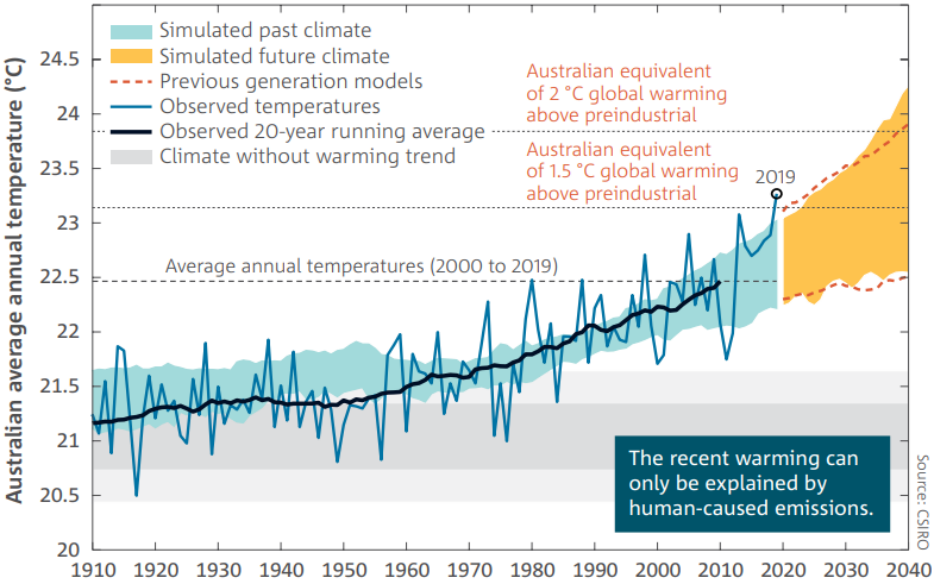
Climate and anthropogenic pressures on honeybee forage

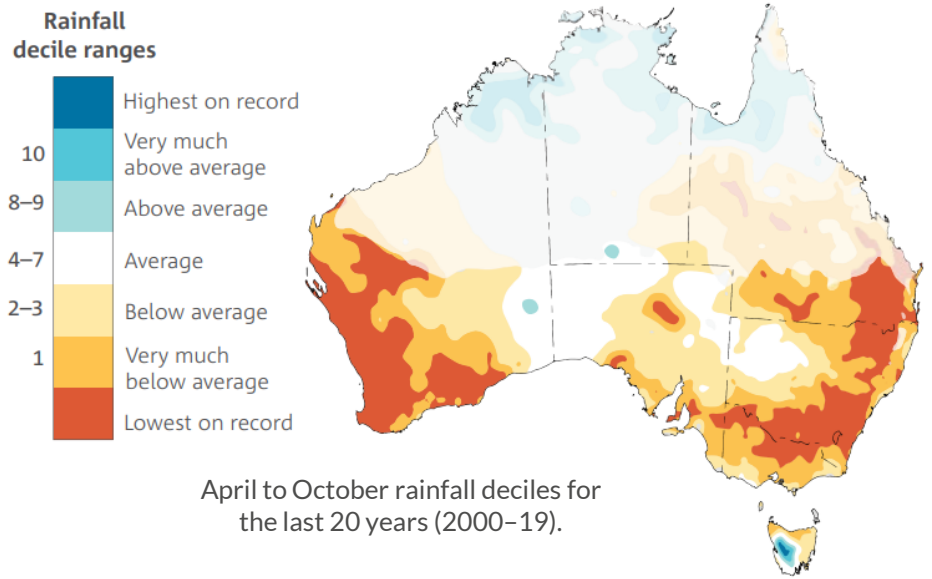
CRCHBP
HONEY BEE PRODUCTS

THE UNIVERSITY OF WESTERN AUSTRALIA

Australian Government
Department of Industry, Science, Energy and Resources

Business Cooperative Research Centres Program





April to October rainfall deciles for the last 20 years (2000–19).

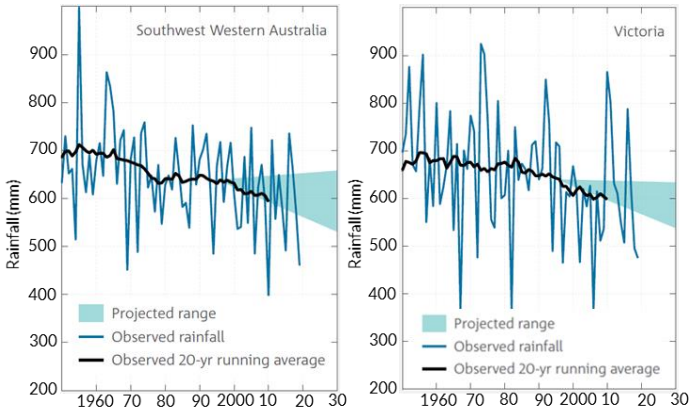
Fewer tropical cyclones but more intense.

Heavy rainfall to become more intense.

Cool season rainfall to decline in south and eastern Australia.

2019 was hottest year on record – to become average with 1.5C global increase.

Longer fire season and more dangerous fire weather.



What does climate change mean for honeybee resource availability – what resources are we talking about?

Coast beard-heath

- Leucopogon allittii
- Leucopogon parviflorus
- Leucopogon polymorphus

Red gum

- Corymbia ficifolia
- Eucalyptus camaldulensis

Salmon gum

- Eucalyptus salmonophloia
- Eucalyptus lane-poolei

In WA 70 out of 284 have changed name

1904
- *Eucalyptus accedens* W.Fitzg. (Powderbark Wandoo)

1934
- *Eucalyptus wandoo* Blakely (Wandoo)
- *Eucalyptus wandoo* Blakely subsp. *Wandoo*

1991
- *Eucalyptus wandoo* subsp. *pulverea* Brooker & Hopper
- *Eucalyptus capillosa* Brooker & Hopper
- *Eucalyptus capillosa* Brooker & Hopper subsp. *Capillosa* (Wheatbelt Wandoo)
- *Eucalyptus capillosa* subsp. *polyclada* Brooker & Hopper (Mallee Wandoo)
- *Eucalyptus nigrifunda* Brooker & Hopper (Desert Wandoo)
- *Eucalyptus livida* Brooker & Hopper (Mallee Wandoo)
- *Eucalyptus lane-poolei* Maiden (Salmonbark Wandoo)

2019
- *Eucalyptus loxophleba* × *wandoo*

Location-based information assists beekeepers to decide where & when to locate their hives.

Flowering times

- Month
- Intensity

Spatial data are mapped, stored & queried within the database.

