The mānuka goldrush – implications for conservation

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The Honey Goldrush?

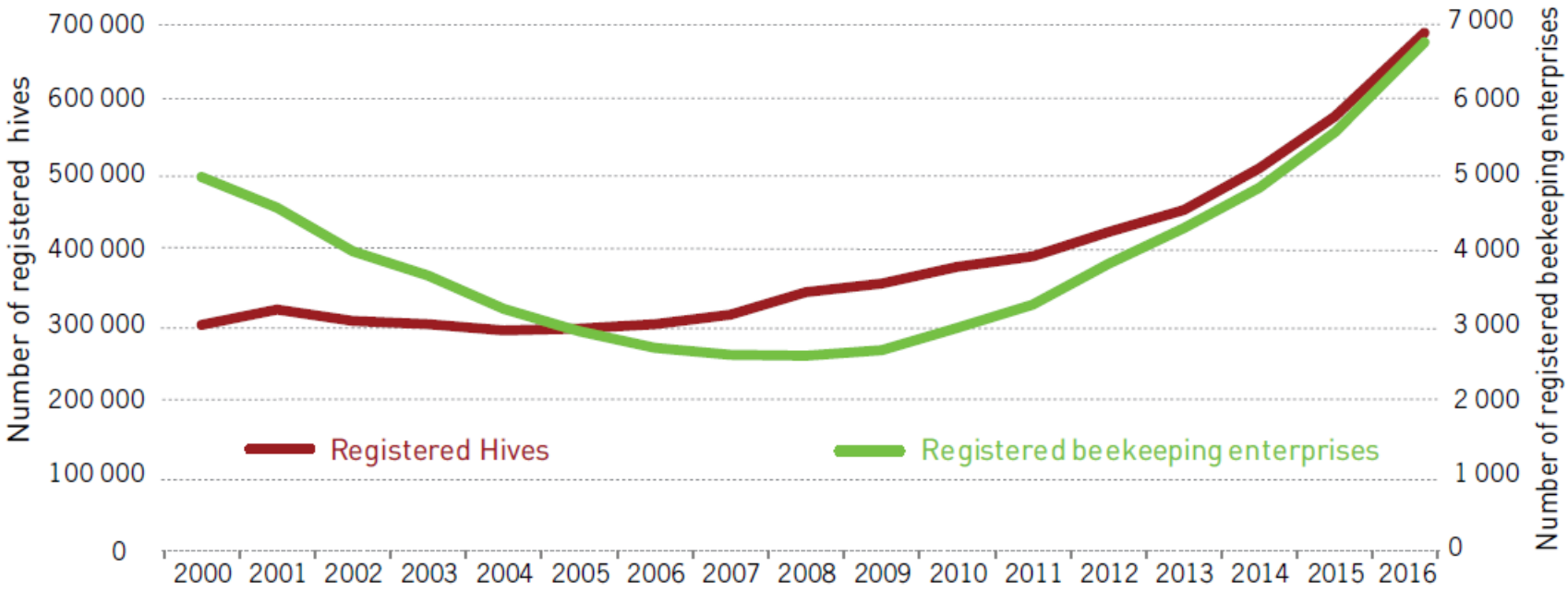
	2011	2016
Number of hives	390,523	684,046
Production (tonnes)	9,450	19,885
Price (clover / kg)	4.10-6.80	9.50-13.00
Price (manuka / kg)	8.00-80.50	12.00-148.00
Export Earnings ($M)	**102**	**315**

Projected to be $1.2B / 80K tonnes by 2028 (Manuka PGP)

MPI Apiculture monitoring report, 2016 *https://www.**mpi**.govt.nz/document-vault/16621*

The stampede

FIGURE 1: REGISTERED BEEKEEPING ENTERPRISES AND HIVE NUMBERS IN NEW ZEALAND[1], 2000 TO 2016



Notes

1 Registered beekeeping enterprises and hives under the National Pest Management Plan for American Foulbrood. Varroa was discovered in hives in New Zealand in 2000.

Source: AsureQuality Limited.

- The price of a hive has doubled in the last 18 months (now around $1000)
- 1 beehive for every 6 people in NZ

*https://www.**mpi**.govt.nz/document-vault/16621*

Claim jumping

- Roughly 10% of colonies (hives) are lost each season (68,000 hives)
- Approx 12% of these are due to wasps (7000 hives)
- Of these, approx 1% of loss is due to theft or vandalism (680 hives)
- 16% of large operations said they had sites overtaken or overcrowded or that they had decreased floral resource

http://www.landcareresearch.co.nz/__data/assets/pdf_file/0019/137404/bee-colony-survey-summary-2016.pdf

The Upsides…

- Encouraging planting of natives
- Production off marginal lands
- Economic benefits to small communities
- Spillover benefits such as erosion control
- Premium product
- Wider industry / supply
- Export earnings

The Downsides…

- Manuka?
- Land access disputes
- Boundary riding disputes
- Theft (408 incidents, six months to Jan) – “organised crime”
- Vandalism
- Starvation of colonies
- Other honeys

The Risks….

- Disease incidence (bees)
- Disease incidence (plants)
- Market instability
- Impacts on other species (native bees / weeds)
- Impacts on mānuka
- Offshore competition
- Native ecosystems
- Fire

Plantation vs natural stands of mānuka

- Plantation stands:
  - Cost $$ to establish
  - Low genetic diversity
  - Suited to local area?
  - Hybridisation with existing plants?
  - Early flowering*
  - **Higher UMF?**

Natural stands:

- No establishment cost
- Natural variation
- Likely suited to local conditions
- No issues with hybridism
- **UMF value?**

Mānuka is usually a successional species…

- Plants don’t live forever, production won’t be optimal forever
- If left, you’ll often get mānuka > forest
- How do we manage for honey / other products
  - Carbon credits?
  - Oils?
- Biological systems aren’t simple

So what do we actually know?

- How mānuka varies over the landscape
- Susceptibility to myrtle rust
- Impacts of bees on native pollinators
- How much manuka vs kanuka we have
- How many hives we can place in an area

So what do we actually know?

