Farming and the decline of bumblebees

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What are bumblebees?

- Hymenoptera; Apoidea (bees); *Bombus*
- ~250 known species
- All social or inquilines
- Annual life cycle (most)
- Feed exclusively on pollen and nectar
- Predominantly N. hemisphere
- Large, hairy - most found in cool regions

B. pratorum

Conservation – current status

25 UK species, 3 extinct, 7 BAP species, 2 critically endangered.

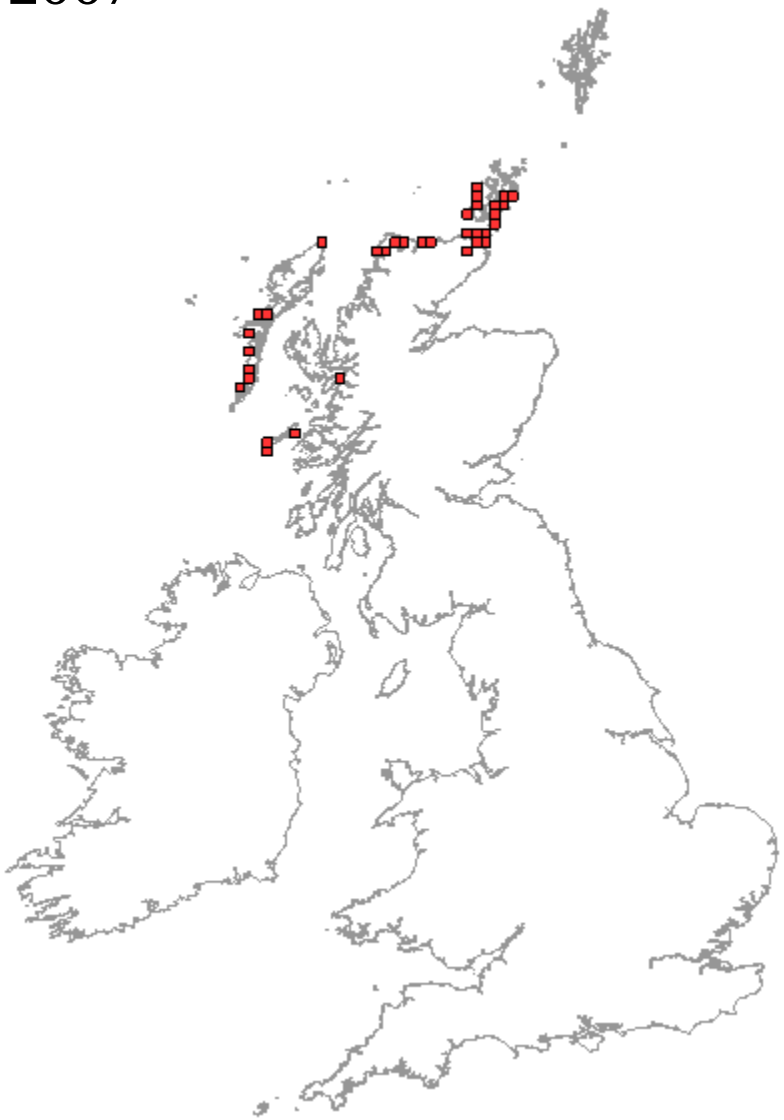
Europe: 13 species extinct in at least one country between 1950 and 2000. Four species extinct throughout region.

Probably 3-4 global extinctions so far

B. pascuorum

Great yellow bumblebee
B. distinguendus

2000-2007



From NBN

Shrill carder bumblebee
B. sylvarum

2000-2007

From NBN

Short-haired bumblebee
B. subterraneus

2000-2007

From NBN

Bbees are major pollinators of crops (e.g. oilseed rape, field beans, tomatoes, peppers, raspberries, strawberries…) and >1,000s spp. of wildflowers – hence of great ecological and economic importance

Causes of declines?

In UK, undoubtedly linked to agricultural intensification, esp. loss of unimproved grasslands ~7,000,000 ha → 250,000 ha (~97%)

Abandonment of clover leys

Hay → Silage

Disease & commercial bumblebees?