Flora availability

- Species
- Flower
- Colour
- Bud
- Fruit

Honey quality & quantity

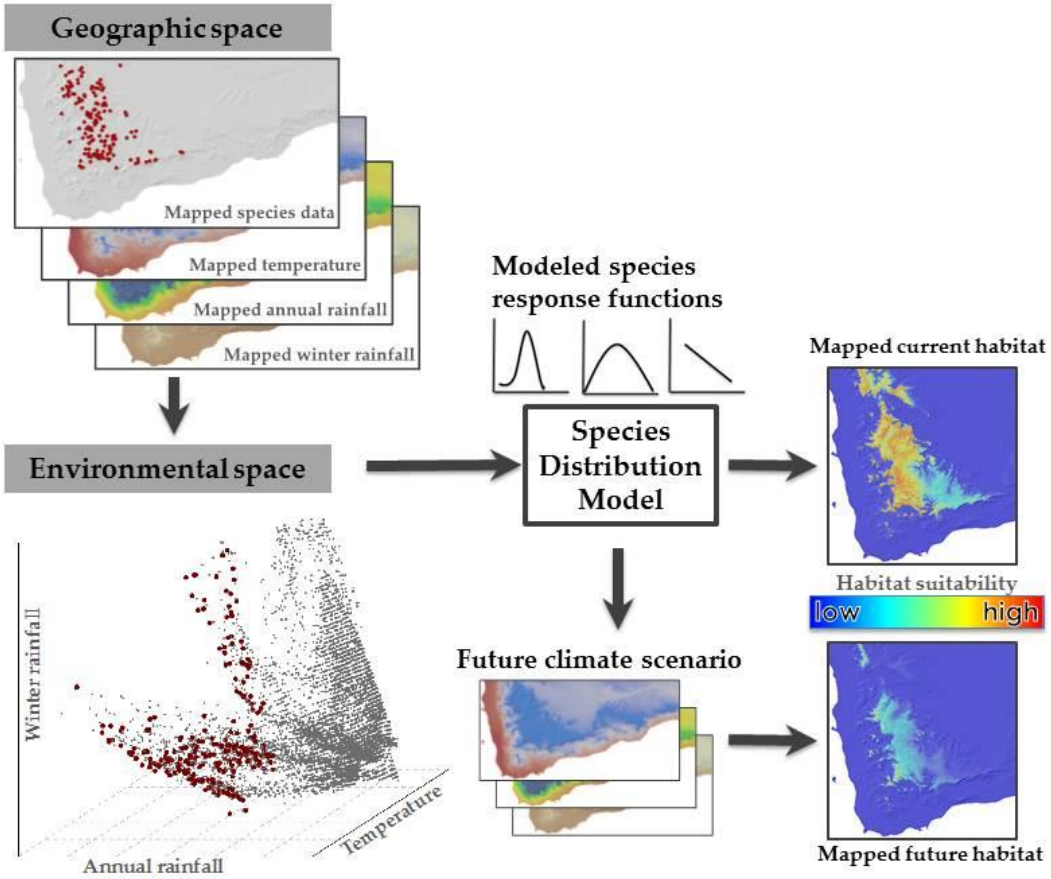
- Pollen
- Nectar

A **melliferous floral database** which can be geographically linked with additional **site information** such as apiary permits, fire activity, climate & soil characteristics & more.

- Traceability
- Accessibility
- Viability

Database

Species Distribution Modelling



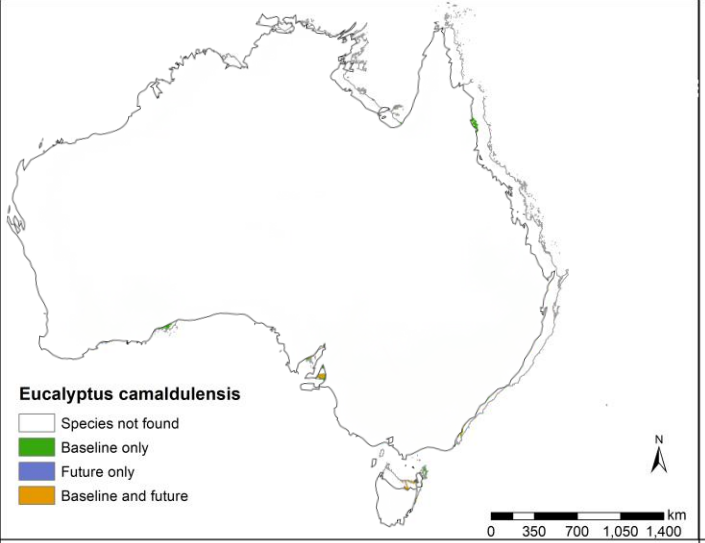
https://www.umces.edu

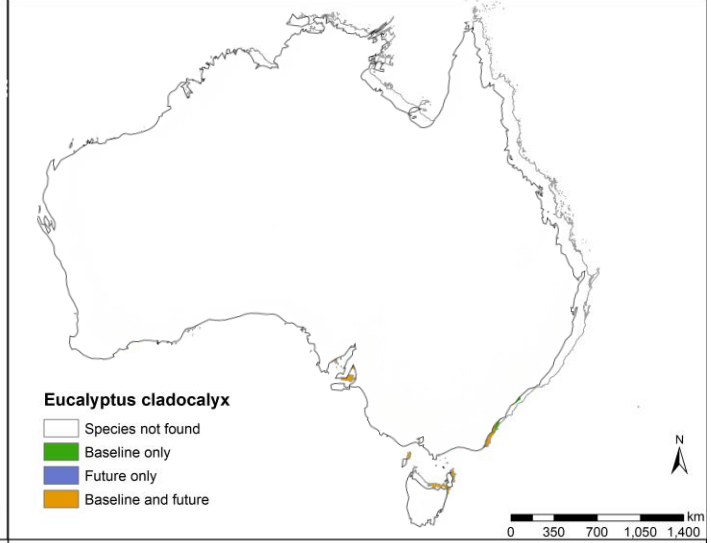
Species data:
Atlas of Living Australia

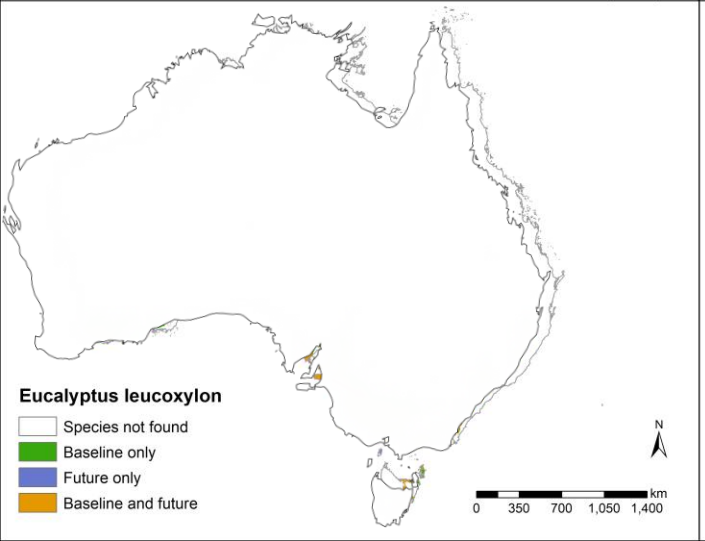
Climate data:
Isothermality - temperature oscillation
Max Temp. of Warmest Month
Mean Temp. of Coldest Quarter
Annual_Precipitation
Precipitation_of_Wettest_Quarter
Precipitation_of_Driest_Quarter

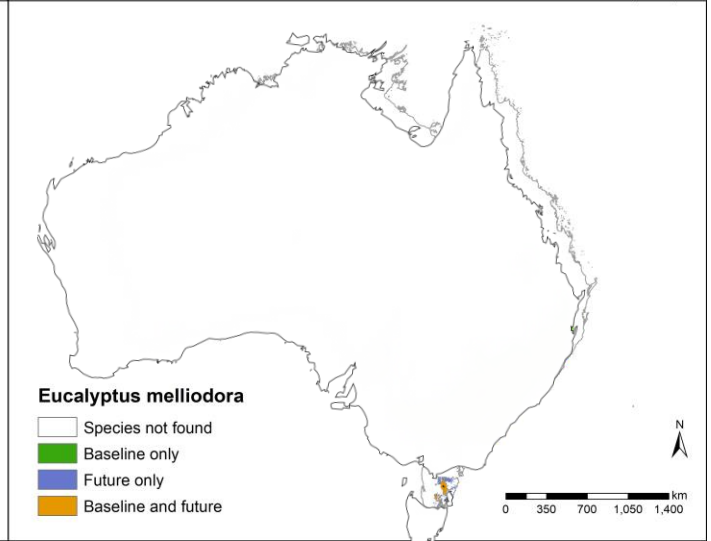
Vegetation mask:
National Vegetation Information System

