NEW ZEALAND MINISTRY OF FOREIGN AFFAIRS & TRADE
MANATŪ AORERE

Ministry of Agriculture
GOVERNMENT OF THE COOK ISLANDS

Manaaki Whenua
Landcare Research

Weeding in Paradise: biocontrol of invasive weeds in Rarotonga

Quentin Paynter
paynterq@landcareresearch.co.nz

RHODES UNIVERSITY
Where leaders learn

Cook Islands Biodiversity & Natural Heritage

USDA ARS

USDA U.S. FOREST SERVICE
Caring for the land and serving people
United States Department of Agriculture

Cook Islands

15 islands
Rarotonga largest, most populous & most diverse flora

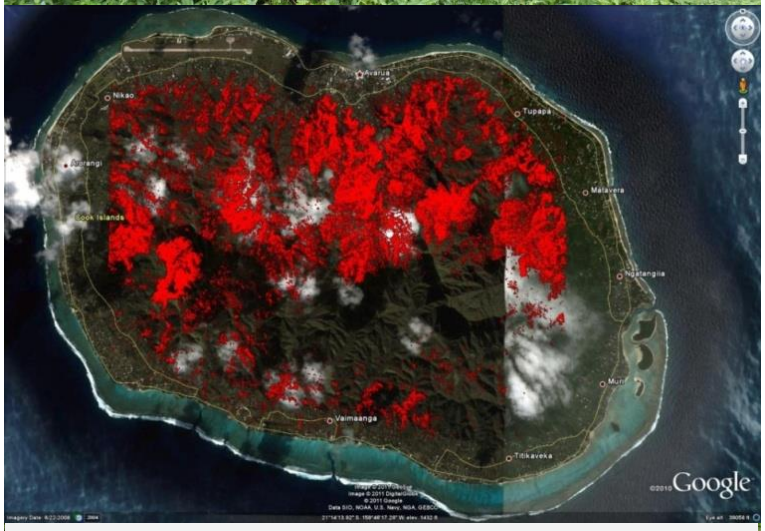

Most visitors head to the beach

Forested island interior is home to most *endemic* species (i.e. species only found in the Cook Islands)

Such as the kakerori flycatcher

Major invasive weed problems

- Many spp: 333 introduced seed plants & ferns outnumber 287 native spp.
- Threaten endemic plants: *Acalypha wilderi* is already extinct; 9 are critically endangered[1]
- Hinder agriculture
- Smothering vines cause deforestation in Rarotonga's forested watershed[2]
- A potential risk to the island's hydrology/ water supply[2]



Remote-sensing image illustrating the extent of invasive vines (red) on Rarotonga[2]

[1]Martin T et al. 2012 Survey of endemic flora of Rarotonga & preparation of IUCN threat assessments, Wildlands Contract Report No. 2497

[2]Matepi M et al. 2010. Report to the Asian Development Bank for Regional Technical Assistance Project 6420, Promoting Climate Change Adaptation in Asia and the Pacific

Biocontrol scoping study

Funded by NZ Ministry of Foreign Affairs & Trade (MFAT) in 2012

Many weed spp.

Where to start?!

Suites of weeds (potential for replacement weeds)

Invasive *Spathodea campanulata* smothered by invasive vines

Target weed prioritisation

Comprehensive listing of invasive spp. in the online Cook Islands Biodiversity Database[1]

46/333 naturalised exotic plants considered “serious” invasive species

In 2012, a workshop was held in Rarotonga to rank the 46 “serious” invasive plants

Considered:

- weed importance
- cost of implementing biocontrol, &
- the likelihood of biocontrol succeeding

[1]http://cookislands.bishopmuseum.org/search.asp

Importance of each weed categorised: high (10 points), medium (5 points) or low (1 point) by 12 local experts with interests in forestry, horticulture, livestock, biodiversity conservation & biosecurity

Max. possible score for a weed = all 12 voting high importance = 120 points

Prioritisation: maximising cost-effectiveness

Cost of implementing biocontrol estimated for each weed sp. on a scale of 1-50, according to factors, such as 'repeat' vs. 'novel' targets[1]

For 'repeat' programmes, likely impact of biocontrol assumed to be same as in countries where biocontrol agents have already been released

For novel programmes, potential impact estimated according to correlations between plant traits & biocontrol impact[2] (e.g. biocontrol impacts are generally greater on clonal weeds vs. weeds that reproduce sexually)

$$S = \underset{\text{score}}{\text{Weed importance}} + \underset{\text{Score}}{\text{Biocontrol impact}} - \text{Biocontrol cost score}$$

[1]Paynter et al. 2015. Factors affecting the cost of weed biocontrol programs in NZ. *Biol. Contr*. 80, 119-127

