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SERDP and ESTCP Webinar Series

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    - (669) 900-6833 or (929) 205-6099
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Pacific Island Ecology and Management: Recovery of Native Plant Communities Following Removal of Non-Native Species

August 22, 2019

Welcome and Introductions

Jennifer Nyman, Ph.D., P.E.
Webinar Facilitator

SERDP DOD • EPA • DOE | ESTCP

Webinar Agenda

- **Webinar Logistics** (5 minutes)
  Dr. Jennifer Nyman, Geosyntec Consultants
- **Overview of SERDP and ESTCP** (5 minutes)
  Dr. Kurt Preston, SERDP and ESTCP
- **Novel Network Connections for Seed Dispersal in Hawaii** (25 minutes + Q&A)
  Dr. Jeffrey Foster, Northern Arizona University
- **Pollination Services in a Hawaiian Dry Forest Ecosystem Impacted by Invasive Predators** (25 minutes + Q&A)
  Dr. Christina Liang, USDA Forest Service
- **Final Q&A session**

In Case of Technical Difficulties

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- Find the Q&A button on your control bar and type in your question(s)
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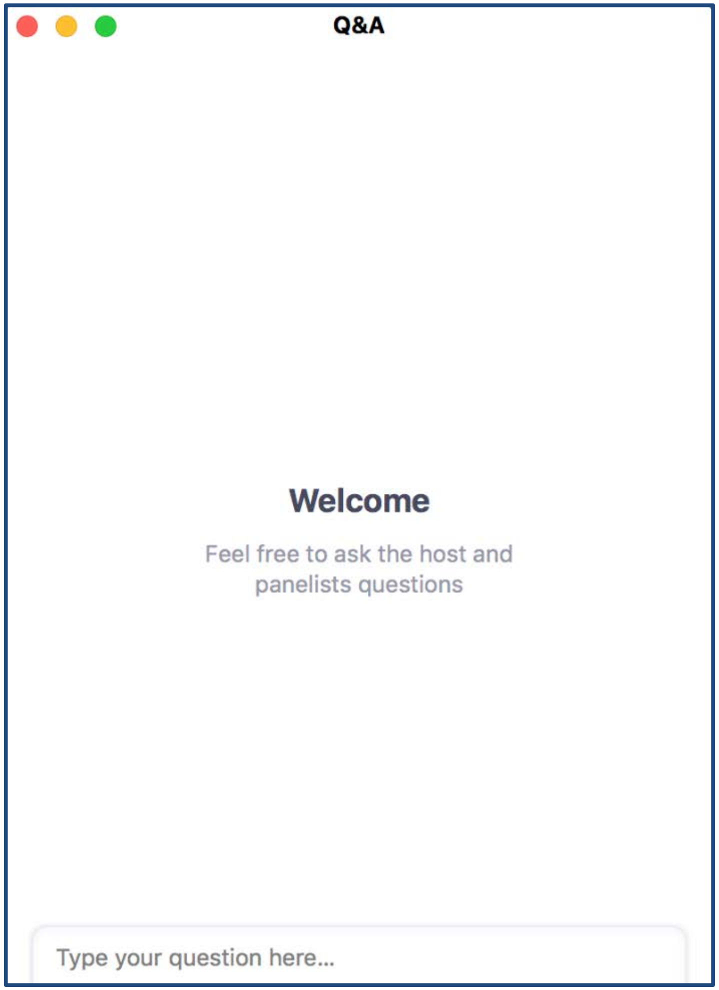


SERDP and ESTCP Overview

Kurt Preston, Ph.D.
Resource Conservation and Resiliency Program Manager

SERDP
DOD • EPA • DOE

ESTCP

SERDP

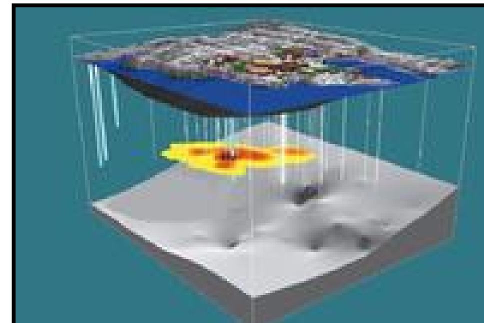
- Strategic Environmental Research and Development Program
- Established by Congress in FY 1991
  - DoD, DOE and EPA partnership
- SERDP is a requirements driven program which identifies high-priority environmental science and technology investment opportunities that address DoD requirements
  - Advanced technology development to address near term needs
  - Fundamental research to impact real world environmental management

ESTCP

- Environmental Security Technology Certification Program
- Demonstrate innovative cost-effective environmental and energy technologies
  - Capitalize on past investments
  - Transition technology out of the lab
- Promote implementation
  - Facilitate regulatory acceptance

Program Areas

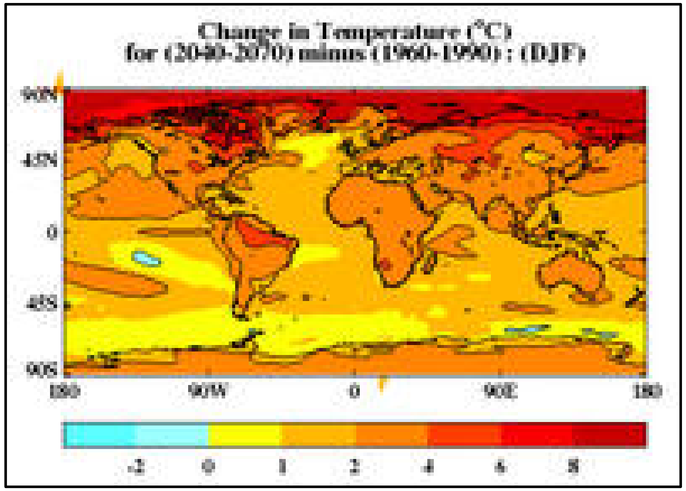
1. Environmental Restoration
2. Installation Energy and Water
3. Munitions Response
4. Resource Conservation and Resiliency
5. Weapons Systems and Platforms





Resource Conservation and Resiliency

- **Natural resources**
  - Ecological forestry
  - Arid lands ecology and management
  - Cold regions ecology and management
  - Pacific island ecology and management
  - Coastal and estuarine ecology and management
  - Living marine resources ecology and management
  - Species ecology and management
  - Watershed processes and management
- **Resilience**
  - Vulnerability and impact assessment
  - Adaptation science
  - Land use and carbon management
- **Air quality**
  - Wildland fire dynamics
  - Fugitive dust



SERDP and ESTCP Webinar Series

Date	Topic
September 5, 2019	The Use of Advanced Molecular Biological Tools in Groundwater Contaminated with Chlorinated Solvents
September 19, 2019	Life Cycle Assessment and Developmental Environment Safety and Occupational Health Evaluation: Tools for Sustainment and Health
October 3, 2019	Variation in Phenological Shifts: How do Annual Cycles and Genetic Diversity Constrain or Enable Responses to Climate Change?
October 17, 2019	Managing Aqueous Film Forming Foam (AFFF) Impacts to Subsurface Environments and Assessment of Commercially Available Fluorine-Free Foams

For upcoming webinars, please visit

http://serdp-estcp.org/Tools-and-Training/Webinar-Series

Save the Date!

SERDP ◆ ESTCP SYMPOSIUM

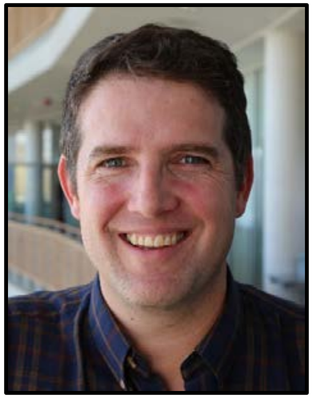
A three-day symposium showcasing the latest technologies that enhance DoD's mission through improved environmental and energy performance

December 3-5, 2019

Washington Marriott Wardman Park

Registration is open

Novel Network Connections for Seed Dispersal in Hawaii



Jeffrey Foster
Northern Arizona University

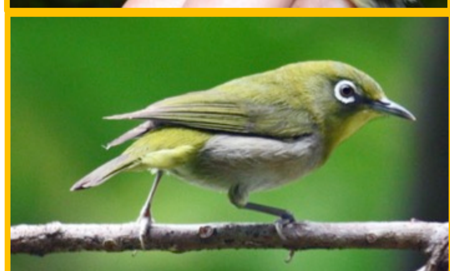
SERDP DOD · EPA · DOE | ESTCP

Agenda

- Extinctions and invasions
- Avian seed dispersers are essential
- Assessed seeds in bird diets in 7 sites
- Seed dispersal networks rapidly complex
- Introduced species play core network roles
- Birds can switch to native plants

Extinctions and Invasions in Hawaii





Extinctions (in past 200 years)

Birds: ~28 species

Plants: >100 taxa

Introductions

Birds: 55 species naturalized

Plants: >860 naturalized

Hawaiian Plants Require Bird Dispersal

U.S. Postal Service; Artist: John D. Dawson

Native Plants Dependent on Birds

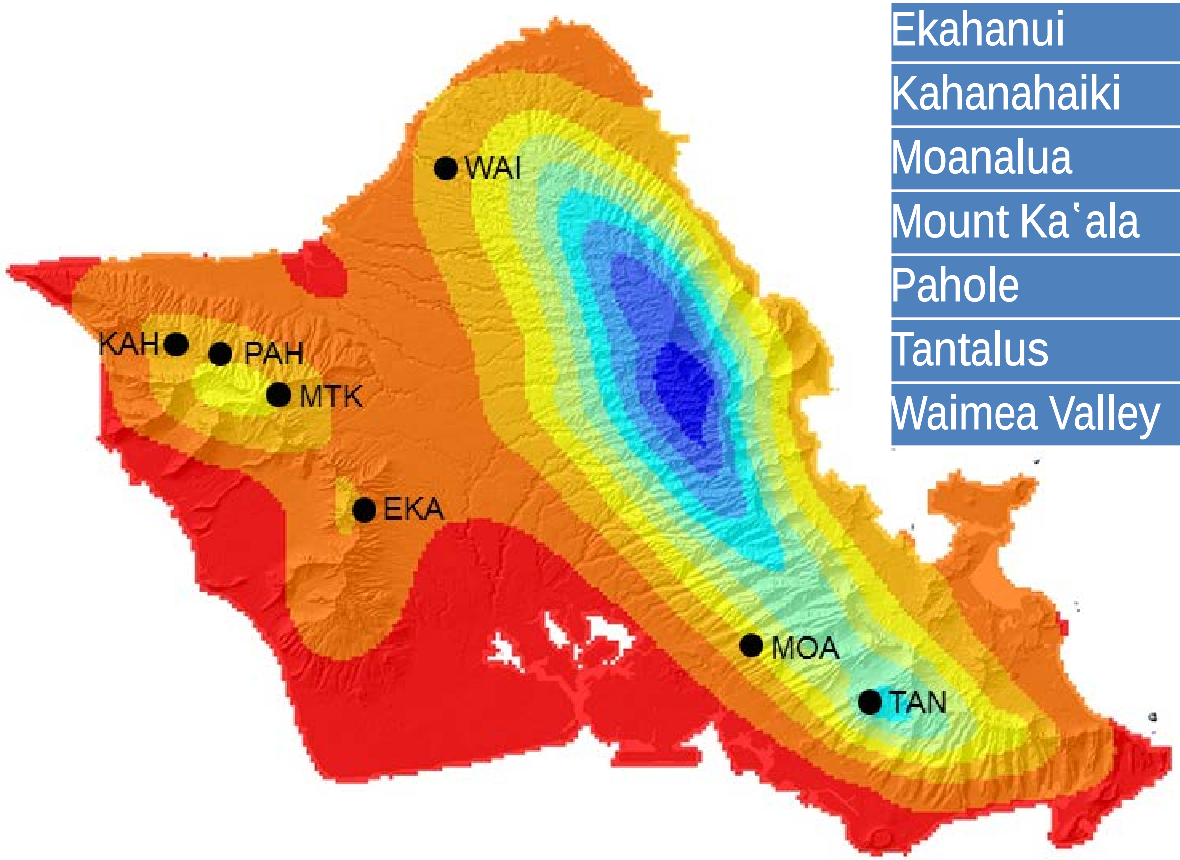
Native Extinctions and Non-Native Introductions

Extinctions

Introductions

Are non-native frugivores replacing roles of extinct native seed dispersers?