Moderate emission scenario
Representative Concentration Pathway (RCP) 6.0 for the Global Climate Model (GCM) CSIRO Mk3 for the year 2055









E. camaldulensis: (river red gum/red gum/murray red gum/centralian river red gum/flooded gum):

E. cladocalyx:

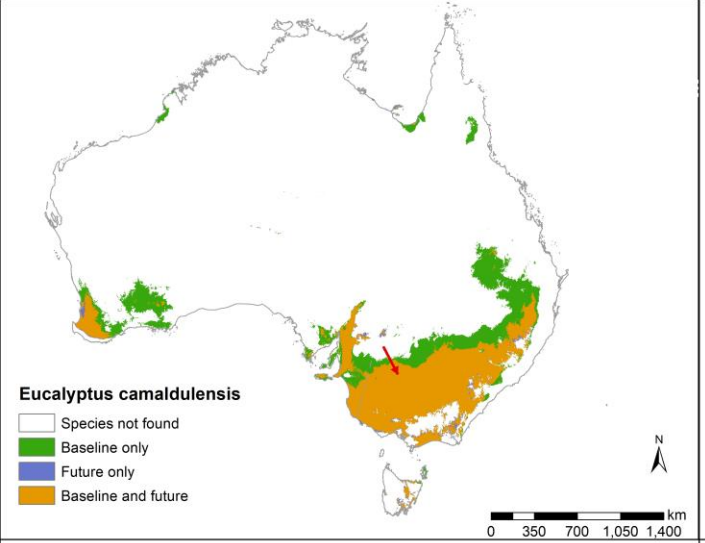
(Sugar gum):

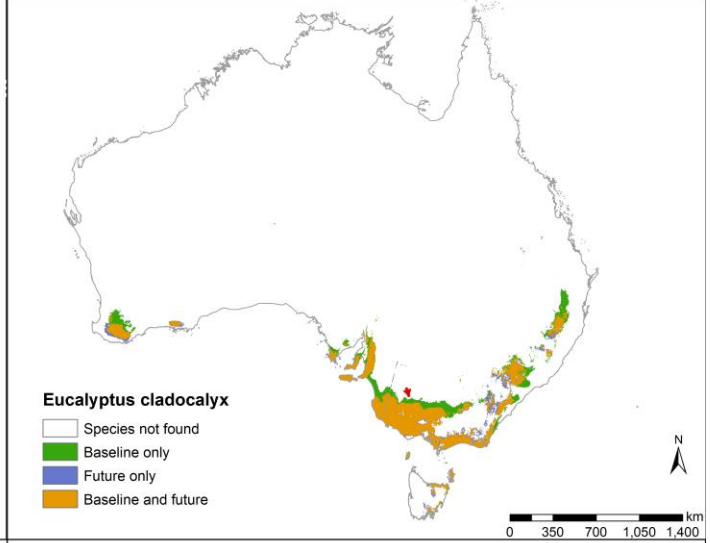
E. leucoxylon subsp. pruinosa:

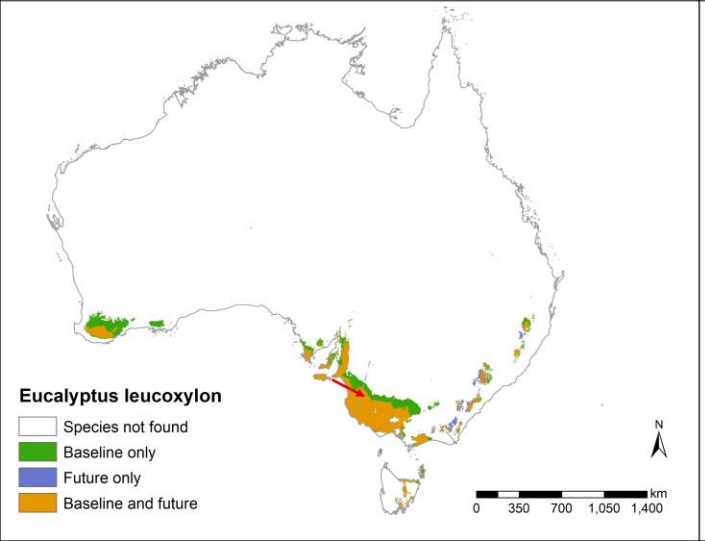
(yellow gum/blue gum/white iron bark)

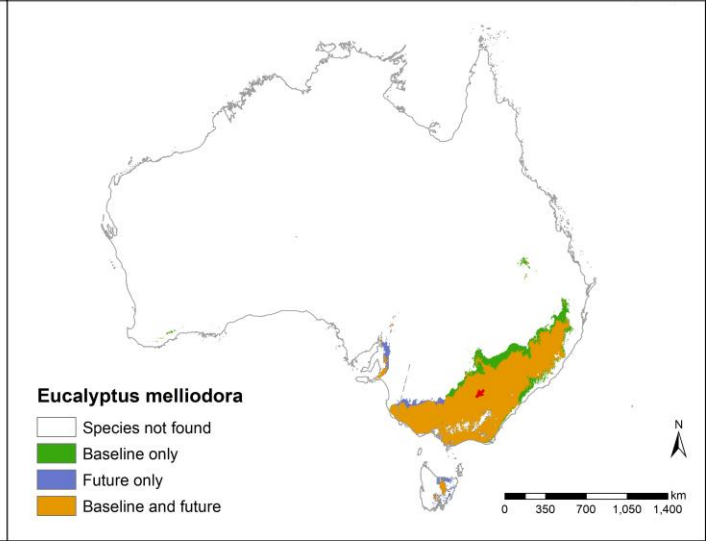
E. melliodora:

(yellow box, honey box or yellow ironbark):









E. camaldulensis:

B – 1053,693 km^2
F – 667,143 km^2
FC – 306,054 km^2

E. cladocalyx:

B – 330,651 km^2
F – 273,483 km^2
FC – 43,110 km^2

E. leucoxylon subsp. pruinosa:

B – 288,990 km^2
F – 198,747 km^2
FC – 39,942 km^2

E. melliodora:

B – 536,742 km^2
F – 491,139 km^2
FC – 59,436 km^2

Beekeepers make cost-effective decisions on where & how to place beehives for foraging a diverse landscape.

Agents

An agent-based model assesses beekeeper & hive mobility between forage locations based on decision rules.

Future forage availability under a changing climate & the implications for beekeeper migration are predicted.

