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Seed Dispersal Networks and Novel Ecosytem Functioning in Hawaii

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25 YEARS OF ESTCP

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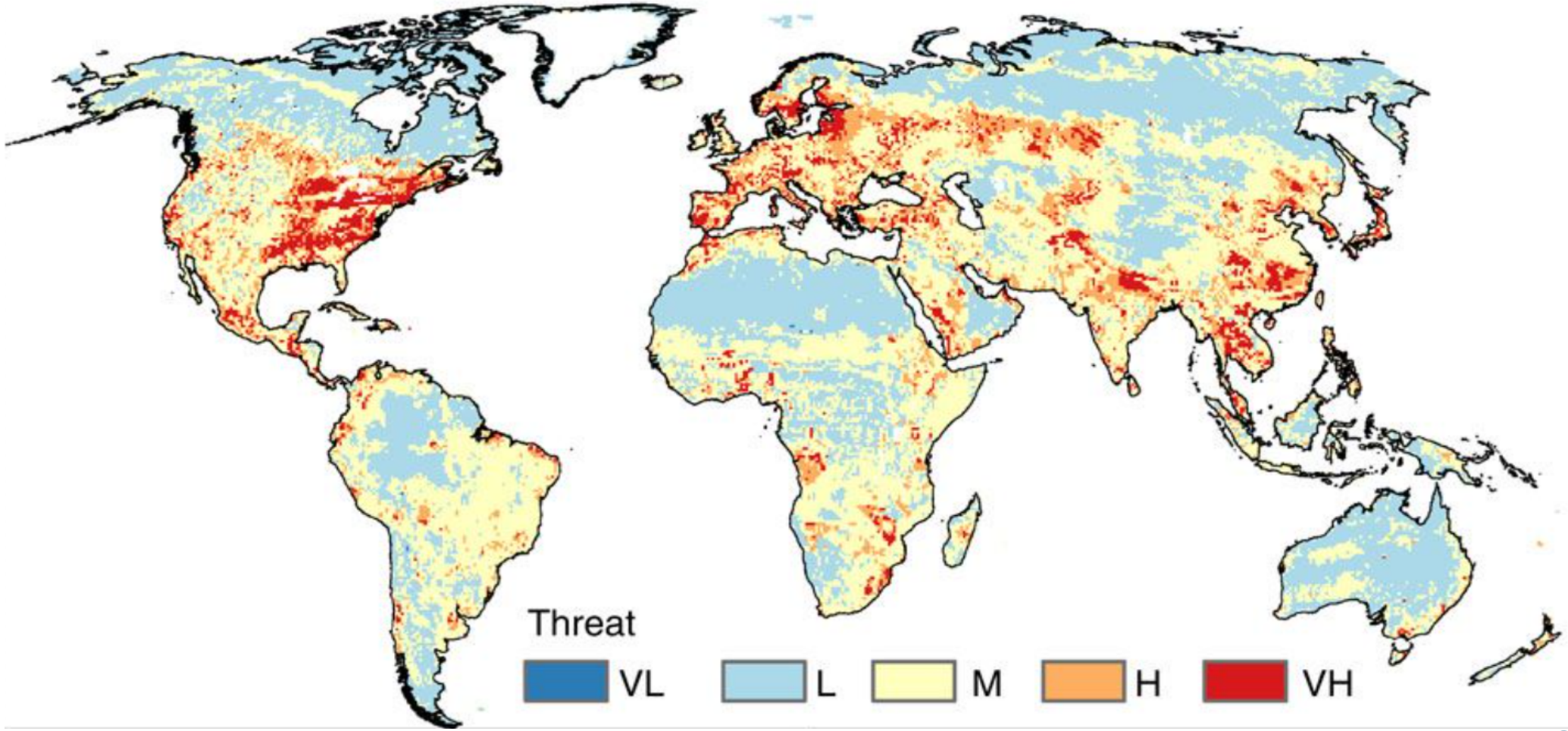
2019 | Enhancing DoD's Mission Effectiveness

Global Movement and Spread of Species



Early et al. 2016; Nature Comm.

Hawaii Archipelago

Extinctions (in past 200 years)

Birds: ~28 species

Plants: >100 taxa

Introductions

Birds: 55 species naturalized

Plants: >860 naturalized

US Army Garrison Hawaii

#	Military Base
1	Air Station Barber's Point
2	NavMag Pearl Harbor
3	Schofield & Wheeler
4	Helemano Military Reservation
5	Naval Computer & Telecommunications Area Master Station Pacific
6	Joint Base Pearl Harbor-Hickam
7	Camp Smith
8	Fort Shafter & USCG Base Honolulu
9	Kaneohe Bay Marine Corps Air Station
10	Bellows Air Force Station

O'ahu Army Natural Resources Program

USAG-HI: 133 TESC Species

Native Plants Dependent on Birds

Native Extinctions and Non-native Introductions

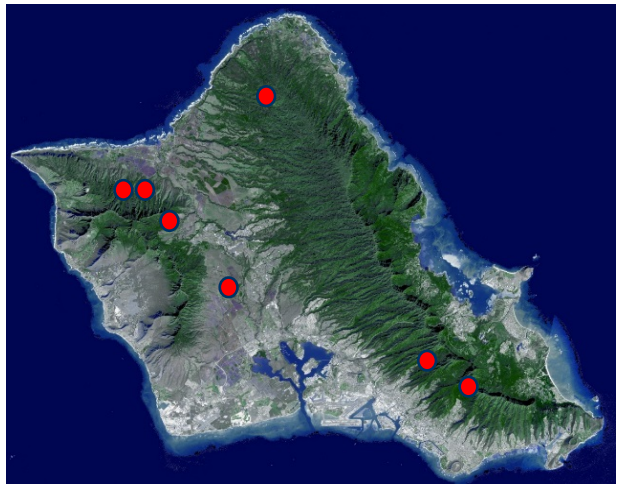
Extinctions

Introductions

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

Seed dispersal networks and effectiveness

Bird-plant interactions
- Identify partners
- Frequency



Landscape traits
- rainfall
- elevation
- vegetation characteristics

Disperser traits
- Local abundance
- Degree of frugivory
- Body size
- Bill size and shape