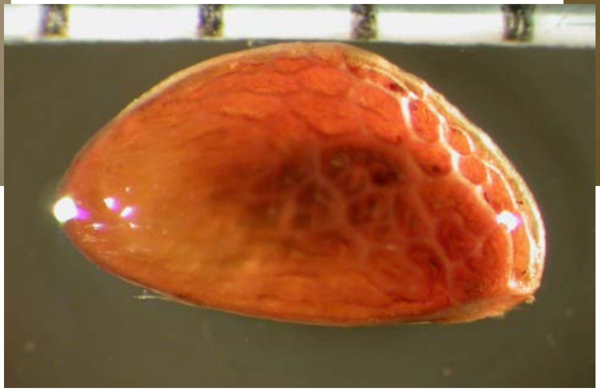
7 Field Sites: Elevation and Rainfall Gradient

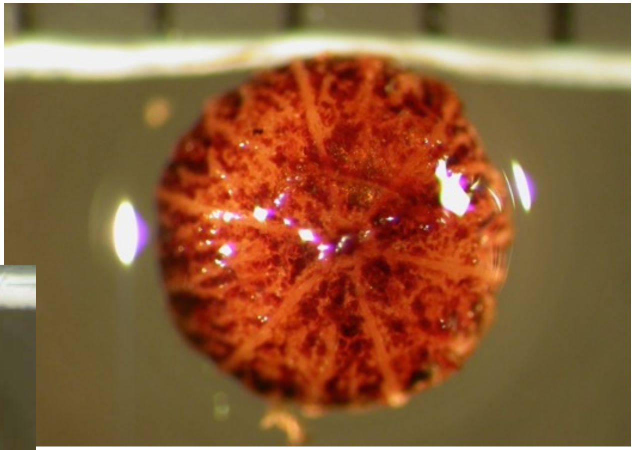


Site	Acronym	Elevation (m)	Rainfall (mm)
Ekahanui	EKA	467	1107.8
Kahanahaiki	KAH	667	1345.8
Moanalua	MOA	108	1884.4
Mount Kaʽala	MTK	1206	1953.7
Pahole	PAH	594	1533.5
Tantalus	TAN	549	3386.1
Waimea Valley	WAI	190	1732.9

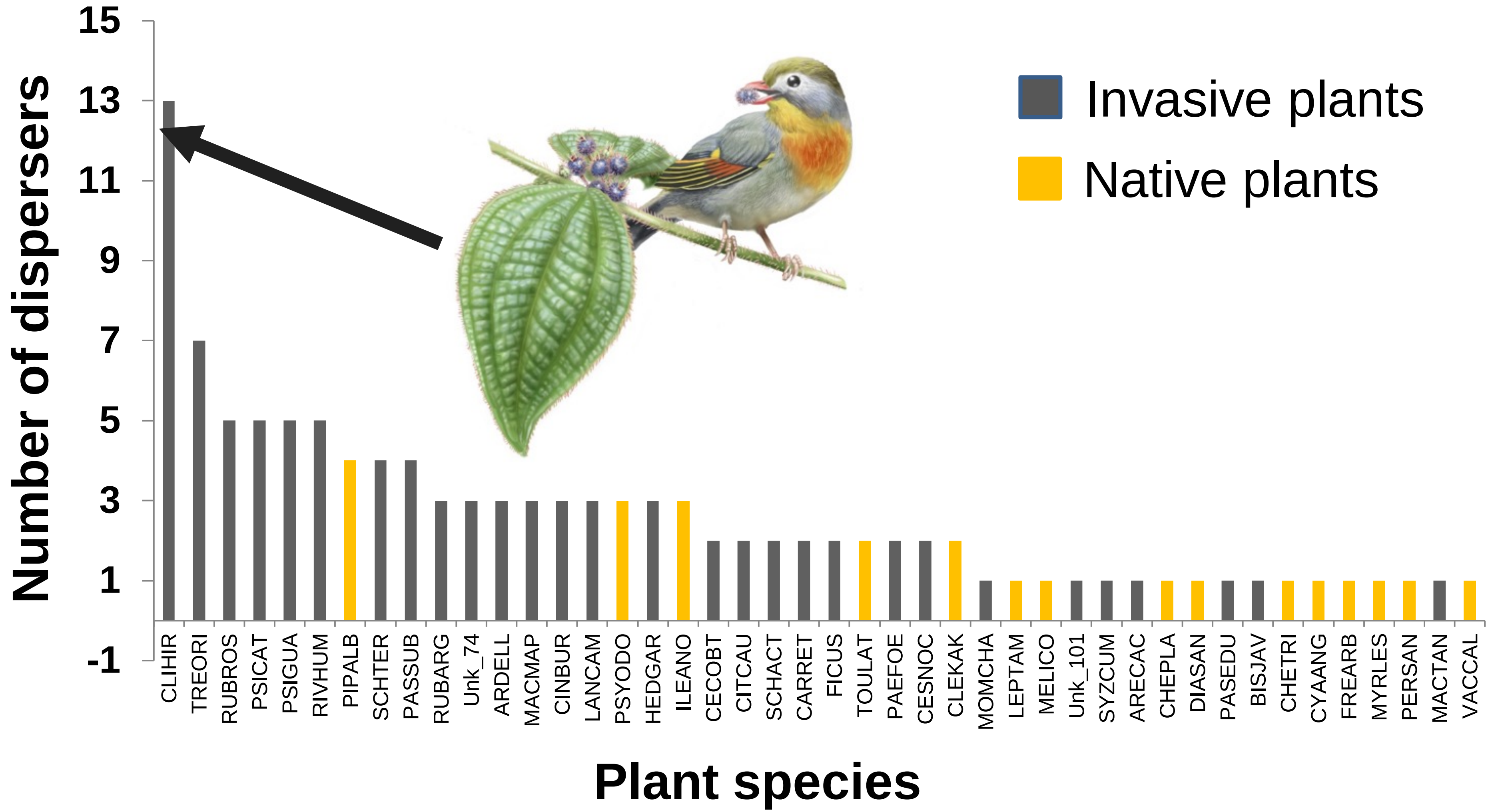
We Sorted a Lot of Bird Poop

- Seeds sorted from 3,278 fecal samples (in 42% of samples)
- 109,424 viable seeds from 44 plant species (15 native)
- 15 of 21 bird species carried seeds