Distance travelled

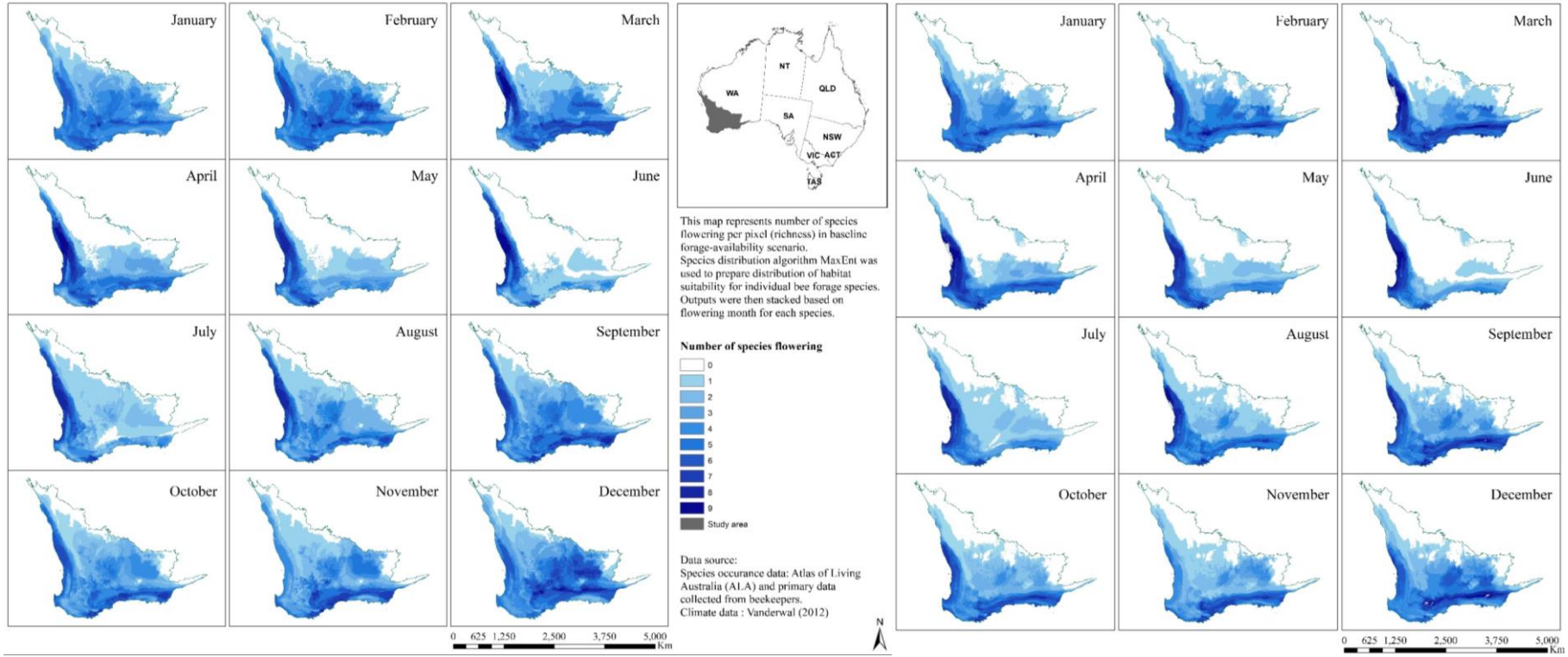
Sites harvested

Frequency visited

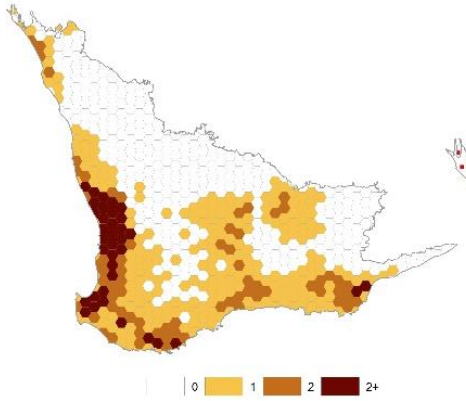
Tested in Western Australia where the distances & frequency of hive migration will increase & shift in an east direction.

Baseline

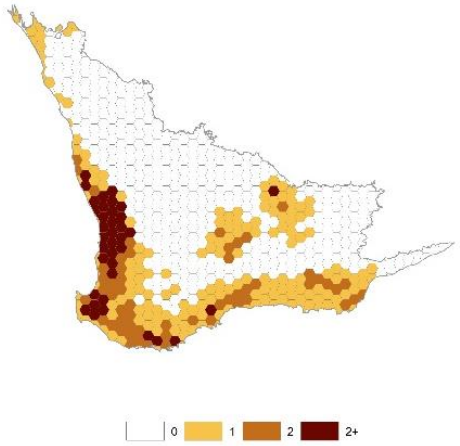
Future



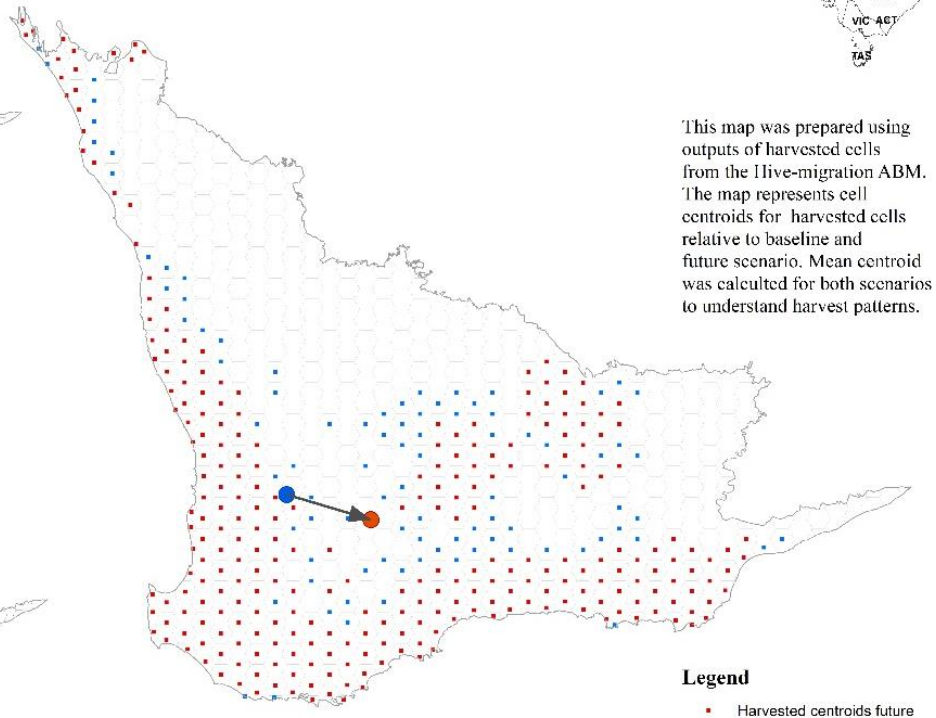
Patel et al. in review)



