European Food Safety Authority

EFSA Scientific Colloquium No. 18

Towards holistic approaches to the risk assessment of multiple stressors in bees

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From Individual Bee to Superorganism:

How to test multiple stressors?

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Programme

DG 1 **Protection of Bees and Pollination Service: Tools and challenges**

DG 2 **Monitoring Bee Populations and Stressors: Harmonization of Protocols and Data Collection**

DG 3 **Testing and Assessing Stressors in Bees: From Laboratory to Field Conditions**

DG 4 **Risk Assessment of Multiple Stressors From Mechanistic to Holistic Approaches**

How to incorporate all variables?

How can we protect all pollinators?

Are honey bees the best model?

Means to test multiple lines of evidence

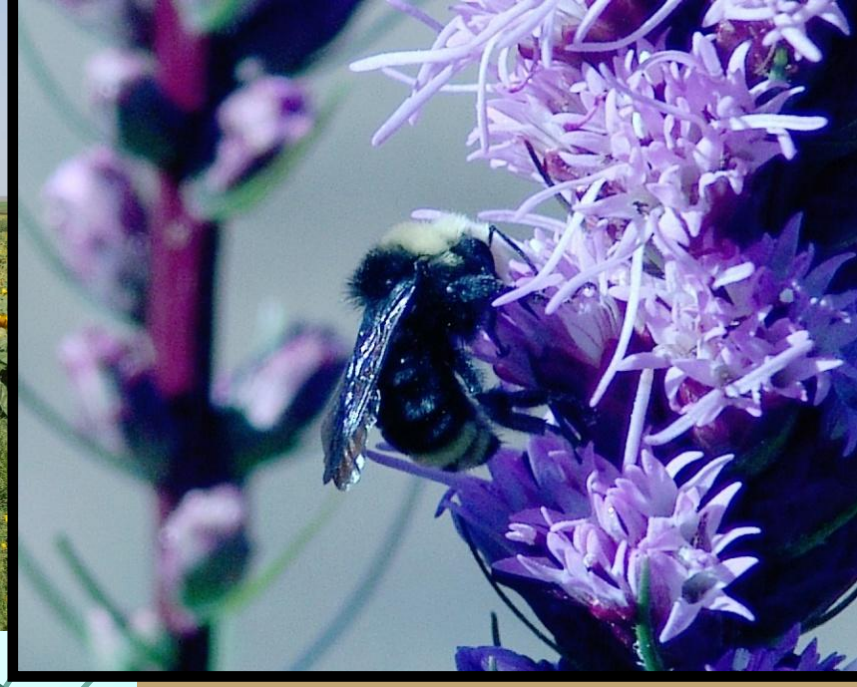
Courtesy of the Washington Post

Test other bees

Use large plot sizes

Modeling to get holistic view

Honey bees have historically been the dominate agricultural pollinator



Many other bees are being explored and used

- Greenhouses
- Squash
- Blueberries