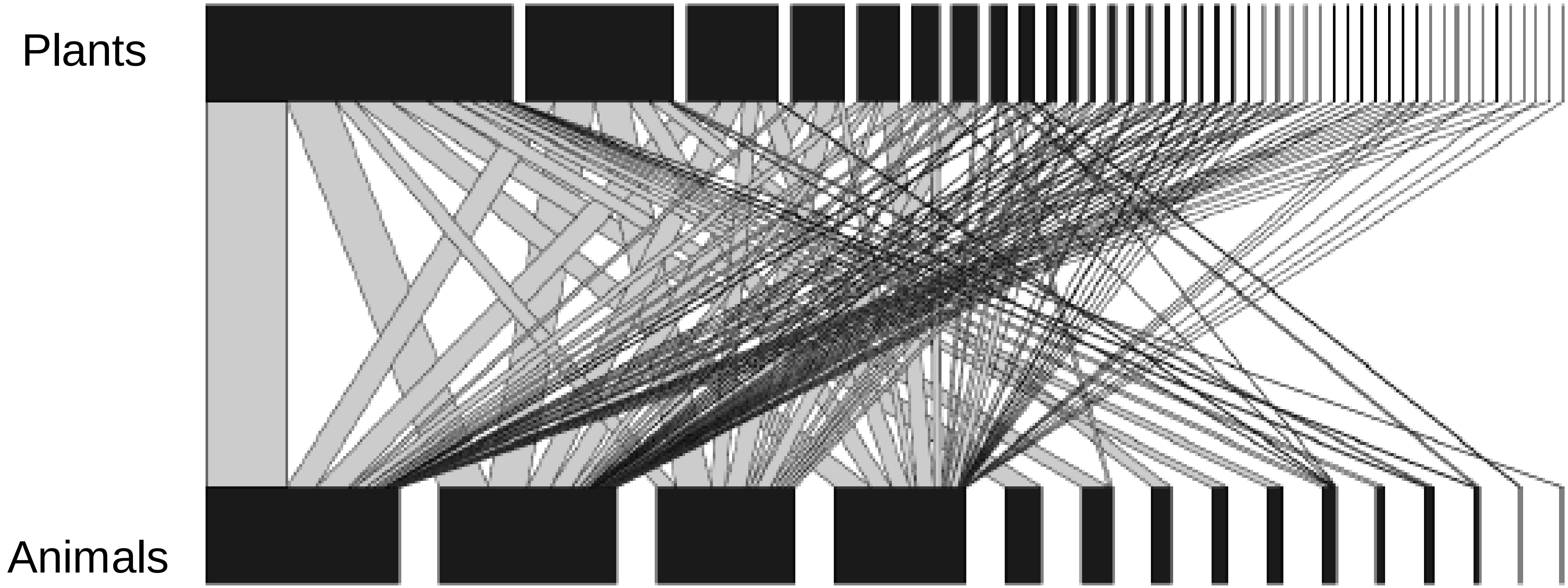




Successful Plant Invaders Have Most Dispersers



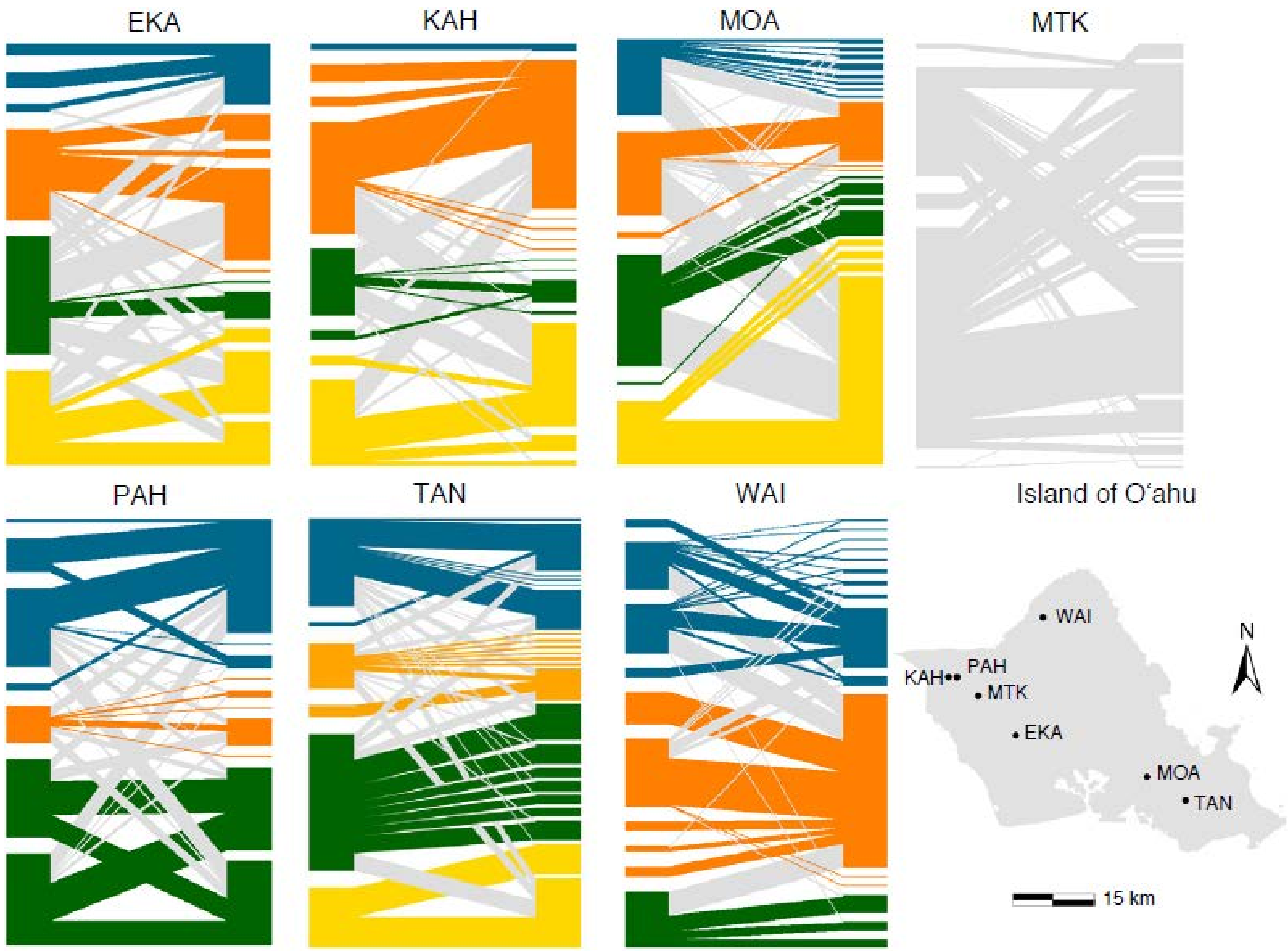
Seed Dispersal Networks are Nested



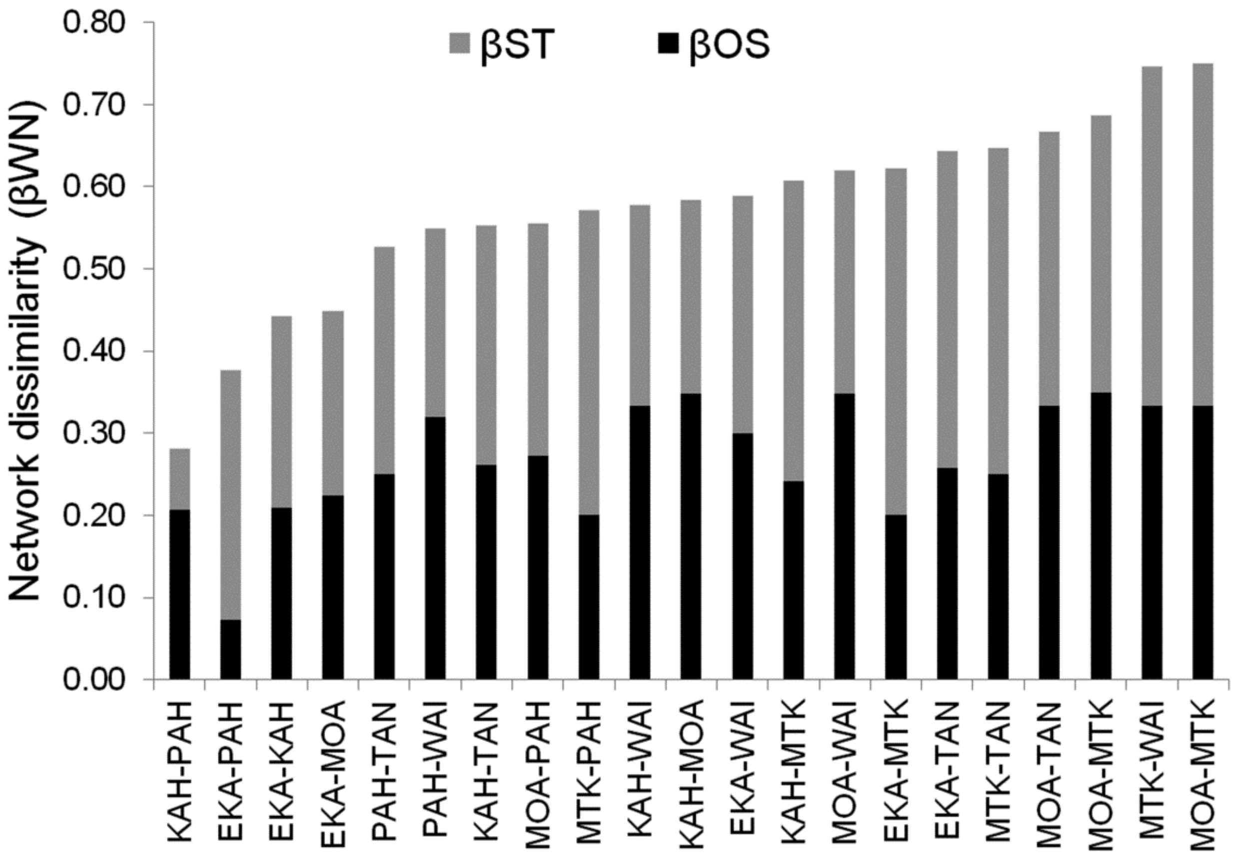
- Complex and specialized despite no interactions between native species

Seed Dispersal Networks are Modular

Networks Modular in 6 out of 7 Sites



Seed Dispersal Networks are Spatially Dynamic



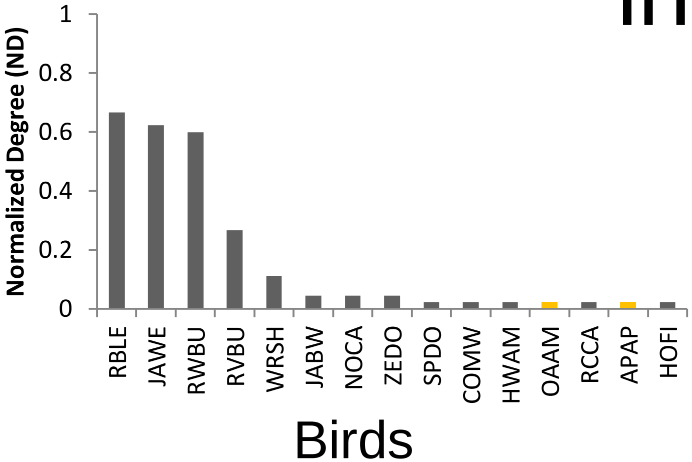
- Interaction dissimilarity among sites is 57%±11%
- Species are highly flexible to switch partners across sites

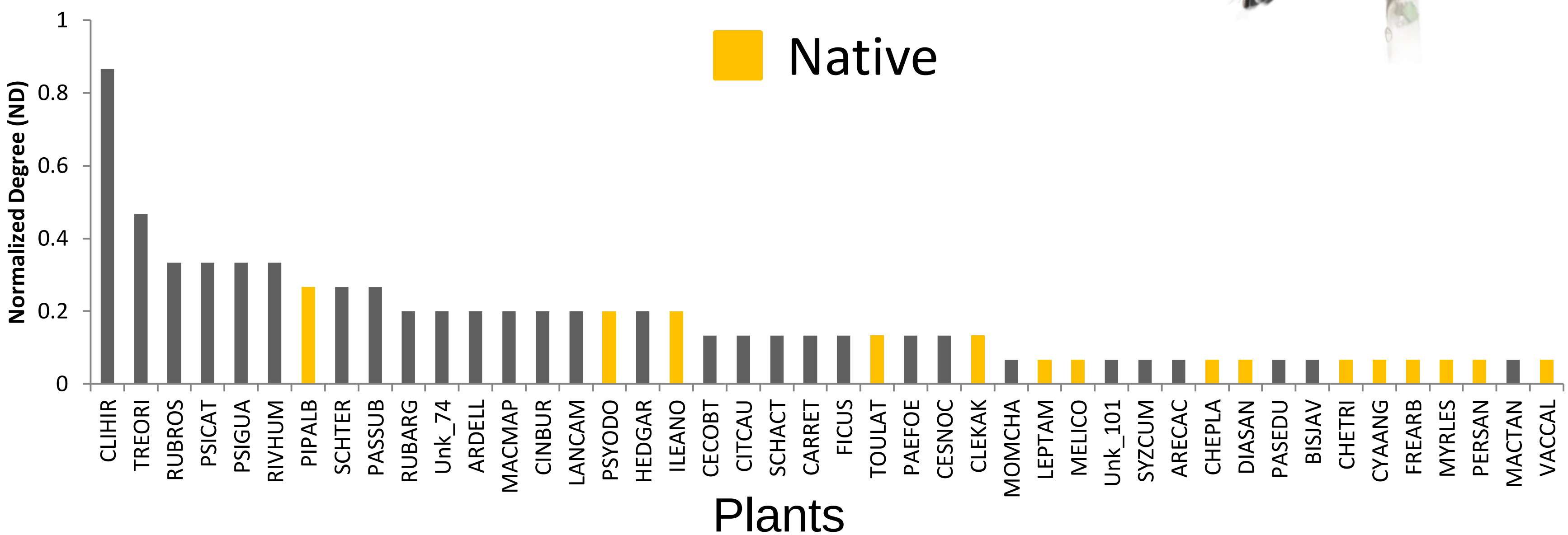
Climate Influences Interactions Indirectly via Effects on Species Distributions

Model	d.f.	logLik	AIC_c	ΔAIC_c	Weight
ΔElevation+ΔRainfall	4	27.90	-45.30	0.00	0.77
ΔElevation+ΔRainfall+ΔInvasion	5	28.31	-42.60	2.69	0.20

- Elevation (β = 0.39) and rainfall (β = 0.24) most influence dissimilarity

Introduced Species Play Core Roles in Networks





Seed Dispersal Networks Complex and Specialized Despite No Interactions Between Native Species

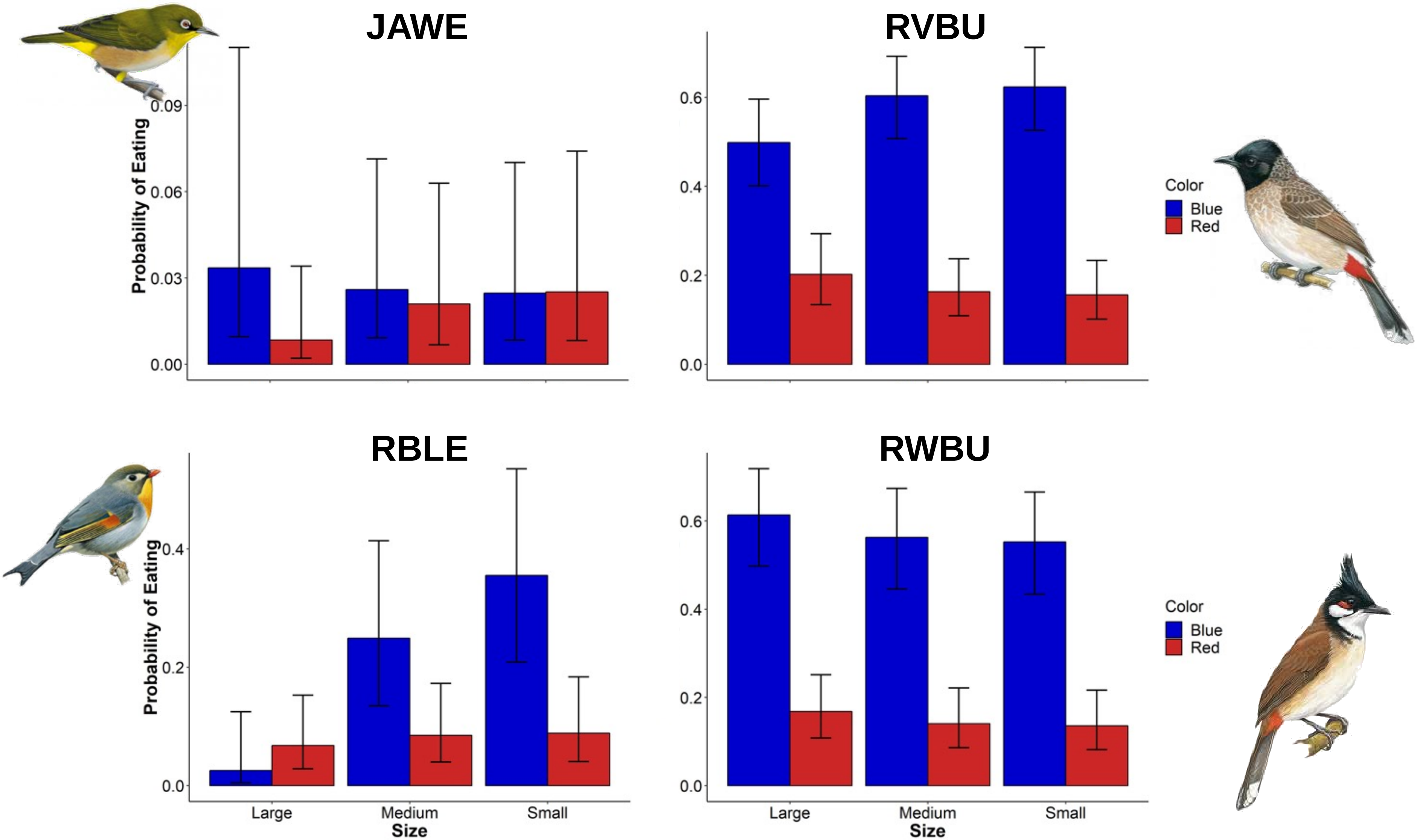
- Organization resembles native-dominated communities worldwide

