Biocontrol of Forest Weeds in Hawai`i

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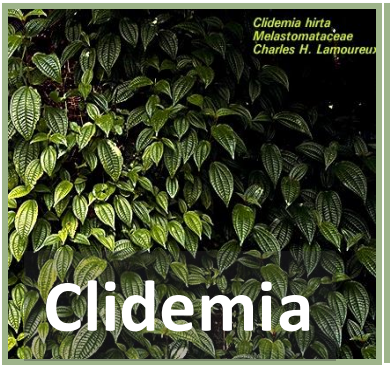
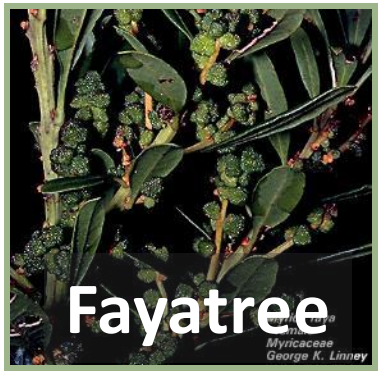
Hawaiian rainforest

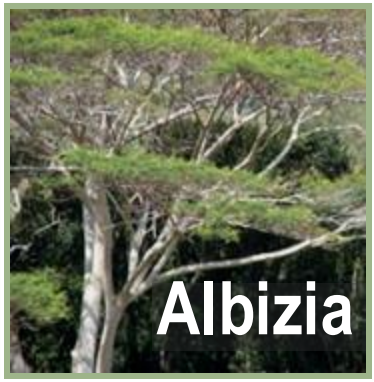
Strawberry guava invasion

Photos: Jack Jeffrey

Land managers in Pacific Islands need new tools for alien plants invading vulnerable forest ecosystems

