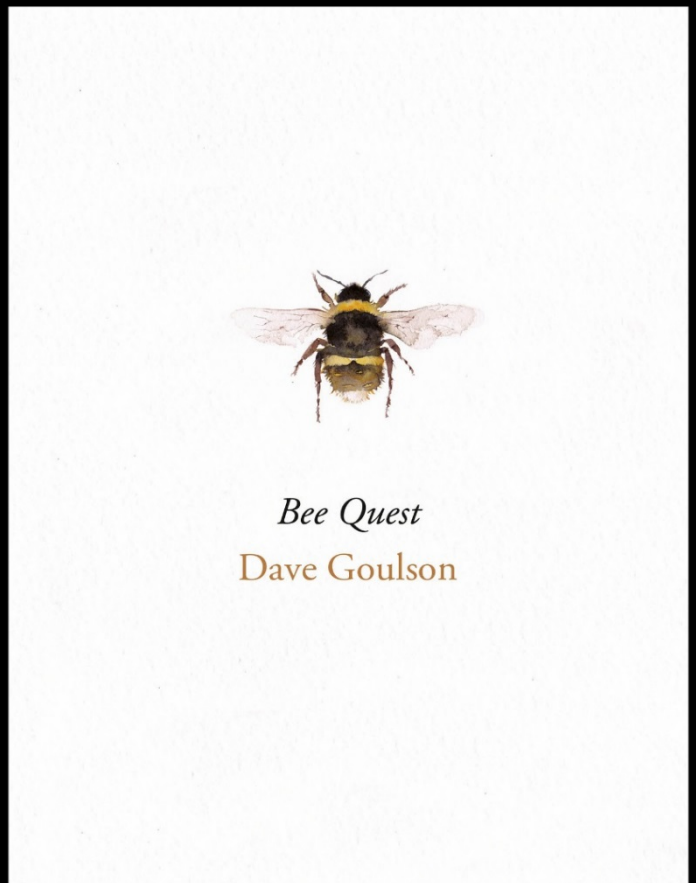
# Bees, pesticides and the future of farming

Prof Dave Goulson
*Life Sciences*
*University of Sussex, UK*




37 D141
Bougainville, Picardy
Street View - Mar 2011
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Iram Drove
Iram Drove
Willingham, England
Street View - Sep 2008
Hide imagery


Tjongervallei
Nieuwehorne, Friesland
Street View - Jul 2009
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40 Oosthoekstraat
Tielt, Flanders
Street View · Aug 2009
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521
Skane County
Street View - Jul 2011
Hide imagery


4988 Co Rd F62
Iowa City, Iowa
Street View - Oct 2012
Co Rd F62
Hide imagery


→ Climate change & flooding…..

*1850*

(reconstruction)

*1932*

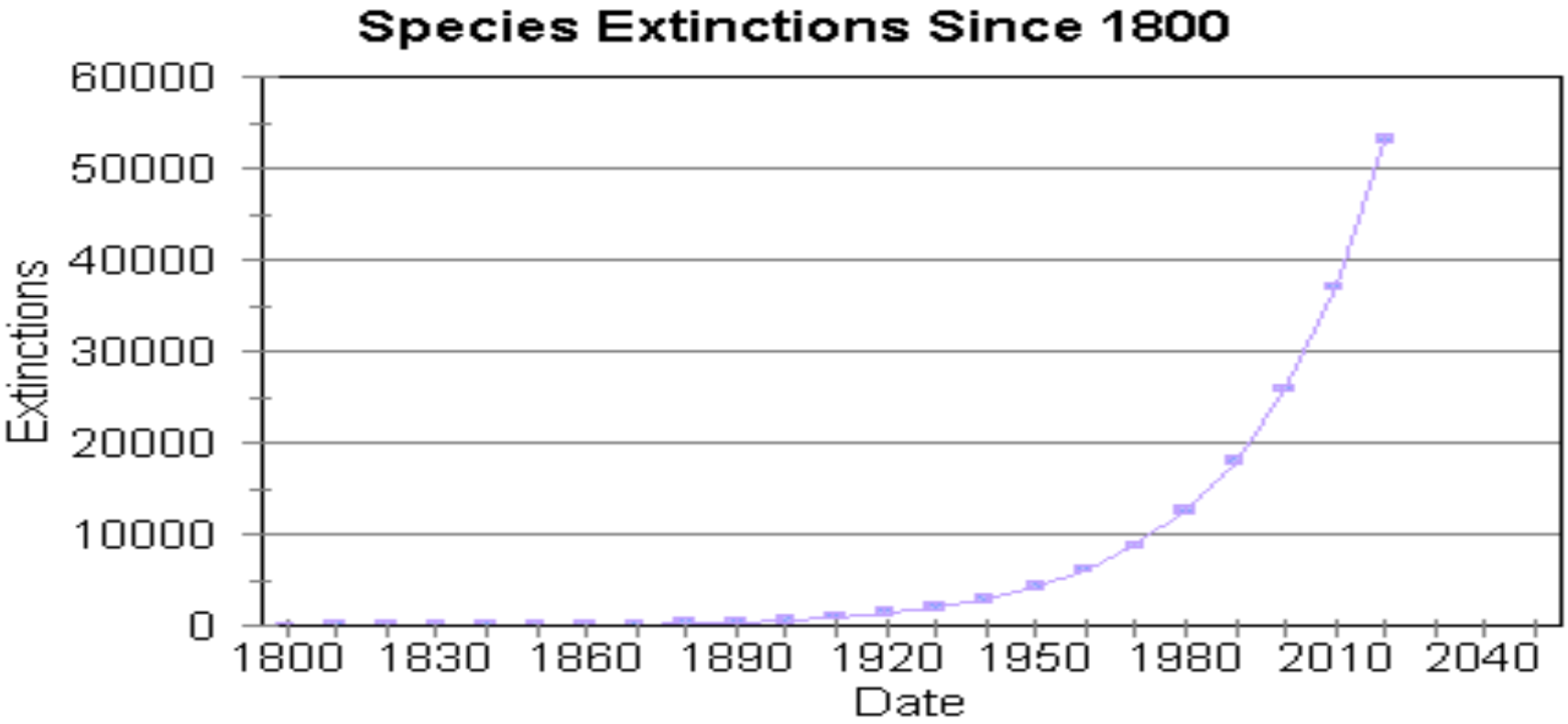
(after Fowler, 1933)

*1979*

*2000*

Sequence of images showing

the emergence of the Holme Post from the wasting peat




We may currently be losing 10,000 species per year
Some experts predict extinction of 2/3 of Earth's species by 2100

e.g. Birds: >1000 sp. Extinct in last 1,000 years, 12-25% of all species. At least 600 more will almost certainly be extinct within 50 years

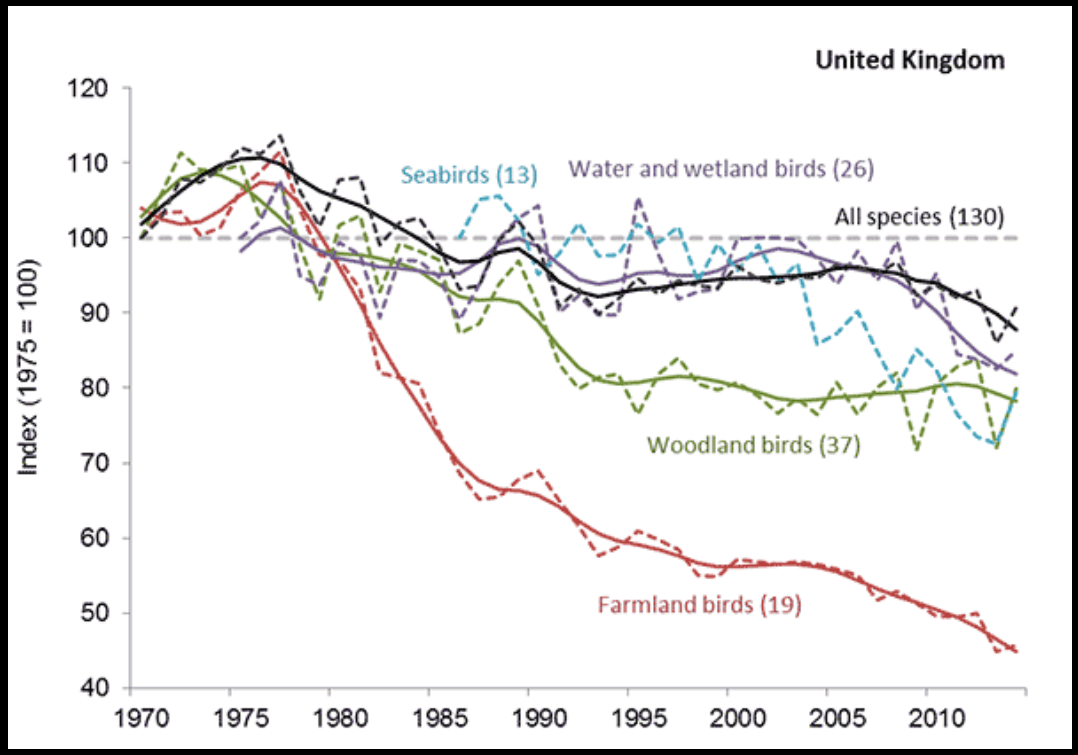
# Do extinctions matter?