Making a Choice

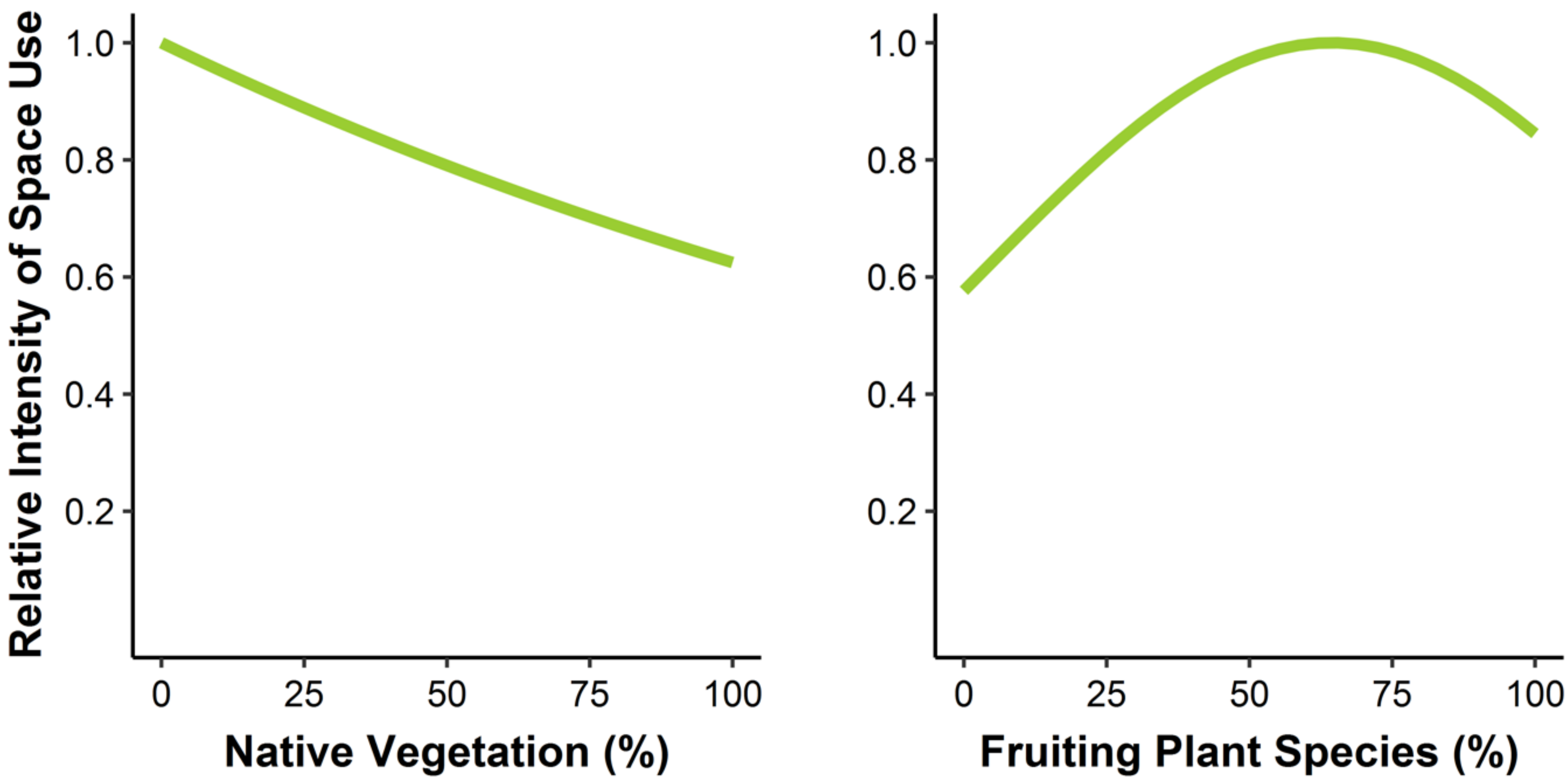
Full Preference Trials

- Fruit color: Blue vs. red
- Fruit size: Small, medium, large

Birds Prefer Blue Fruits



White-eyes Spend More Time in Exotic Habitats with High Number of Fruiting Plants



Conclusions

- Non-native birds are only dispersers of native plants
  - 100% of interactions are novel and 93% involve non-native fruits
- Novel networks present complex structure and specialization
  - Similar to native dominated communities worldwide
  - Core network species, both bird and plant, are all introduced
  - Non-native species show high diet flexibility and partner switching

Conclusions (Cont'd)

- Variation in bird communities across sites influenced by climate
- Non-native birds prefer small, blue fruits
- Bird species vary in space use, affecting seed deposition sites
- Extensive variation in all measured factors (e.g., sites, within and between species, interactions)

Benefits to DoD

- Management may take the following into account
  - Improve seed dispersal of threatened native plants by using bird flexibility to switch resources
  - Increase seed dispersal of other natives by planting highly attractive native plants (e.g., mamaki)
  - Identify non-native plant species that are likely to become increasingly problematic (e.g., *Trema*) for Army land managers
  - Determine buffer distances for eradication of new invasions (e.g., *Miconia*) based on potential dispersal distances
  - Identify endangered plant species that require human intervention for dispersal and germination (e.g., lobeliads)

For additional information, please visit

https://www.serdp-estcp.org/Program-Areas/Resource-Conservation-and-Resiliency/Natural-Resources/Pacific-Island-Ecology-and-Management/RC-2434

Speaker Contact Information

jeff.foster@nau.edu; 928-523-4008

Q&A Session 1

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Plants, Pollinators, and Invasive Predators in Hawai'i

Dr. Christina Liang
USDA Forest Service

Agenda

- Research focus and approach
- Results
- Conclusions and relevance

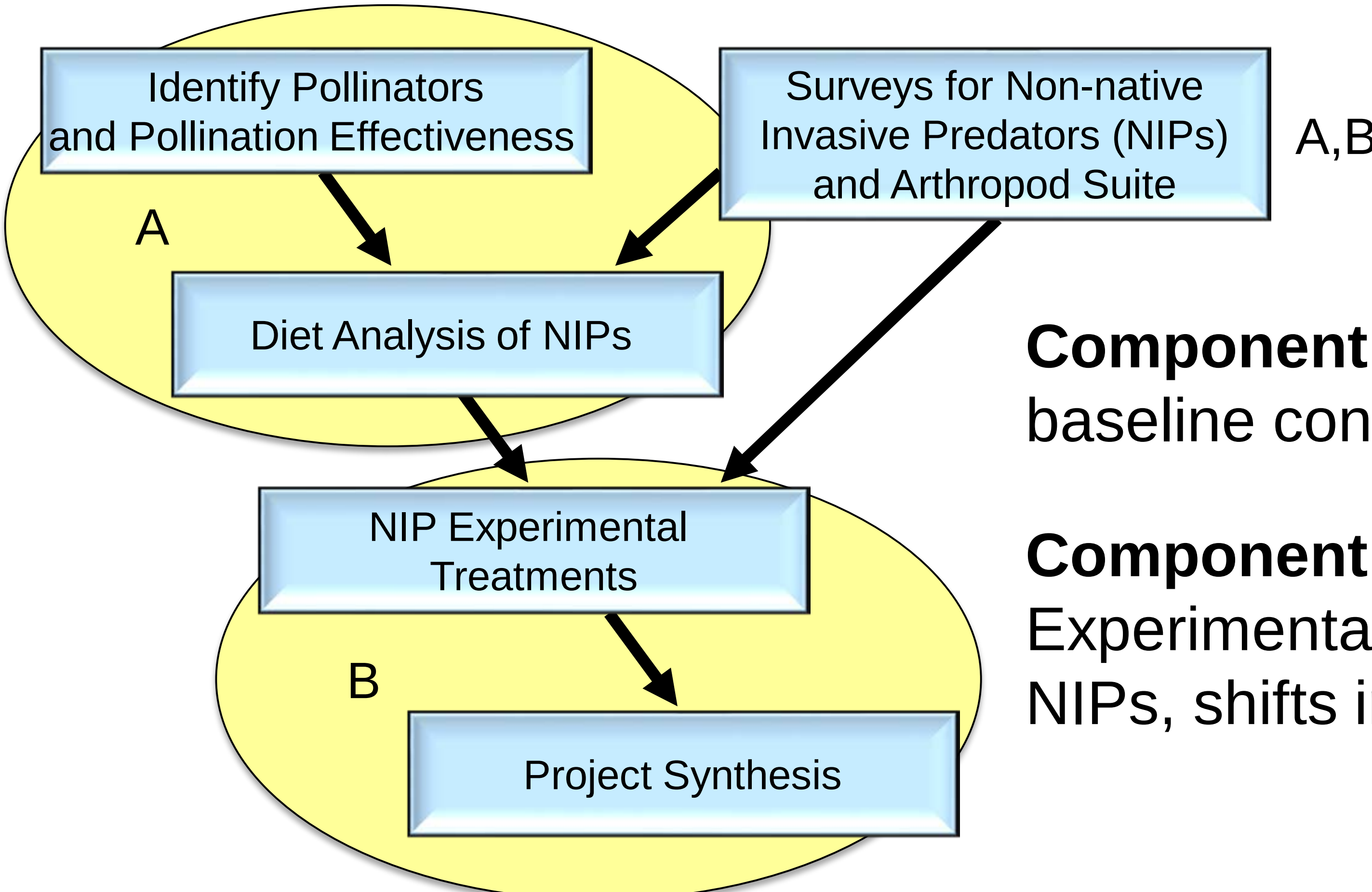
SERDP SON: *Recovery of Ecological Processes Impacted by Non-Native Invasive Species in the Pacific Islands*

- Effects of altered ecological processes
- Implications of management actions, particularly for TER-S (Threatened, Endangered, and At-Risk Species)

Research Focus

- Pollination services in a highly invaded Hawaiian ecosystem
  - Pollination studies → direct relationship between pollinators and TER-S plants
  - Predator diets → direct relationship between invasive predators and pollinators
  - Predator control → indirect relationship between predators and native plants