Plant traits (fruit & seed)
- abundance
- phenology
- nutrition

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Seed Dispersal Networks: Field Methods

Bird-plant interactions

- Mist-netting (fecal)
- Game cameras

Plant and bird traits

- phenology (surveys and seed rain traps)
- abundance (point counts and transect surveys)
- morphology (bird and fruit)
- nutrition (lipid, carbs, protein)

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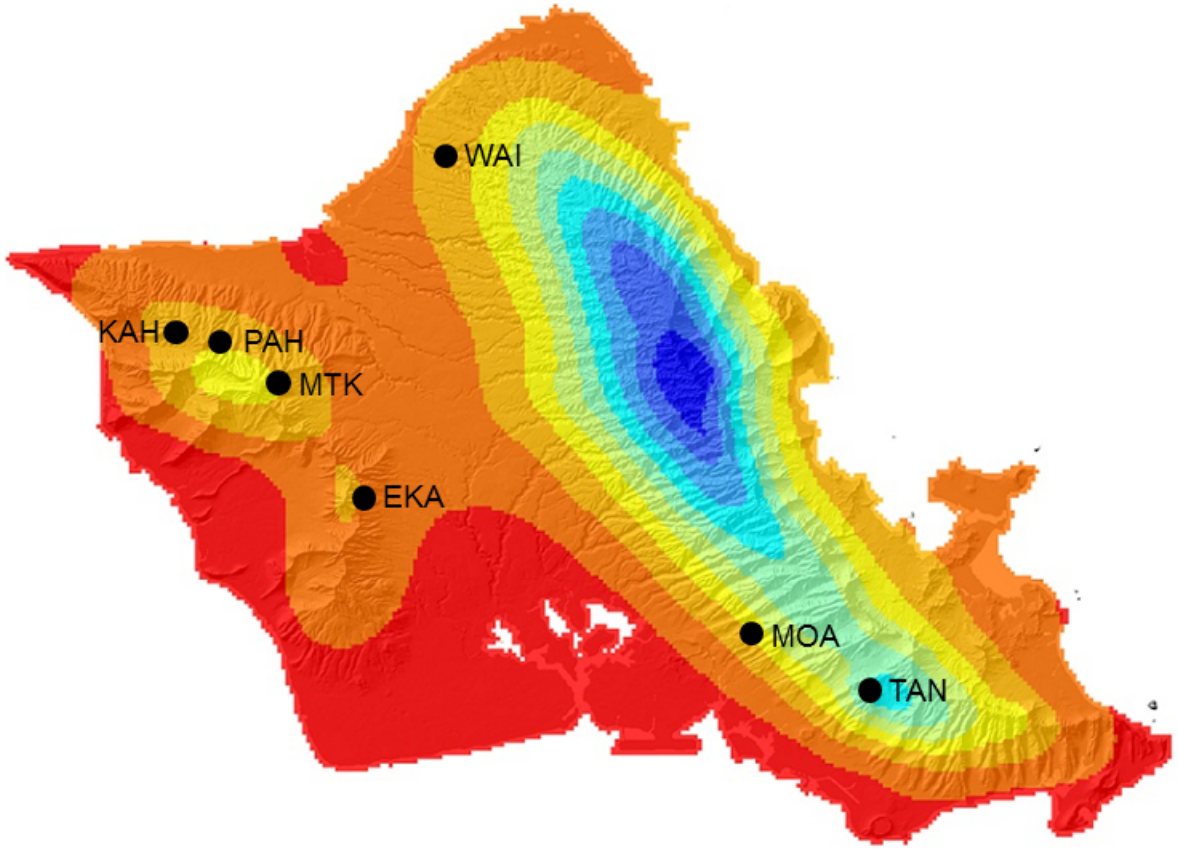
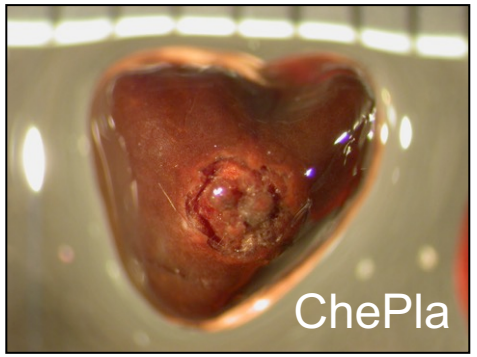
7 Field Sites: Elevation & Rainfall Gradient

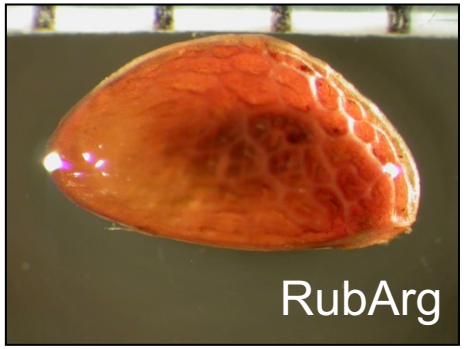


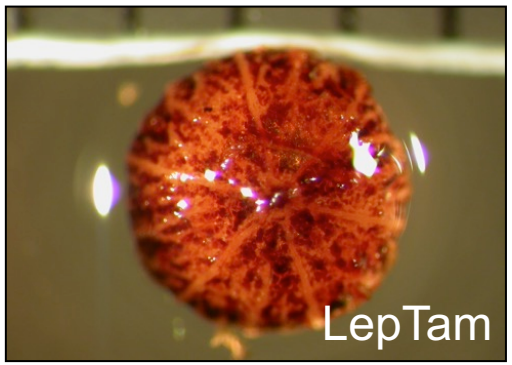
Site	Acronym	Elevation (m)	Rainfall (mm)
Ekahanui	EKA	467	1107.8
Kahanahaiki	KAH	667	1345.8
Moanalua	MOA	108	1884.4
Mount Kaʻala	MTK	1206	1953.7
Pahole	PAH	594	1533.5
Tantalus	TAN	549	3386.1
Waimea Valley	WAI	190	1732.9