Harvested forage cells - baseline



Harvested forage cells - future



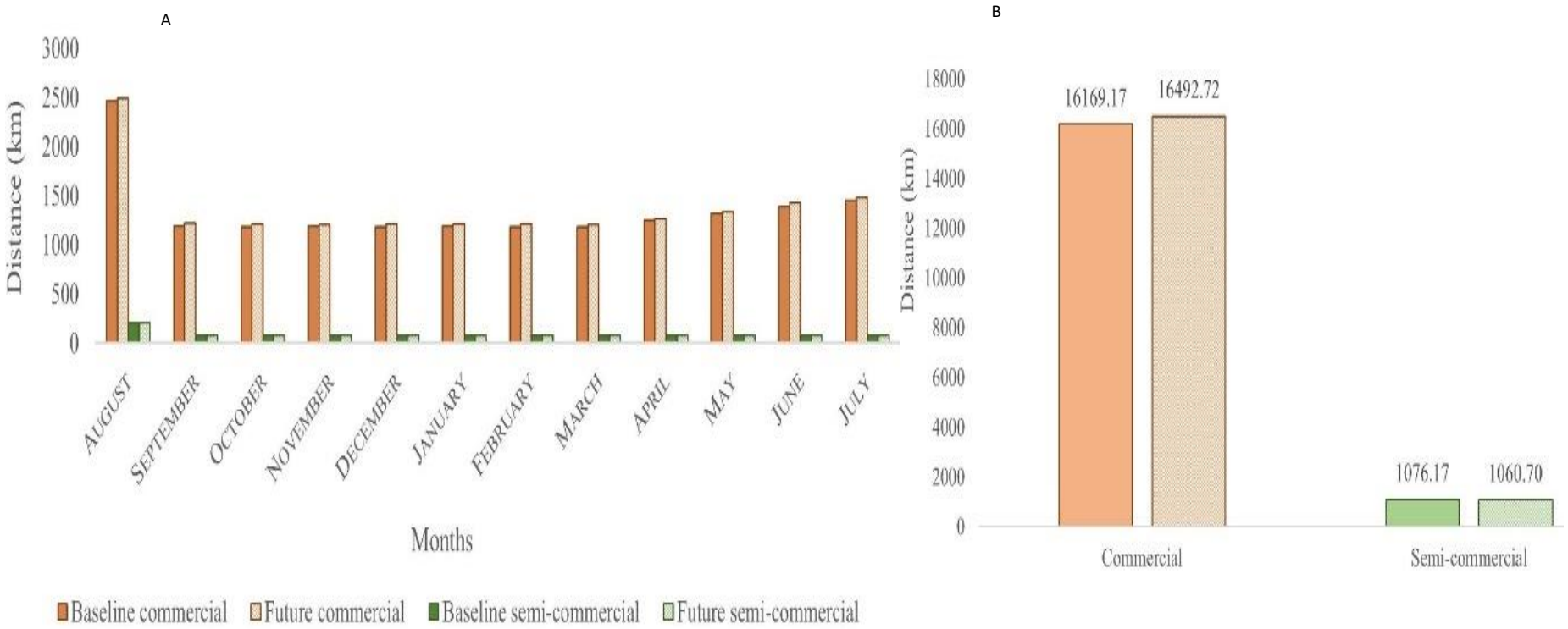
This map was prepared using outputs of harvested cells from the Hive-migration ABM. The map represents cell centroids for harvested cells relative to baseline and future scenario. Mean centroid was calculted for both scenarios to understand harvest patterns.

Legend

- Harvested centroids future
- Harvested centroids baseline
- Mean centroid baseline
- Mean centroid future
- Centroid Shift
- Hexgrid 30km
- Study area

Patel et al. in review)

Climate impacts on travel distance



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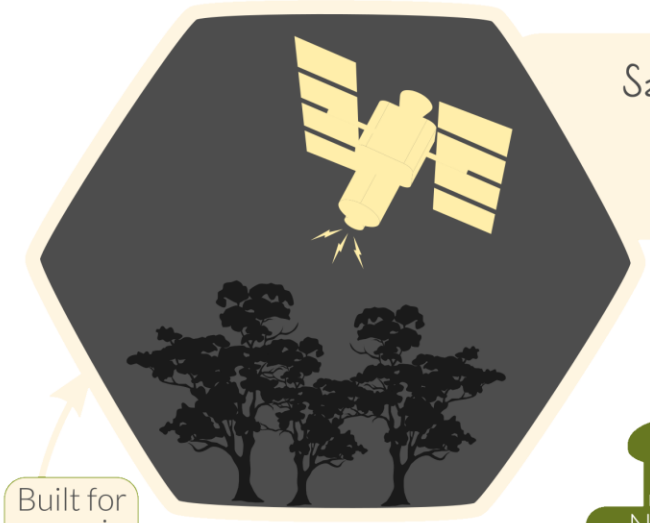
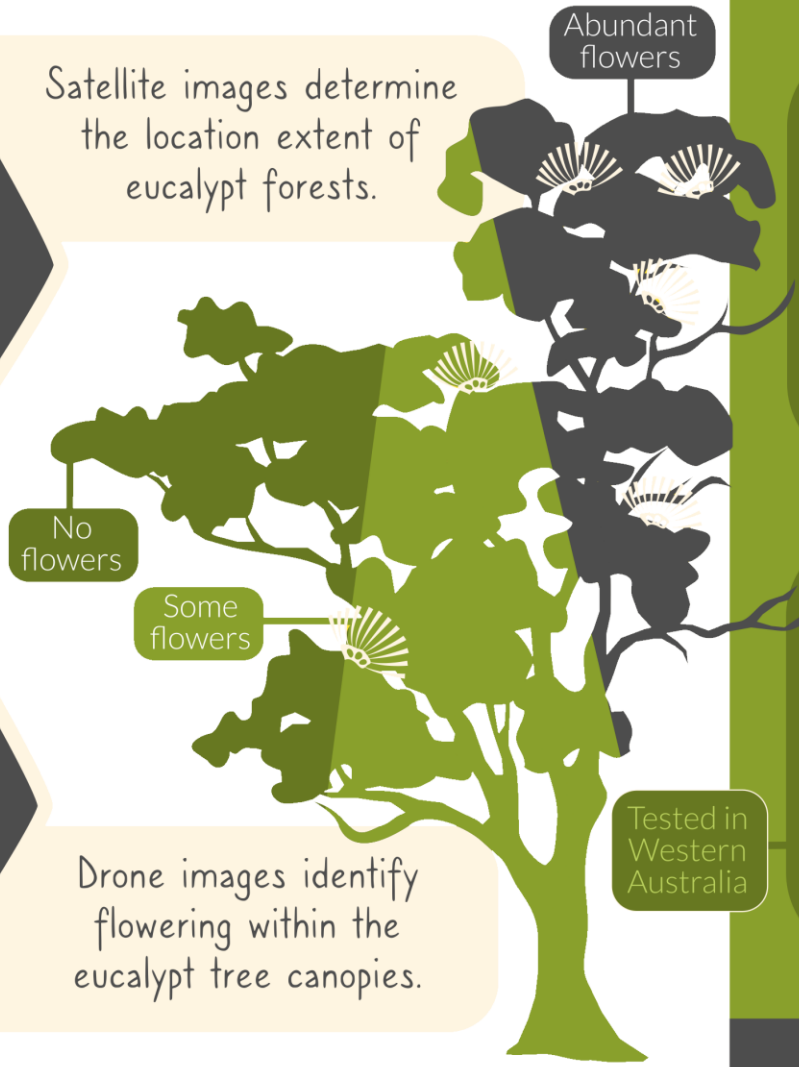


Built for marri forest

Satellite images determine the location extent of eucalypt forests.

Drone images identify flowering within the eucalypt tree canopies.