- How mānuka varies over the landscape X
- Susceptibility to myrtle rust X
- Impacts of bees on native pollinators X
- How much mānuka vs kanuka we have X
- How many hives we can place in an area X

Variation in mānuka

- Relationship to honey characteristics
- Uniqueness of local genotypes
- Impact of plantation activities
  - Flowering times
  - Disease susceptibility
  - Local populations

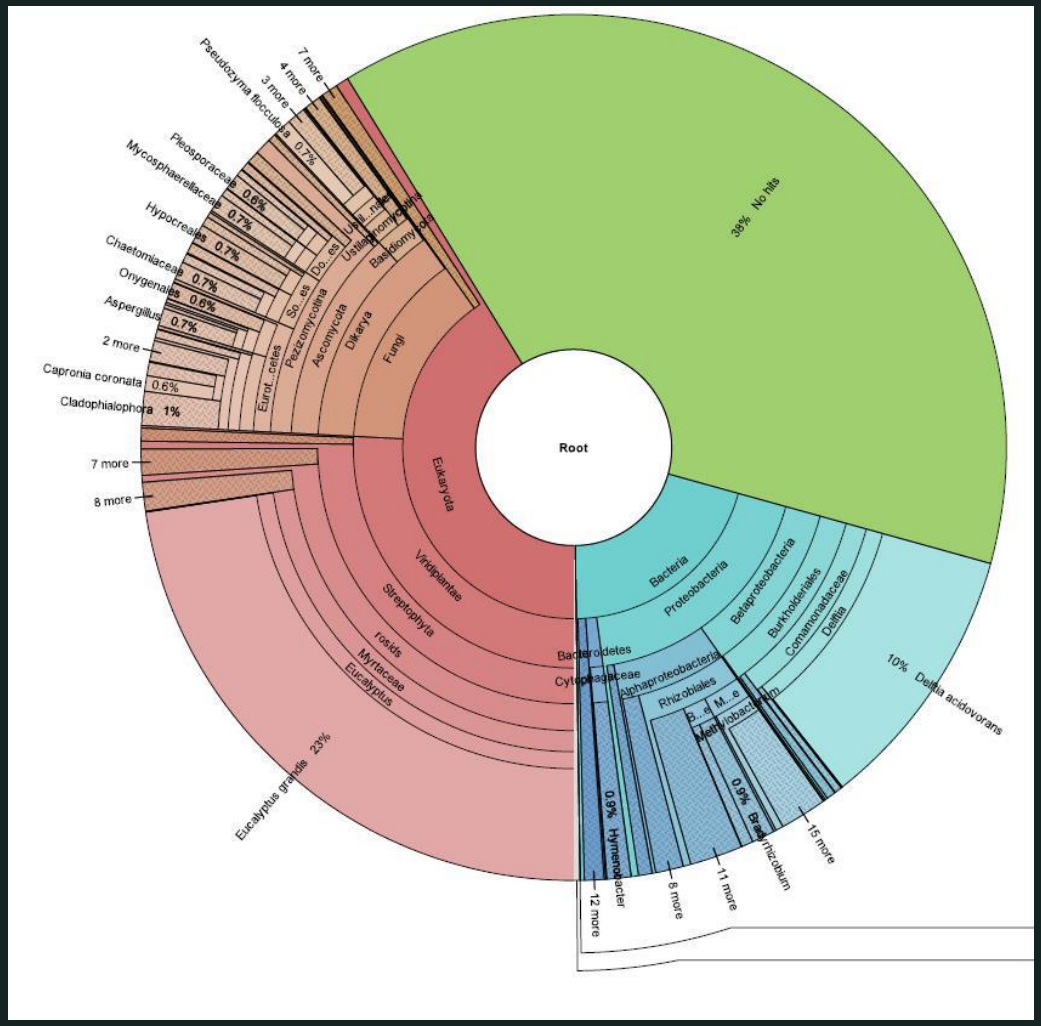
A mānuka genome

Illumina shotgun and mate-pair sequencing

N scaffolds	12,787
SUM (bp)	470,508,241
MIN (bp)	881
MEDIAN (bp)	3804
MAX (bp)	2,489,503
N50 (bp)	234,341

23% of the contigs are similar to plant sequences

297Mb of 470Mb assembly is plant (300Mb estimated by flow cytometry)



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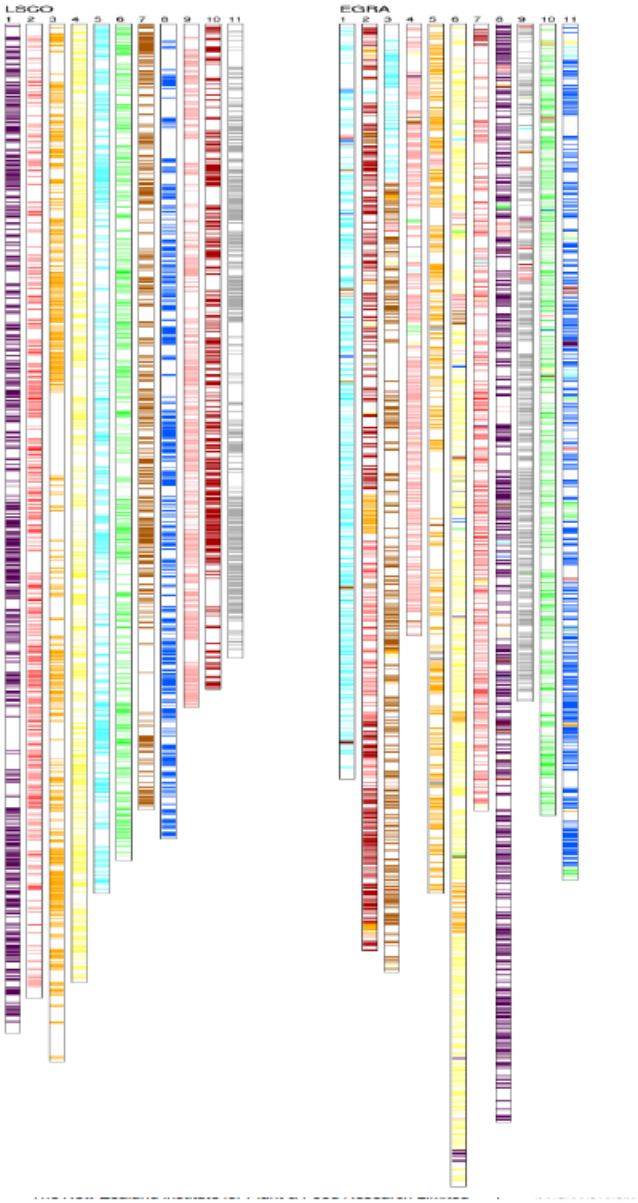
Crimson Glory v0.1 PGA versus Eucalyptus

	Manuka PGA cluster										
Eucalyptus chr	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1					X						
2										X	
3							X				
4									X		
5			X								
6				X							
7		X									
8	X										
9											X
10						X					
11								X			

Conservation of synteny (gene content within chromosome) between manuka and Eucalyptus

Renumbering of manuka assembly based on Eucalyptus chromosomes



A Landscape approach

- 19 Maori Entities
- Approx 30 samples per site, often multiple sites per Stakeholder
- Pooled samples for low-coverage genome resequencing
- Provenance, local uniqueness, traceability
- Baseline to pursue breeding?