Bird-Fruit Interactions: Fecal samples & Game Cameras

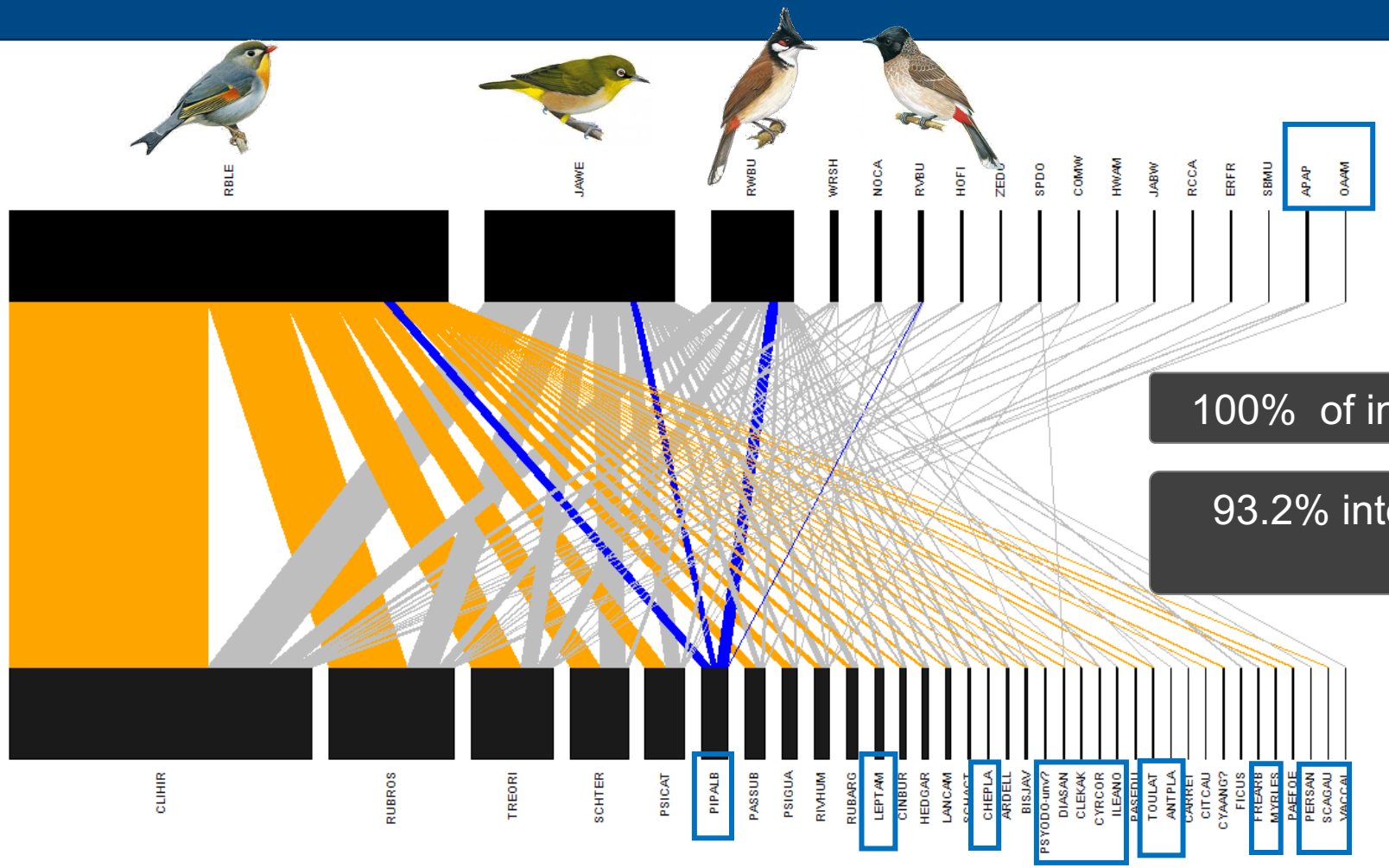
Sorted 3438 avian fecal samples (seeds in 43%)
27 bird species (18 carried seeds)
56 plant species (26 native)