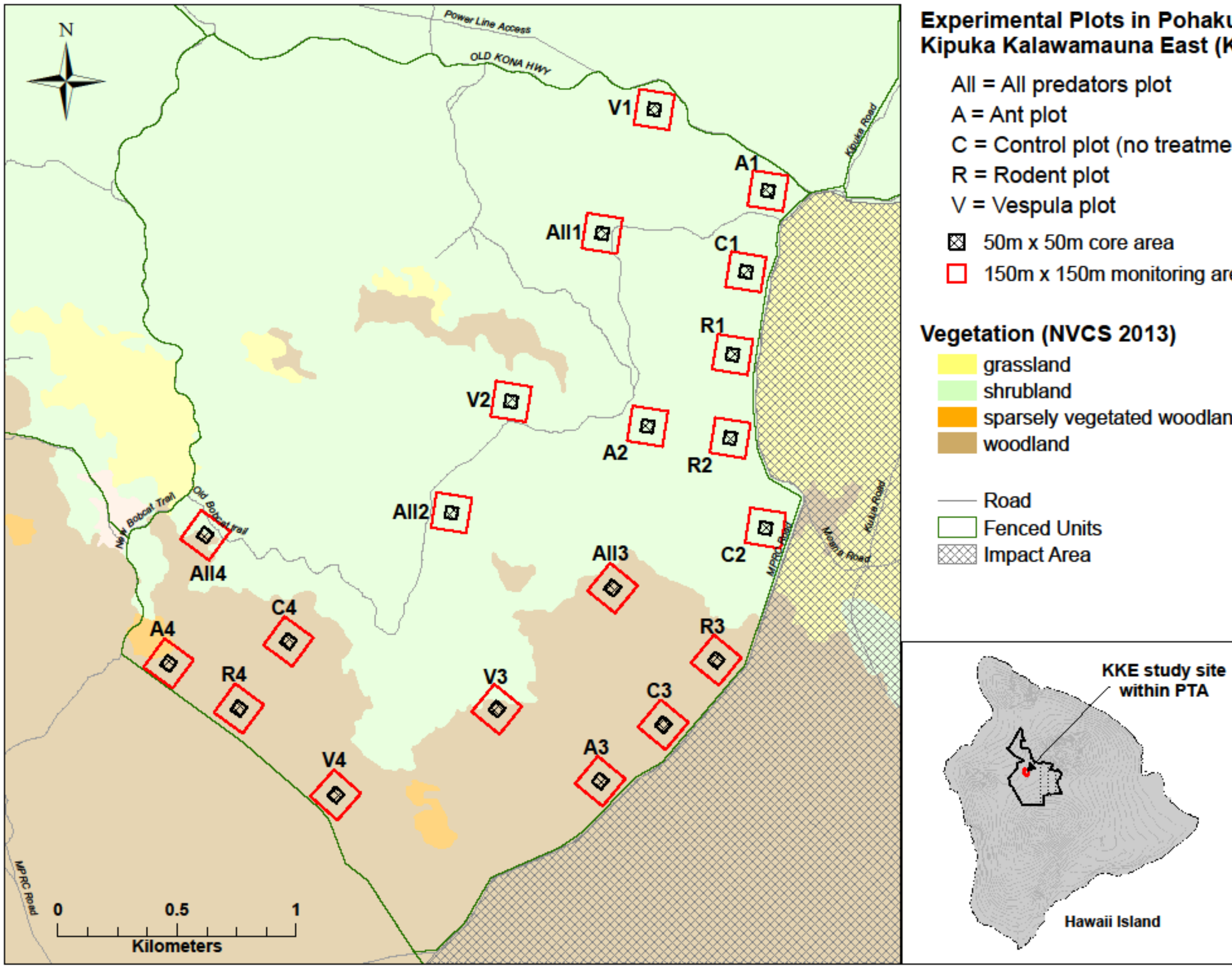
Research Approach

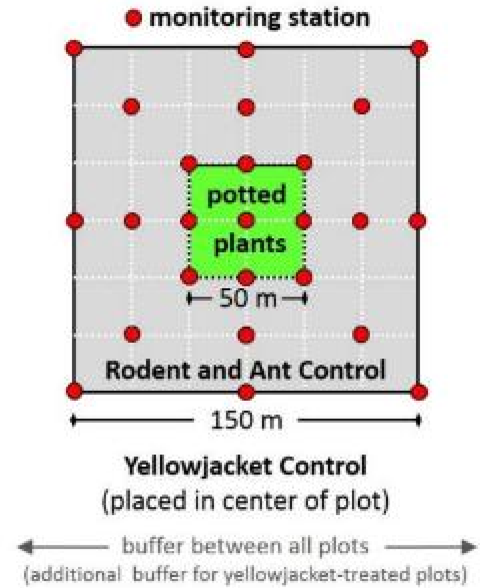


Component A: Current baseline conditions

Component B: Experimental removal of NIPs, shifts in pollination

Experimental Plots

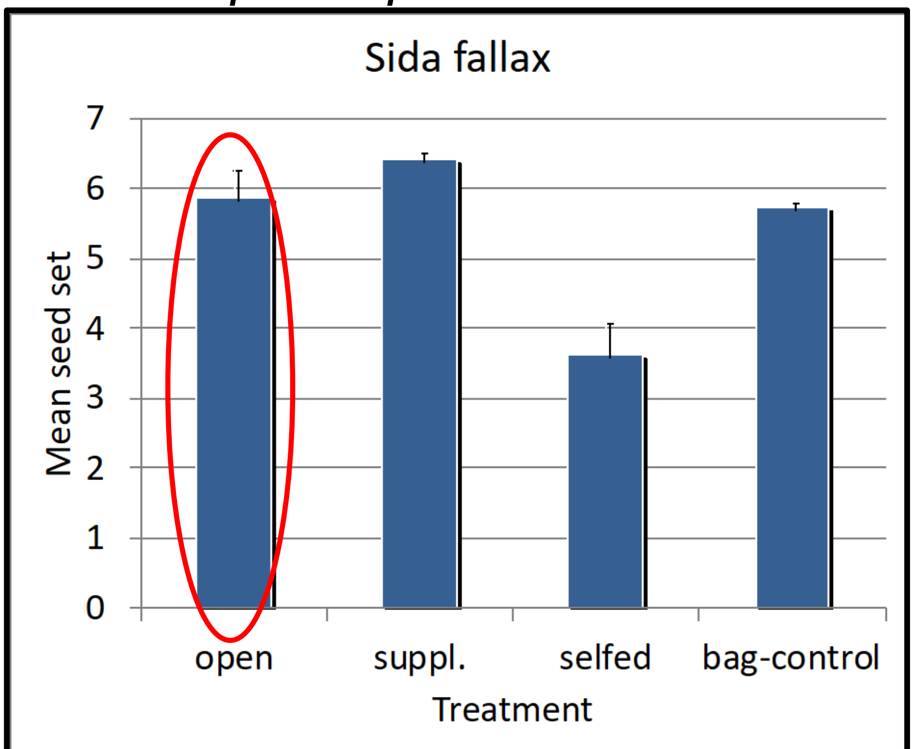




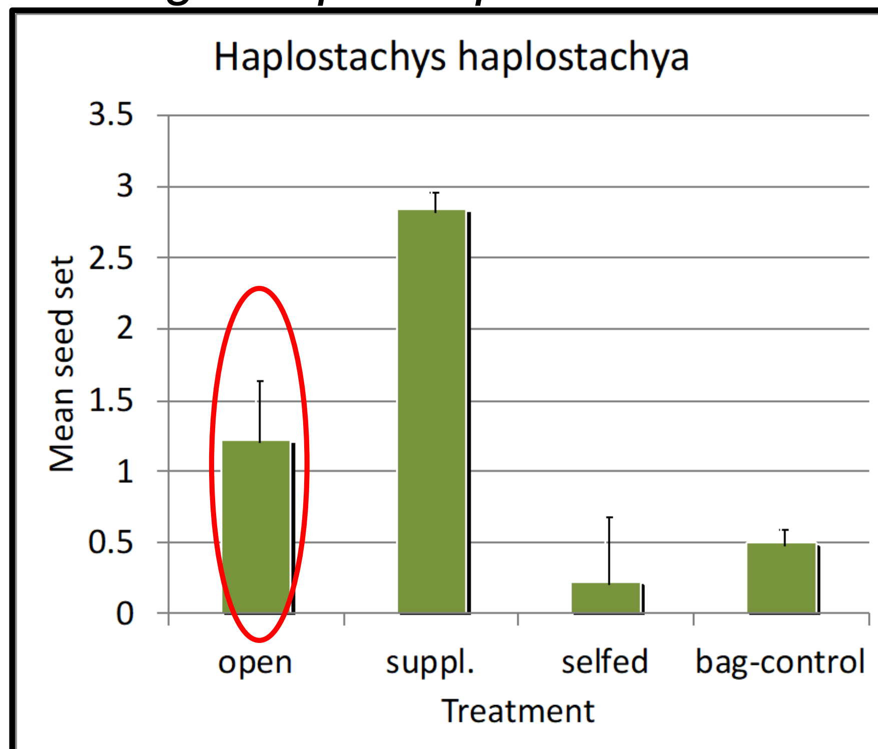
Baseline Pollination Effectiveness

- Endangered plants are more pollen limited than common plants

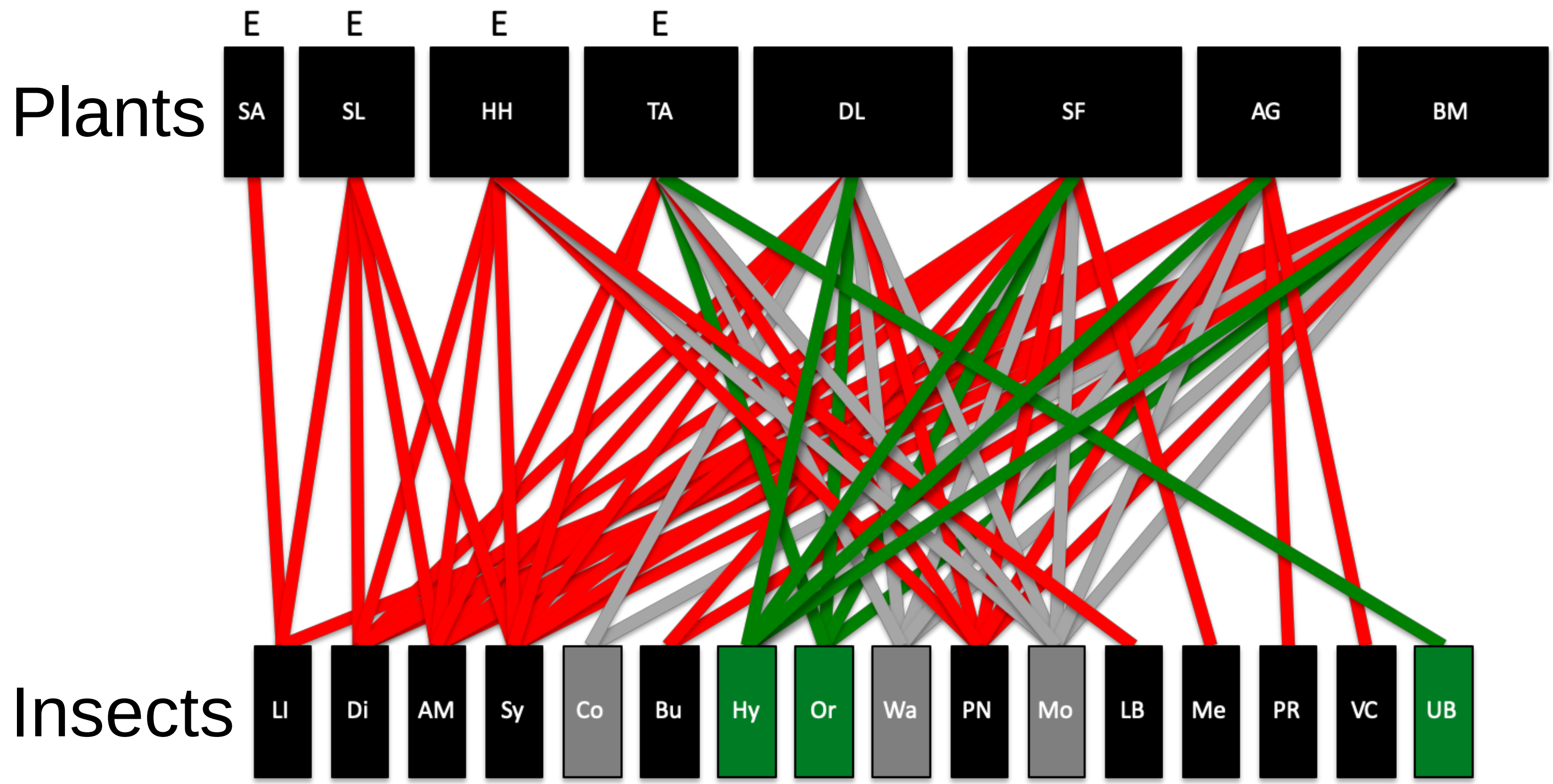
Common plant species:



Endangered plant species:



Baseline Pollinator Identification



E = Endangered species
Red = Non-native insects
Green = Native insects
Gray = Insects of indeterminate origin

- Effort = 576.36 hours of flower observations

Baseline Pollinator Importance

- Non-native flower visitors were the most important pollinators for 6 of 8 plant species

Most important for common plants

Non-native visitors



Most important for endangered plants

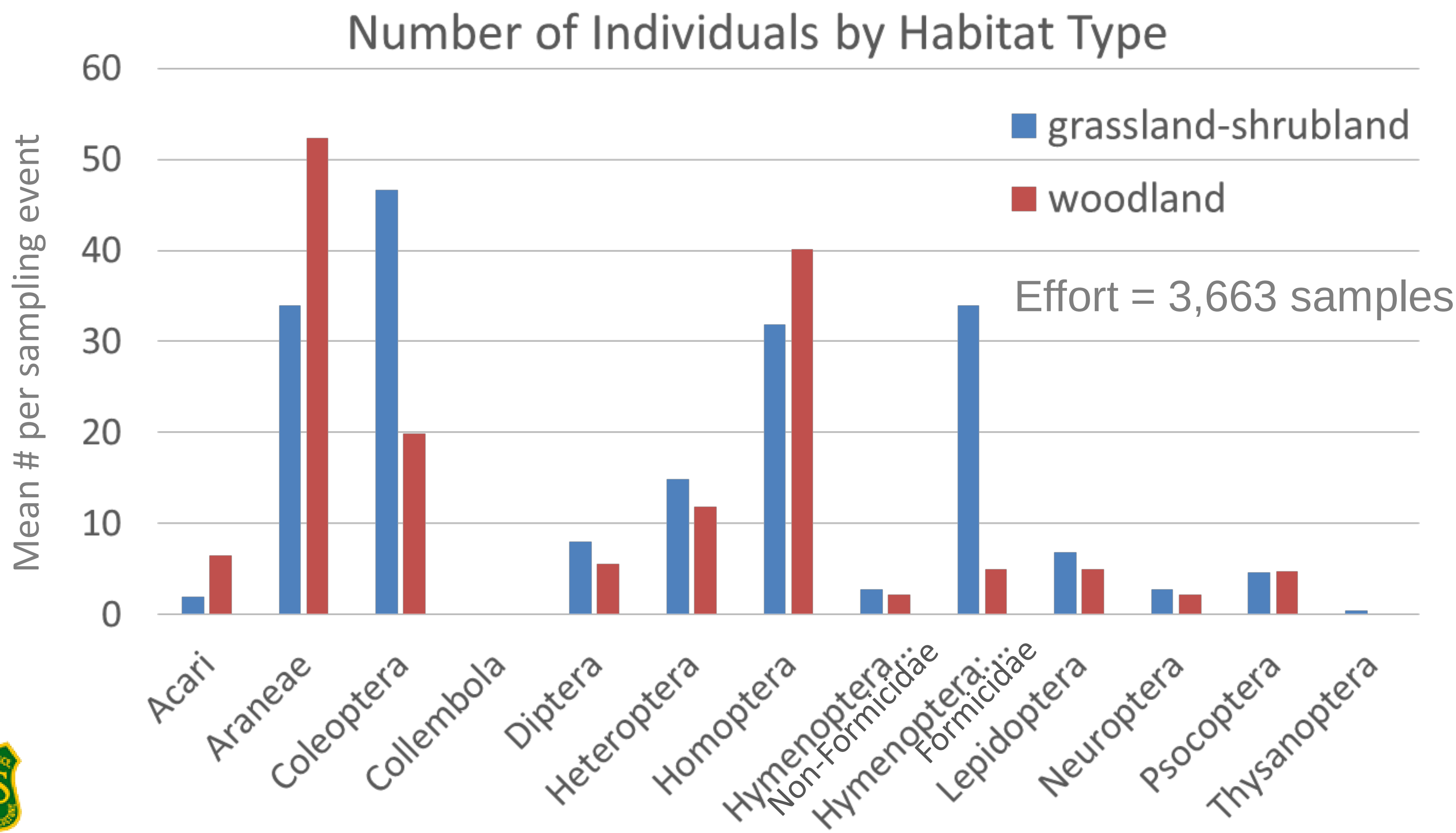
Non-native visitors



Native visitor

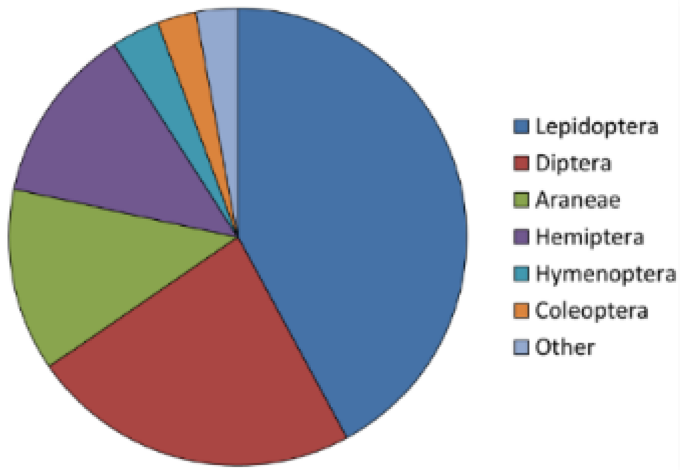
Photo credits: Alvesgaspar, S. Sepp, David Anderson, Gail Hampshire, Starr Environmental