- Beyond a taxonomic revision – industry in it's infancy – appropriate tools

So far….

- Approx 1000 samples are sequenced
- Data is being analysed
- Preparation for field season two

- But, there's suddenly a new application for this work!

Susceptibility to myrtle rust

- 3 yr, $1.5M Catalyst project, led by PFR
- Geoff Pegg, Queensland as a collaborator
- A range of myrtaceae, not just manuka
- Manuka will target those samples with genomic data from the Landscape genomics study

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- Approx 30 seeds per plant
- Can screen up to 2000 accessions per year, of 20 seeds each!
- Seedlings grown and challenged with rust
- Seed will also be banked

- Will allow us to look for QTLs for resistance

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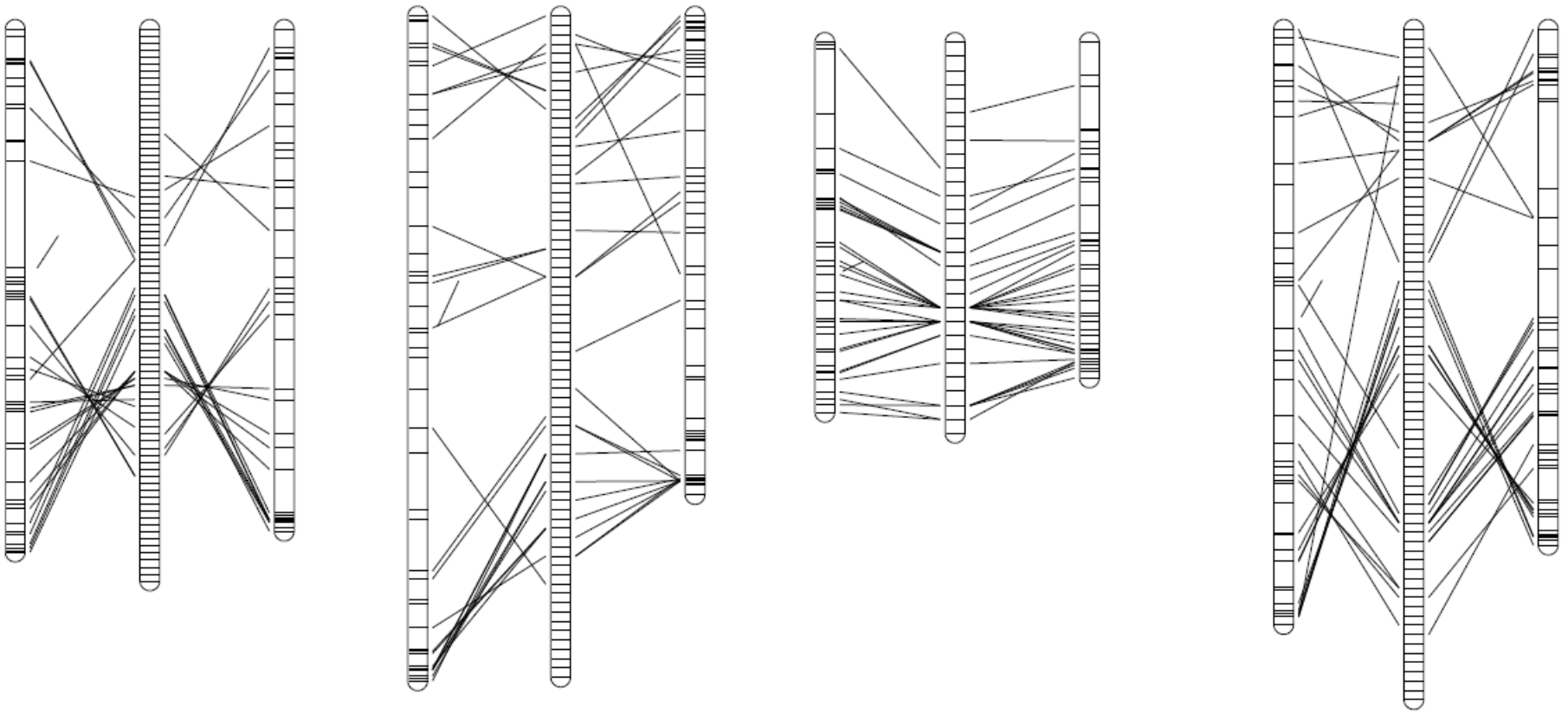
Linkage map versus PGA assembly

PGA

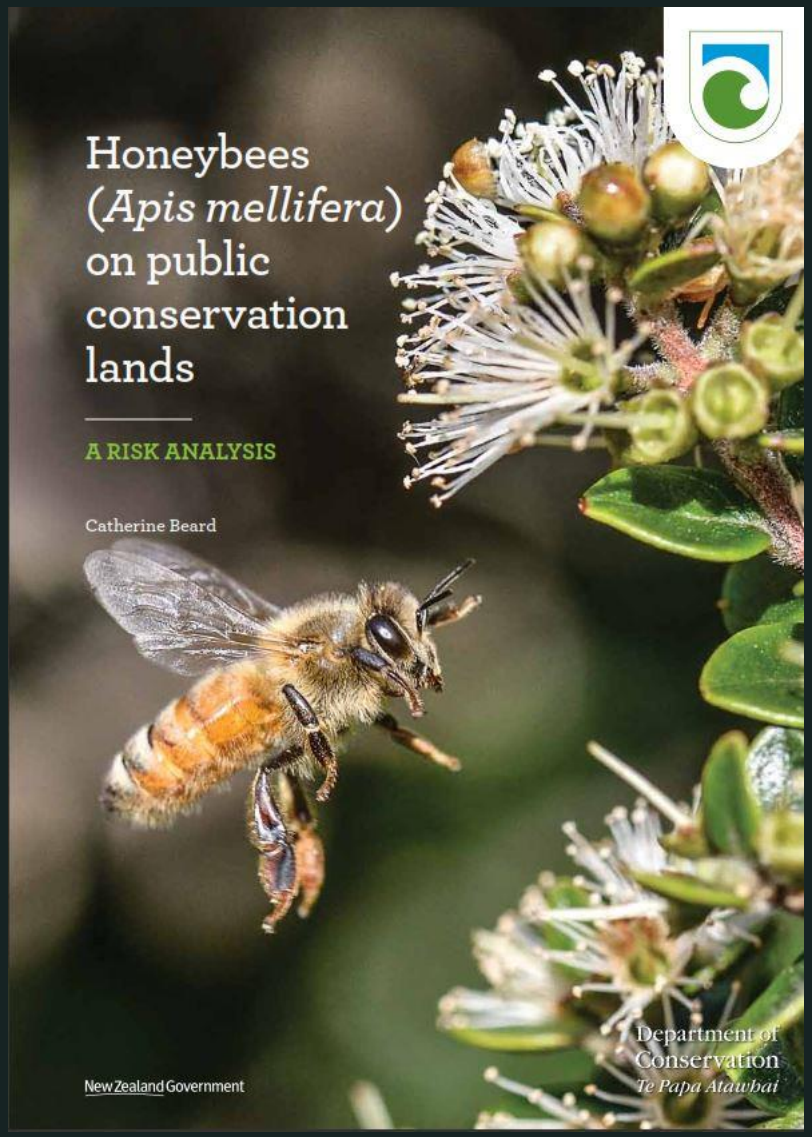
Linkage map (GBS)



