1

What are the densities of feral honey bee colonies in natural and agricultural areas across Australia?

- Is pollination satisfactory?
- Biosecurity response
- Conservation concerns
- Access to forests

2

Recommended stocking rates for most crops

2-8 hives / ha

- FREE J. B. (1970). *Insect pollination of crops*. Academic Press
- MCGREGOR S. E. (1976). *Insect pollination of cultivated crop plants*. USDA Washington.
- DELAPLANE, K.S AND MAYER, D.E. (2000). Crop pollination by bees. CABI Publishing

3

Actual stocking rates in many Australian crops

She'll be right mate. Plenty of bees up in them hills

4

Surveys show that the density of feral bee colonies in Australia is 10-100 times **lower** than the recommended stocking rate.

- Wyperfeld National Park Victoria: 0.5-1.5 colonies per ha
- Grenfell NSW 0.005 colonies per ha
- Stratford NSW 0.0025 colonies/ha

OLDROYD B. P., THEXTON, E. G., LAWLER, S. H. & CROZIER, R. H. (1997). Population demography of Australian feral bees (*Apis mellifera*). *Oecologia* **111,** 381-387.
HINSON E. M., DUNCAN, M., LIM, J., ARUNDEL, J. & OLDROYD, B. P. (2015). The density of feral honey bee (*Apis mellifera*) colonies in South East Australia is greater in undisturbed than in disturbed habitats. *Apidologie* **46,** 403-413.

5

Are there enough pollinators in our agricultural landscapes?

6

Manual surveys are too slow

OLDROYD B. P., SMOLENSKI, A., LAWLER, S., ESTOUP, A. & CROZIER, R. (1995). Colony aggregations in *Apis mellifera*. *Apidologie* **26,** 119-130.

7

8

9

Much easier to have the bees come to you

10

11

- Catch drones
- Genotype drones at microsatellite loci
- Use complicated maximum likelihood program
- **Number of feral colonies in flying range**




12

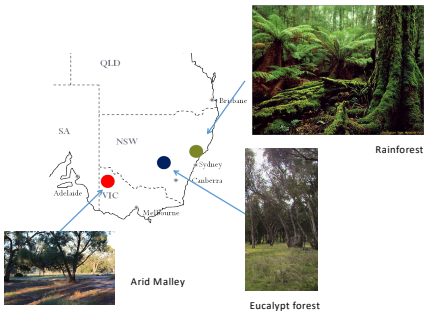
Queen in unknown colony

Sons

22 28	22	28	28	28
36 36	36	36	36	36
13 17	13	17	13	17
16 12	16	12	12	16
8 5	8	5	8	5
96 89	89	96	89	89

Maximum of 2 alleles per locus per mother. All her sons carry one of these alleles

13



Rainforest

Arid Malley

Eucalypt forest

14

Disturbed and undisturbed sites

Grenfell agricultural area and Wedden Mountains National Park

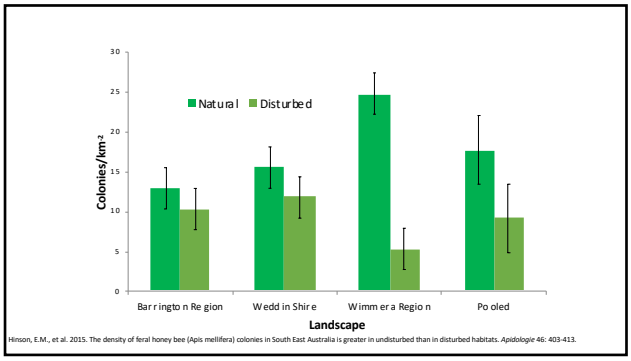
15

NSW survey

Site	Disturbed/natural	Drones sampled	Estimated colonies/km²
Gloster Tops	Undisturbed	79	10.4
Stratford Park	Disturbed	123	5.6
Allyn River	Undisturbed	72	15.4
Monkerai	Disturbed	70	13.8
Ben Hall's cave camp	Undisturbed	62	12.2
Grenfell	Disturbed	70	12.9
Holly camp	Undisturbed	278	18.9
Tyagong	Disturbed	74	10.6
Black flat	Undisturbed	222	27.7
Lake Albacutya	Disturbed	29	6.2
Lake Brambrook	Undisturbed	241	21.0
Yaapeet	Disturbed	13	4.4

Hinson, E.M., et al. 2015. The density of feral honey bee (*Apis mellifera*) colonies in South East Australia is greater in undisturbed than in disturbed habitats. *Apidologie* 46: 403-413.