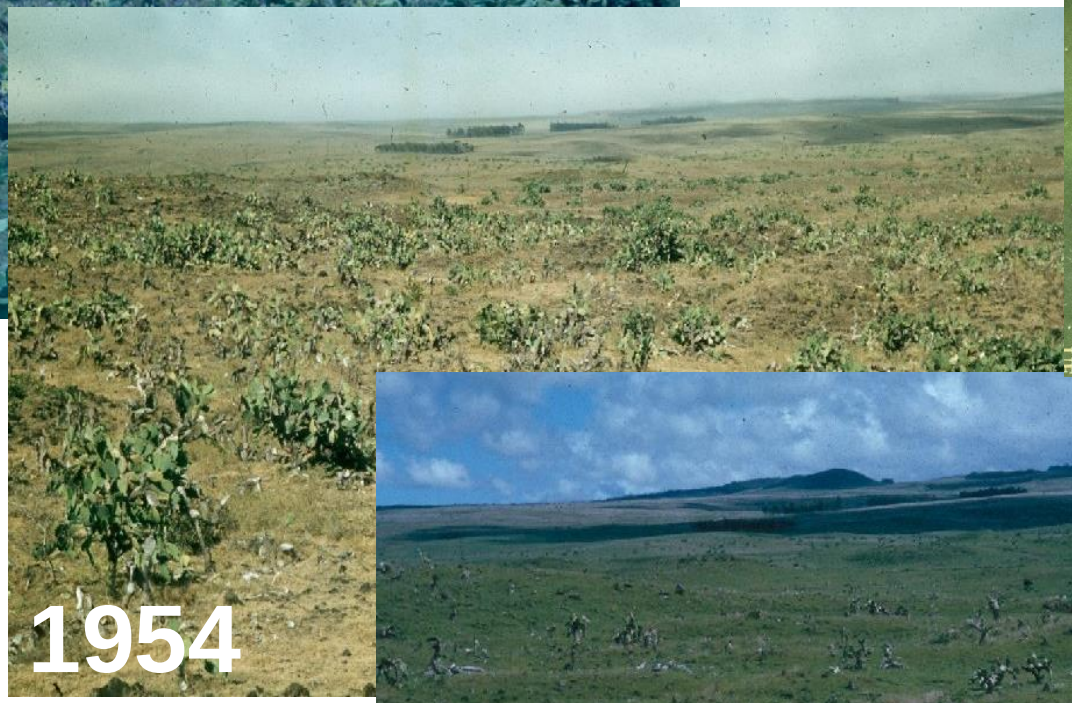






Forest weed biocontrol partners since 1978: US Forest Service, National Park Service, Univ. Hawaii, Hawaii Dept. Agric., Hawaii Dept. Land & Natural Resources, US Geological Survey, US Fish & Wildlife Service, Hawaii Invasive Species Council, Watershed Partnerships, The Nature Conservancy

Prickly Pear Cactus (Panini) in Hawaii: Biocontrols released 1949-1951



Habeck & Bennet Univ Florida

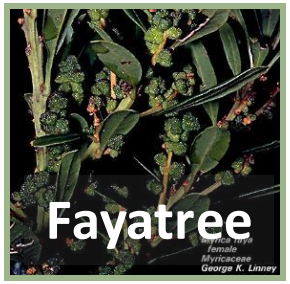
photos: Hawaii Dept of Agric

Impacts

- Usually gradual
- Plants and biocontrols remain interacting

Developing biological control for Pacific Island forest weeds

Target Selection



Foreign Exploration

Laboratory Testing

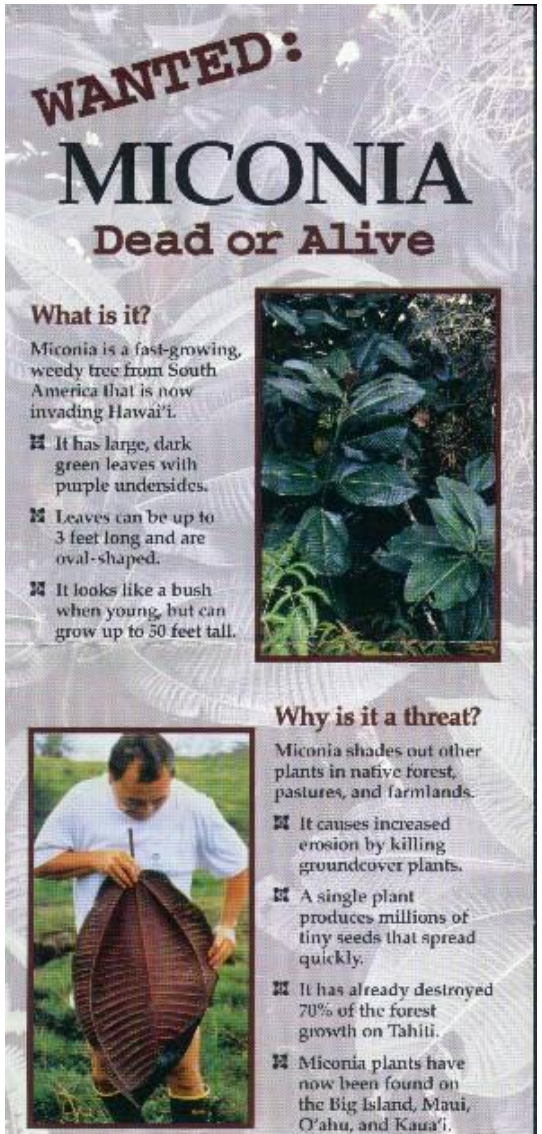
Release & Monitor

Guava biocontrol

Biocontrol is a lengthy process involving much collaboration!