Pesticides?

The rise of commercial bumblebees

- Since 1988, commercially reared bumblebees have been shipped around the globe. Main trade is in *B. terrestris dalmatinus* from S. Europe.
- Currently shipped to ~60 countries, from S. America to Korea, probably exceeds 1 million nests
- Primarily for tomato pollination
- More recently, used for outdoor / polytunnels crops e.g. raspberries, strawberries, hard fruits.

A UK perspective:

- ~60,000 nests per year imported to UK
- ~45,000 for glasshouse crops e.g. tomatoes, cucumbers
- ~15,000 for soft fruit

For most soft fruit, insect pollination is essential for marketable crops:

Lye et al. 2011 *J Econ Entomol* 104: 107-114 - Yield of raspberries increased by 8% by using commercial bumblebees, so there are not enough wild bumblebees

Pollination options for soft fruit growers:

- Do nothing
- Buy commercial bees*
- Boost wild bee numbers
- Buy commercial bees & boost wild bees

Currently, 72% of pollination provided by wild bumblebees even when commercial bumblebees used

Lye, G.C., Jennings, S.N., Osborne J.L. and Goulson, D. 2011. Impacts of the use of non-native commercial bumble bees for pollinator supplementation in raspberry. JOURNAL OF ECONOMIC ENTOMOLOGY 104: 107-114.

Are there more sustainable alternatives such as boosting wild pollinator populations, which might reduce the need for commercial bumblebees?

Environmental risks and costs associated with commercial bumblebees:

- Escape into wild
- Carbon footprint
- Expensive
- Risk of supply failure
- Introduction of parasites

Disease and commercial bumblebees

- No independent disease screening, or agreed list of diseases
- Nests reared on pollen from honeybees
- Evidence that nests are infected with a range of parasites (disputed)
- Evidence that bumblebees are often infected with ‘honeybee’ diseases including *Nosema ceranae* and Deformed Wing Virus
- Controversial but strong evidence that non-native pathogens spread with commercial bumblebees have devastated populations of some bumblebees in both North and South America

<u>Global redistribution of bee diseases…..</u>

Pesticides

Neonicotinoids:

	UK use 2010
Imidacloprid	188,000 Ha
Clothianidin	728,000 Ha
Thiamexotham	298,000 Ha
Thiacloprid	49,000 Ha
Acetamiprid	7,000 Ha

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

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

Widely sold for garden use e.g *Ultimate Bug Killer*

0.6 – 28 ppb found in pollen and nectar of seed-treated crops e.g. oilseed rape: 0.7ppb of imidacloprid in nectar, 6ppb in pollen (Bonmatin et al. 2003)

Neonicotinoids:	honeybee LD50:
Imidacloprid	18 ng/bee
Clothianidin	22 ng/bee
Thiamexotham	30 ng/bee
Thiacloprid	14,600 ng/bee

Hence a bee would need to consume ~26ml of rape nectar or ~3g of pollen to receive an LD50.

Evidence for sublethal effects?

Meta-analysis by Cresswell et al 2011:

In lab, honeybee performance reduced by 6-20%, but no mortality.

Mommaerts et al 2010:

Evidence for impaired foraging ability in bumblebees

Studies almost all lab based…

Whitehorn et al, *Science* 2012

Fed bumblebee nests for 2 weeks on:

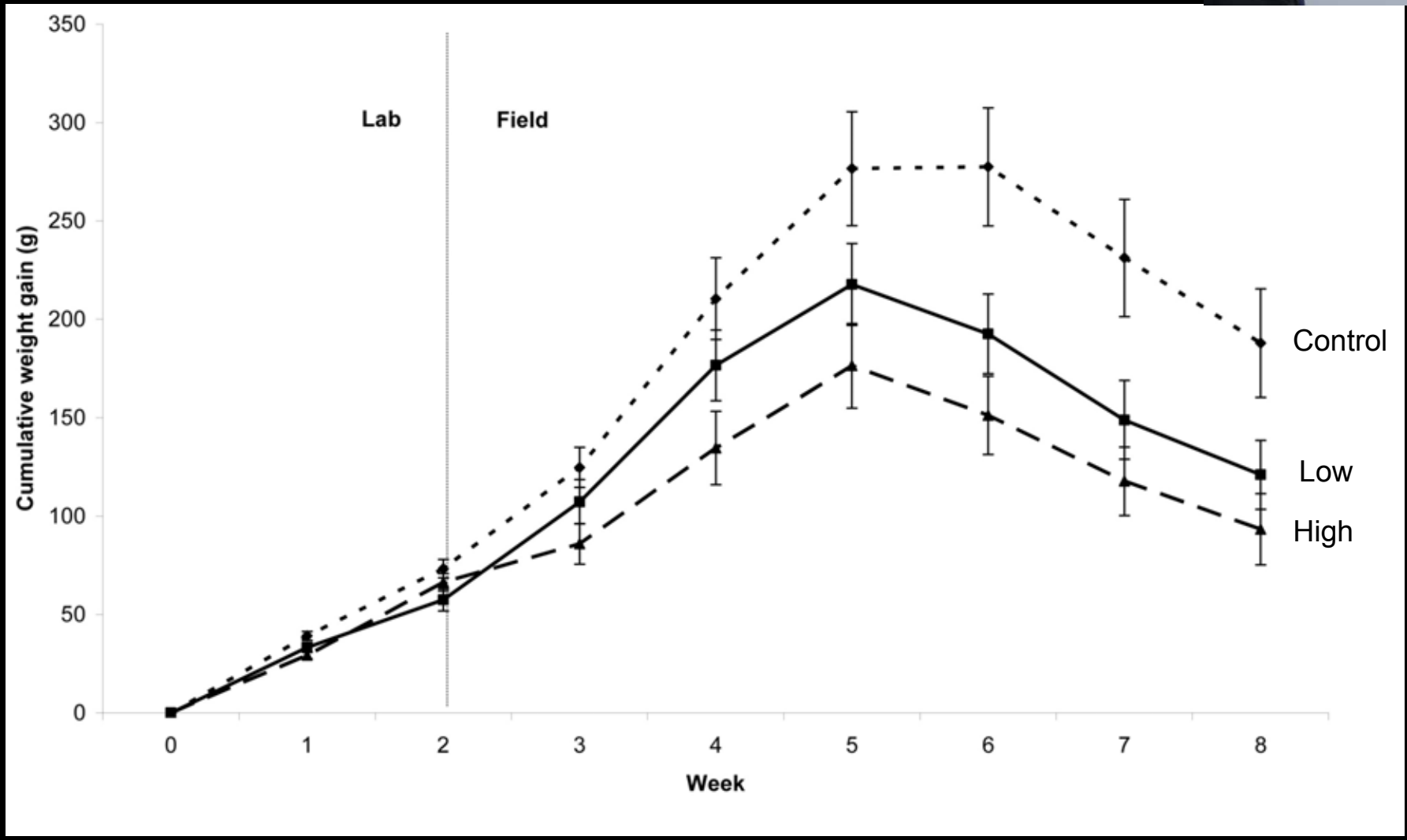
a) Nectar, pollen (control)