16



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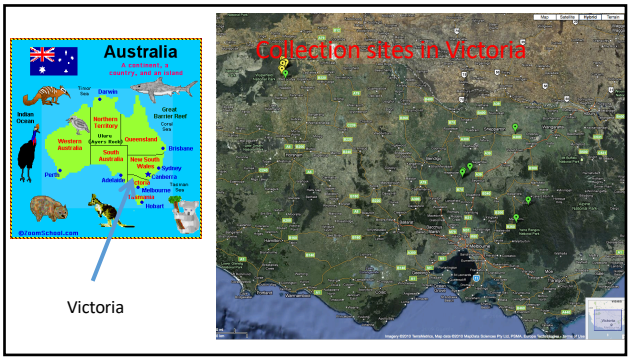

18

Victorian survey

Site	Colonies / km^2 2 km flight range	Colonies km^2 agent based models
Wyperfeld	6.4	0.9
Yaapeet	5.6	0.7
Dookie	3.1	0.4
Pukapunyal	2.7	0.3
Eildon	3.3	0.6
Marysville	2.9	0.4

Note that this is 10-100 times less than recommended (50 colonies / km^2)

Arundel, J., B.P. Oldroyd, S. Winter. 2012. Modelling honey bee queen mating as a measure of feral colony density. *Ecol Mod* 247: 48-57.
Arundel, J., et al. 2014. Remarkable uniformity in the densities of feral honey bee *Apis mellifera* Linnaeus, 1758 (Hymenoptera: Apidae) colonies in South Eastern Australia. *Aust Ent* 53: 328-336.

19

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20

Marysville fires

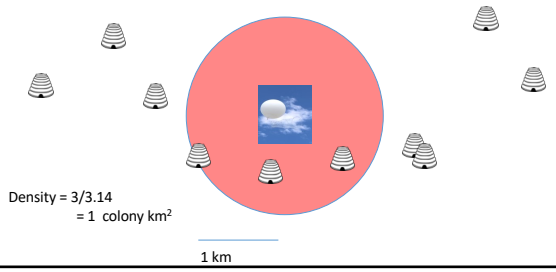
21

How far do drones fly?

- Need to exactly know how far males fly

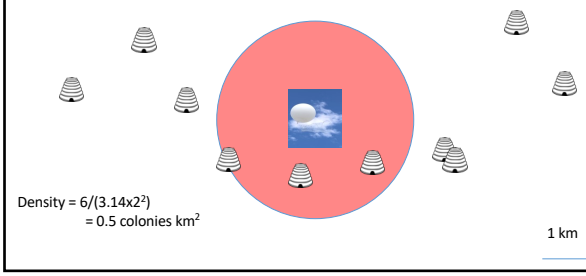
22

From how far can we attract males?



23

From how far can we attract males?



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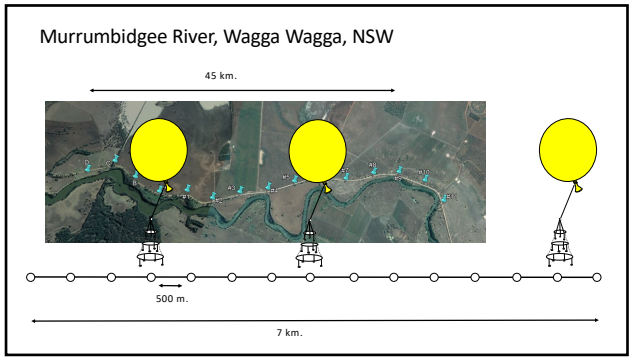
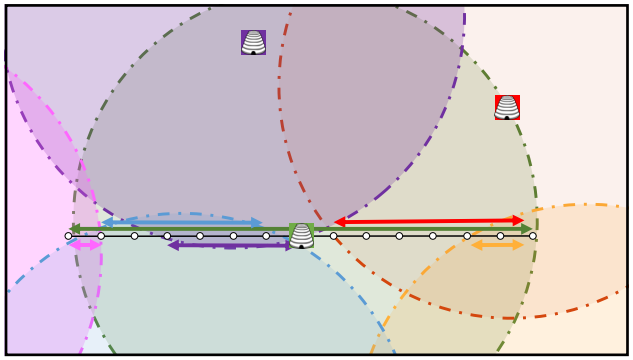
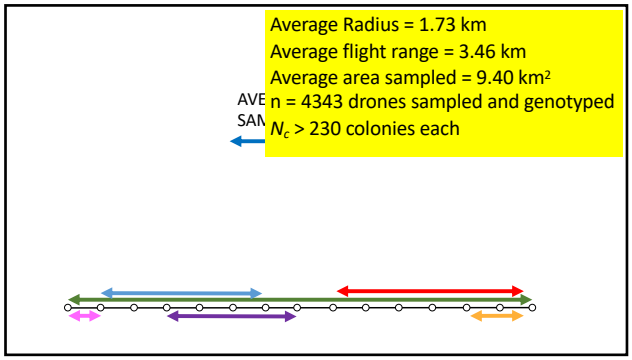

Murrumbidgee River, Wagga Wagga, NSW
45 km.
500 m.
7 km.