Miconia in Tahiti since 1937

in Hawaii since 1959



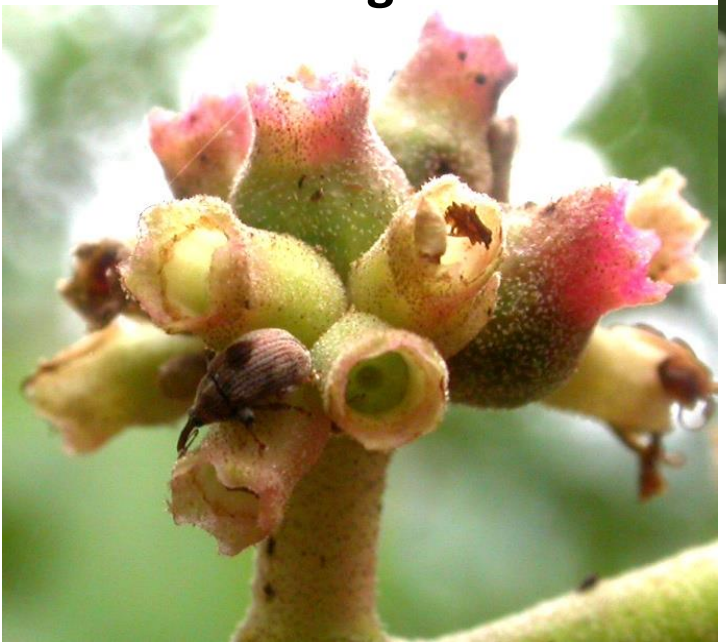
Miconia containment effort costing > $1 million annually

Colletotrichum biocontrol - 1997

New prospects for *Miconia calvescens* biocontrol

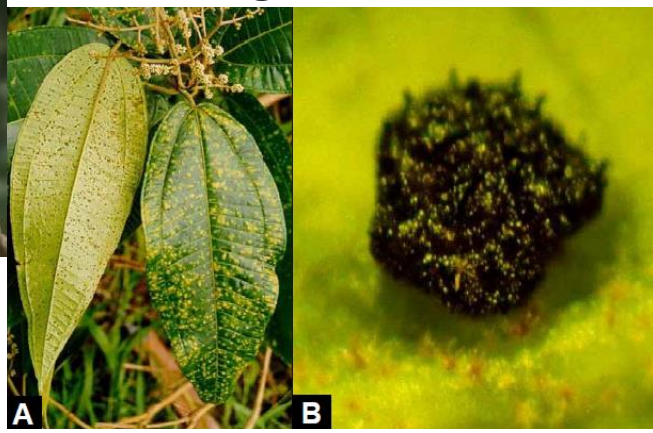
Euselasia chrysippe

Anthonomus monostigma
attacking fruit



Allorhogas granivorus
fruit gall wasp

Coccodiella miconiae
leaf fungus



Partners: Univ Costa Rica,
Univ Reg. Blumenau, Univ Fed. Vicosa (Brazil)

Tibouchina herbacea, Waihee Ridge, Maui

Photo: Forest & Kim Starr

Syphraea uberabensis host specific on *Tibouchina* and close relatives

(all expected host plants are melastomes invasive in Hawaii)

Collaborator:
Univ Reg. Blumenau

Feeding Damage
(score 0-6)

Eggs/Female/Day

Order Myrtales

Melastomataceae

Melastoma
Pterolepis
Tibouchina

Cibotium glaucum
Myoporum sandwicense
Fragaria vesca
Rubus hawaiensis
Rubus ellipticus
Sophora chrysophylla
Acacia koa
Wikstroemia sandwicensis
Dodonaea viscosa
Terminalia catappa
Oenothera laciniata
Epilobium ciliatum
Fuchsia magellanica
Cuphea hyssopifolia
Cuphea ignea
Cuphea carthagenesis
Lythrum maritimum
Eugenia uniflora
Psidium cattleianum
Syzygium jambos
Syzygium malaccense
Syzygium cumini
Metrosideros polymorpha P
Metrosideros polymorpha G
Tetrazygia bicolor
Miconia calvescens
Clidemia hirta
Medinilla cummingii
Arthrostema ciliatum
undifolia
nervium
nervium
omerata
villeana
ongifolia
erbacea