Seed dispersal networks

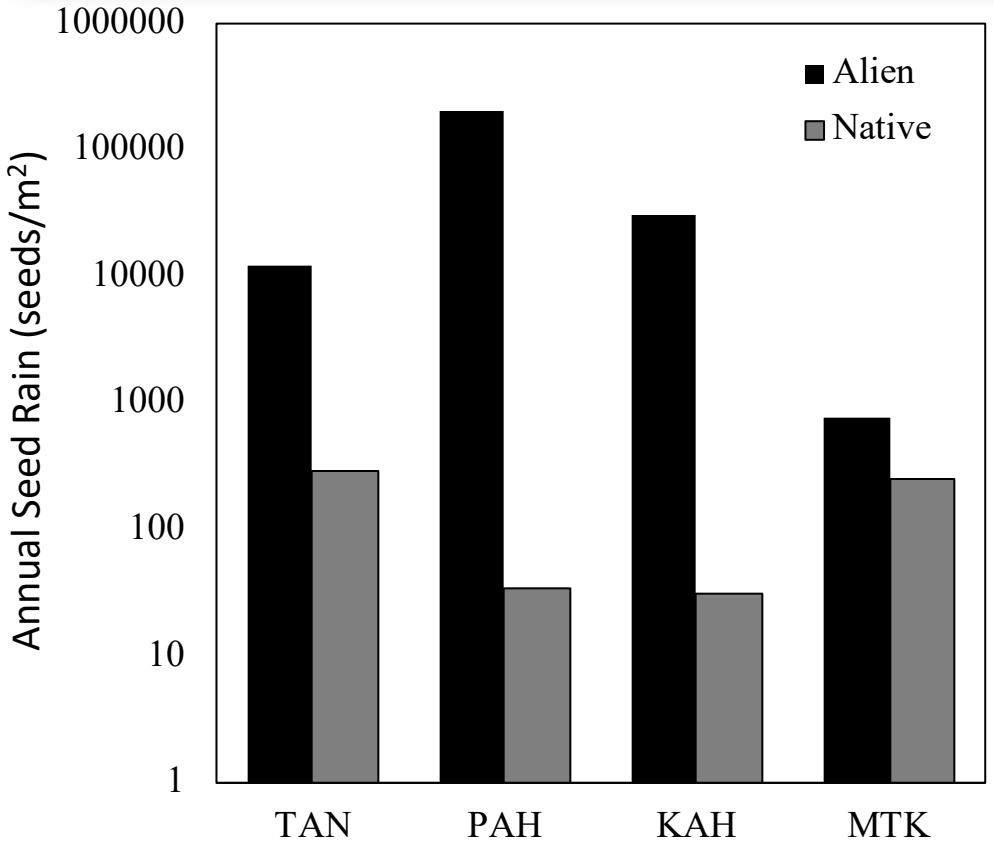


100% of interactions are novel

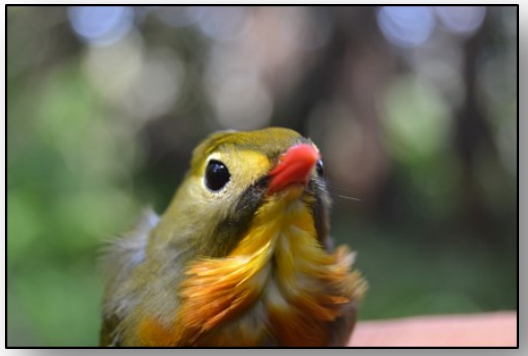
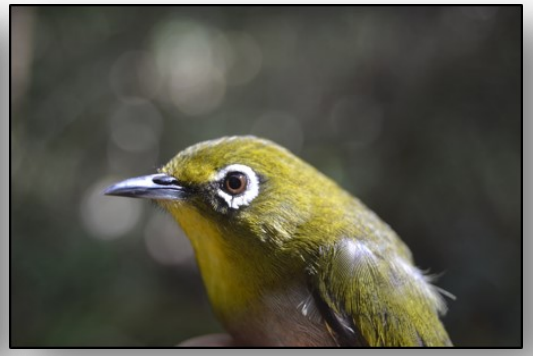
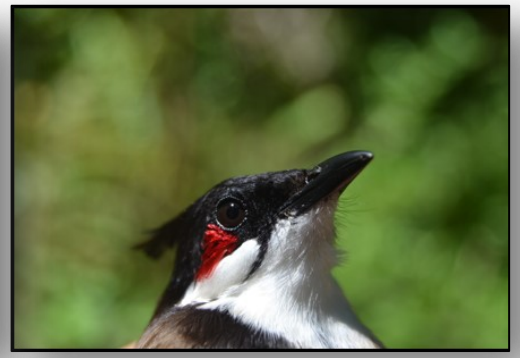
93.2% interactions with alien seeds

Dispersal of non-native plants by non-native birds

Majority of seeds in seed rain traps are non-native (1.6 million seeds counted)



Primary seed dispersers in network


Time since invasion

Red-billed leiothrix

(Leiothrix lutea)

- 1928 from SE Asia
- Experience pop. fluxes
- 84-96% fecal samp. w/ seeds

Japanese white-eye

(Zosterops japonicus)

- 1929 from East Asia
- Widespread & abundant
- 45-92% fecal samp. w/ seeds

Red-whiskered bulbul

(Pycnonotus jocosus)

- 1965 from SE Asia
- Expanding into highlands
- >90% fecal samp. w/ seeds

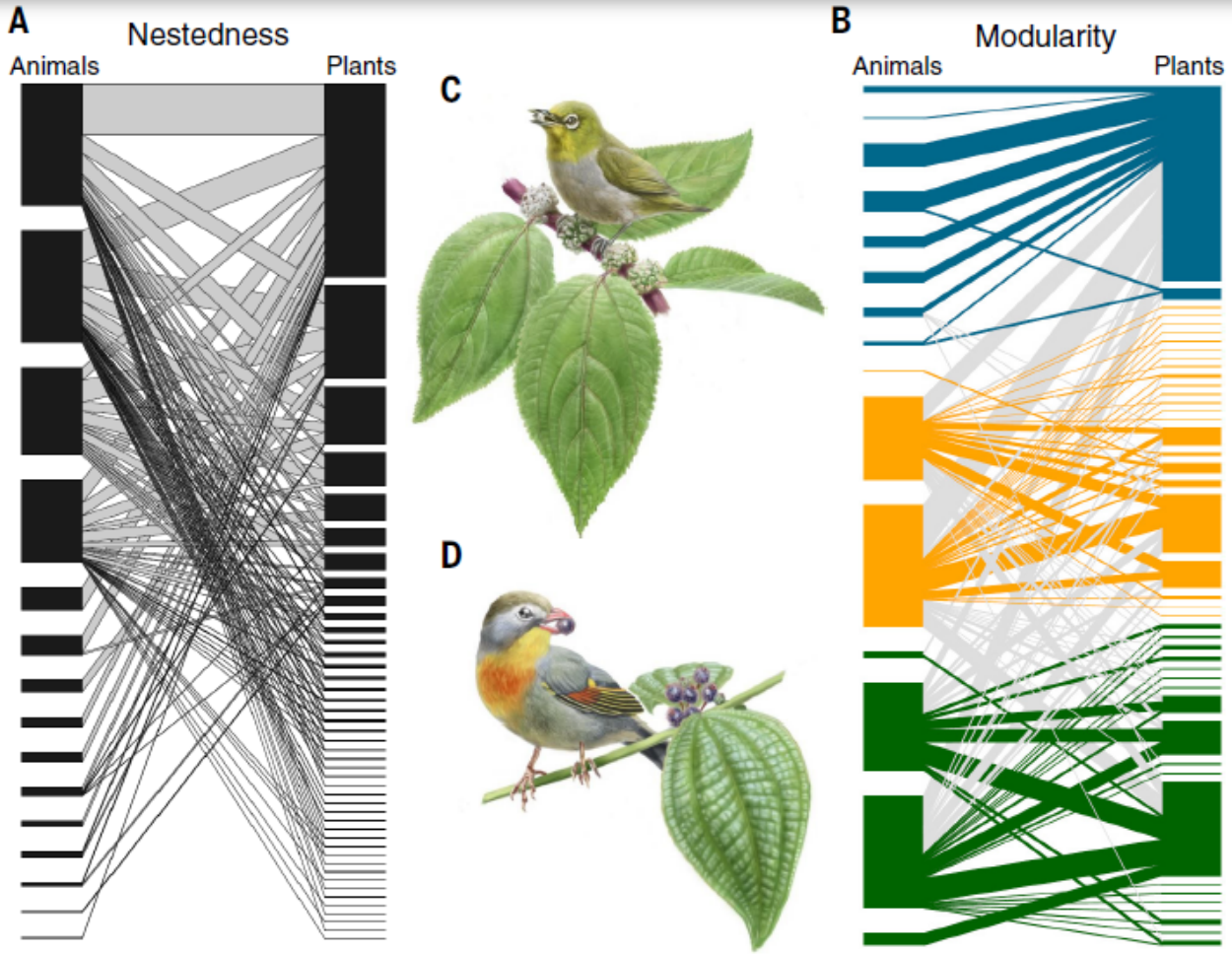
Red-vented bulbul

(Pycnonotus cafer)