[2]Paynter et al. 2012. Plant traits predict the success of weed biocontrol. *J. Appl. Ecol.*, 49, 1140-1148

Implementation

In November 2013, a weed biocontrol programme began (funded by MFAT Partnership Fund)

Partnership between MWLR & the Cook Islands Ministry of Agriculture, with assistance from the Cook Islands Natural Heritage Trust to target the following weeds:

Weed species	Common name	Total Score
Xanthium pungens	Cocklebur	173.83
Mikania micrantha	Mile a minute weed	138.00
Cardiospermum grandiflorum	Grand balloon vine	136.00
Passiflora rubra	Red passionfruit	131.00
Spathodea campanulata	African tulip tree	129.00
Psidium cattleianum	Strawberry guava	123.00

Xanthium pungens (*X. strumarium* sp. agg.) Cocklebur/Noogoora bur (Asteraceae)

Annual cropping weed native to N America

Repeat programme: controlled by *Puccinia xanthii* rust fungus in Australia

Xanthium pungens (*X. strumarium* sp. agg.) Cocklebur/Noogoora bur

P. xanthii host-range well documented[1]

Only 1 Cook Island plant sp. (*Melanthera biflora*) required testing

Puccinia xanthii obtained from Australia

Testing in Auckland showed *M. biflora* is not a host

Melanthera biflora

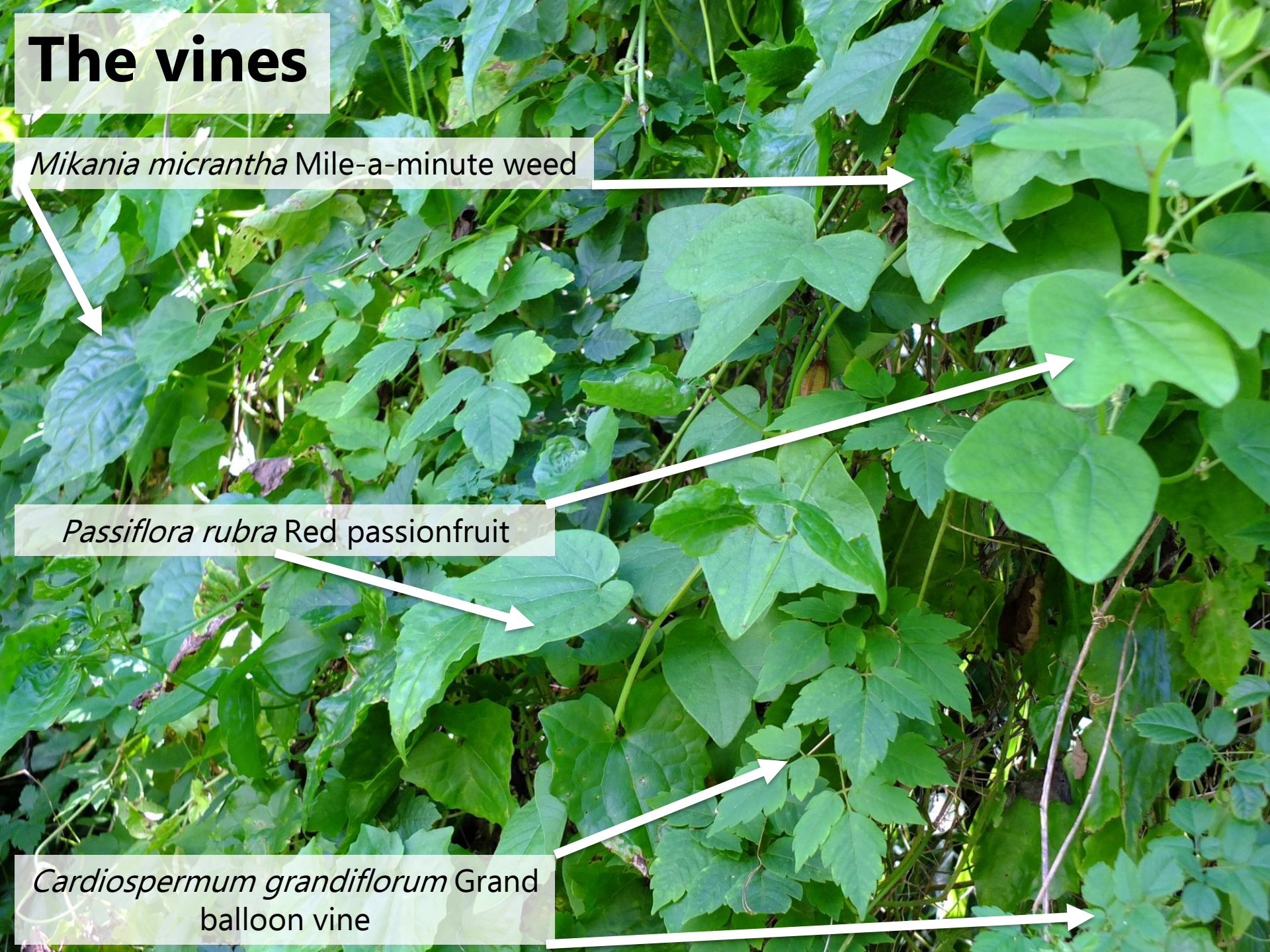
Morin, L. et al. 1993. *Canadian Journal of Botany,* **71,** 959-965.