Implications of myrtle rust

- How many years to impact fully realised
  - Growing tips
- What are the implications of large-scale, low variation plantations?
- What about O'hia dieback?

Impacts on native pollinators



- Work is underway
- Comparison of traditional and Next-generation methods
- Diversity of samples is staggering!

Honey bee impacts

- Malaise traps
- Samples collected, sorted, identified (above 5mm fraction)
- Metagenomics approach to compare traditional methods

One of the few systematic collections of invertebrates undertaken and scrutinised to this level

How much manuka vs kanuka we have

Why distinguish?

Land Evalulation – understanding the resource on Hapu, Iwi, Regional Scales

Optimal Beehive Placement

Understanding ecology

Why RPAS?

High Resolution – 3 cm (cf. 10m for Sentinel)
-can resolve individual flowers

Flexible deployment –
-can be scheduled around phenology

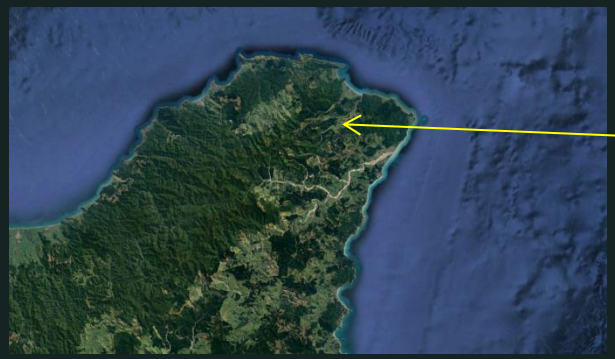
Imagery can be collected by non-specialist
-beekeepers, land owners, etc.

Provide underpinning science to validate satellite data

but …

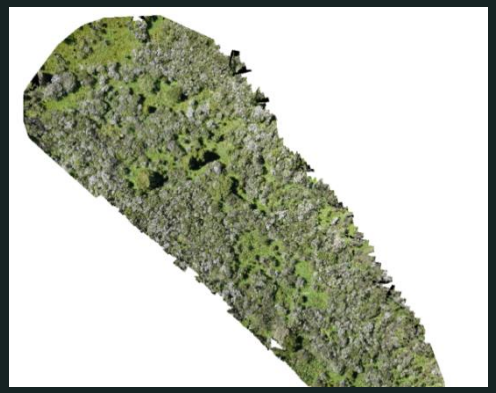
Limted extent – especially for multi rotor
– think 15 ha per set of batteries
(20 minute flight)