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

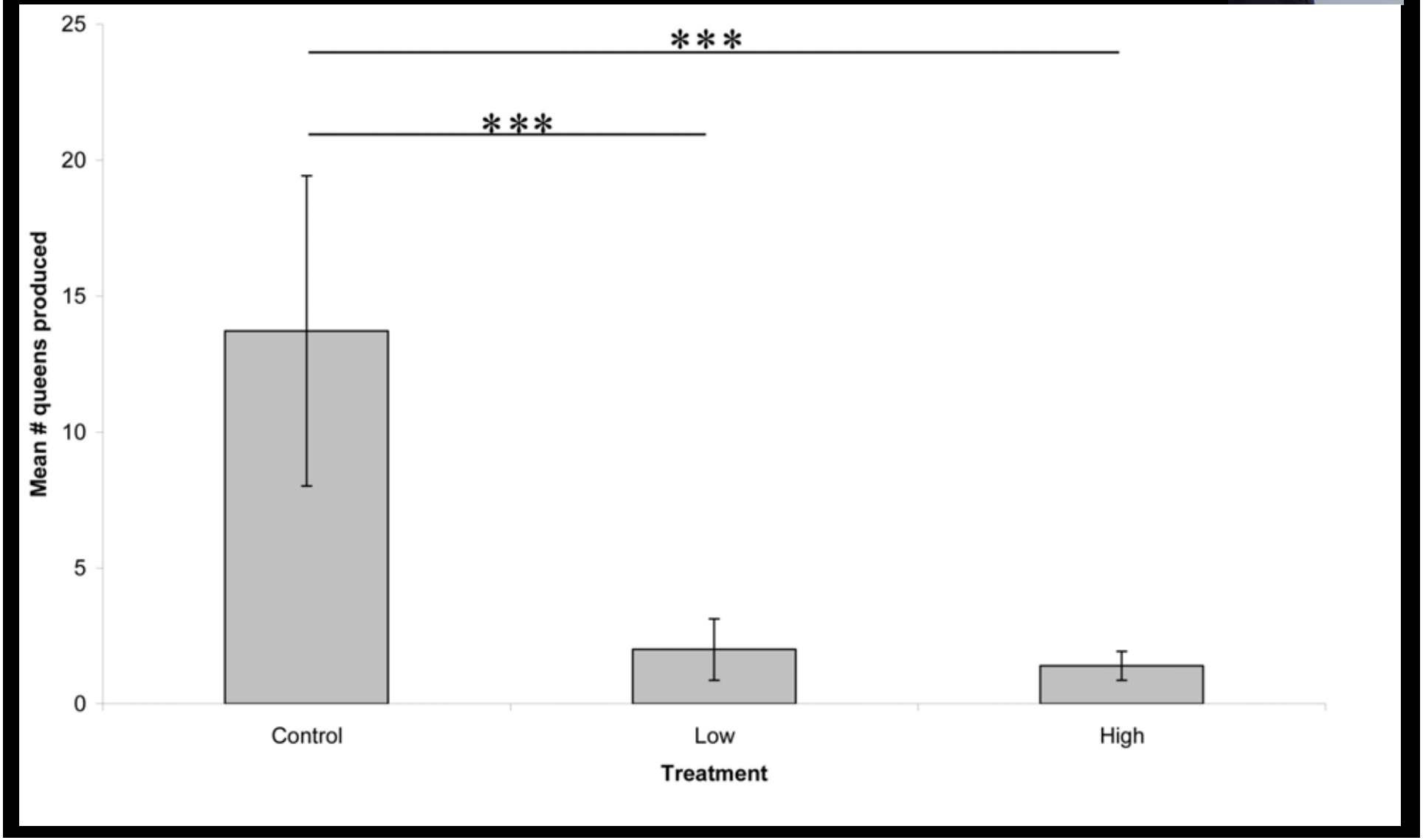
c) Nectar, pollen + 2 x field realistic imidacloprid (high)

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

Whitehorn et al, *Science* 2012



Whitehorn et al, *Science* 2012



Henry et al. *Science* 2012

- RFID tagged honeybees
- Exposed them to a single dose of thiamexotham (1.34 ng in a 20-µl sucrose solution) or control
- Examined homing success

- Released at a familiar location 1km from hive, homing success reduced by ~10% compared to controls
- Released at an unfamiliar location 1km from hive, homing success reduced by 32% compared to controls
- Released at a familiar location 70m from hive (simulating field trial), homing success reduced very little

Persistence

Neonicotinoids are water soluble, and leach from seed treatments into soil water.

Clothianidin half life in soil: 148 to 1155 days (US EPA report 2010)

<u>Krupke et al 2012:</u>

- 9ppb in soil 1 year after treated crop grown
- 1-9ppb in dandelions growing in field margin

Potential scale of effects is large…

Summary

Bees face multiple threats / stressors:

- Habitat loss
- Restricted diet
- Parasites
- Pesticides

These probably act synergistically.

<u>How do we manage farmland to reduce these threats and ensure that we support healthy and diverse pollinator populations?</u>

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