Xanthium pungens (*X. strumarium* sp. agg.) Cocklebur/Noogoora bur

P. xanthii was released on 2 farms by the CI MoA in Oct 2016 & is now widespread in Rarotonga

Highly damaging outbreaks, after rain, especially in winter/cool season & farmers report *X. pungens* is less of a problem now

X. pungens (=*strumarium*) is also invasive in NZ, so *P. xanthii* could be released in NZ if necessary!


The vines
Mikania micrantha Mile-a-minute weed
Passiflora rubra Red passionfruit
Cardiospermum grandiflorum Grand balloon vine

Cardiospermum grandiflorum Grand balloon vine (Sapindaceae)

South American vine

Also invasive in South Africa

Work in S. Africa indicated a South American rust fungus *Puccinia arechavaletae* is damaging & highly specific[1]

Additional testing in Auckland on all 3 Cook Islands native Sapindaceae confirmed *P. arechavaletae* safe to release in Rarotonga

Simelane, D.O et al. 2011. *African Entomology,* **19,** 269-277.

Cardiospermum grandiflorum Grand balloon vine

P. arechavaletae released Dec 2017

Spread throughout Rarotonga by March 2018!

Devastating impacts within a few months!

Mikania micrantha (Asteraceae) Mile-a-minute weed

Native to Central & S America

Repeat programme: Ecuadorian rust fungus *Puccinia spegazzinii* already released in the Pacific region (Fiji, PNG, Vanuatu)

Host-range well-known[1] (the most extensively tested biocontrol agent in the world!). Further host-range testing unnecessary

Rust obtained from Vanuatu & shipped to Rarotonga via MWLR containment facility in Auckland

Established in Rarotonga in 2017

Chantal Probst (MWLR) & Maja Poeschko (CI MoA) set up *P. spegazzinii* inoculations in Rarotonga

[1]Ellison, C.A., et al. 2008. *Biological Control,* **45,** 133-145.

Mikania micrantha Mile-a-minute weed

Having major impacts, especially in the forested interior of Rarotonga

Passiflora rubra (Passifloraceae) Red passionfruit

- Native to S America, Caribbean
- No native *Passifloraceae* in Cook Islands, but exotic *Passiflora* spp. grown for fruit (esp. *P. edulis*)
- Novel biocontrol target

- BUT *Heliconius* butterflies are important herbivores of *Passiflora* spp. & their ecology is very well known
- Larvae of several *Heliconius* spp. feed only on plants in sub-genus Decaloba to which *P. rubra* belongs, but not on edible *Passiflora* spp. (sub-genus Passiflora)[1]

[1]Benson et al. 1975. *Evolution,* **29,** 659-680

Heliconius erato cyrbia

Only uses *P. rubra* & related *P. punctata* in native range (Ecuador)[1]