Distinguishing by flower



Block D7B

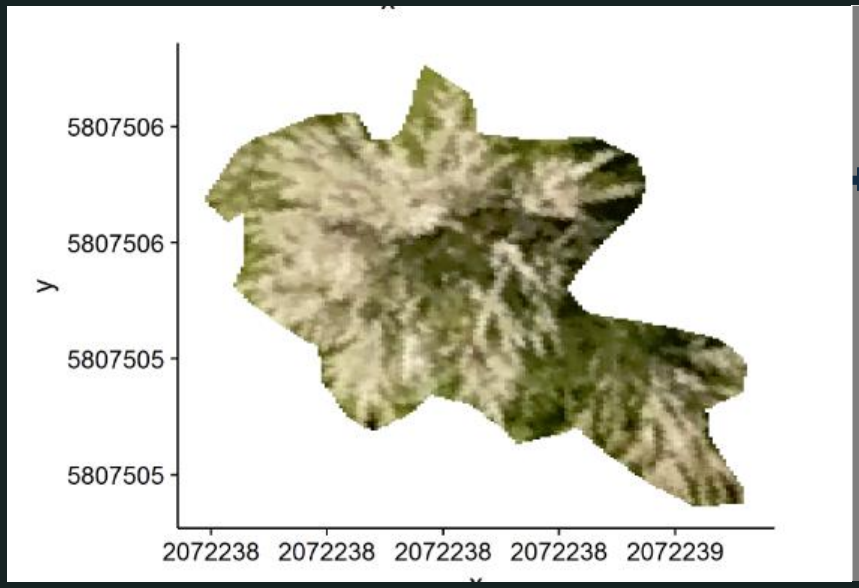
Tibbles Property near Tikitiki

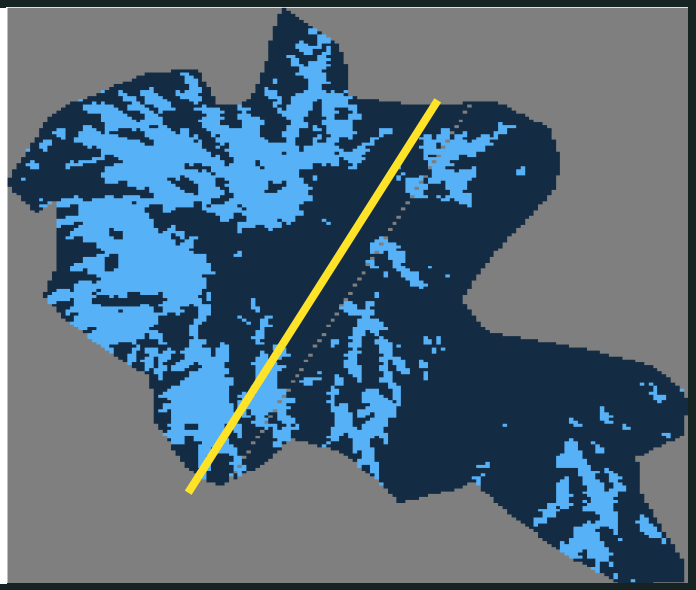


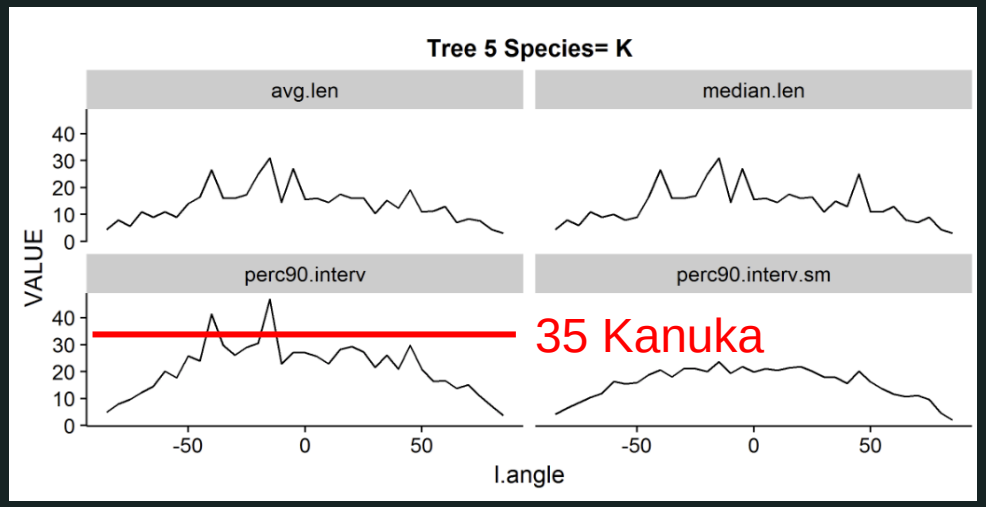
The imagery

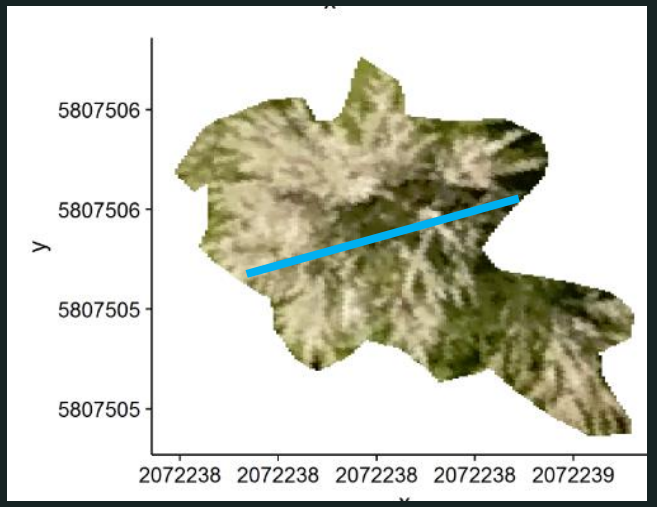
Closer

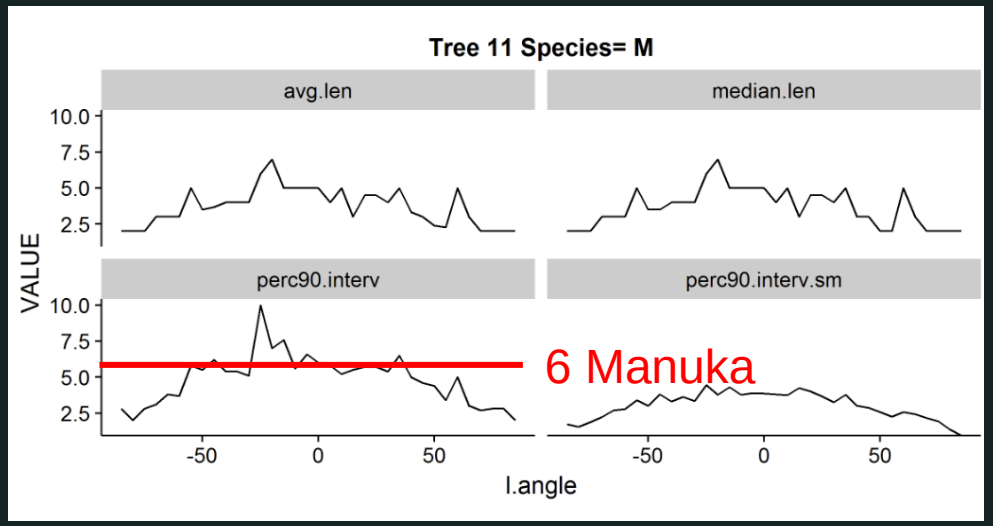
Look for contiguous Intervals

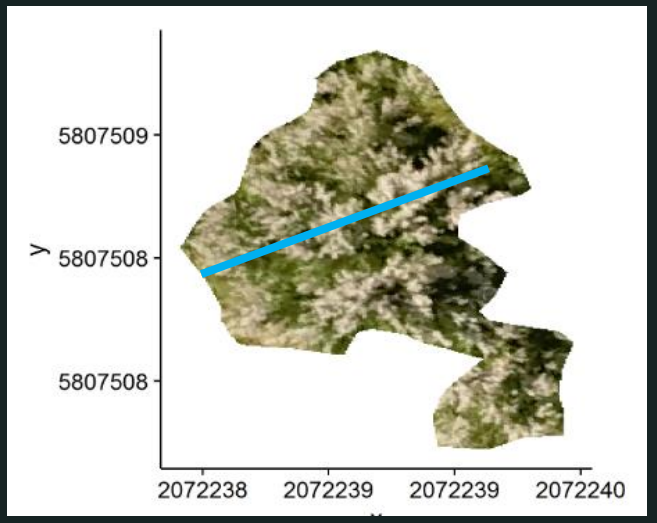






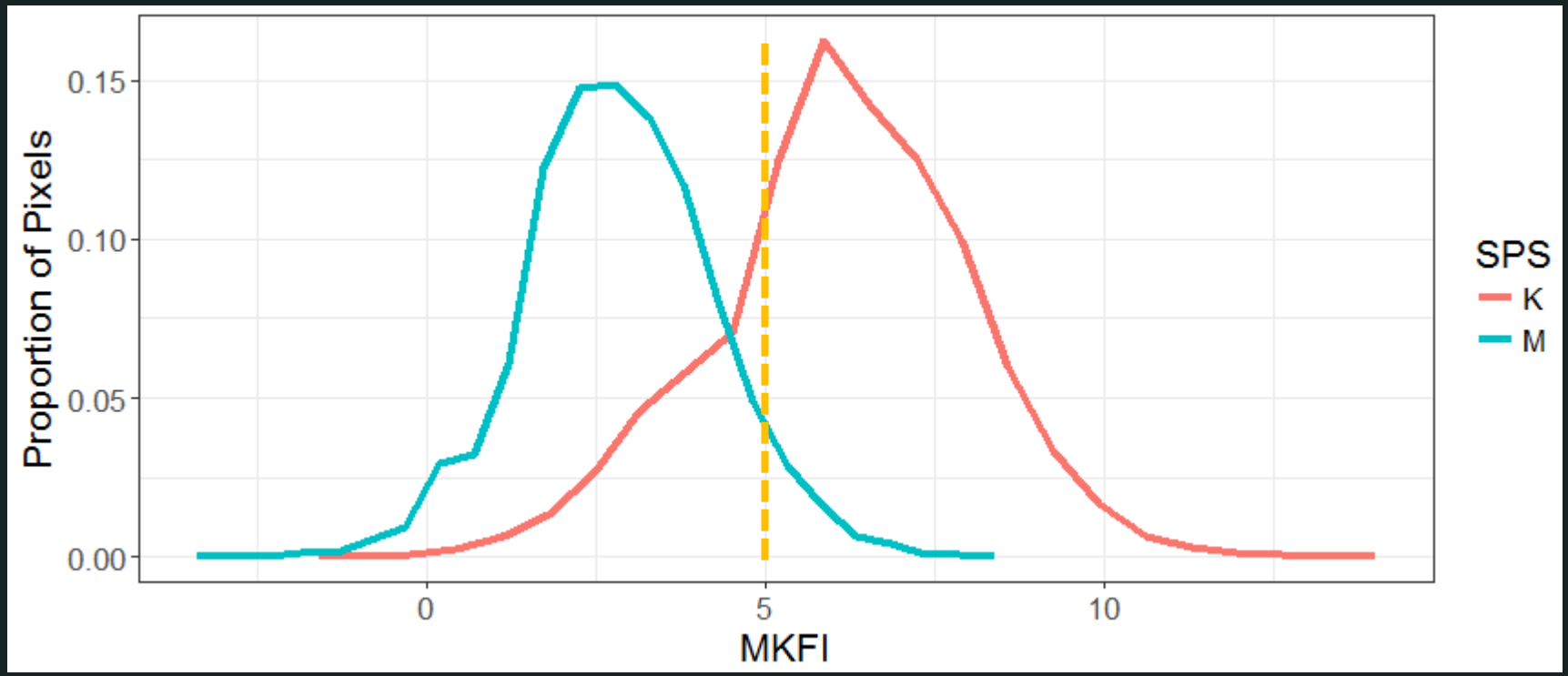






The “streakiness” index

The Manuka-Kanuka Flower Index (MKFI)



If peak MKFI < 5, then species is Manuka, otherwise Kanuka

90% Accurate on Test Data Set

Future Directions

Further validation of M-K Distinction Indices

Start using object recognition software (E-cognition) to do hierarchical segmentation into objects (trees, then flowers)

Explore the use of mutispectral / hyperspectral techniques in combination with object-based techniques

Possible outcome

A “methodological pipeline” that can be deployed routinely by end-users

How many hives we can place in an area?

- If you double the hives do you halve the yield?
  - No, it's likely worse than that
- Hive losses due to wasps on the rise
  - Likely already compromised
- Boundary stacking

Limiting resources for honey bees

Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Spring b uild up			Clover & Kiwifruit pollination		Summer Honey Flow		Autumn preparation for winter			Over-wintering		