0 1 2 3 4 5 6

0 1 2 3 4 5 6 7 8

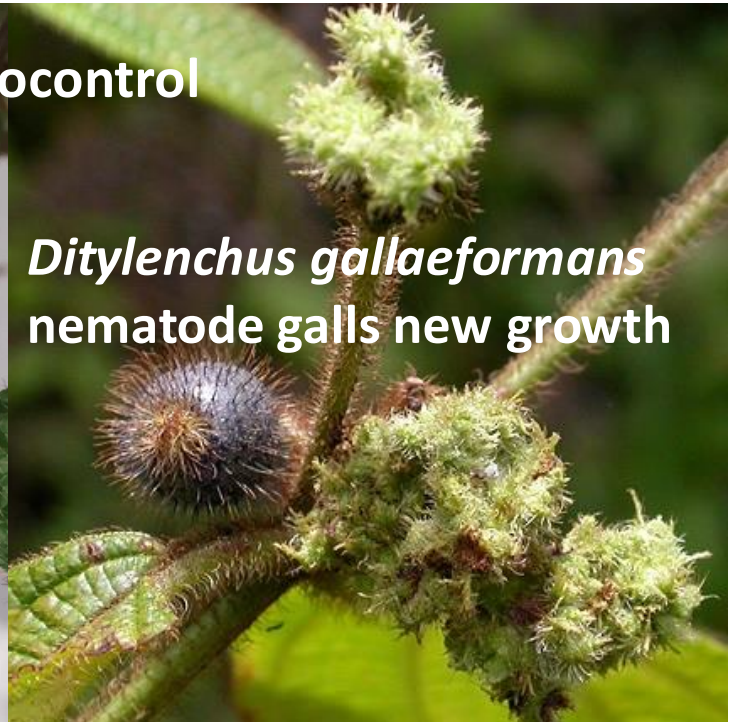
Biocontrol of Clidemia (*Miconia crenata*)

Need greater impacts from biocontrol

Research at IPIF evaluates efficacy of past biocontrols and potential new agents from tropical American native range

Partners:
Univ Costa Rica,
Univ Reg. Blumenau,
Univ Fed. Vicosa (Brazil)
Queensland Dept Ag

New Prospects for Biocontrol



Schinus terebinthifolius: Biocontrol agent tested and released in Florida (Hawaiian plant species also tested in USDA-ARS-IPRL quarantine)

***Pseudophilothrips ichini* adults on Christmas berry leaf tips**

New Hawaii EA addresses:

Invasion by *Schinus*

Host specificity of thrips

Expected effects on *Schinus* and native species

Biocontrol of Devilweed (*Chromolaena odorata*)

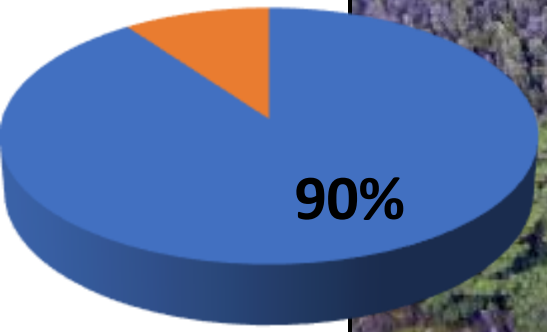
Cecidochares connexa native to Colombia established on *Chromolaena odorata*

Indonesia	1995
Palau	1999
Phillipines	2001
Papua New Guinea	2001
Guam	2002
Northern Marianas	2003
Cote d'Ivoire	2003
Micronesia	2004
India	2005
Timor	2005
Australia	2019