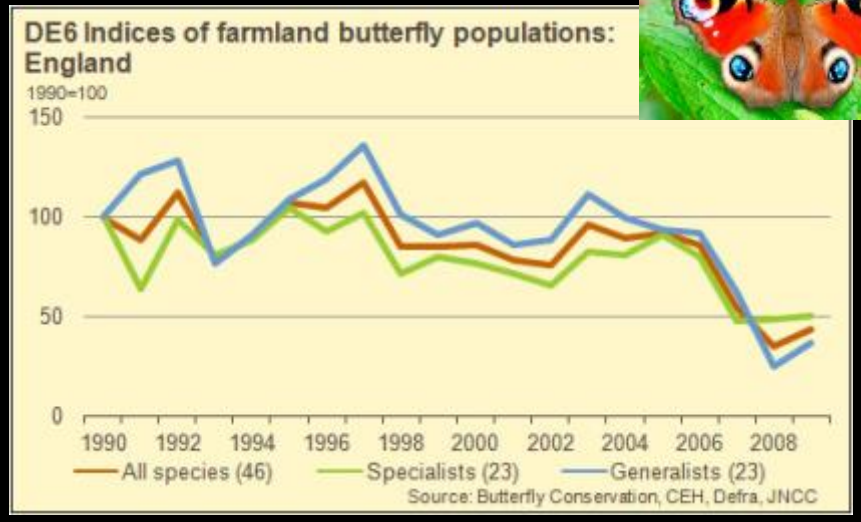
*"Should we worry about the endangerment of all species? Pandas and tigers for sure, but armadillos? I passionately believe in saving the whale, the tiger, the orang-utan, the sea turtle and many other specifically identified species. (But) will the world and humankind be very much the poorer if we lose a thousand or so species?"* **M**arcel Berlins, Guardian, 8 Oct 2008

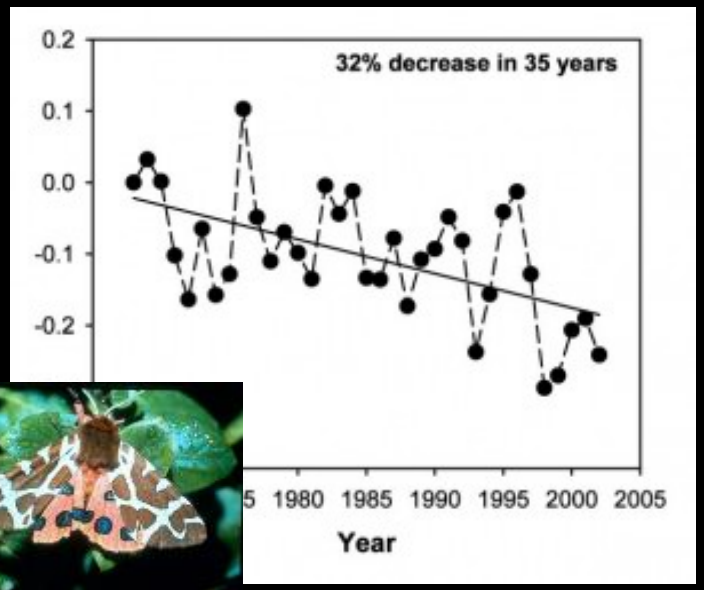
*"To keep every cog and wheel is the first precaution of intelligent tinkering*" Aldo Leopold, 1993

# In Europe, most farmland wildlife is in decline:

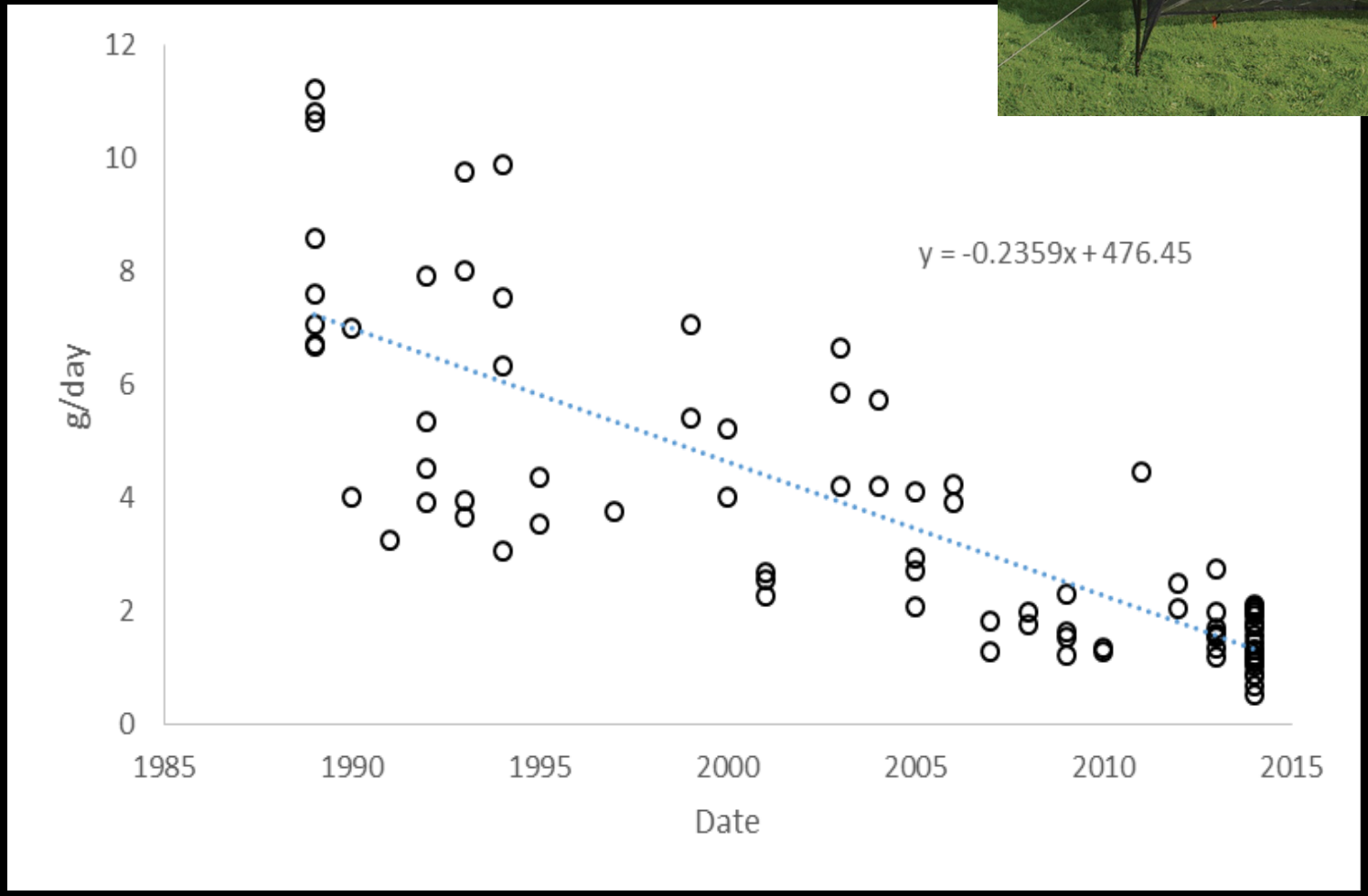
- Birds
- Butterflies
- Bees
- Moths
- Carabid beetles
- WWF estimates



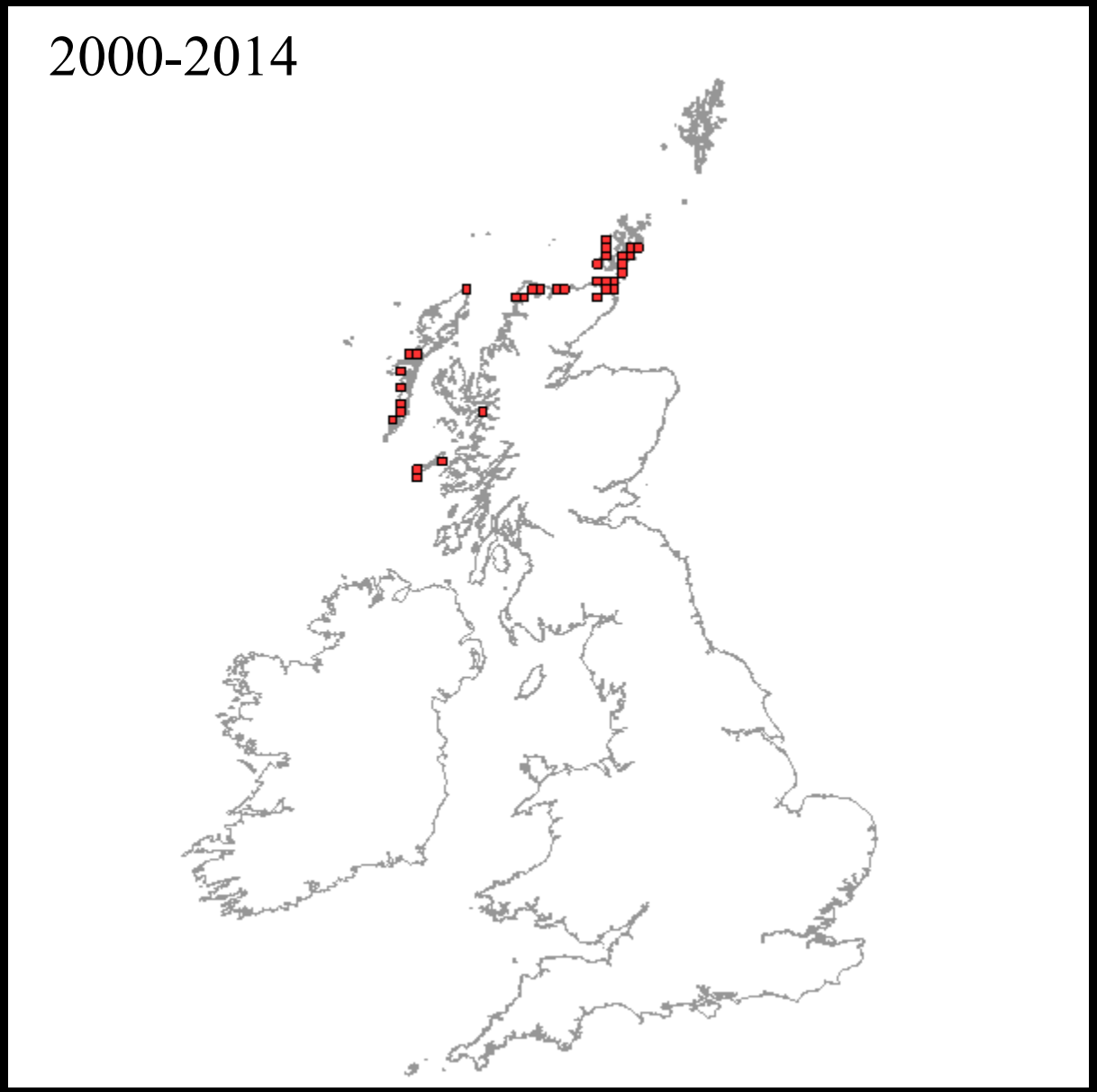



Catch per day (grams of insects) in Malaise traps deployed at 63 sites in Germany between 1989 and 2014.