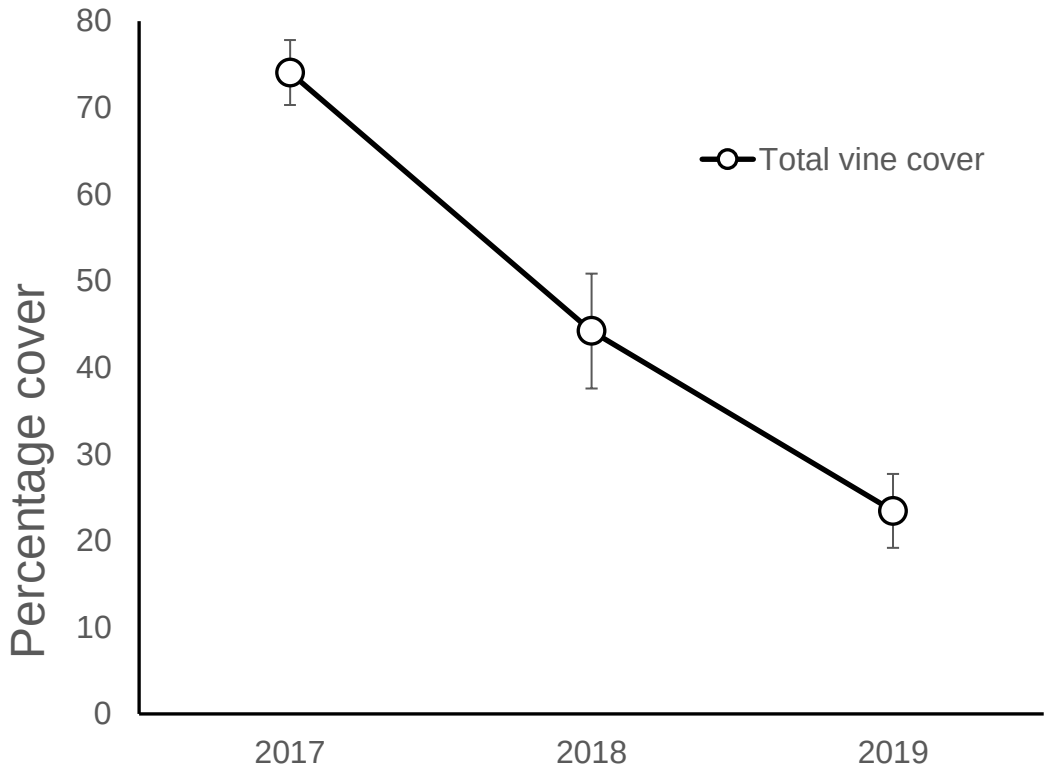
Pupae obtained from Heliconius Butterfly Works[2] (Ecuador)

Host-range testing indicated no development on *P. edulis P. ligularis* or *P. quadrangularis* in no-choice larval starvation tests

Released on Rarotonga in August 2016 & now well established & very common

[1]Jiggins, C.D., et al. 1997 *Ecological Entomology,* **22,** 361-365
[2]http://www.heliconiusworks.com/

Percentage cover of target vines over time at 20 *P. arechavaletae* release sites



Dec 2017

Dec 2019

Dec 2017

Dec 2019

Vines have declined: Benefits to native plants, exotic plants & crops (depending on what was being smothered!)

Spathodea campanulata (Bignoniaceae)
African tulip tree

A large African tree invading forested interior of Rarotonga

Spathodea campanulata

Researchers from Rhodes University, (South Africa) collected candidate agents in Ghana in 2014 & conducted host-specificity testing

2 agents approved for release in Rarotonga:

- Eriophyid mite *Colomerus spathodeae* released Jan 2017 & is widely established, but minor impacts to date
- Leaf-mining beetle *Paradibolia coerulea* release delayed, due to Covid-19


Psidium cattleianum (Myrtaceae)
Strawberry guava
A small South American tree
invading forested interior

Psidium cattleianum Strawberry guava

A gall-forming scale insect *Tectococcus ovatus* already released in Hawai'i is highly host-specific[1]: further host-range tests unnecessary

Eggs shipped to Rarotonga in August 2016 & microscopic 'crawlers' painstakingly transferred to potted plants

Field releases made in Nov 2016 & Jan 2017. Established & spreading slowly from release sites

Strawberry guava is invasive in NZ; *T. ovatus* could also be released here!

[1]Wessels, F.J., et al. 2007. *Biocontrol,* **52,** 439-449.

Conclusions

1. Rapid, impressive impacts against cocklebur, grand balloon vine, mile-a-minute weed
2. Red passionfruit increased slightly, despite *H. erato cyrbia*, but there was an overall reduction in vine cover (benefitting both native plants & weeds)
3. Strawberry guava biocontrol agent spreading slowly, but potentially very damaging in the long-term
4. A second agent is needed for African tulip tree & we aim to release it, once international travel is possible

Conclusions

This project is on course to become a major success helped by:

1. Local stakeholders identifying the most important weeds (local 'ownership' of the project; evidence that the project was needed; strategic selection of a suite of the most important weed targets to reduce risk of replacement weeds)
2. Relatively low implementation costs: mainly repeat programmes & a unique opportunity, where a candidate agent for *Passiflora rubra* could be bought "off-the-shelf"
3. Helpful sharing of biocontrol agents between agencies

The future

MFAT is funding two new projects to expand weed biocontrol work in the Pacific region

- Biocontrol of pasture weeds in Vanuatu
- Biocontrol of weeds to mitigate climate change in several countries, including the Marshall Islands, Niue, Tonga, Wallace and Futuna
- Work in Rarotonga will also continue…

Thanks to Sarah Dodd, Maja Poeschko & Cook Islands Ministry of Agriculture, Gerald McCormack, Iain Paterson, Tracy Johnson, Chantal Probst, Lynley Hayes & MFAT

Any questions?

Paynterq@landcareresearch.co.nz