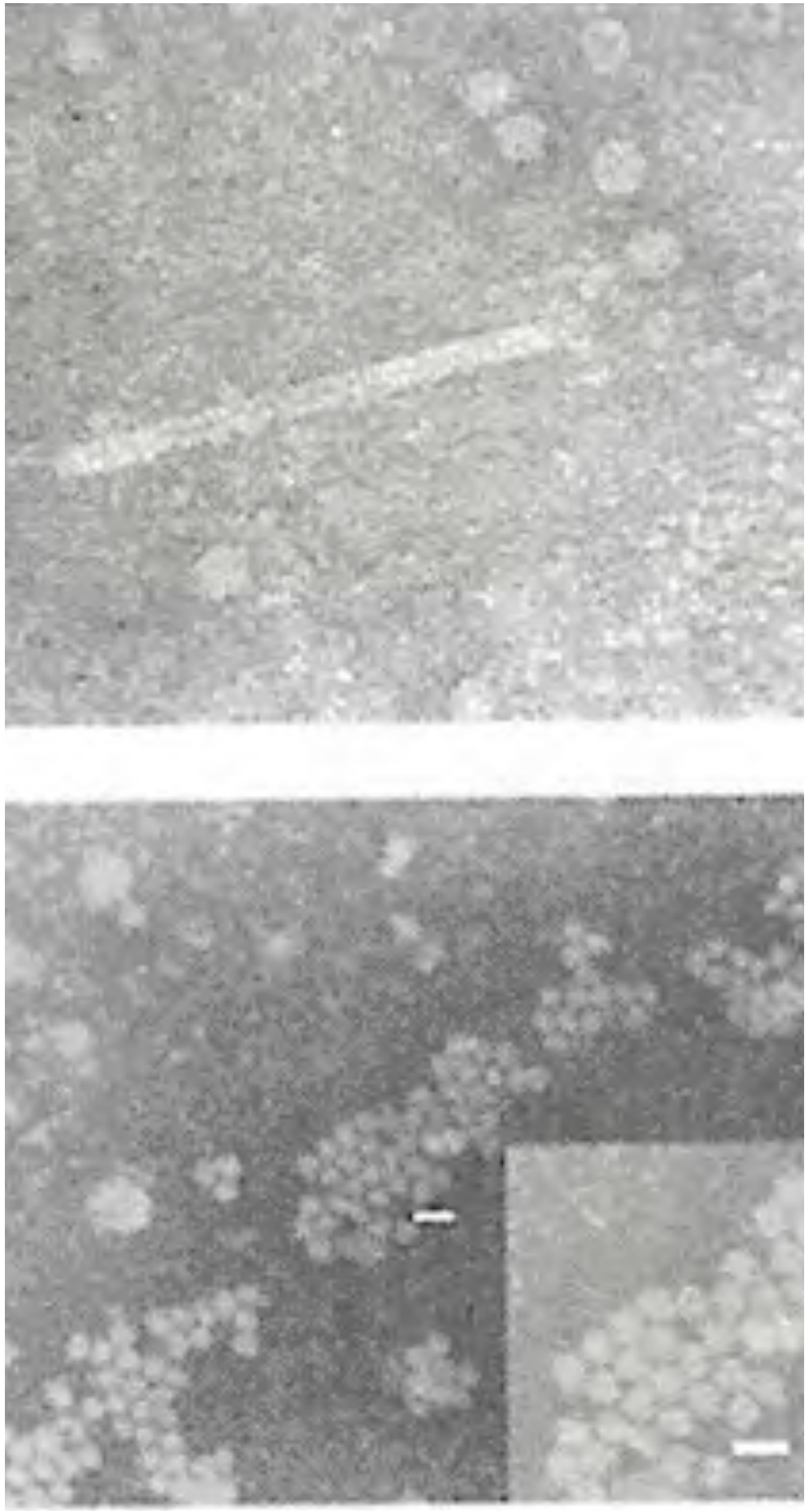


Microsporidians

Nosema ceranae (a)
Nosema apis (b)

Viruses

- 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

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

The New Normal ?

30 - 40% Loss - the cost of doing Business

Industrial Beekeeping

Major Causes of Bee Poisoning

- 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!

- 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!