- 1966 from India
- Established in lowlands
- >90% fecal samp. w/ seeds

Hawaii seed dispersal networks

SDNs are complex and specialized despite there being no interactions between native species



Vizentin-Bugoni, Tarwater, Foster, Drake, Gledtisch, Hruska, Kelley and Sperry, 2019, *Science*

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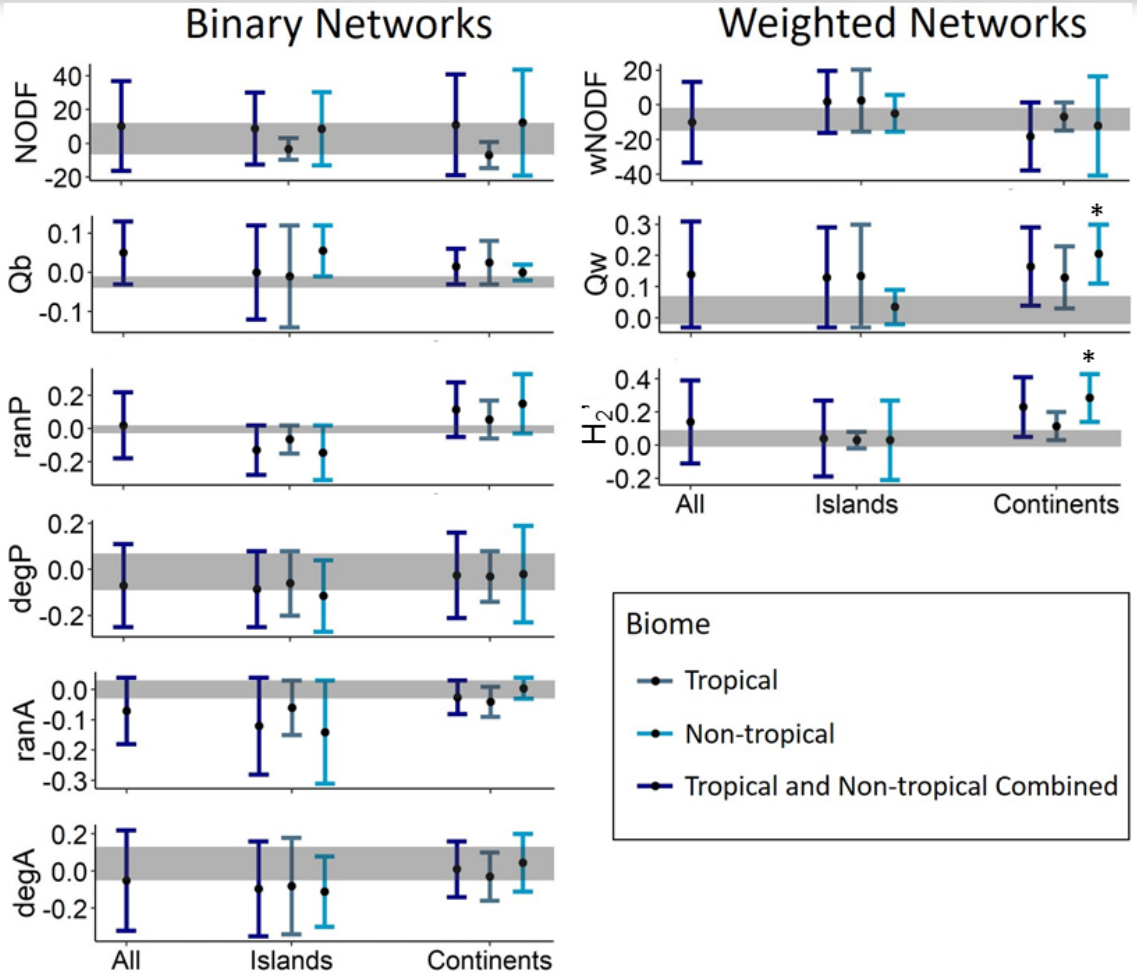
Hawaii seed dispersal networks

Novel SDNs structure and stability are similar to 42 native-dominated communities