25

26



27


Average Radius = 1.73 km
Average flight range = 3.46 km
Average area sampled = 9.40 km²
n = 4343 drones sampled and genotyped
N_c > 230 colonies each

28

Transect experiment summaries

First transect

Average Radius = 1.82 km
Average flight range = 3.64km
Average area sampled = 10.41 km^2
n = 2288 drones sampled and genotyped
N_c = 236 colonies
Colony density* = 25.11 colonies/km^2

Second transect

Average Radius = 1.63 km
Average flight range = 3.26 km
Average area sampled = 8.34 km^2
n = 2055 drones sampled and genotyped
N_c = 263 colonies
Colony density* = 27.98 colonies/km^2

* Based on an average area sample from both experiment (9.4 km^2)

29

Conclusions

- Density of colonies in Wagga is 4.04 colonies per km^2
- A single balloon attracts drones from a 7.8 km^2 radius
- Average flight range: 3.16 km
- Maximum flight range: 7 km
- Probably better to sample from two spots 500 m apart.

30

A potential problem – worker-laid males

Queen-laid drone brood (big cells)

Worker-laid drone brood (little cells)

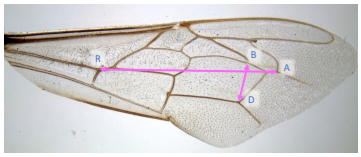
31

- We noticed that in early sprin
- If they are worker-laid, that
number
- Worker-laid males would be dec
colonies.

Drone from worker cell (Queenless colony)

Drone from queen cell (Queenright colony)

32

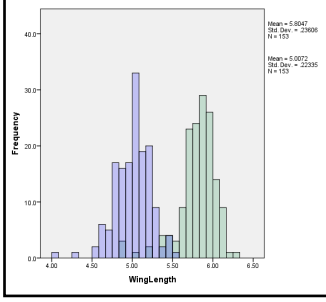


Wing size of worker-laid and queen-laid males

Drone from worker cell (Queenless colony)

Drone from queen cell (Queenright colony)

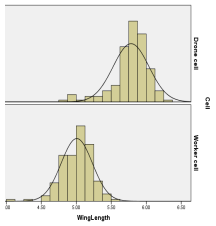
33



Wilk's lambda = 0.277

P < 0.001

5.70% misclassified (18/316)



34

We reject small bees

- Any male with a wing width less than 5.5 mm will be discarded.

35

We are interested in how colony density and identity change across time.

- Sampling two ovals in Sydney once a month throughout the project.

36

Jan-April 2018

Monthly sampling

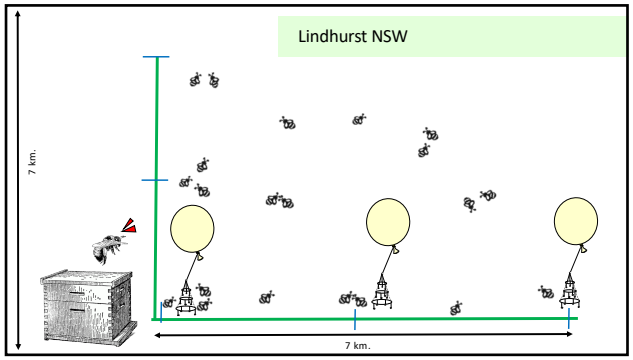
September 2017-April 2018

37

Plans for spring

- Transect out from one colony in an isolated area.
  - How far will the drones fly?
- Drones to watch drones
  - Observe how drones behave around drone balloons

38

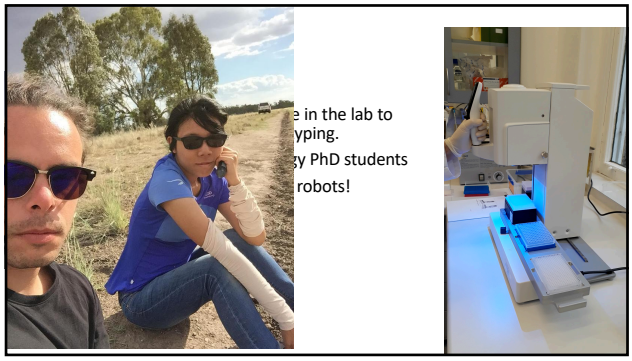


39

- Our dedicated team of professional drone catchers and gene jocks is eager to sample near your crop!

Michael Holmes
Wee Utaipanon

40



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yping.
gy PhD students
robots!

41

Securing Pollination

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Thanks to: Bob McDonald, Jonathan Arundel, Eloise Hinson, Gabi Buchmann, Michael Duncan

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