- Available Free - pubs.wsu.edu

Change In The Mindset Of The Farming Community

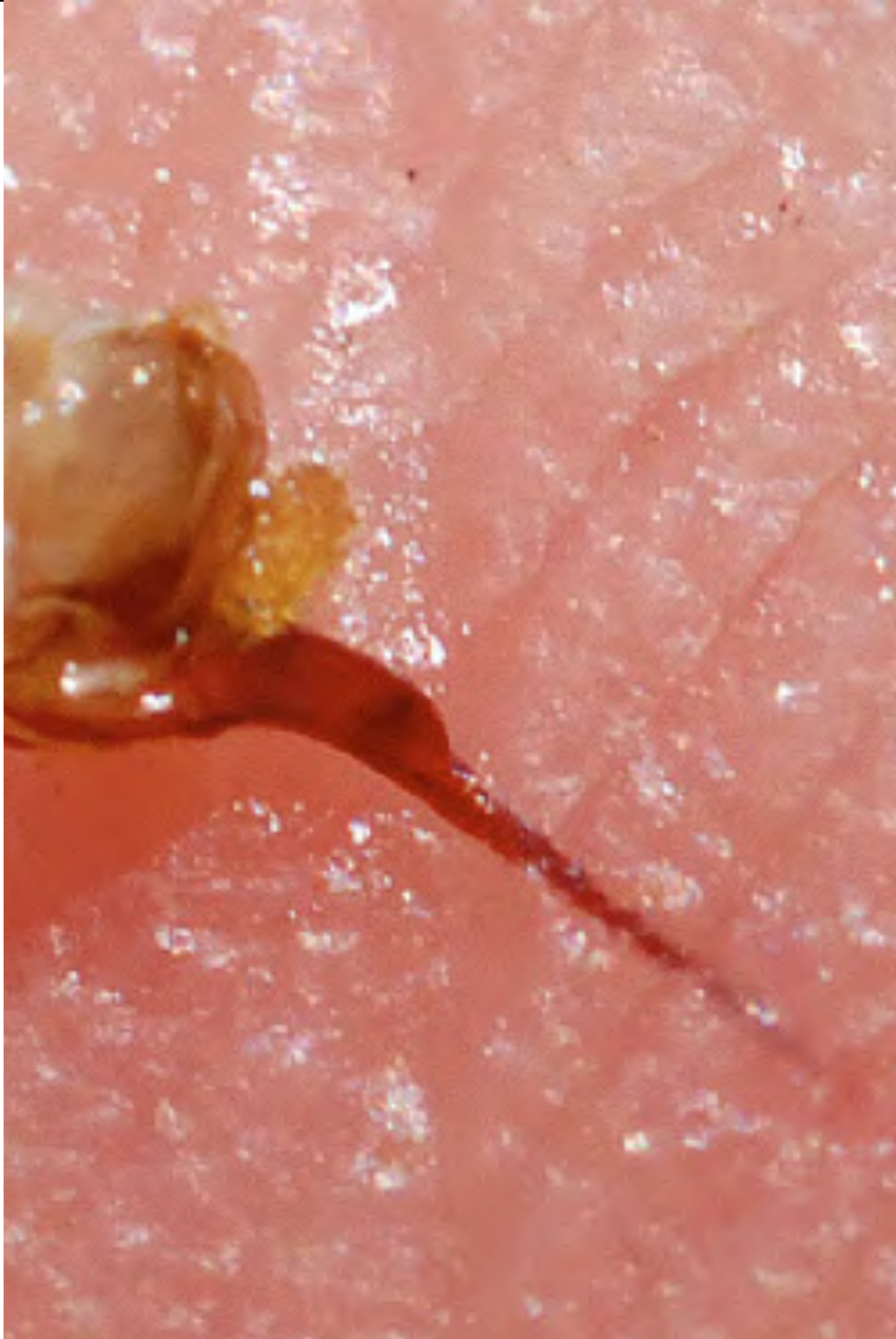
- Avoid Spraying During Bloom - Still a good recommendation
- Develop Products Or Strategies That Reduce The Impact On Pollinators

Change In The Mindset Of The Farming Community

- 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

- 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 University Extension

Washington State Noxious Weed Control Board

Very Nice - THANK YOU!