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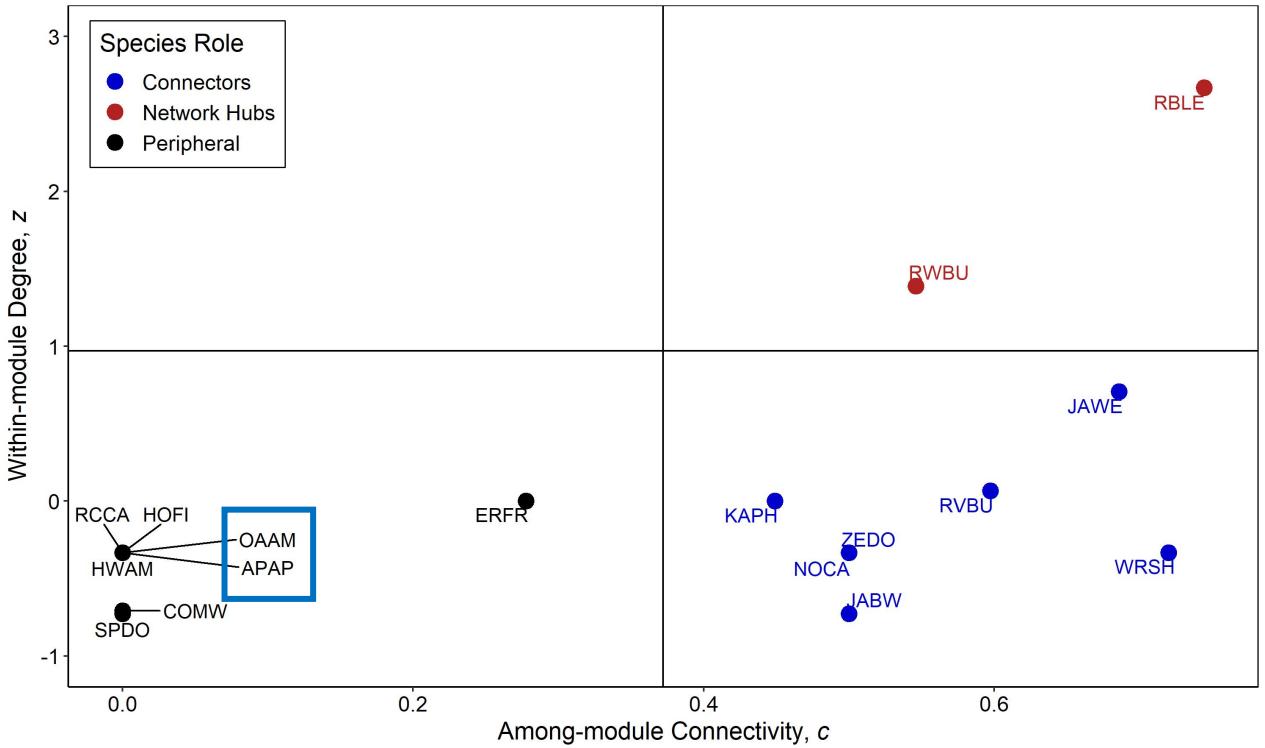
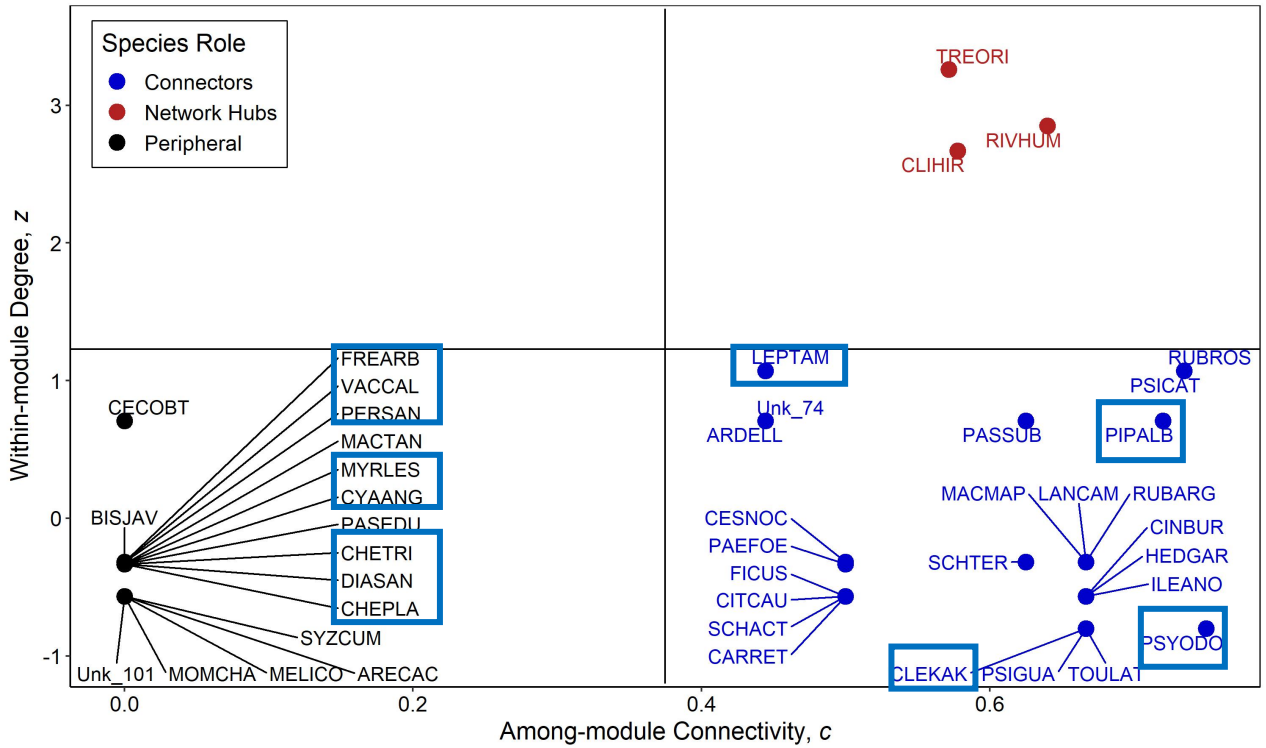
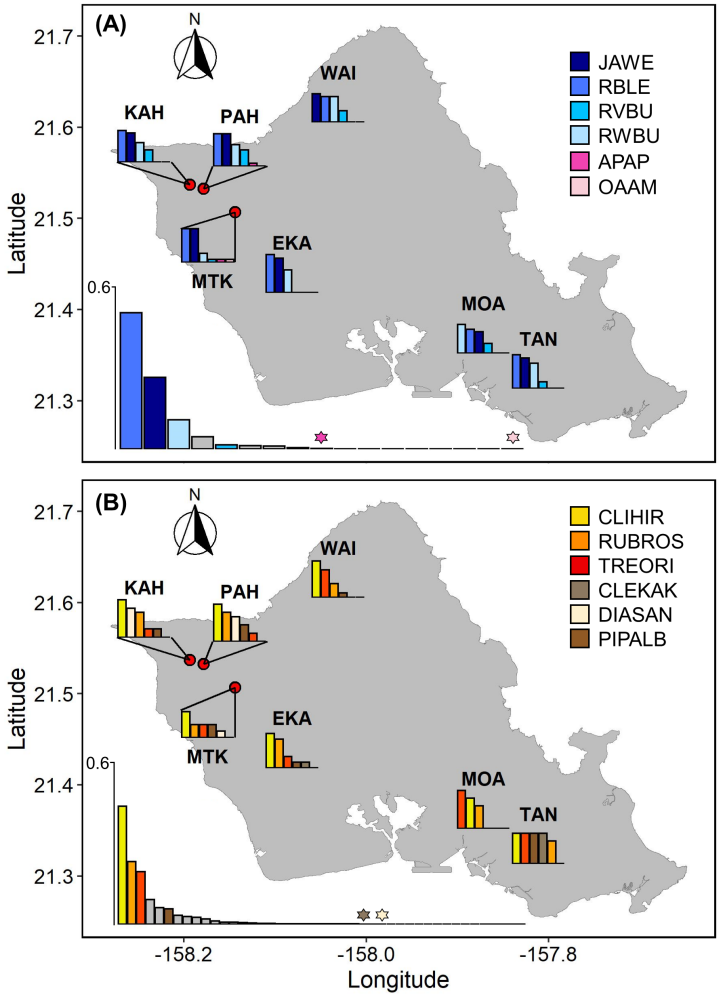
Hawaii seed dispersal networks: Species Roles (regional scale)