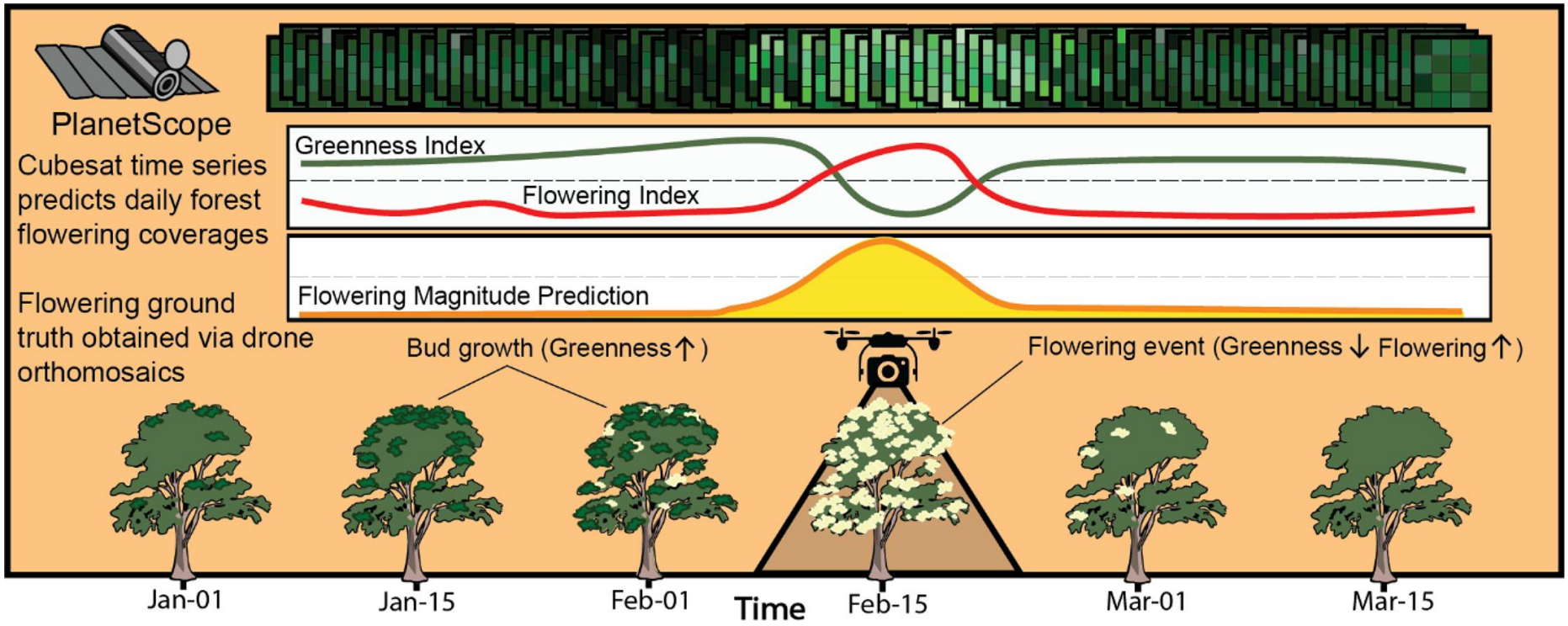


Indices detect green vegetation & cream-coloured flowers to create a flowering footprint.

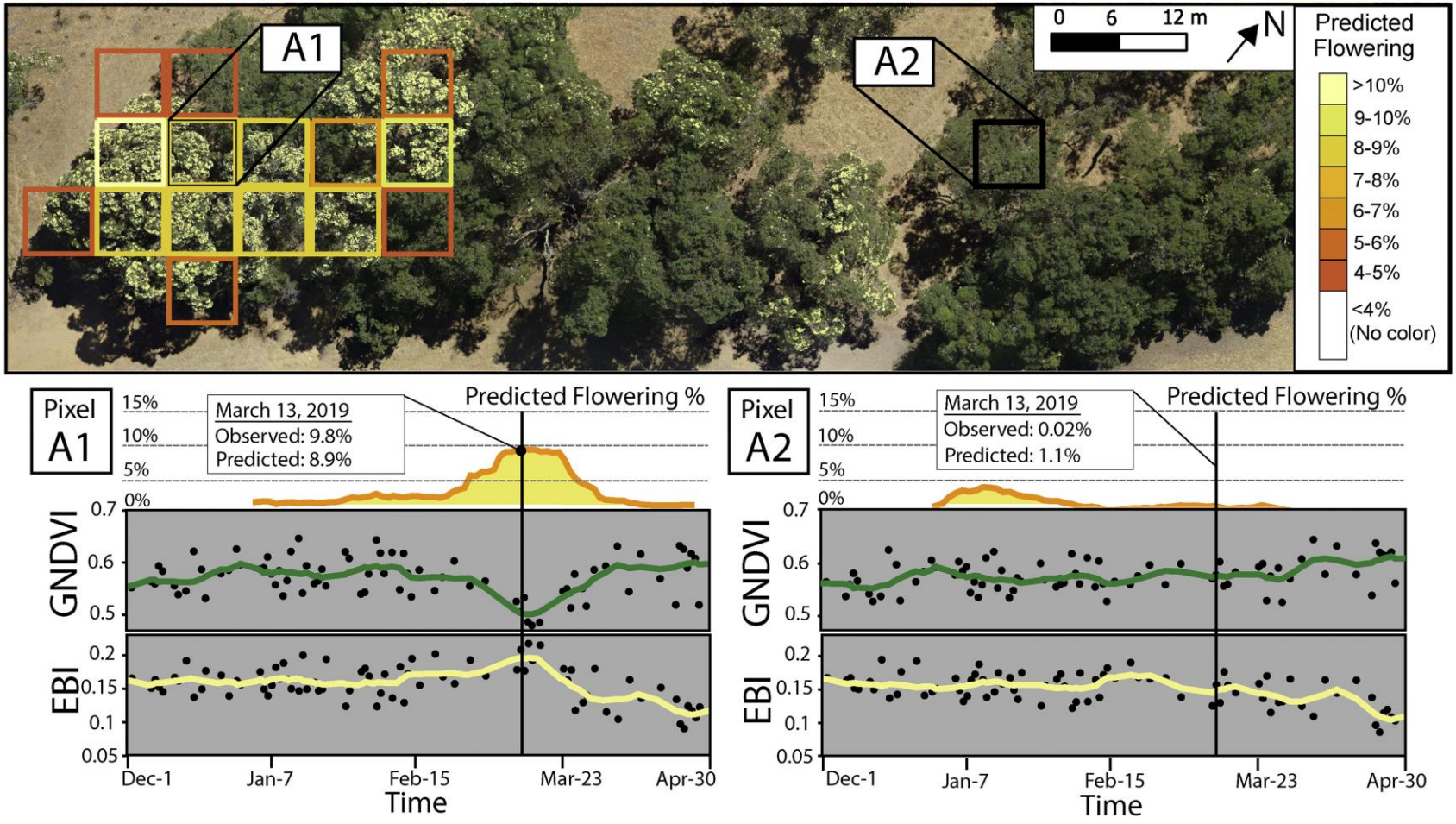
TIME SERIES

A machine learning model predicts daily amounts of flowering through season.