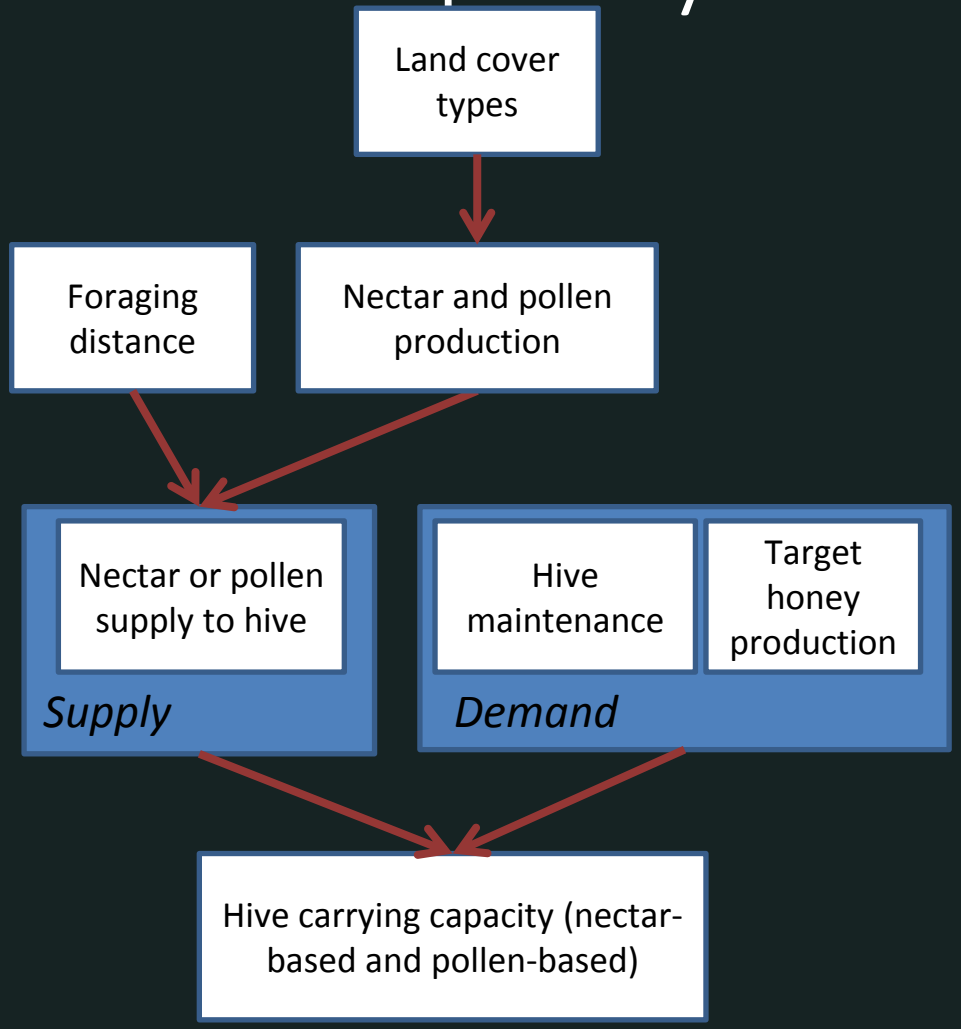
Protein Rich Pollen

Target Crop for pollination

Good Honey Plants

Protein Rich Pollen

Spatial framework for hive carrying capacity



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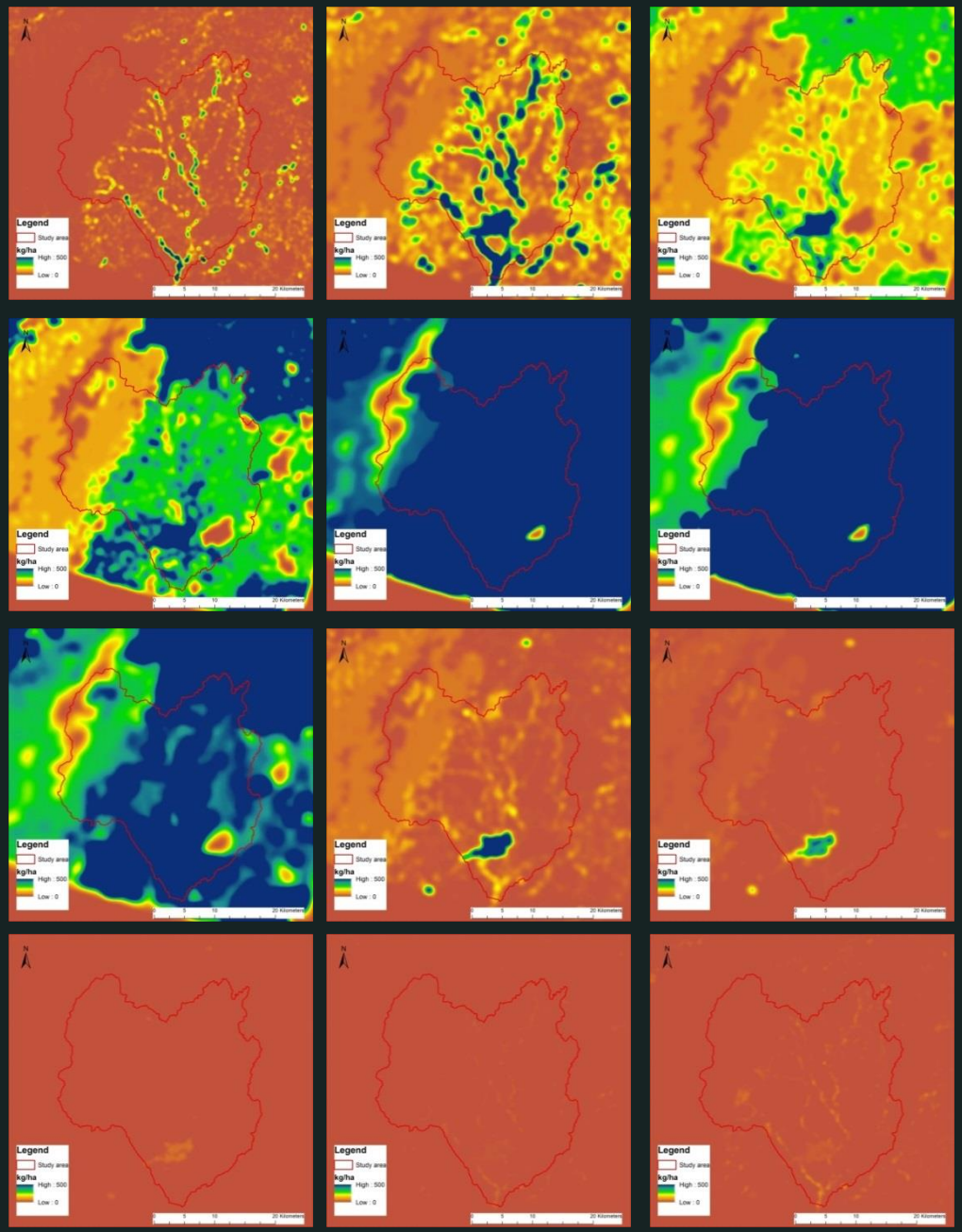
Nectar supply through the year



August – October (spring)
build-up

November – January (summer)
Honey flow, target crop
for pollination

February – April (autumn)
Preparation for winter
High demand for nectar

May – July (winter)
Over-wintering

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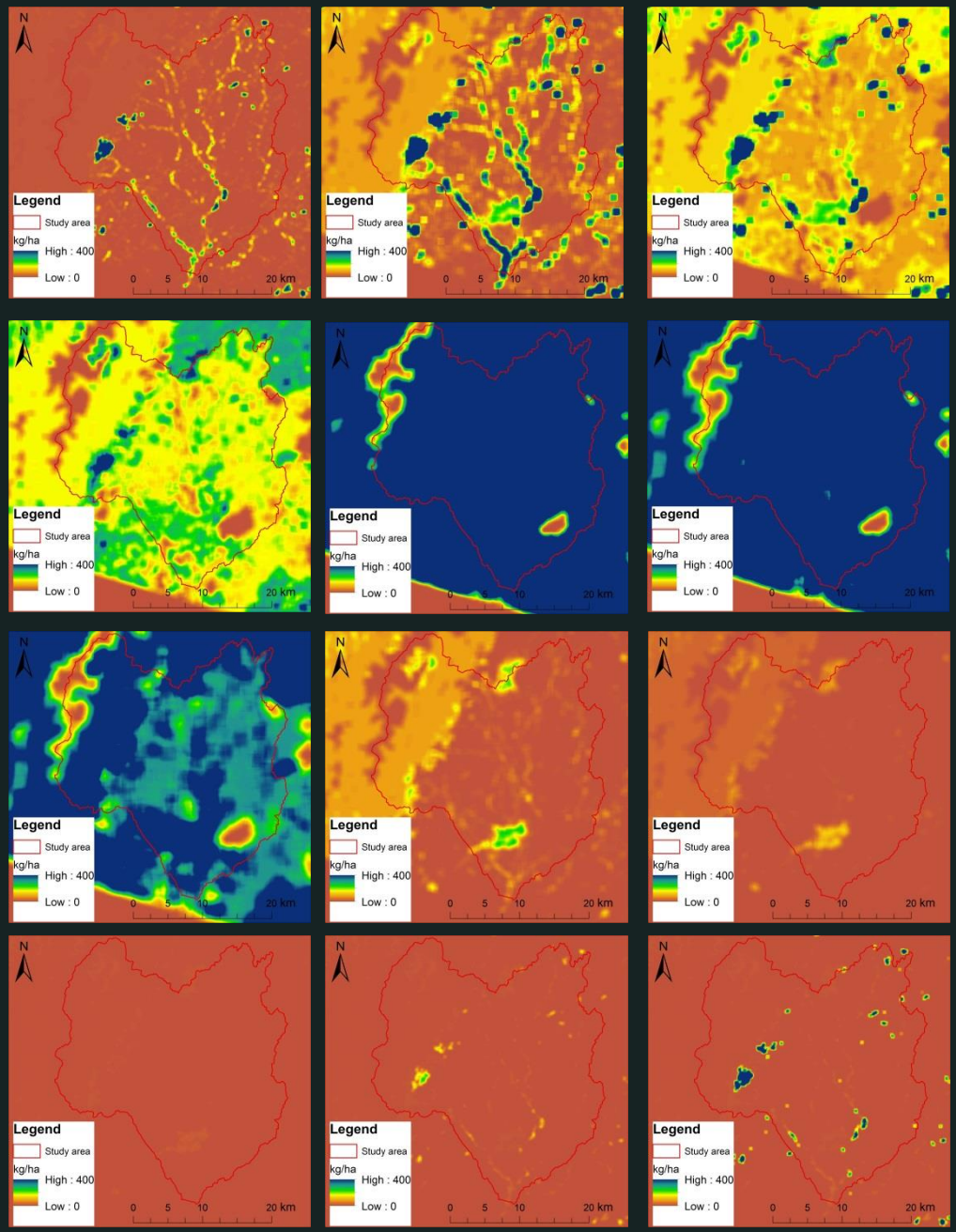
Pollen supply through the year