Most important species (network hubs) are all non-native





Hawaii seed dispersal networks: Species Roles (local scale)



Non-native birds important throughout Oahu

Plant management can be effective at the site level

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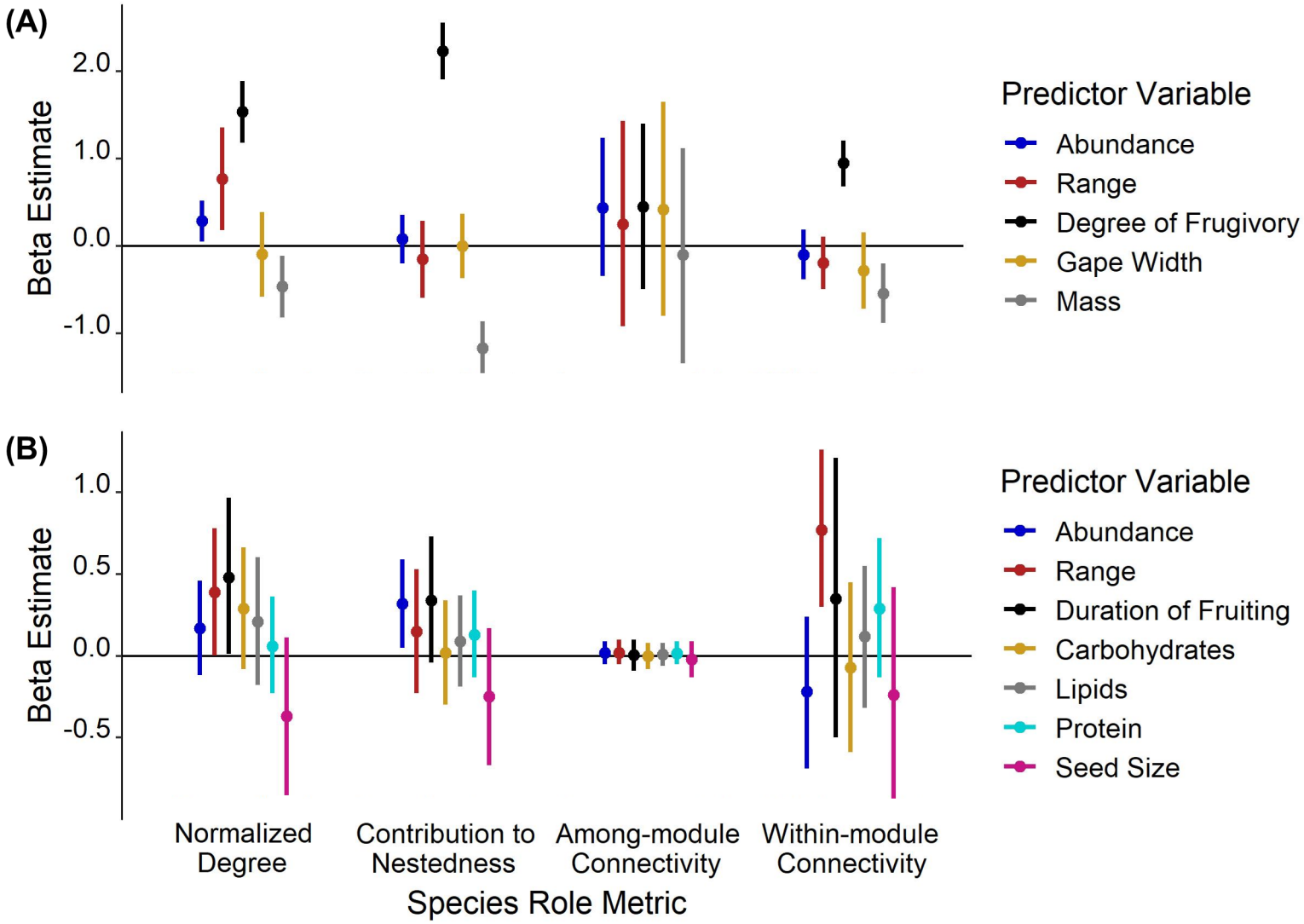
Seed dispersal networks: Drivers of species roles (regional)