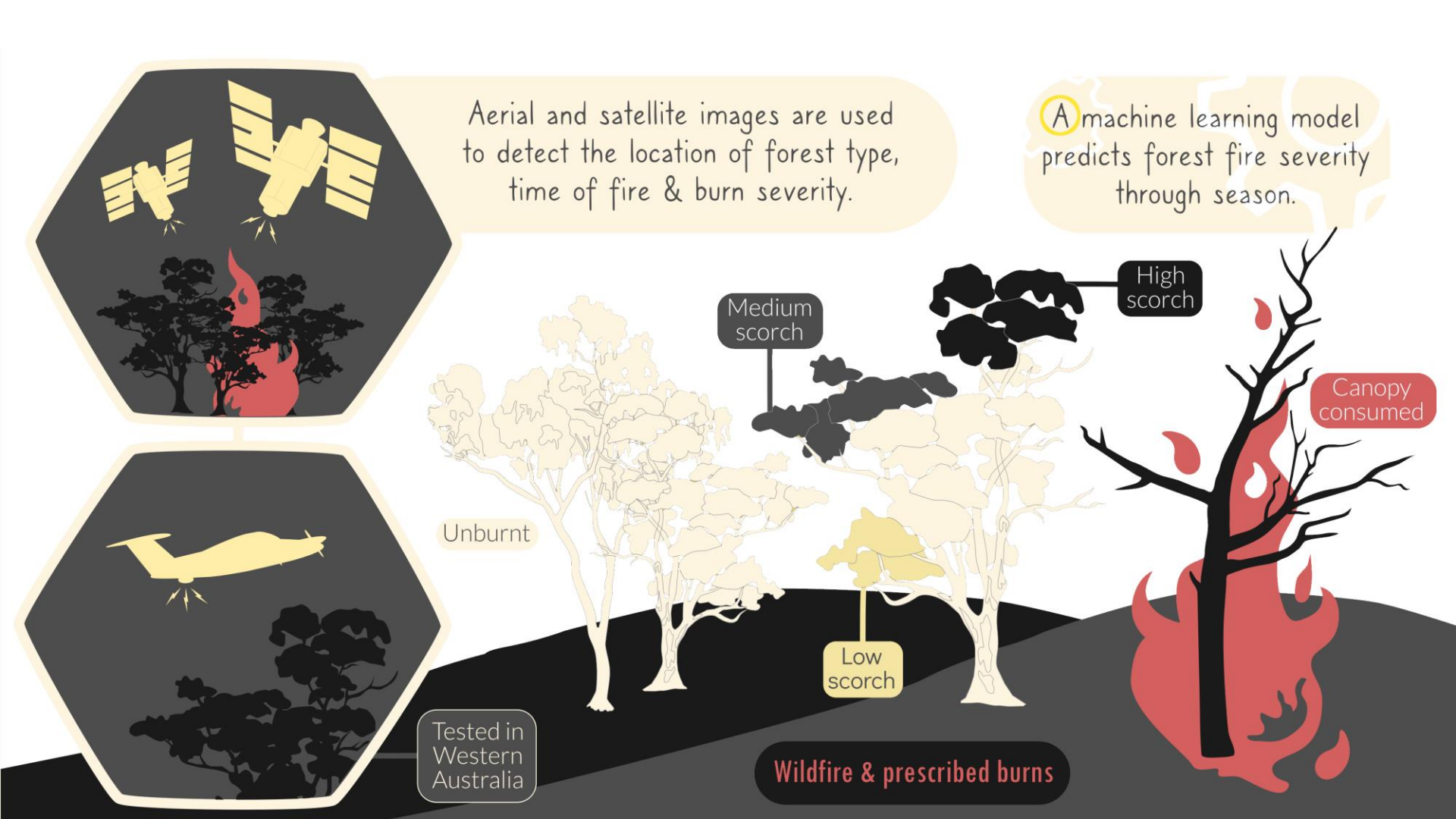
Satellite prediction of forest flowering phenology



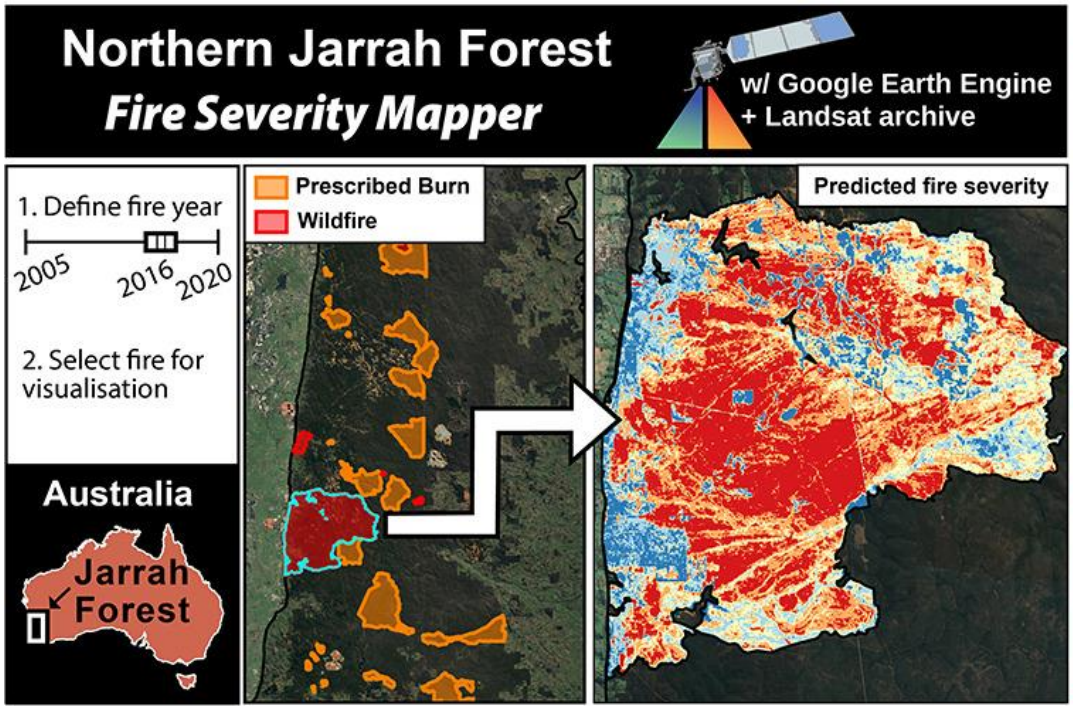
Dixon et al., 2021

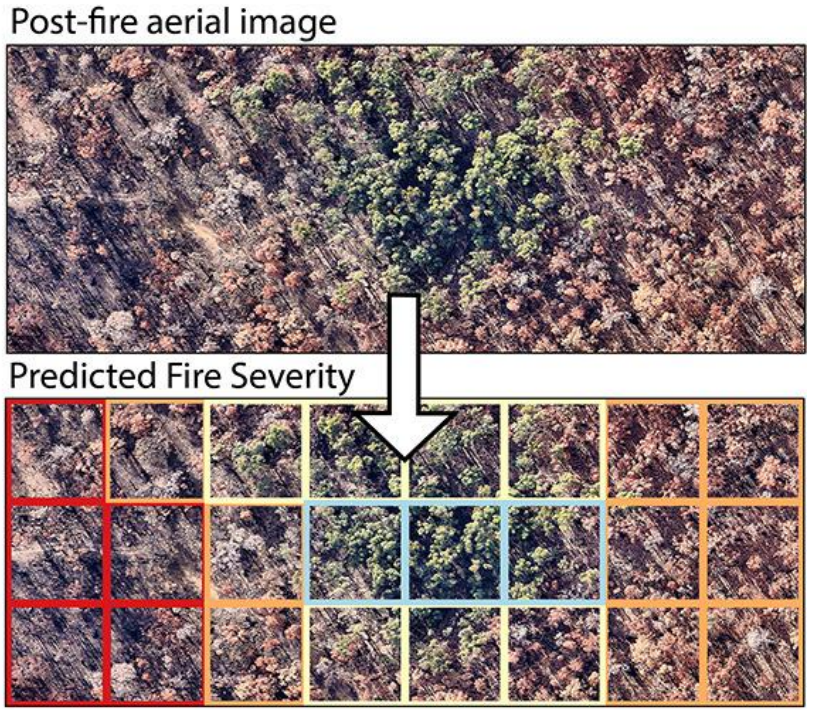


Dixon et al., 2021


Aerial and satellite images are used to detect the location of forest type, time of fire & burn severity.
A machine learning model predicts forest fire severity through season.
High scorch
Medium scorch
Canopy consumed
Unburnt
Low scorch
Tested in Western Australia
Wildfire & prescribed burns