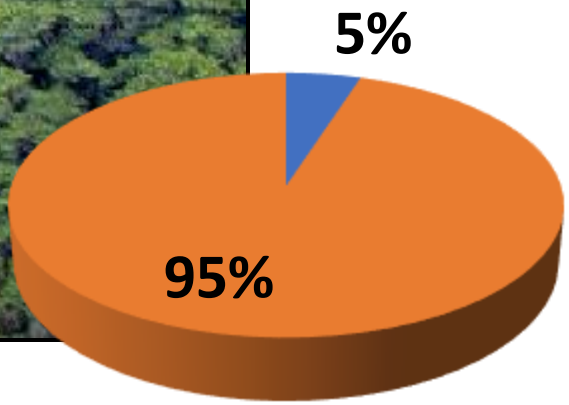
Host specificity tests with Hawaiian plants

Loss of native trees under invading albizia (*Falcataria falcata*)

(Hughes et al)



Native *Metrosideros* Forest



Falcataria-invaded

Live *Metrosideros*

Dead *Metrosideros*

Biocontrol of Albizia (*Falcataria falcata*)

Evaluating natural enemies in Indonesia and Papua New Guinea

Partners:

IPB University (Bogor)
Pattimura University (Ambon)
Gadjah Mada Univ (Yogyakarta)
Natl Agric Research Inst (PNG)
Landcare Research (NZ)
Queensland Dept Agriculture

Prioritized for study:

Galling rust fungus

Leaf galling mite

Stem boring weevil

Biocontrol of Himalayan raspberry (*Rubus ellipticus*) & mysore raspberry (*Rubus niveus*)

CABI searching in India and China for host-specific enemies that will not attack Hawaiian *Rubus*

Himalayan ginger biocontrol

Exploration
in Sikkim, India

Merochlorops sp.

Partners:
CABI-UK,
Landcare NZ

CABI-UK

Morella faya in Hawaii

Previously released agents have been ineffective

Need exploration in most biodiverse area of native range: Canary Islands

Potential partners at Univ. La Laguna

Biocontrol of African tulip tree (*Spathodea campanulata*) in Fiji and Cook Islands developed by international partners including SPC, Landcare (NZ), UK and African researchers

Flea beetle from Africa
Rhodes Univ. – South Africa

Fountain Grass *Cenchrus setaceus*

Support exploration in native range: North & East Africa

(Preliminary surveys by Hawai'i Dept Agriculture discovered a fungal pathogen in Tanzania)

New collaborator:

European Biological Control Laboratory

USDA Agricultural Research Service

Biocontrol of African Grasses ?

Guinea grass

Buffelgrass

Cane grass

Molasses grass

Para grass

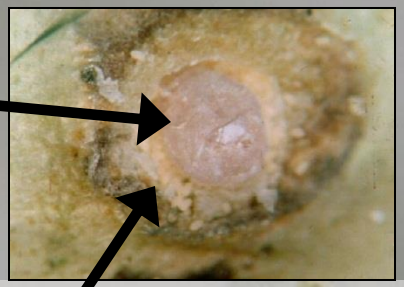
New collaborator:

RHODES UNIVERSITY
Where leaders learn

Strawberry guava biocontrol release and establishment 2012

Insect forms leaf galls

Life cycle of *Tectococcus*



female
inside gall
cannot move

eggs

wax

Hatched insects (crawlers)
feed and start galls

Applying Strawberry Guava Biocontrol

Establishment of *Tectococcus ovatus* in forest areas 2013-2016

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Production of *Tectococcus* for field application

Biological Control of Strawberry Guava:

Selecting cuttings with mature *Tectococcus ovatus* for application

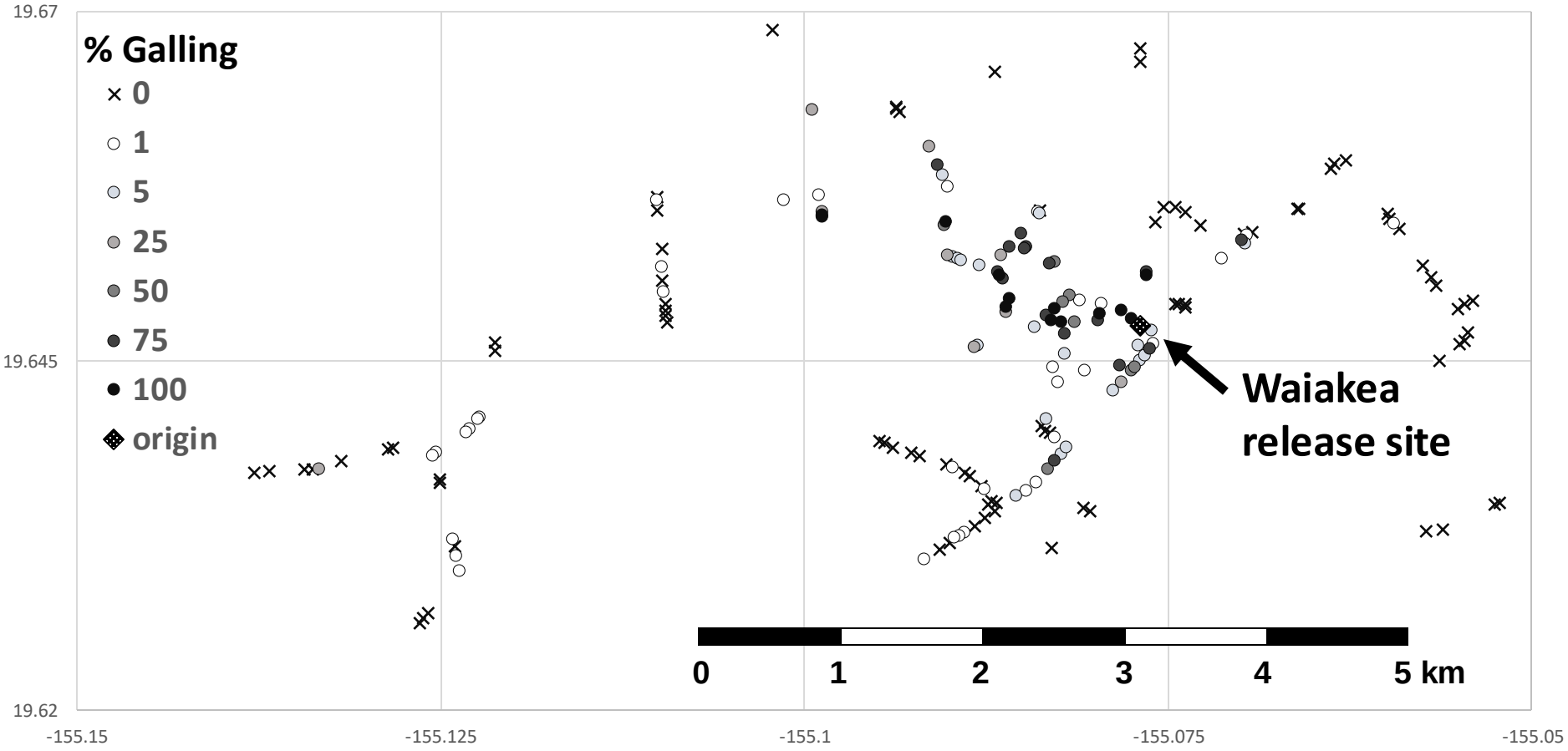
Too young	Just right	Too old
Galls large but still immature, leaves and stem tender and pliable	At correct stage, leaves are fully formed and stiff, stem rigid but still green and not woody.	Galls darkened or rotting, leaves darker and aging, stem turning woody.

10x magnified views of female galls in cross-section.