Baseline Arthropod Monitoring

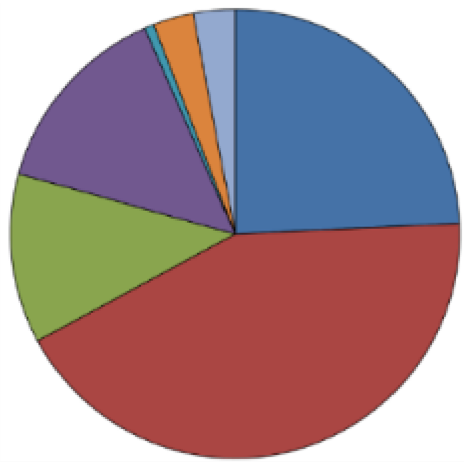


Predator Diet Analyses

House mouse

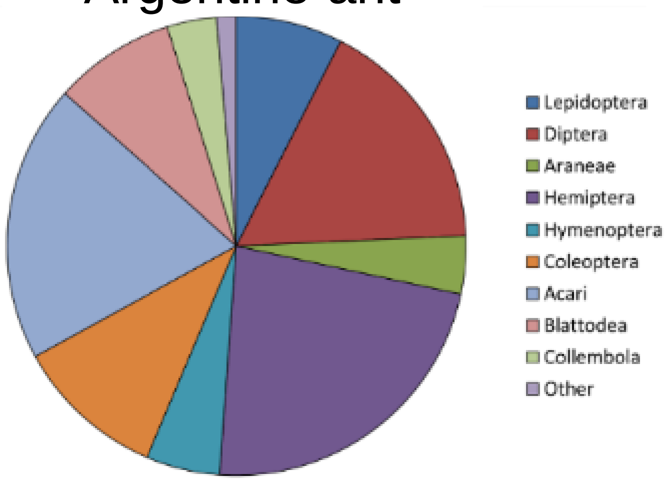


Black rat

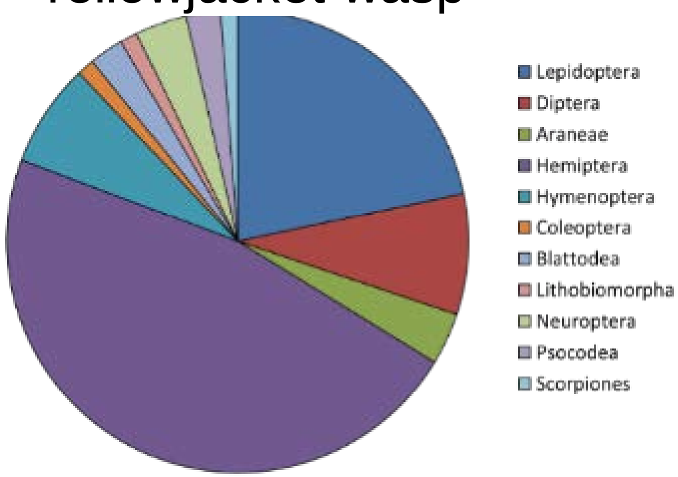


Predators are eating insect pollinators

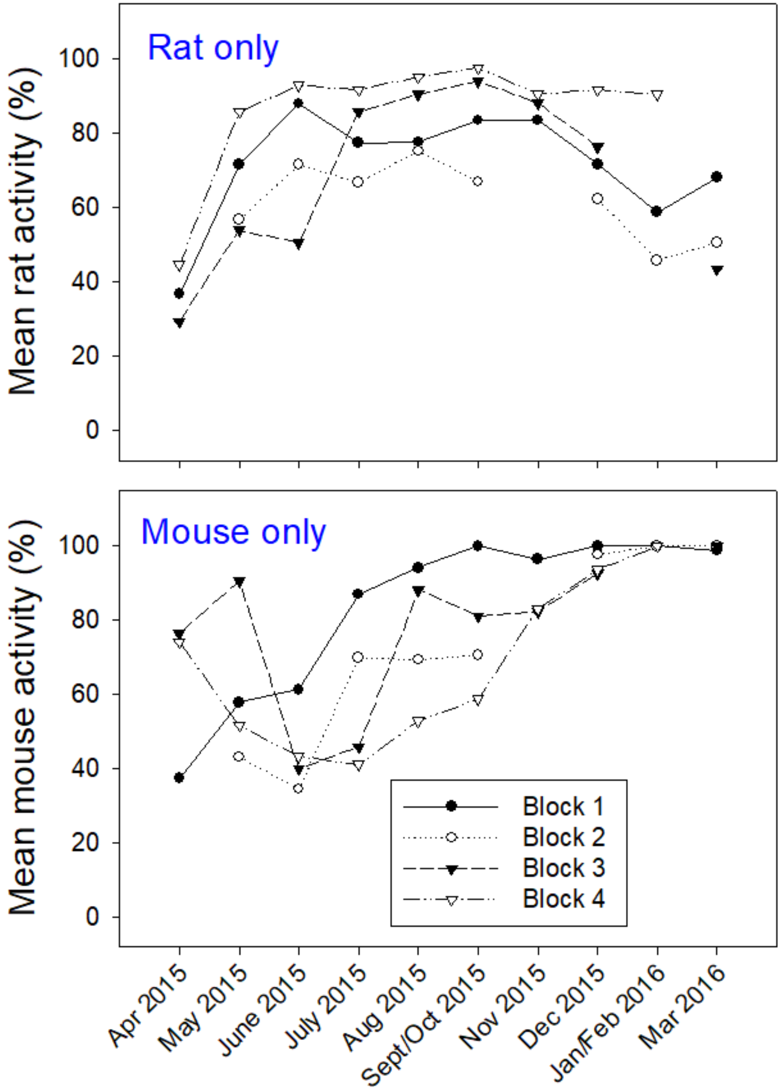
Argentine ant



Yellowjacket wasp

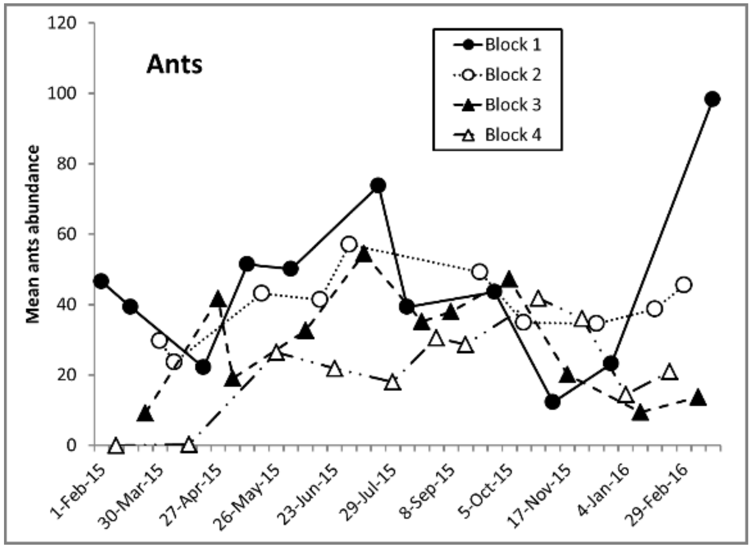


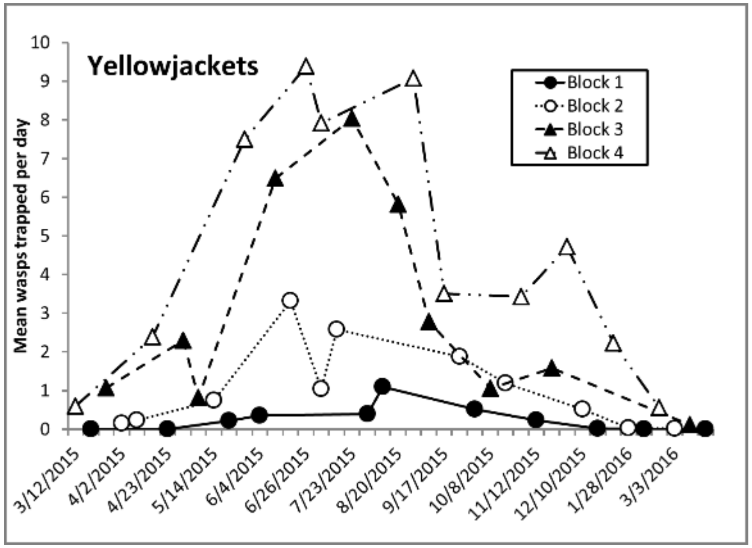
Baseline Predator Monitoring



Predator numbers fluctuate over time and space

Baseline Predator Monitoring

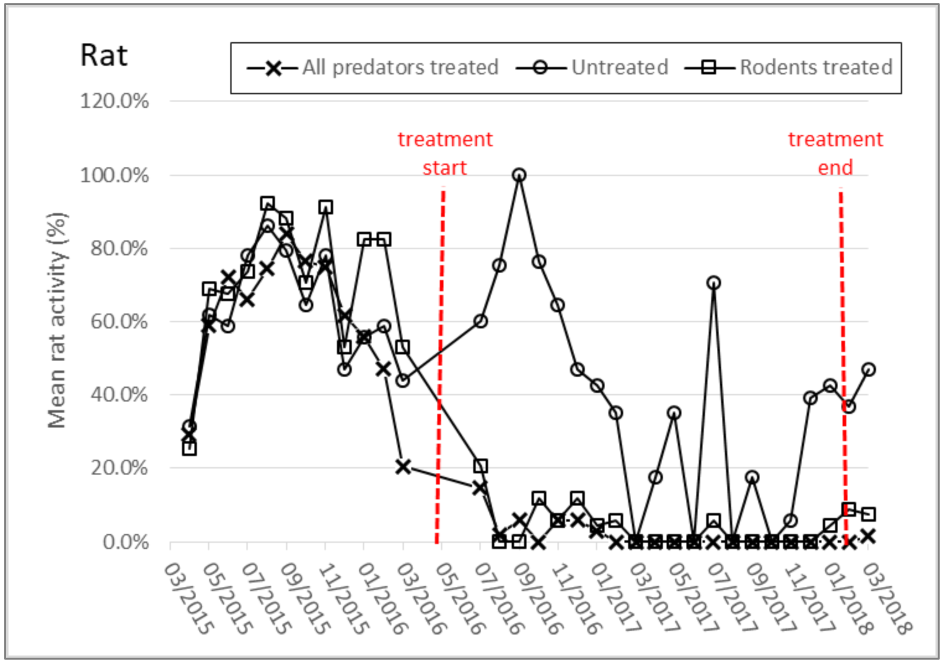


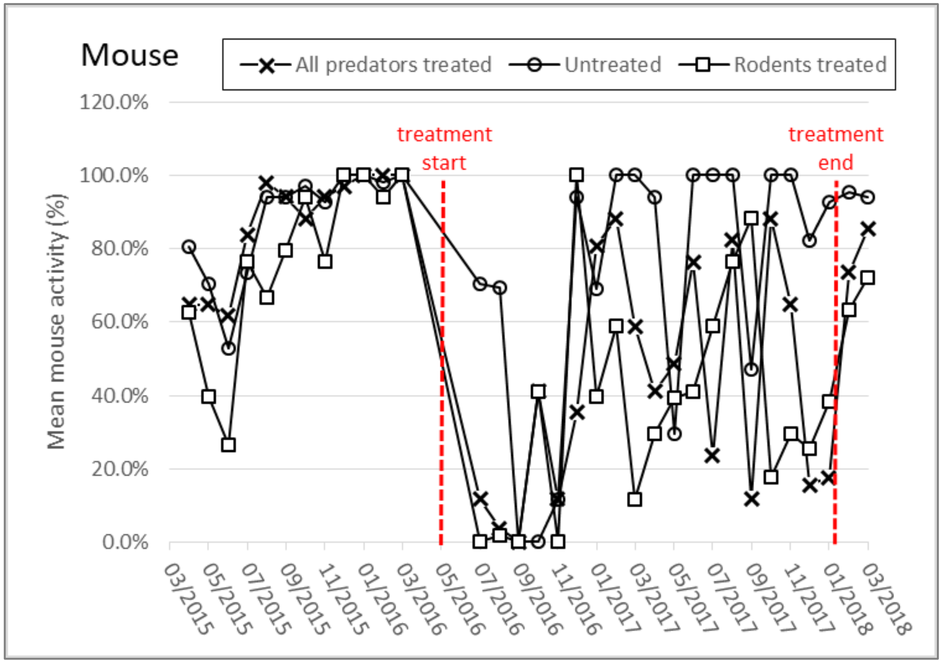


Predator numbers fluctuate over time and space

Experimental Rodent Control

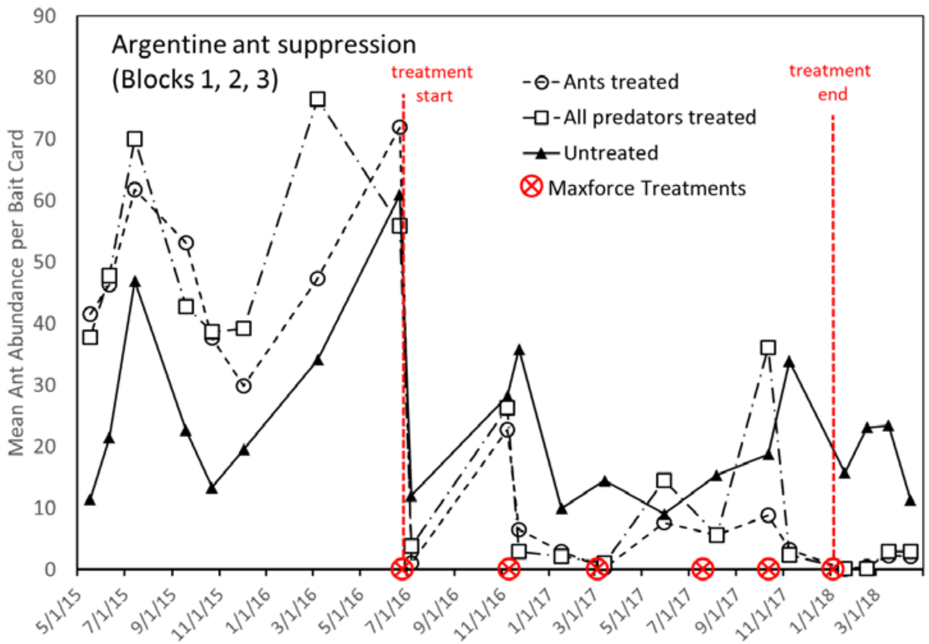