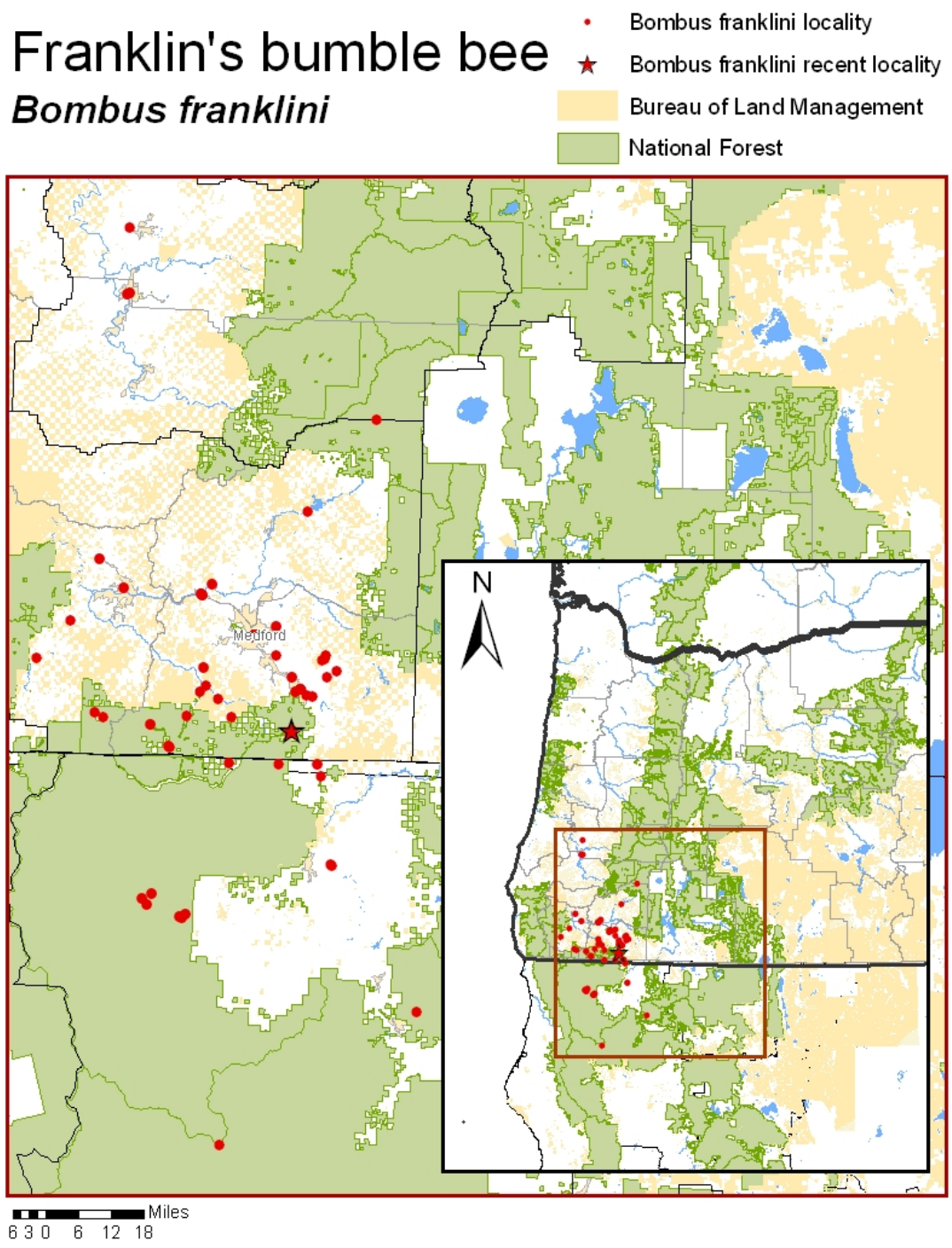
# Great yellow bumblebee




From NBN

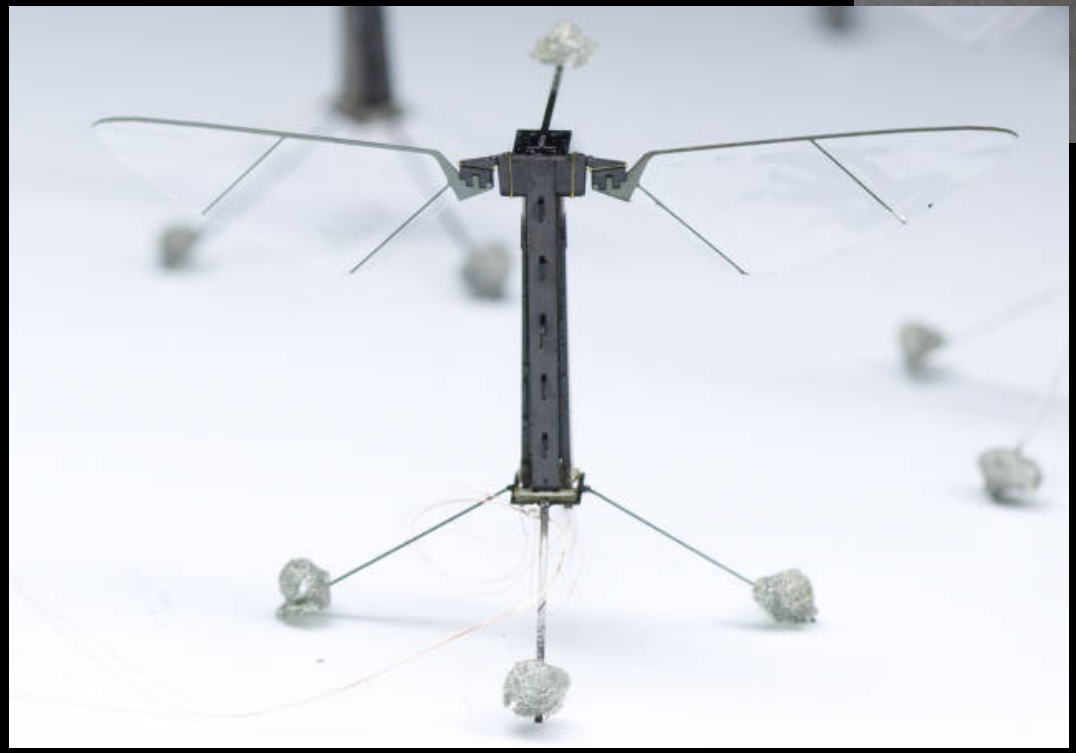
# Franklin's bumble bee

***Bombus franklini***





Your produce choices
*without* bees



Declines 1945-1990 are easy to explain…

<u>Agricultural intensification:</u>

> loss of 97% of haymeadows and chalk grassland
> Introduction of pesticides and inorganic fertilizers
> Abandonment of leys and rotations
> Loss of hedgerows
> Drainage of marshes etc…

… but why do declines continue despite >£400 million spend on agri-environment schemes in UK alone?