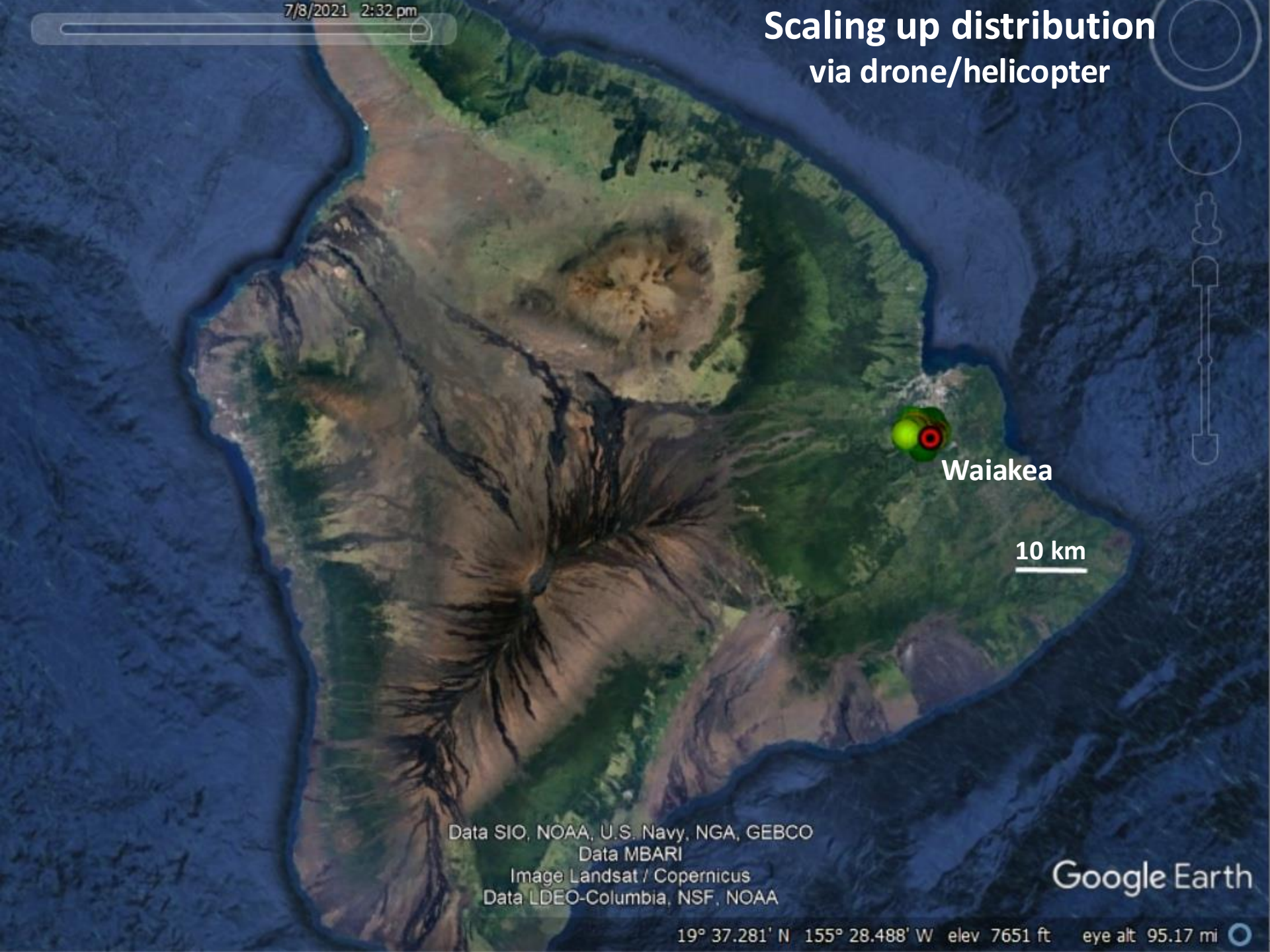
For more info: tracy.johnson@usda.gov

Methods for distributing strawberry guava biocontrol

Natural dispersal of guava biocontrol October 2012 - July 2021



3.5–5.5 km spread in 9 years (400-600 m per year on average)


7/8/2021 2:32 pm
Scaling up distribution
via drone/helicopter
Waiakea
10 km
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data MBARI
Image Landsat / Copernicus
Data LDEO-Columbia, NSF, NOAA
Google Earth
19° 37.281' N 155° 28.488' W elev 7651 ft eye alt 95.17 mi

Mahalo!