- Rats were suppressed but not mice

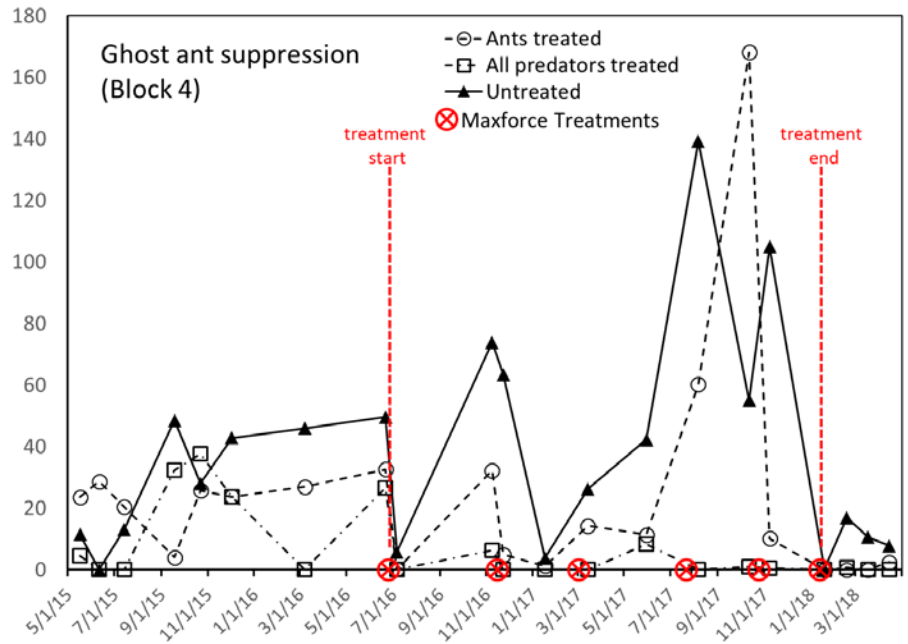




Experimental Ant Control

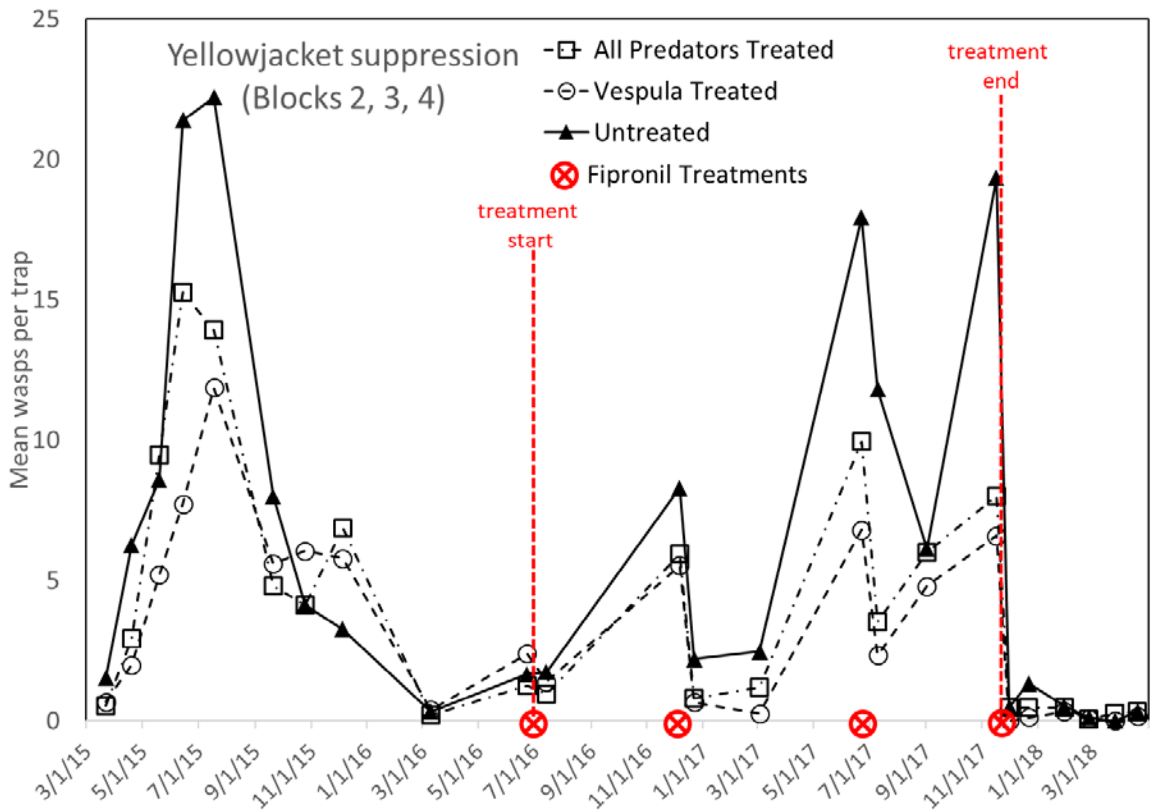
- Argentine ants were suppressed but not ghost ants





Experimental Yellowjacket Control

- Yellowjackets were not consistently suppressed

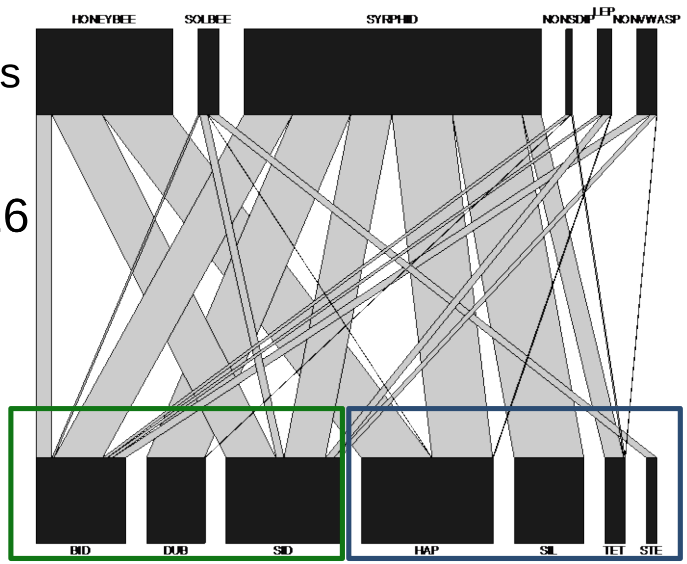


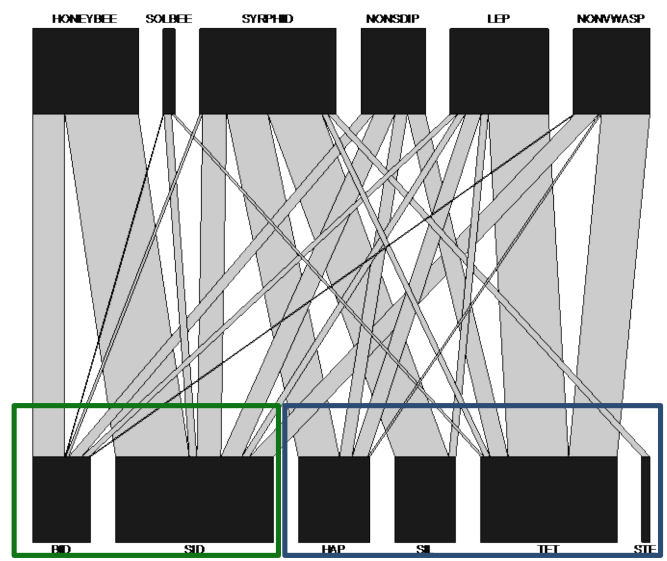
Experimental Pollination Networks

Pollinators

August 2016 – January 2017

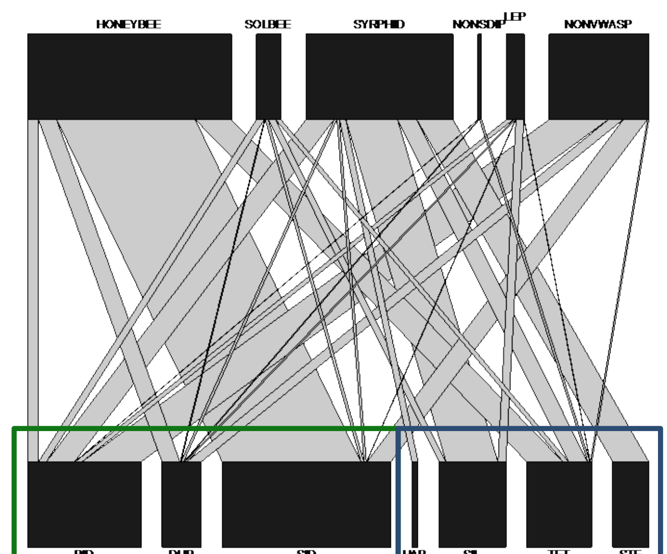
Plants





February – June 2017

Pollination networks in 3 time periods



Pollinators

July – November 2017

Plants

Effects of NIPs on Networks

How does the frequency of predators affect <u>pollination communities</u>?