# Pesticides

## Agrochemical applications on an oilseed rape field in E Sussex

| | | | | |
|---|---|---|---|---|
| 25/08/2012 | Insecticide and fungicide | Cruiser | 280 g/l thiamethoxam, 8 g/l fludioxonil and 32.3 g/l metalaxyl-M | Seed dressing |
| 28/08/2012 | Herbicide | Shadow | Quinmerac, Dimethenamid-p, Metazachlor | Spray |
| | Herbicide | Dictate | 480g/litre bentazone as sodium salt in the form of soluble concentrate | Spray |
| | Fungicide | Fiddle | Clomazone | Spray |
| 08/09/2012 | Molluscicide | Tds Major | Metaldehyde | Slug pelleter |
| 12/09/2012 | Herbicide | Shadow | Quinmerac, Dimethenamid-p, Metazachlor | Spray |
| 10/10/2012 | Herbicide | Crawler | Carbetamide | Spray |
| 05/11/2012 | Fungicide | Genie 25 | Flusilazole | Spray |
| | Insecticide | Gandalf | Beta-cyfluthrin | Spray |
| 16/02/2013 | Fertiliser | Double Top | Ammonium Sulphate and Ammonium Nitrate | Fertiliser spreader |
| | Herbicide | Crawler | Carbetamide | Spray |
| | Herbicide | Pilot Ultra | Quizalofop-P-ethyl | Spray |
| 10/04/2013 | Fertiliser | Nitram | Ammonium nitrate | Fertiliser spreader |
| 22/04/2013 | Fertiliser | Nitram | Ammonium nitrate | Fertiliser spreader |
| 17/05/2013 | Fungicide | Filan | Boscalid | Spray |
| | Fungicide | Flanker | Picoxystrobin | Spray |
| | Insecticide | Alert | Alpha-cypermethrin | Spray |
| 05/06/2013 | Fungicide | Propulse | Fluopyram, Prothioconazole | Spray |
| | Insecticide | Hallmark Zeon | 100 g/l lambda-cyhalothrin and 1,2-benzisothiazolin-3-one | Spray |
| | Insecticide | Gandalf | Beta-cyfluthrin | Spray |
| | Insecticide | Mavrik | Tau-fluvalinate | Spray |

= 22 chemicals + ? adjuvants

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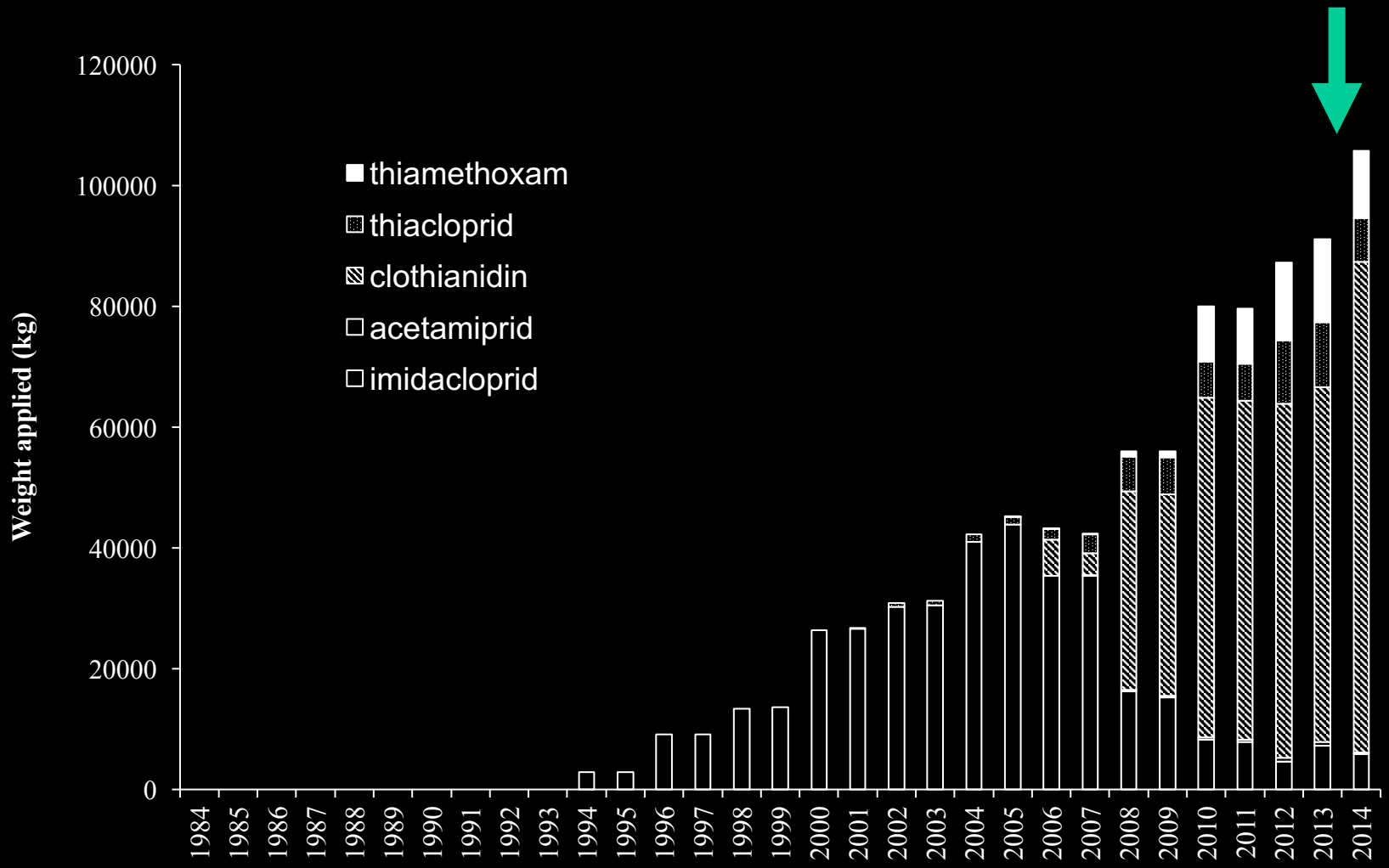
# Neonicotinoids

| | UK use 2015 |
|---|---|
| Clothianidin | 81,167 kg |
| Thiamethoxam | 11,126 kg |
| Thiacloprid | 7,323 kg |
| Imidacloprid | 5,863 kg |
| Acetamiprid | 304 kg |

Mainly used as seed dressing on rape (canola), cereals, maize, sunflower, beet.

Also sprayed on top fruit, soft fruit, and as a soil drench or granular formulation for turf / pasture.

# Neonicotinoid usage



# Toxicity

| Compound | LD50 in honeybees |
| --- | --- |
| Imidacloprid | 4 ng/bee (≈ clothianidin ≈ thiamethoxam) |
| Cypermethrin | 160 ng/bee |
| Dimethoate | 191 ng/bee |
| DDT | 27,000 ng/bee |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Provado
Ultimate Bug Killer
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£6.99


POISON
KEEP OUT OF REACH OF CHILDREN
READ SAFETY DIRECTIONS
FOR ANIMAL TREATMENT ONLY
BAYER
advocate®
for Dogs 10-25kg
100g/L IMIDACLOPRID, 25g/L MOXIDECTIN
Fleas, heartworm & worms
Once a month topical flea and worm treatment
• Stops fleas feeding in 3-5 minutes
• Prevents heartworm and controls intestinal worms and larvae
WATER RESISTANT FORMULATION
3 x 2.5mL tubes
Fleas
Flea larvae
Heartworm
Intestinal worms
Intestinal worm larvae
Demodectic mange
Sarcoptic mange
Ear mites
Lice

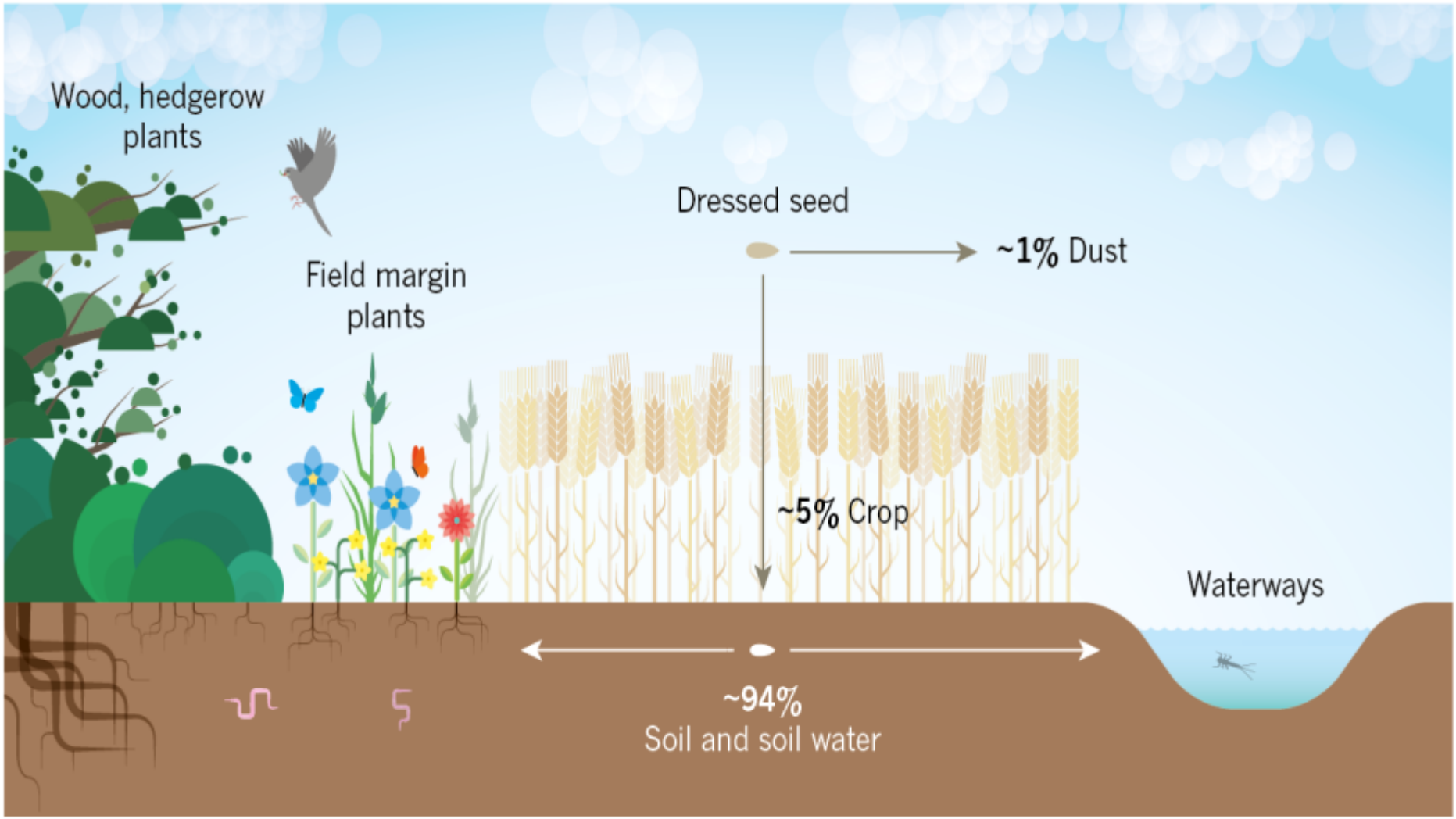

FREE
SEEDS
for Bees
See inside collar for seeds
Bayer
Garden
BAYER
Provado
Ultimate
Bug Killer
Ready to Use
1 litre