A good first step

But more needs to be done

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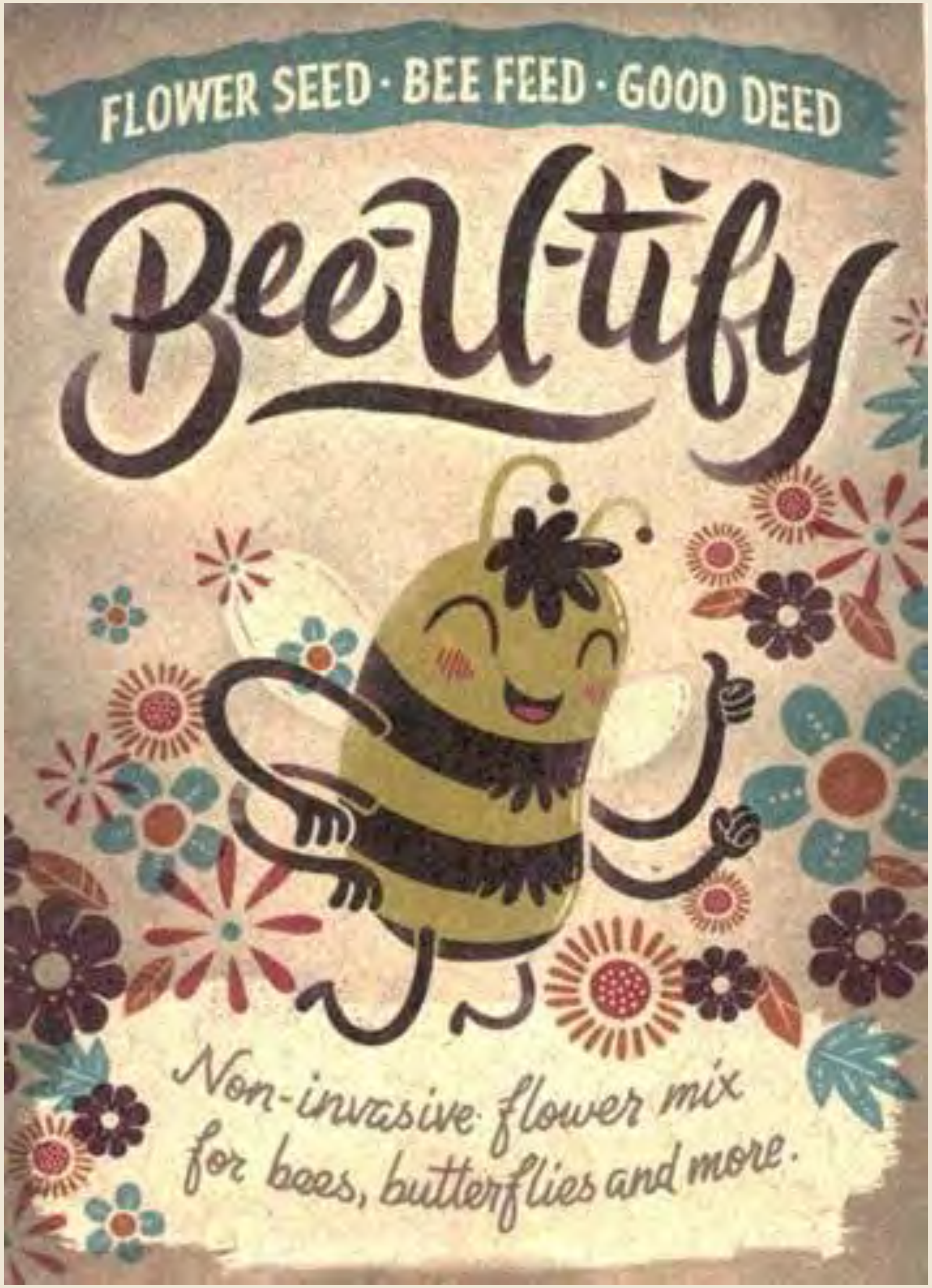

Conservation Biology

Review

The Potential Conservation Value of Non-Native Species

MARTIN A. SCHLAEPFER,*† DOV F. SAX,‡ AND JULIAN D. OLDEN§

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†INRA, Ecologie et Santé des Ecosystèmes, 35042 Rennes, France