Bumble Bees

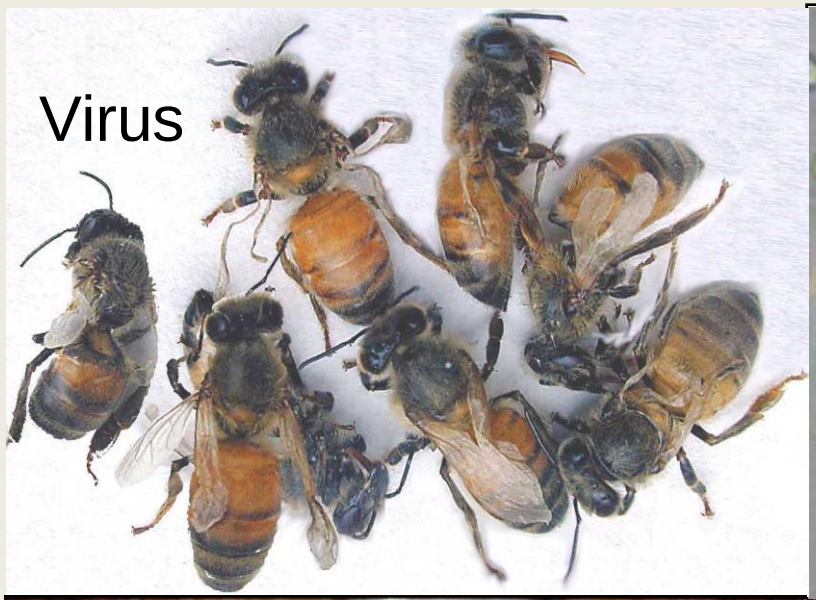
Osmia

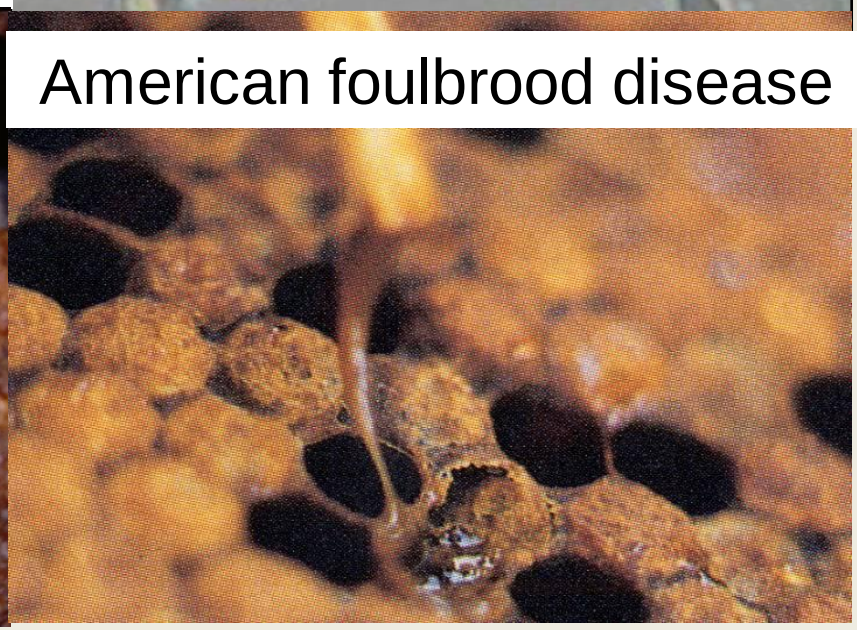
Alfalfa Leafcutter Bees

Two recent papers have demonstrated impacts on reproduction and foraging in Bumble Bee colonies following sub-lethal exposure

Whitehorn *et al.* 2012 *Science* Gill *et al. Nature 2012*

Honey Bee Diseases and Pests





HONEY BEE LOSSES WORLDWIDE ARE SIGNIFICANT

U.S. Honey Bee Colony Losses over a seven year period, 2007-13

- 2007 survey = 32% colony loss
- 2008 survey = 35% colony loss
- 2009 survey = 29% colony loss
- 2010 survey = 34% colony loss
- 2011 survey = 34% colony loss
- 2012 survey = 22% colony loss
- 2013 survey = 31% colony loss

vanEngelsdorp et al. 2007, 2008, 2009 and 2011


Pollination and honey production are protection goals

Almonds in CA need 1.5 million honey bee colonies

Major Migratory Routes of Honey Bee Colonies

California almonds require 1.5 million honey bee colonies each year; that represents more than half of all managed colonies In the U.S.

Tier III studies are meant to reflect the real world

What is an ideal plot size?

How many colonies per hectare?