August – October (spring)
build-up – high demand for pollen

November – January (summer)
Honey flow, target crop for pollination

February – April (autumn)
Preparation for winter

May – July (winter)
Over-wintering

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What we can answer

- Where and how many hives can we leave all year-round?
- Which areas are pollen- or nectar-limited?
- How many hives can we have for summer honey collection?
- What is the benefit of restoration planting for floral resources?

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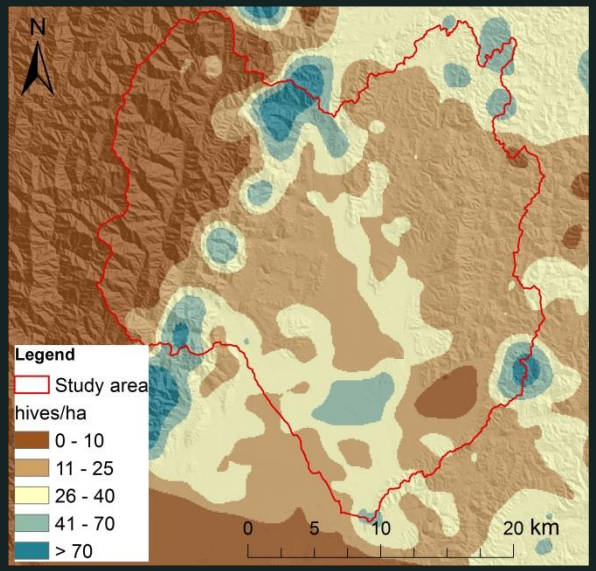
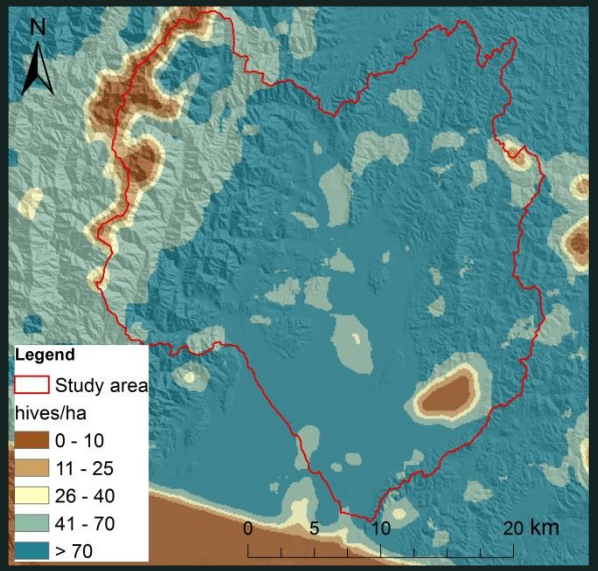
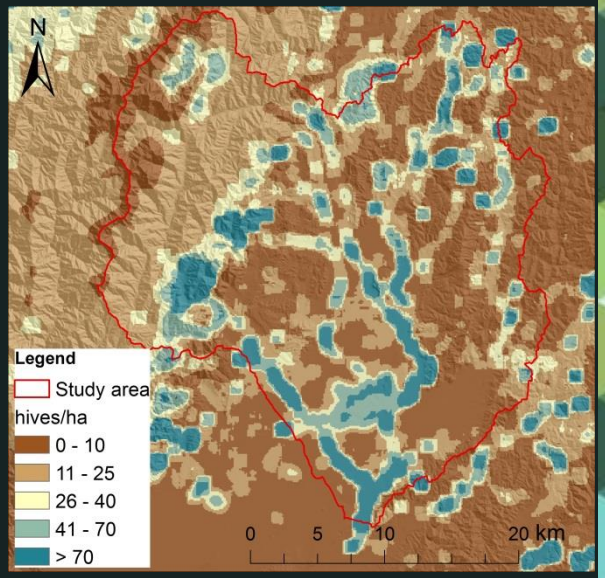
Where and how many hives can we leave all year-round?



Based on nectar availability for the year



Based on pollen availability for the year



Based on pollen availability for September

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Next steps…

- Improving biological resolution of nectar and pollen availability (empirical, catchment-scale fieldwork);
- Determining environmental drivers of nectar and pollen production (flowering records, citizen science, climatic records…);
- Regional scale management by producers for sustainable honey industry

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The Industry

- Fantastic opportunity
  - Regional growth
  - Marginal Lands
  - Ecosystem services

Most exciting opportunity from a native plant for 70 years?

- Industry in it's infancy
  - Former cottage industry
  - Production approaches applied, but with limited underlying knowledge base
  - Need to walk before we run

- Market is easily damaged, not quickly repaired
  - Possibly a bit like the environment?

So what do we actually know?

- How mānuka varies over the landscape
- Susceptibility to myrtle rust
- Impacts of bees on native pollinators
- How much mānuka vs kanuka we have
- How many hives we can place in an area

Acknowledgements

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