RHS PERFECT FOR POLLINATORS™

| Common name | Species and variety | Retailer | Insecticides | Fungicides |
|---|---|---|---|---|
| Achillea | Achillea millefolium 'Desert Eve Deep Rose' | B&Q | 1 | 3 |
| Ageratum | Ageratum houstonianum | Aldi | 3 | 4 |
| Allium | Allium hollandicum | Wyevale | 2 | 1 |
| Bellflower | Campanula portenschlagiana | Wyevale | 0 | 2 |
| Catmint | Nepeta cataria 'Six Hill Giant' | Wyevale | 2 | 3 |
| Catmint | Nepeta cataria 'Walkers low' | Wyevale | 1 | 2 |
| Coreopsis | Coreopsis grandiflora 'Early Sunrise' | B&Q | 1 | 3 |
| Cosmos | Cosmos bipinnatus 'Casanova Violet' | Homebase | 4 | 1 |
| Crocus | Crocus vernus 'Golden Yellow' | Wyevale | 1 | 1 |
| Daffodil | Narcissus jonquilla 'Tete-a-Tete' | Wyevale | 0 | 0 |
| Dahlia | Dahlia x hybrida 'Gallery Art Fair' | Staverton's | 0 | 1 |
| Dahlia | Dahlia x hortensis 'Bishop of Llandaff' | Wyevale | 1 | 0 |
| Dahlia | Dahlia x hybrida 'Mystic Dreamer' | B&Q | 2 | 2 |
| Dutch iris | Iris tingitana × I. xiphium | Wyevale | 1 | 3 |
| Foxgloves | Digitalis purpurea 'Dalmatian White' | Wyevale | 1 | 1 |
| Grape hyacinth | Muscari armeniacum | Wyevale | 1 | 5 |
| Heathers | Erica carnea | Wyevale | 5 | 5 |
| Lavender | Lavandula stoechas 'Victory' | Wyevale | 0 | 3 |
| Lavender | Lavandula angustifolia | Wyevale | 0 | 1 |
| Lavender | Lavandula stoechas 'Papillon' | Wyevale | 0 | 3 |
| Salvia | Salvia longispicata x S. farinacea 'Mystic Spires' | Staverton's | 1 | 0 |
| Salvia | Salvia nemerosa 'Sensation Deep Rose' | Homebase | 0 | 0 |
| Scabious | Scabiosa columbaria 'Pink Mist' | Wyevale | 1 | 1 |
| Scabious | Scabiosa columbaria 'Butterfly Blue' | Homebase | 3 | 2 |
| Strawberry | Fragaria × ananassa 'Toscana F1' | Homebase | 2 | 2 |
| Thistles | Cirsium atropurumeum | Wyevale | 2 | 1 |
| Verbena | Verbena x hybrida | Aldi | 3 | 3 |
| Veronica | Veronica spicata | Staverton's | 2 | 4 |
| Wallflower | Erysimum linifolium 'Bowles's Mauve' | Wyevale | 1 | 1 |

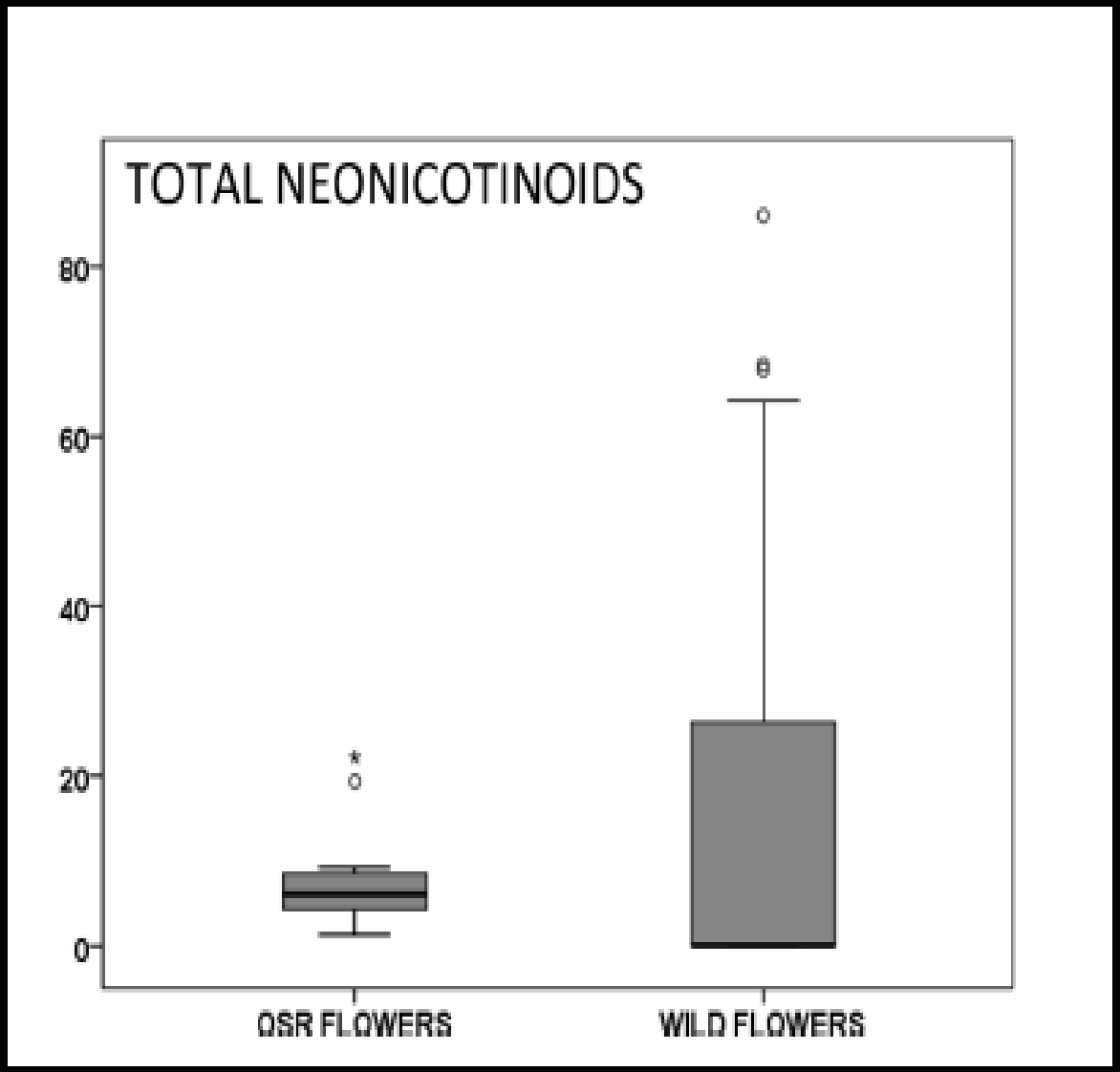
**Table 1: Number of pesticides detected in different ornamental plants.**

# Environmental fate of neonic seed dressings




Goulson, D. 2014. *Nature*, doi:10.1038/nature13642

Botias et al. 2015 Environmental Science & Technology 49: 12731-12740




97% of neonic residues in pollen collected by honeybees was from wildflowers

# Whitehorn et al, *Science* 2012

Simulated bumblebee nest being near rape field:

Dosage: Imidacloprid, 0.7ppb in nectar, 6ppb in pollen

Fed bumblebee nests for 2 weeks on:

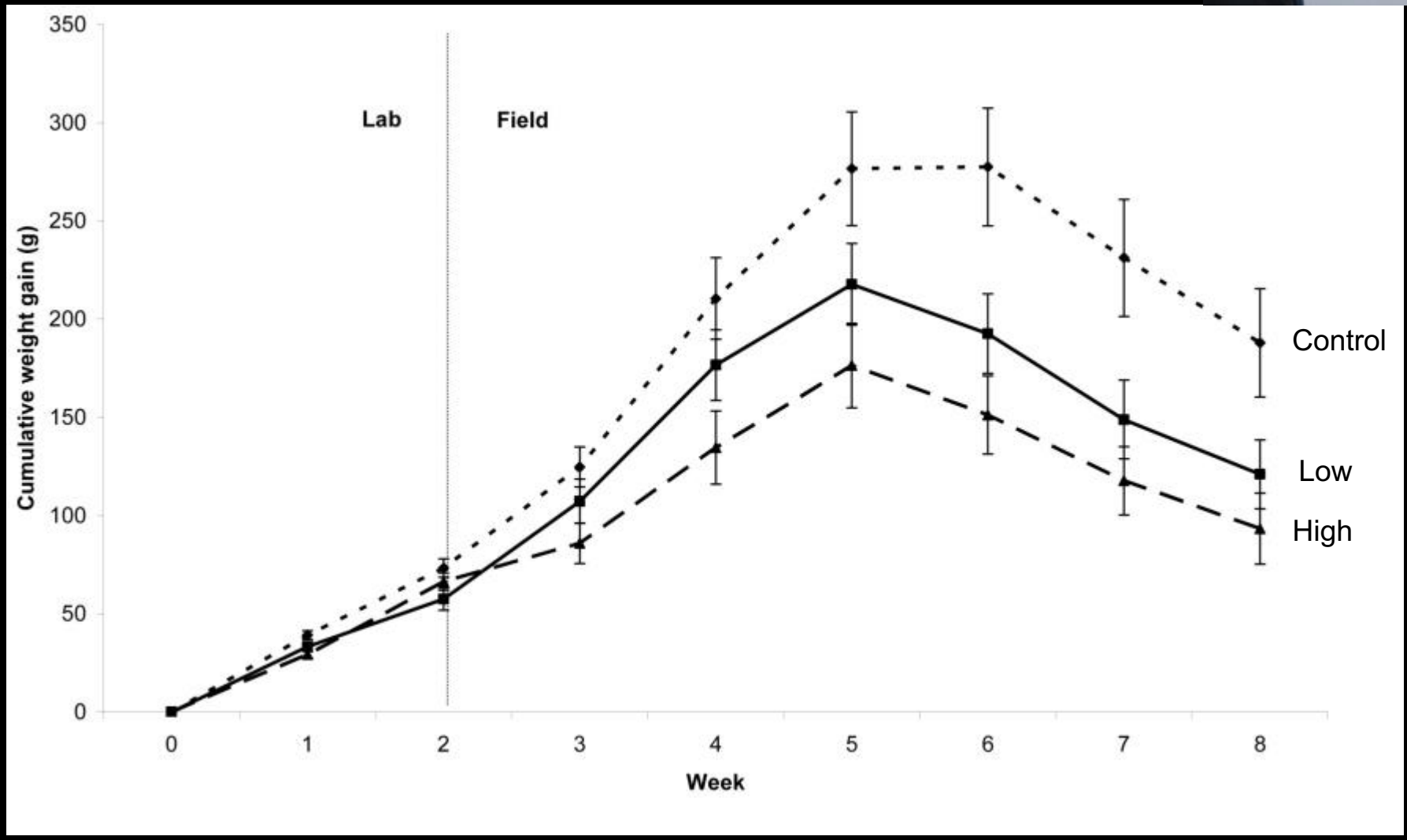
a) Nectar, pollen (control)

b) Nectar, pollen + field realistic imidacloprid (low)

c) Nectar, pollen + 2 x field realistic imidacloprid (high)

After 2 weeks, nests placed in the field…..

# Whitehorn et al, *Science* 2012



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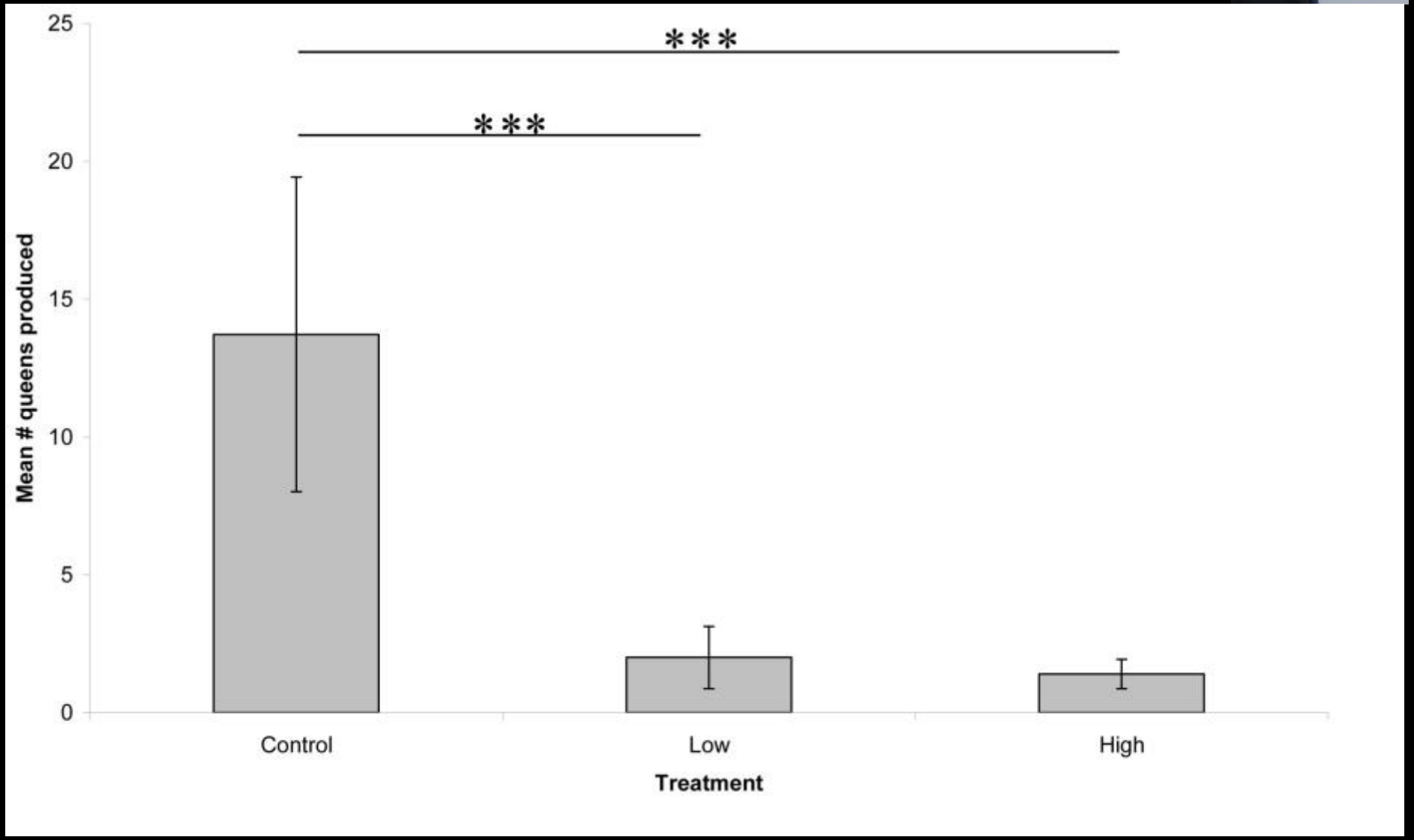
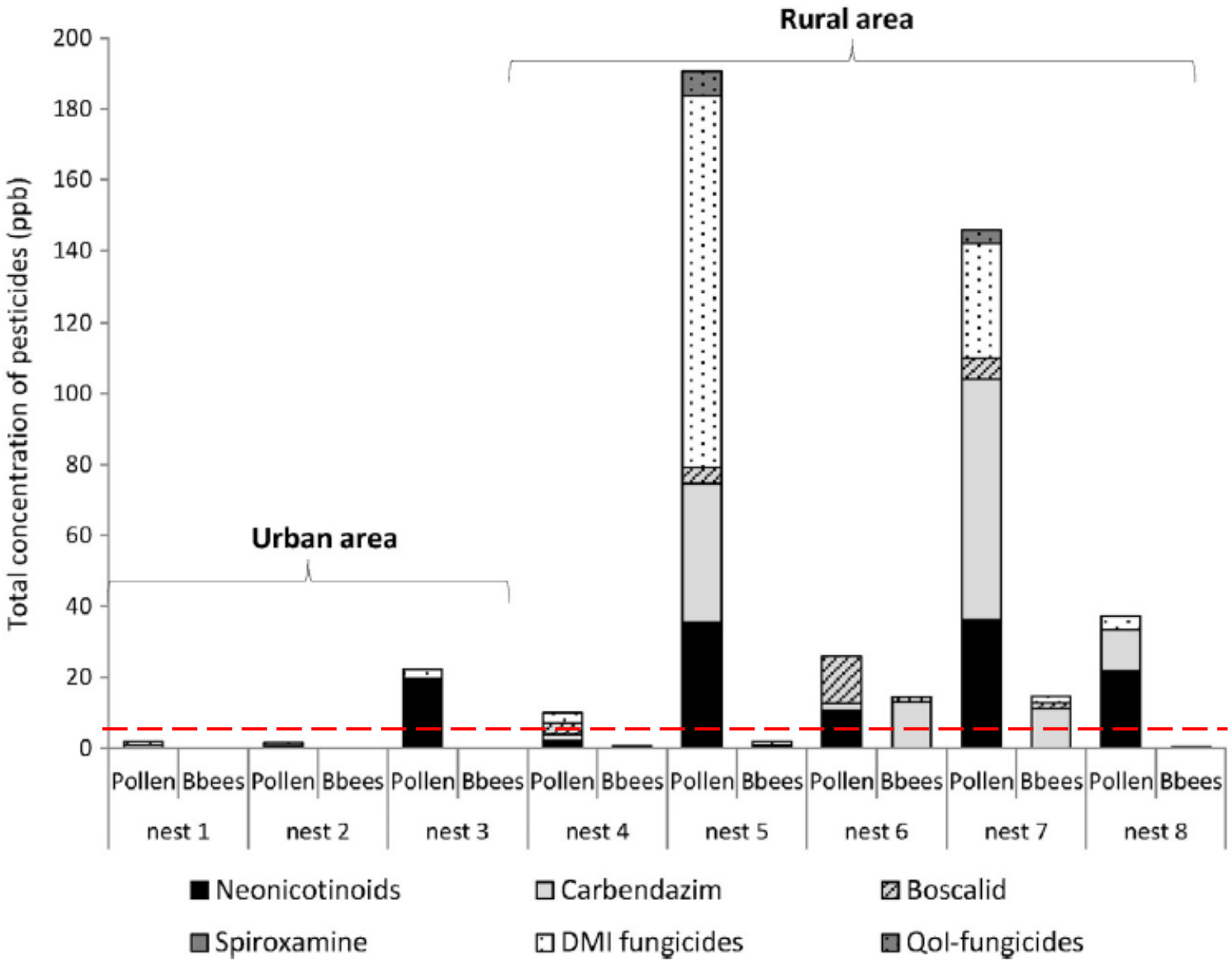
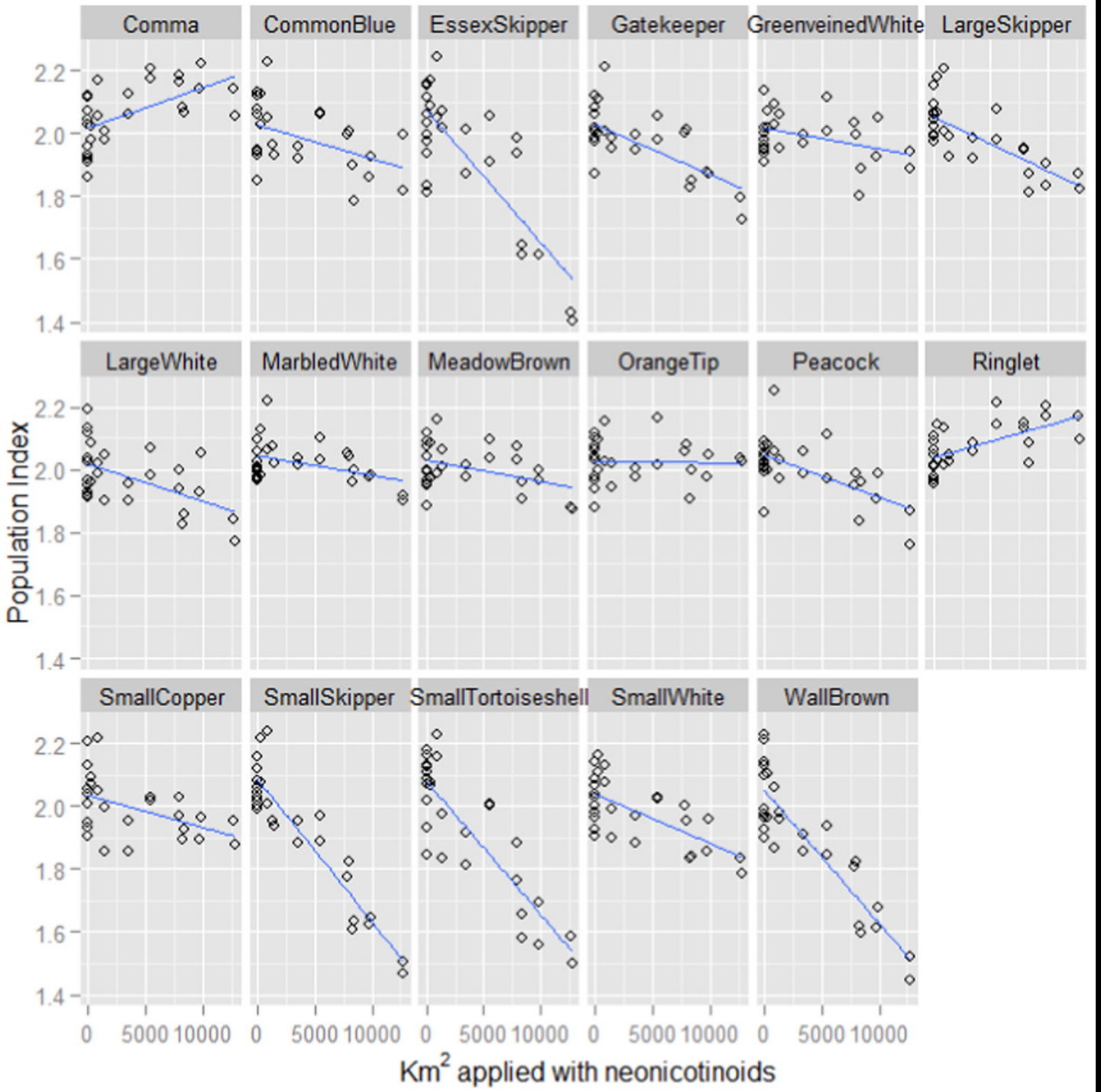