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

§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.*

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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

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Things To Consider With Bee Gardens

Abundance

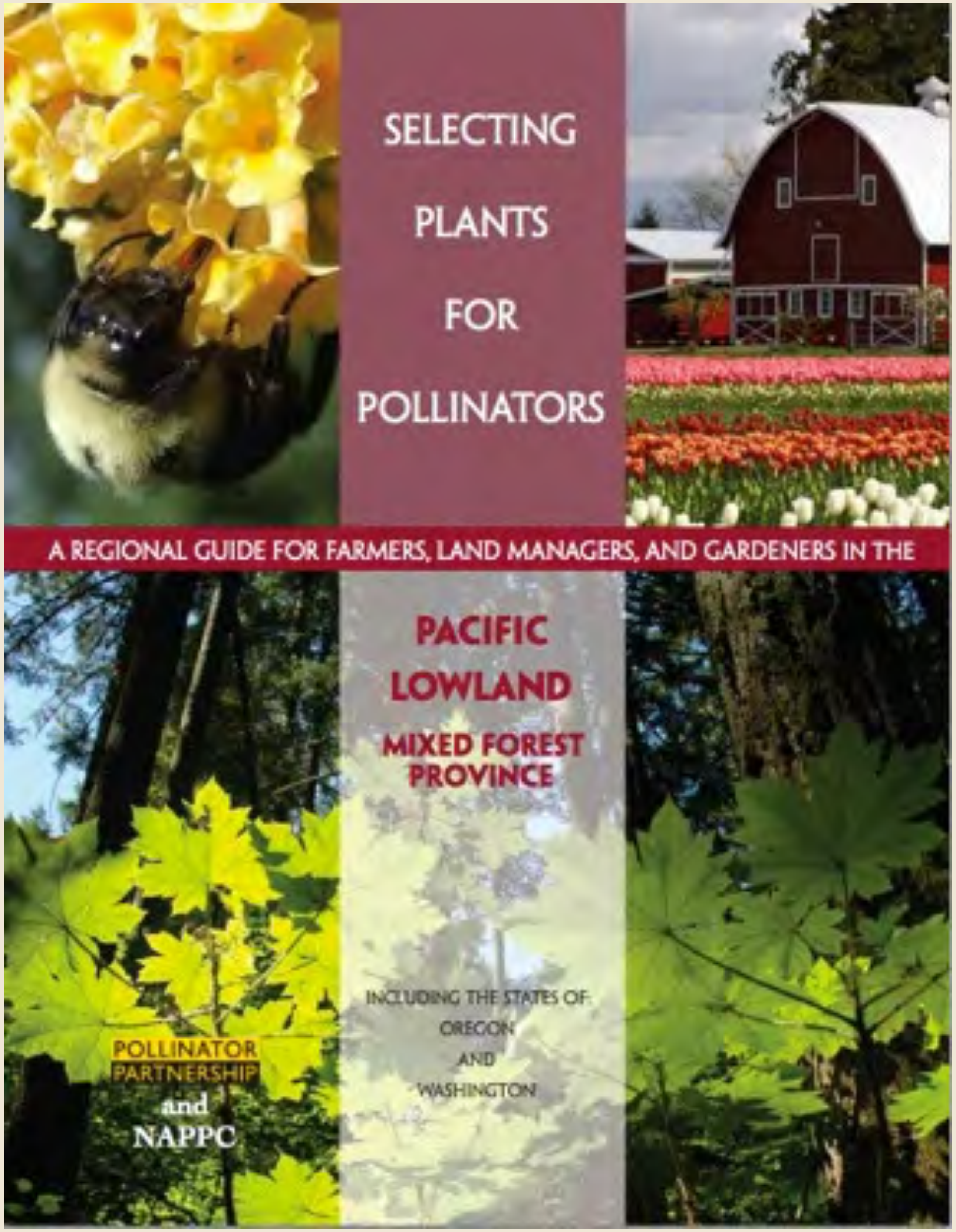
Sequence

Diversity

Pesticide Use

Resources for Selecting Plants

www.pollinator.org



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Resources for Selecting Plants

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Thanks!

Questions?