Attractiveness of crop

Competing flowers nearby

Density of crop planting

Weather during bloom

Swedish oilseed rape (canola) study

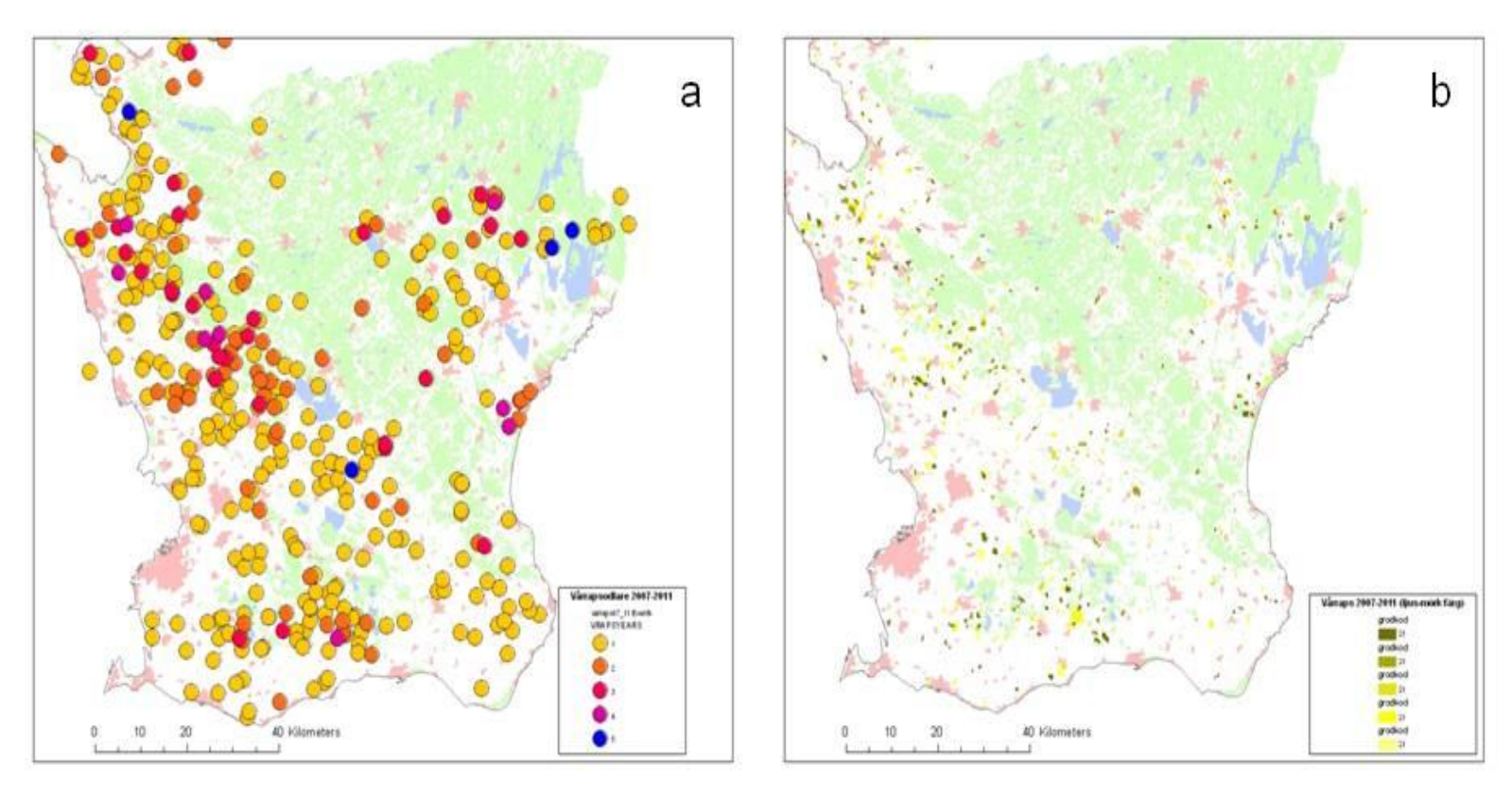
16 plots of 5? hectares each

6 hives per plot

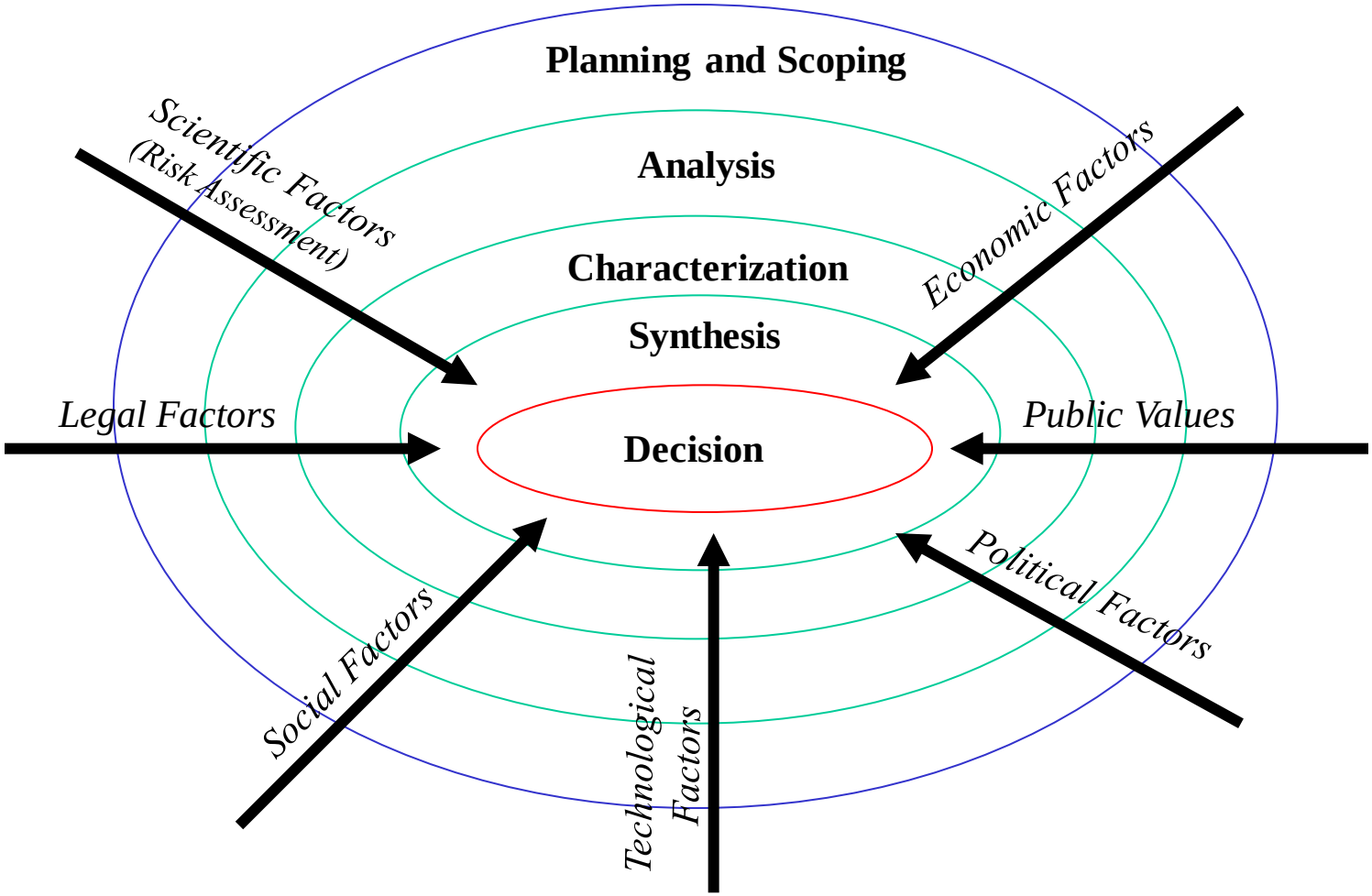
Clothianidin treated seed in ½ plots

Swedish canola study

16 plots of 5 hectares each



Risk Management Decision Framework



Weight of Evidence

- Interpretation of field study within risk assessment will be made in the context of data drawn from lower Tiers
- Available data taken into account for consistency, coherence, and biological plausibility
- Available data may include:
  - Tier I laboratory acute/chronic toxicity
  - Open literature
  - Non-target arthropod data
  - Sublethal effects
  - Incident reports
  - Tier II semi-field studies
  - Tier III full field studies
  - Exposure data