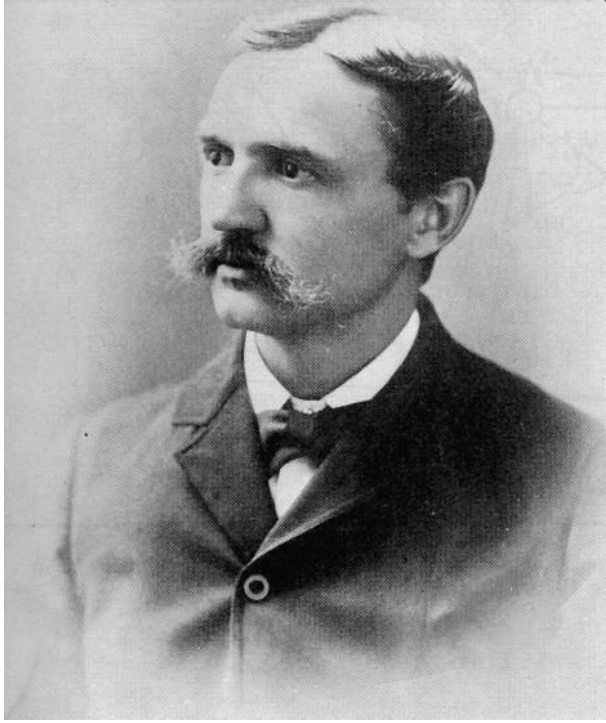
To the many partners that share our vision for conservation of island ecosystems

More info: www.biocontrolhawaii.org

J. Jeffrey

Hawaii has a long history of biocontrol introductions

First release of weed enemies against lantana in 1902



Albert Koebele
1853 - 1924

Vidalia beetle for cottony cushion scale

Biocontrol introductions in Hawaii, 1900-1995

Parasitoids

Predators

Herbivores

Species

50
40
30
20
10
0

0s 10s 20s 30s 40s 50s 60s 70s 80s 90s

Decade

Follett et al., 2000 (Source: Hawaii Dept. of Agriculture)

Non-target effects of biocontrol in Hawaii

"The importation of parasites to control various moths of economic importance, together with the accidental importation of other parasites, has resulted in the wholesale slaughter and near to complete extermination of countless species. It is now impossible to see the Hawaiian Lepidoptera in the natural proliferation of species and individuals of Perkin's day."

Zimmerman 1958

Howarth 1983. Classical biocontrol: Panacea or Pandora's box? ***Proc. Hawaii. Entomol. Soc.*** **24:239-44**

History of non-target issues (Reimer 2002)

Frequency of host-specific biocontrol introductions

Before 1944: 54.7%

1944-1975: 77.4%

Since 1975: 100% (over 50 introductions)

	Invasive Plants targeted for biocontrol in Hawaii	Biocontrols introduced
Successes	Lantana	1902-1974
	Purple nutsedge	1925
	Prickly Pear cactus	1949-1951
	Gorse	1949-1995 …
	Clidemia	1953-1995 …
	Christmas berry	1954 …
	Hamakua pamakani	1955-1974
	Emex	1957-1962
Non-target issues	Melastoma	1958-1964
	Puncturevine	1963
	Florida blackberry	1963-1966
	Klamath weed (St. Johnswort)	1965-1966
	Fayatree	1991 …
	Banana poka	1991-1996
	Ivy gourd	1996-1998
	Miconia	1997 …
	Strawberry guava	2012 …
	Fireweed	2013 …

Next: Aerial distribution to remote forests