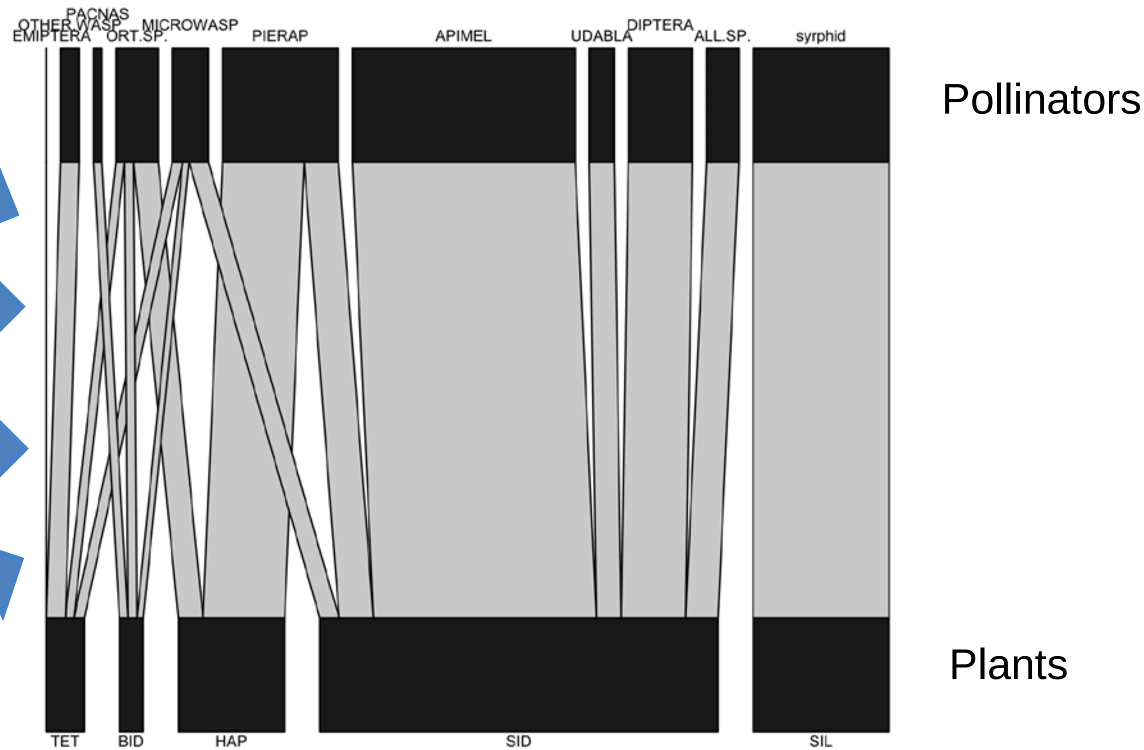


Photo credits: black rat – CSIRO; argentine ant – Penarc; yellowjacket – JL Boyer

Pollination Network Measures

	Hypothesis	Ants	Wasps
Number of pollinator species	↓	↓	
Shannon diversity of interactions	↓		↑
Shannon evenness of interactions	↑		↑
Weighted connectance	↑		

	Hypothesis	Ants	Wasps
Plants per pollinator	↑		
Pollinators per plant	↓		↑
Niche overlap	↑		

↑ (blue) Hypothesized direction with higher number of predators

↑ (red) Experimental results

- More ants → fewer pollinator species
- More yellowjackets → pollinators are more generalist
- No effect of rats or mice on networks

Predator-Pollinator Model

Frequencies

Ant Yellowjacket Mouse Rat

Frequency **Relationships**

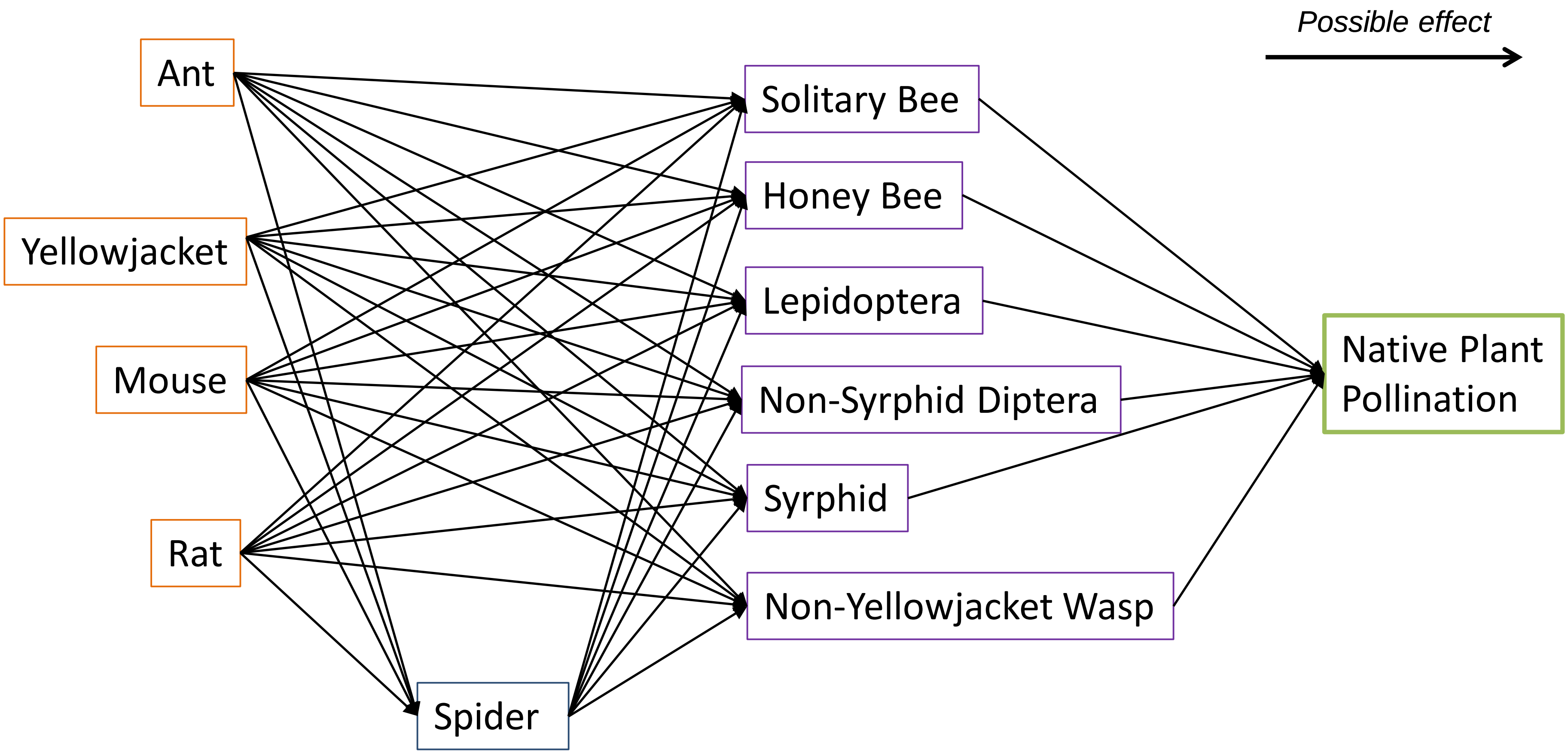
Spider = A1 * Ant + A2 * Yellowjacket + A3 * Mouse + A4 * Rat

Frequency or PVI **Relationships**

Pollinator = A1 * Ant + A2 * Yellowjacket + A3 * Mouse + A4 * Rat + A5 * Spider

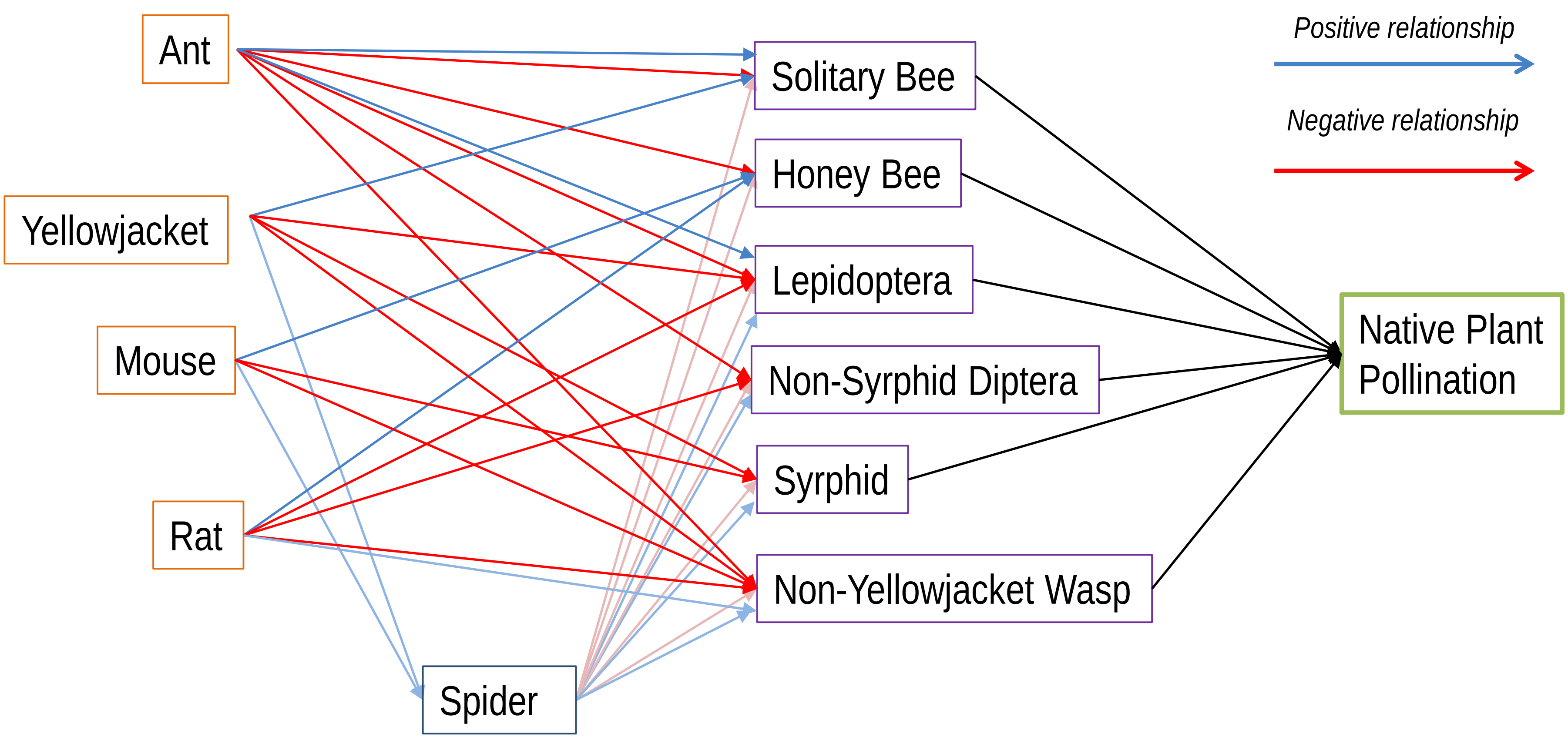
Hypothetical Interactions

How do NIPs affect pollination services and native plant reproduction in Hawai'i?



Experimental Results

- Relationship between NIPS and pollinators



Plants-Pollinators-Predators

	Bidens	Haplostachys (E)	Sida	Silene (E)	Tetramolopium (E)
Solitary bees	Ants (-)	Ants (+)	---	---	Ants (-)
Honey bees	Rats (+)	---	---		Mice (+) Ants (-)
Moths and butterflies	Ants (-) Wasps (-)	---	Wasps (-)	Rats (-) Ants (-) Wasps (-)	Rats (-) Ants (+)
Non-syrphid flies	---	Rats (-) Ants (-)	---		---
Syrphid flies	---	---	Mice (-)	Wasps (-)	---
Non-vespid wasps	Ants (-) Wasps (-)	Rats (+) Ants (-) Wasps (-)	Mice (-) Rats (-) Wasps (-)		Wasps (-)

Conclusions

- Pollination differs for threatened vs. common plant species
  - Endangered species are more pollen limited
- Pollinator interactions are localized
  - Variation in time and space
- Predators can affect pollination
  - Network measures, modelled relationships
- Predator control is initially effective
  - Continuous effort is necessary

Benefits to DoD

- Elimination of ants, yellowjackets, and rats could assist in recovery of plants at PTA
  - Including endangered species
- Rats but not mice can be effectively suppressed
- Ants can be suppressed for short time periods
- Yellowjackets are difficult to control

Acknowledgements

- Co-PIs: Clare Aslan (NAU), William Haines (UH Mānoa), Aaron Shiels (USDA APHIS), Manette Sandor (NAU post-doc)
- PTA NRO staff
  - Joy Anamizu, Edna Buchan, Rogelio Doratt, Steve Evans, Dan Jansen, Nikhil Inman-Narahari, Kathleen Kawakami, Pomai Lyman, Rachel Moseley, Peter Peshut, Jonathan Raine, Lena Schnell, and Pamela Sullivan
- Field staff and greenhouse staff
  - Asa Aue, Heather Coad, Bryce Colby, Mary Donofrio, Jordan Felt, Kaitlyn Jacobs, Christian King, Joey Latsha, Israel Leinbach, Tom McAuliffe, Lindsey Perry, Martha Sample, Dean Sedgwick, Josh Smith, Alison Wagner, Taylor Warner, Taite Winthers-Barcelona; Kim Dillman, Jaime Enoka, Patrice Moriyasu

For additional information, please visit

https://www.serdp-estcp.org/Program-Areas/Resource-Conservation-and-Resiliency/Natural-Resources/Pacific-Island-Ecology-and-Management/RC-2432

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Q&A Session 2

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The next webinar is on September 5, 2019

The Use of Advanced Molecular Biological Tools in Groundwater Contaminated with Chlorinated Solvents

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