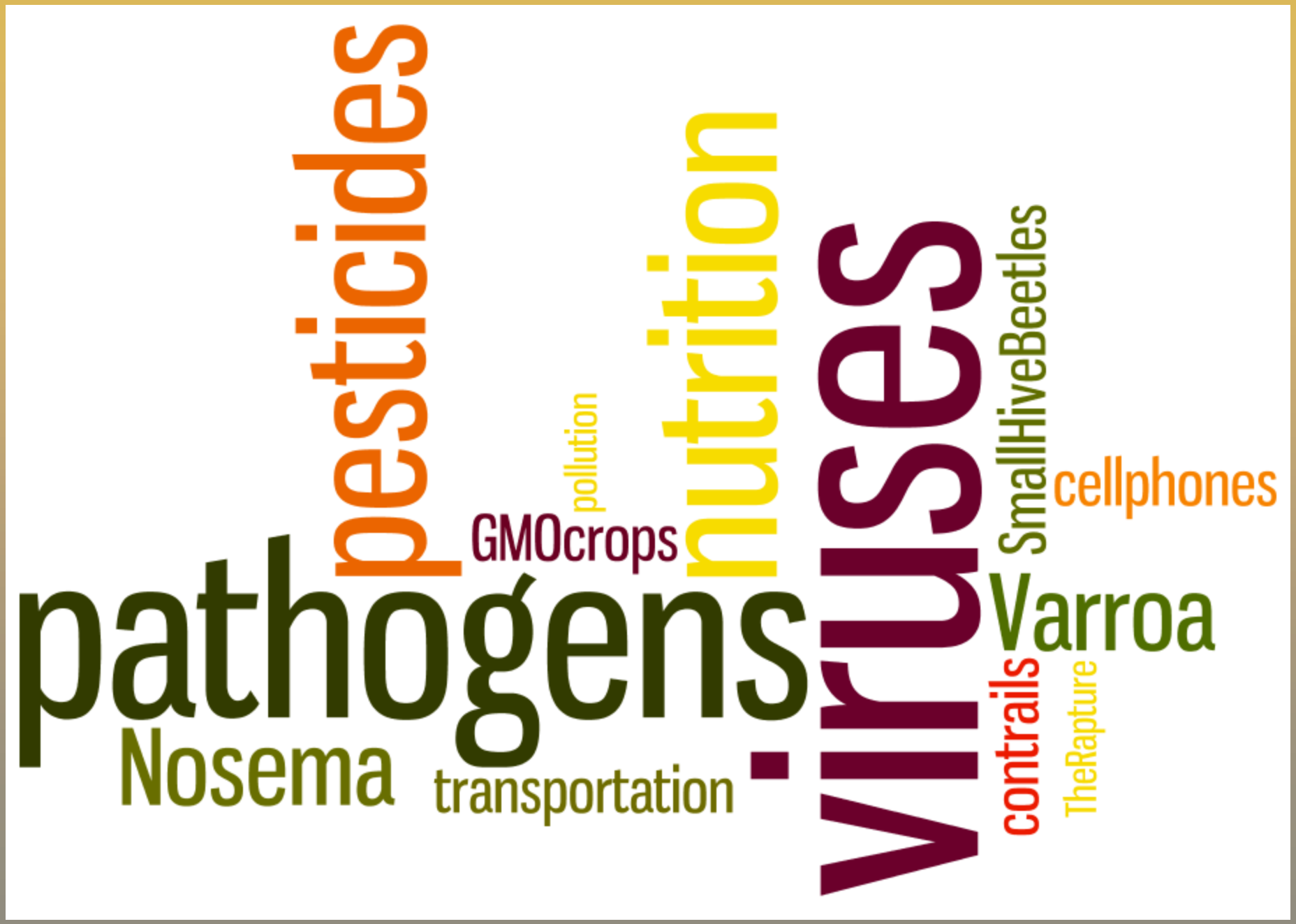
Utility of Colony Simulation Models

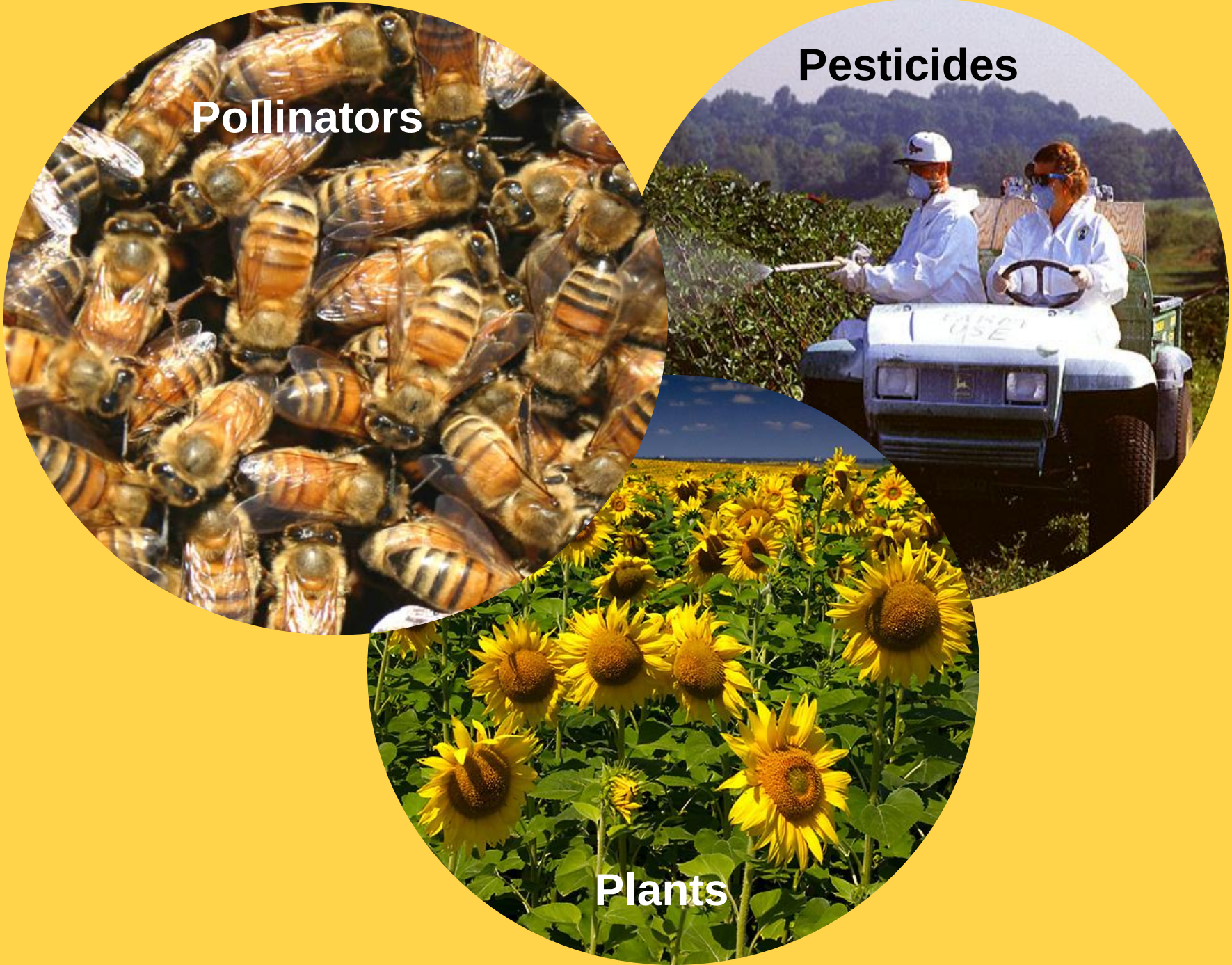
- **Understanding interdependent biological processes**
- **Interpret and relate sublethal measurement endpoints to assessment endpoints**
  (e.g., colony strength and survival, quantity of hive products)
- **Inform the design of higher tier studies**
  (e.g., timing, scale, replication, duration)
- **Assist interpretation of Tier II and III study results**
  Account for observed variability in endpoints (e.g., season)
  Account for other non-chemical factors (e.g., weather)
- **Incorporate data from multiple assessment Tiers**
- **Integrate chemical and non-chemical stressors**

Desired Features of a Colony-level Simulation Model

- **Account for major factors that determine colony dynamics**
  - intra-colony and eventually, inter-colony
- **Quantitatively link various measurement endpoints to assessment endpoints**
  - colony strength & colony survival, production of hive products
- **Readily parameterized, using existing biological and pesticide-specific data**
- **Adaptable to pesticide uses that differ across regions**
  - Account for geographic variation in use pattern, crops, climate, landscape
- **Scientifically defensible, transparent, well documented, publically available**[1]
  - Sensitivity and uncertainty analysis
  - Evaluation relative to empirical data

[1] Guidelines for environmental model development have been published by the USEPA Council on Regulatory Environmental Models (CREM) http://www.epa.gov/crem/index.html. Guidelines for "Mechanistic Effects Models" are under development as part of an European Commission CREAM project (http://cream-itn.eu/)


pesticides
nutrition
pollution
viruses
SmallHiveBeetles
cellphones
GMOcrops
pathogens
Varroa
Nosema
transportation
contrails
TheRapture


Pollinators
Pesticides
Plants

Summary

- All pollinators are threatened
- The honey bee superorganism is complex
- Test multiple pollinators and formulated product
- Realistic plots sizes are ideal but expensive
- Modeling can identify gaps and synthesizes diverse data

Its not rocket science

Pollinator Health and Risk Assessment:

Its not rocket science

Its much more complex !