David et al. 2016 *Environment International* 88: 169-178



# Neonicotinoid usage/ pollution levels strongly correlate with:

- Declines in diversity and abundance of aquatic invertebrates in Netherlands - Van Dijk et al. (2012)
- Rates of insectivorous bird decline in Netherlands - Hallmann et al. (2014)
- Frequency of death of honeybee colonies in UK - Budge et al. (2015)
- Rates of decline of UK wild bees Woodcock et al. (2016)
- Rates of decline of farmland butterflies in UK & California, Gilburn et al. (2015); Forister et al. 2016.




Gilburn et al. 2015 PeerJ 3:e1402

# Do we need neonics to maintain yields?

[A ban on neonicotinoids] *"would have tremendous economic implications.. Over a five year period, the EU could lose €17 billion.. and… 50,000 jobs"* From Humboldt Forum, 2013

What evidence is there for these claims?

- US & Italian studies show seed-dressings on soya & maize do not improve yield e.g. EPA announcement on Soya (30 million ha, ~40% treated at a cost of ~$176 million)
- 2014 & 2015 yields near all-time high for crops without neonics in EU, above average for 2014/15 OSR in UK (bit lower in 2015/16).

- Arable farmer Peter Lundgren explains how he farms without neonics: https://vimeo.com/233666623

Pesticides

# Farms could slash pesticide use without losses, research reveals

Study shows almost all farms could significantly cut chemical use while producing as much food, in a major challenge to the billion-dollar pesticide industry

19,789

Damian Carrington,
Environment editor

@dpcarrington

Thursday 6 April 2017 16.04 BST

Many farmers want to reduce pesticide use but do not have good access to information on alternatives, scientists say. Photograph: Remy Gabalda/AFP/Getty Images

Pesticides

# Farms could slash pesticide use without losses, research reveals

Study of 1,000 French farms concluded:

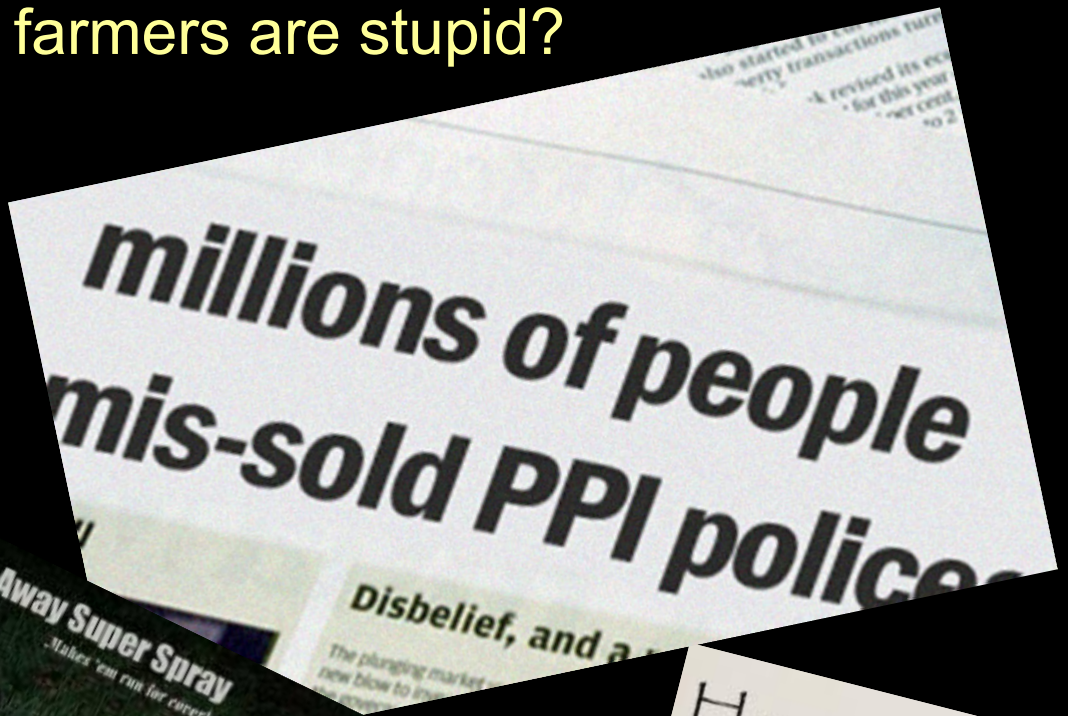
- Insecticides: lower levels would result in more production in 86% of farms and no farms at all would lose production.
- 78% of farms would be equally or more profitable when using less pesticide of all types.
- The farmers using low levels of chemicals employ other methods to control pests: e.g. rotating crops, mechanical weeding, using resistant varieties and carefully managing sowing dates and fertiliser use.