Regional-scale fire severity mapping of Eucalyptus forests





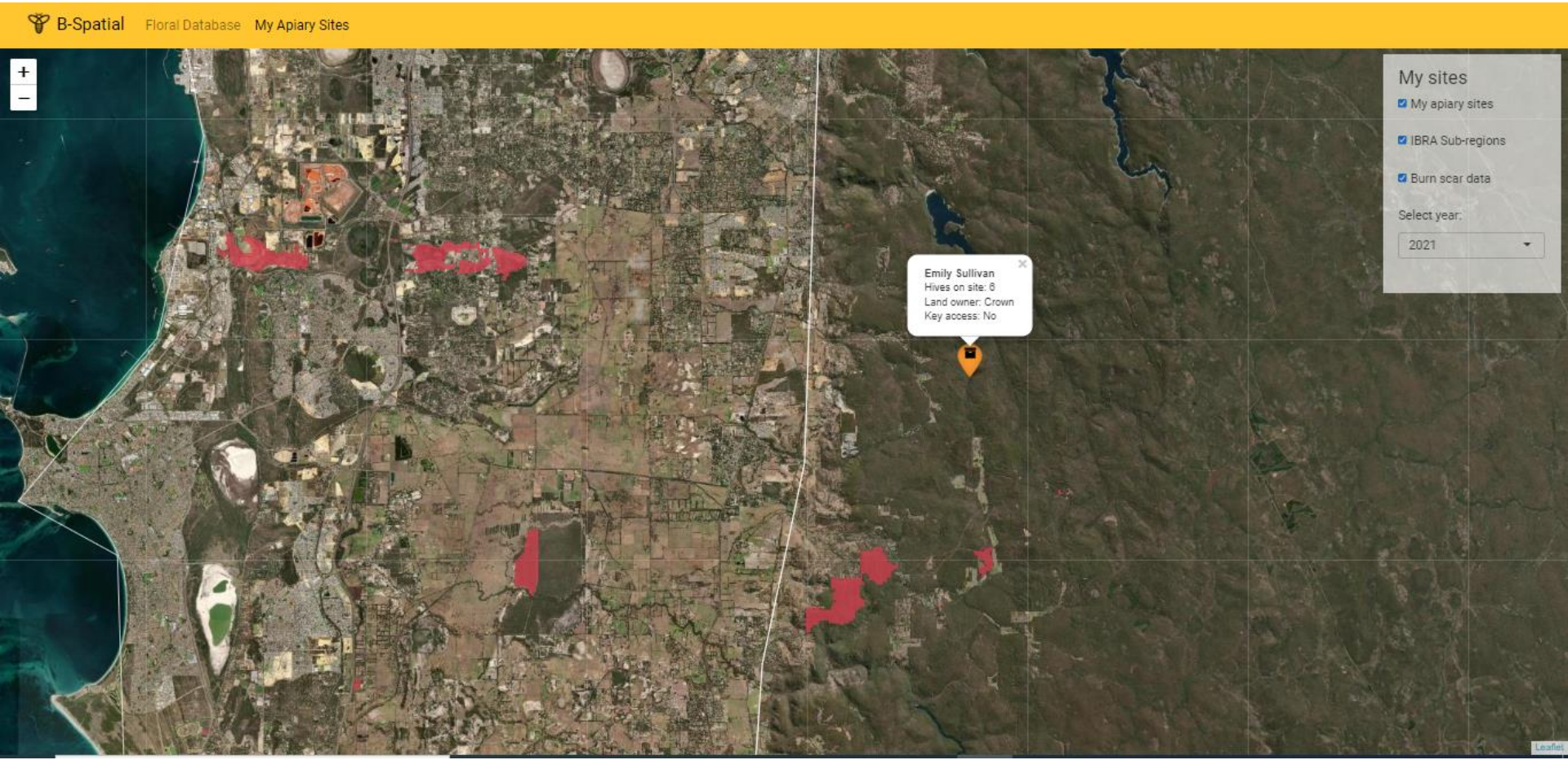
Dixon et al., 2022

Regional-scale fire severity mapping of Eucalyptus forests

B-Spatial Floral Database My Apiary Sites

Species Name	Common Name	Quality Rating		Flowering Months											
		Honey Quality	Pollen Quality	J	F	M	A	M	J	J	A	S	O	N	D
Acacia baileyana	Cootamundra wattle	-	4						■	■	■	■			
Acacia idiomorpha	Coastal limestone wattle	-	-						■	■	■				
Acacia lasiocarpa	Panjang	-	-					■	■	■	■	■	■		
Acacia pulchella	Prickly moses	-	4					■	■	■	■	■	■	■	■
Acacia spathulifolia	Gold carpet/Gold carpet wattle	-	-						■	■	■	■	■		
Acacia stenoptera	Narrow winged wattle	-	-			■	■	■	■	■	■	■	■	■	■
Agonis flexuosa	Peppermint	1	1							■	■	■	■	■	■
Allocasuarina fraseriana	Sheoak	-	4					■	■	■	■	■	■		
Allocasuarina huegeliana	Rock sheoak	-	4	■				■	■	■	■	■	■	■	■
Allocasuarina humilis	Dwarf sheoak	-	4					■	■	■	■	■	■	■	
Alyogyne huegelii	Lilac Hibiscus/Native hibiscus	-	-	■					■		■	■	■	■	■
Andersonia lehmanniana	Andersonia	-	-					■	■	■	■	■			
Arctotheca calendula	Capeweed	3	5								■	■	■	■	
Banksia armata	Prickly dryandra	4	4						■	■	■	■	■	■	
Banksia attenuata	Candle banksia/Yellow banksia/Slender banksia	4	4	■	■								■	■	■
Banksia fraseri	Frasers dryandra	4	4				■	■	■	■	■	■			
Banksia grandis	Bull banksia	2	4	■								■	■	■	■

1–25 of 117 rows Show 25 Previous 1 2 3 4 5 Next


B-Spatial
Floral Database
My Apiary Sites
+
−
My sites
My apiary sites
IBRA Sub-regions
Burn scar data
Select year:
2021
Emily Sullivan
Hives on site: 6
Land owner: Crown
Key access: No
Leaflet

Conclusions

What we know:

- Average temperatures are increasing and will continue to do so
- Rainfall is decreasing particularly during important periods of the year
- What changes in climate mean for bioclimatic niches of melliferous flora
- How land—use will constrain these niches
- We can model beekeeper interactions with current and future resource distributions

What we don't know:

- How climate change will impact phenology (particularly as distributions change)
- The impact of prescribed/wildfire on a broad range of melliferous flora
- How fire and climate interact to impact resource availability and phenology