Lechenet et al. 2017 Nature Plants 3:17008

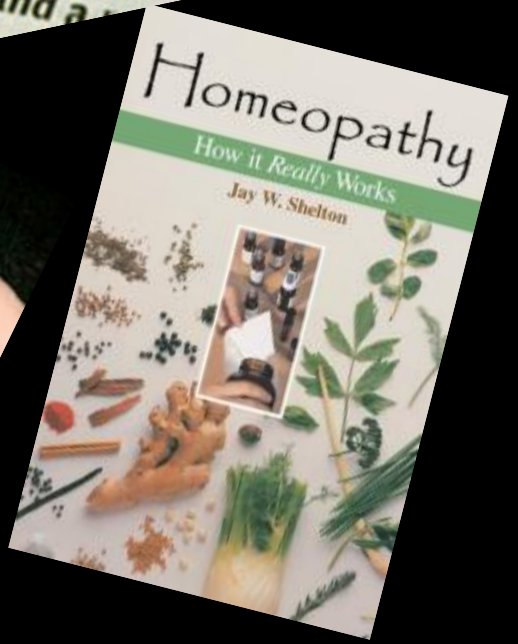
- Applying neonics to soya beans reduced yield by 5%
- Slugs immune to neonics, but became toxic by eating seedling
- 60% of predatory ground beetles killed

Douglas et al. 2014. Journal of Applied Ecology

# Am I saying farmers are stupid?



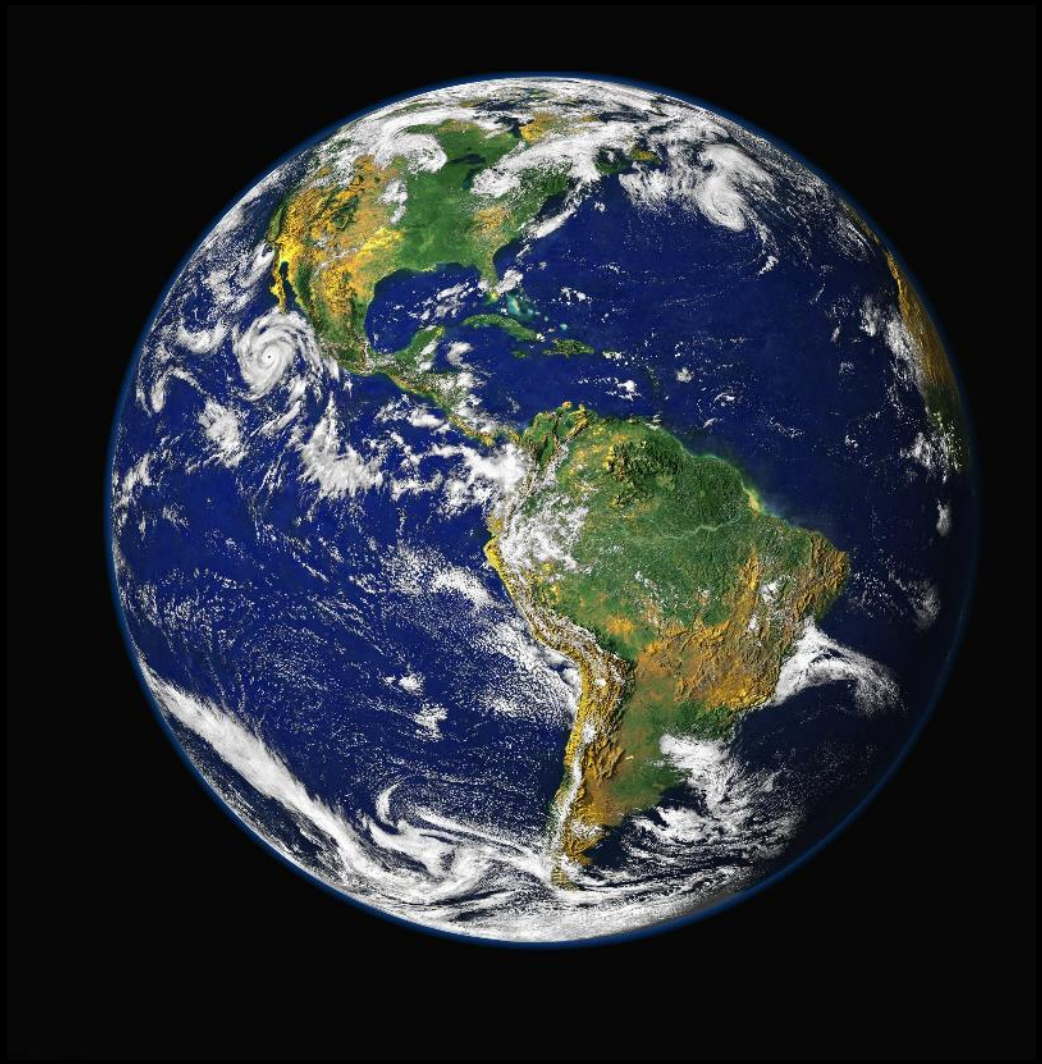




Is this approach to farming the only way to feed the world?

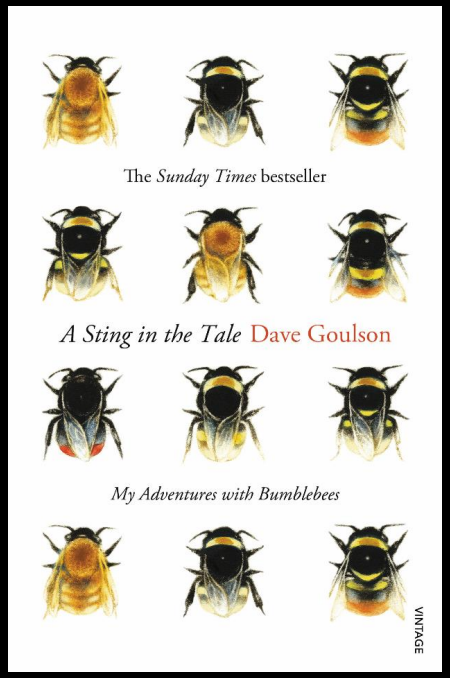

Organic?

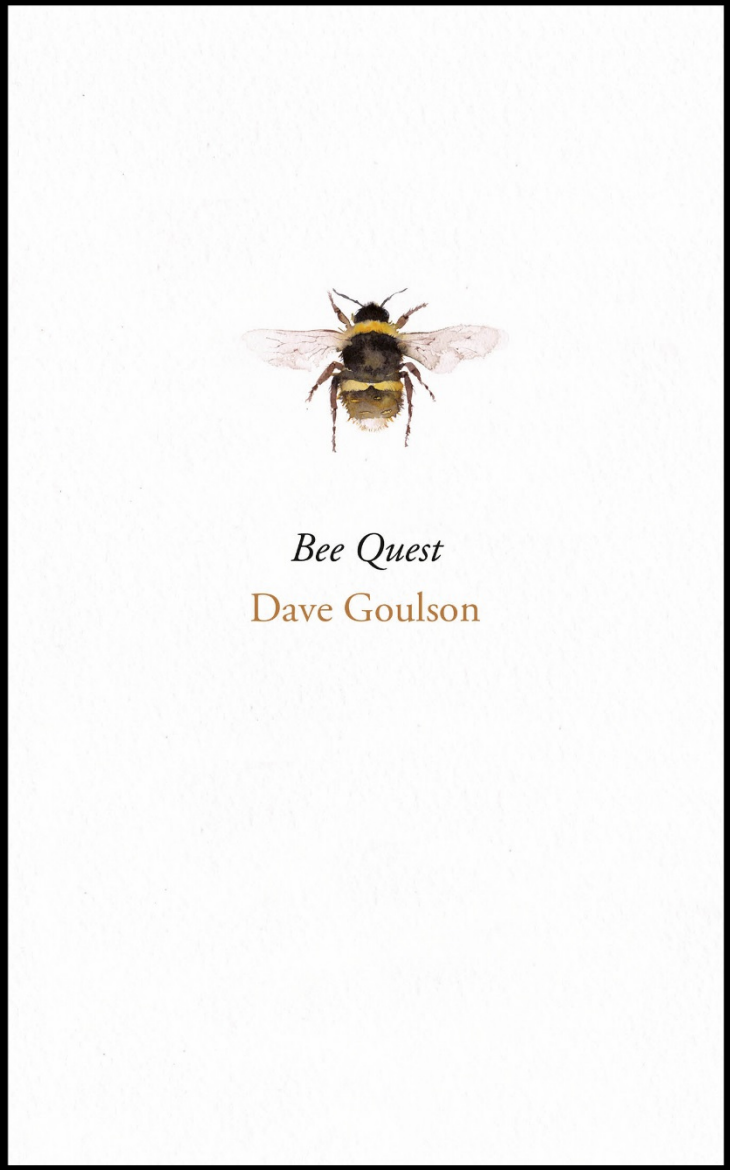
Permaculture/
agroforesry?

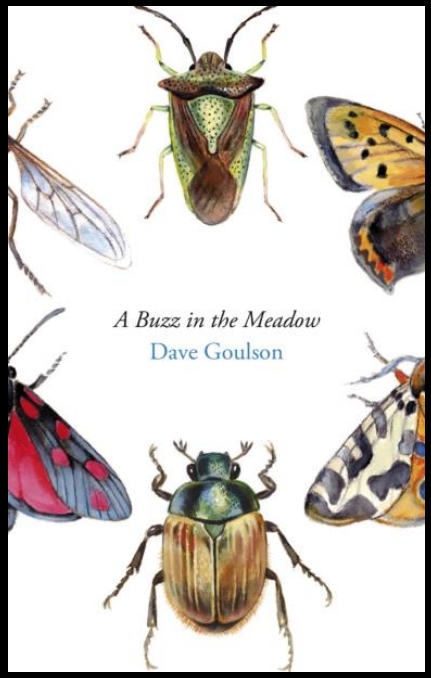

Support local, small-scale food production?



# Thank you!


The *Sunday Times* bestseller
*A Sting in the Tale* Dave Goulson
*My Adventures with Bumblebees*
VINTAGE


*Bee Quest*
Dave Goulson


*A Buzz in the Meadow*
Dave Goulson