Birds that are more abundant and frugivorous are more important in network

Plants that have higher availability are more important in network



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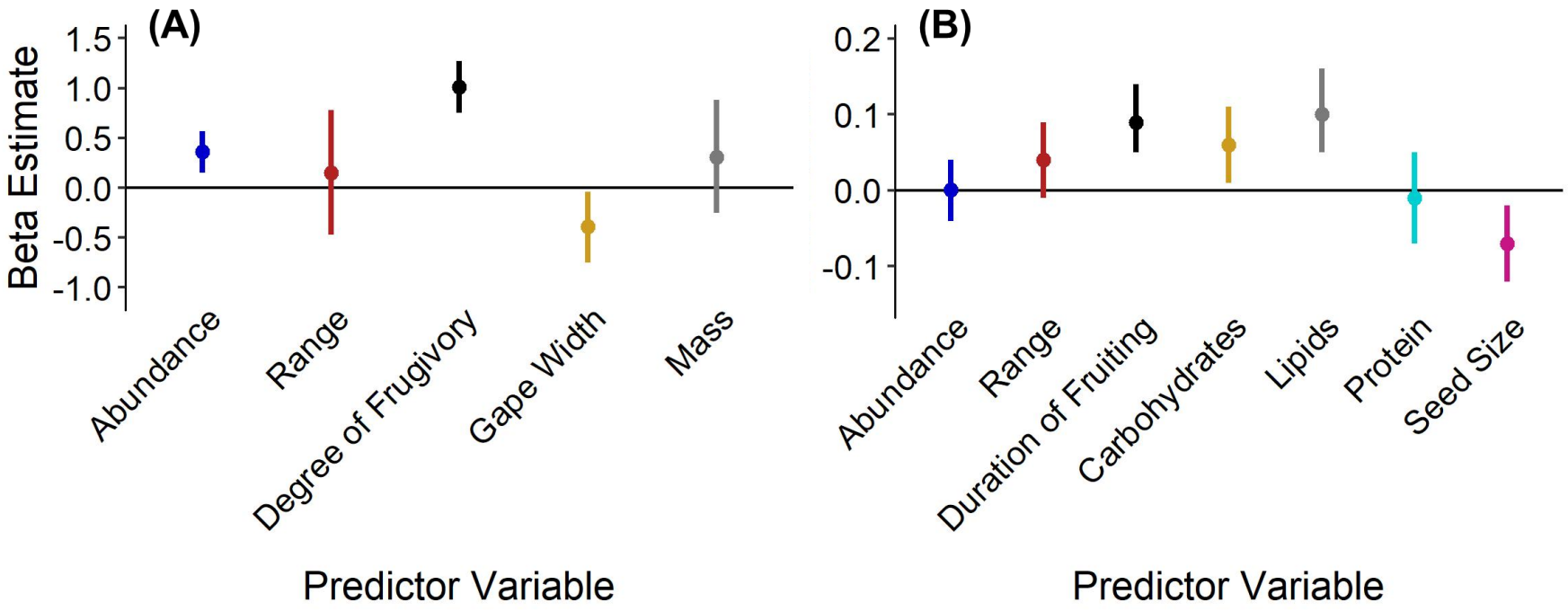
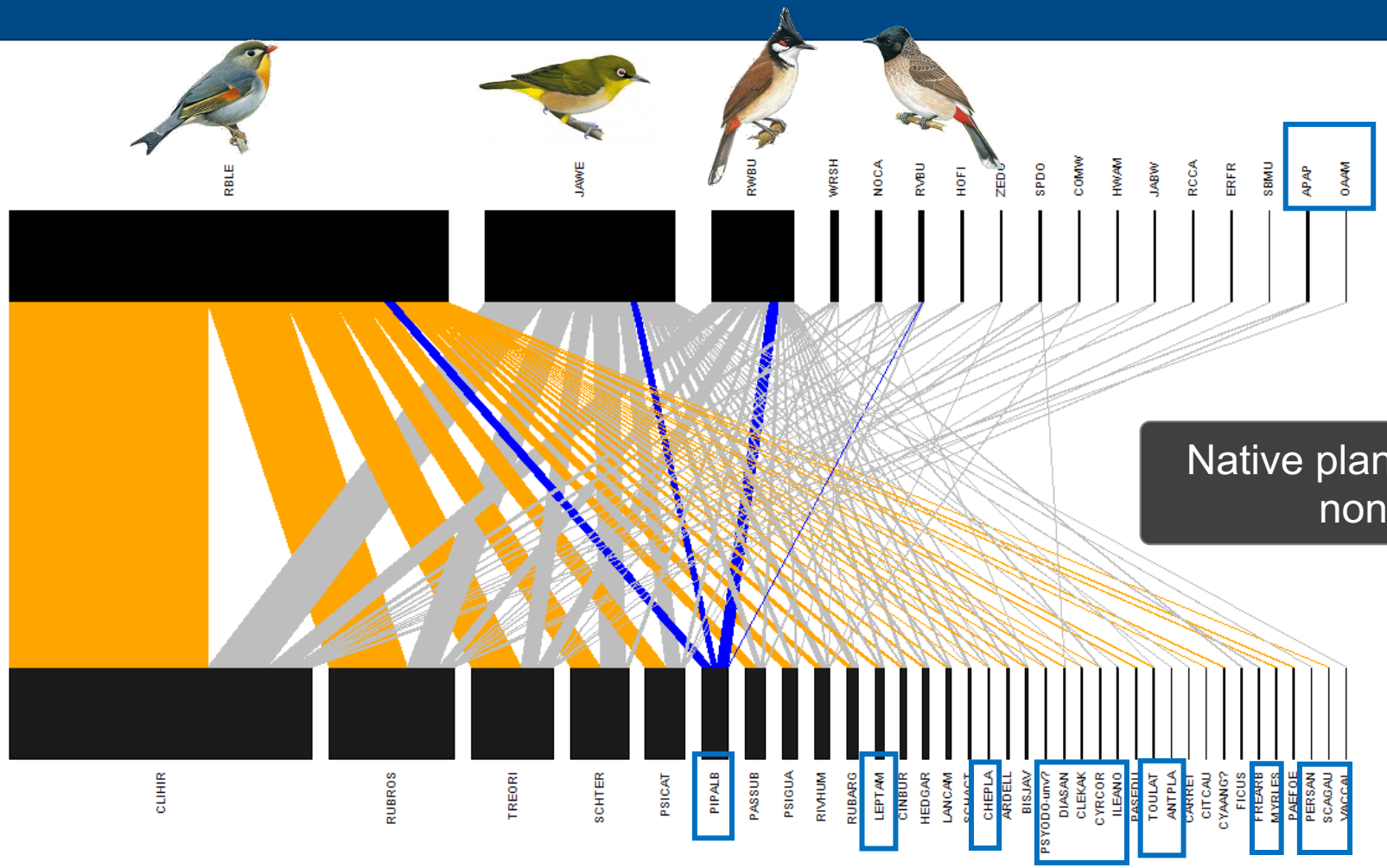
Seed dispersal networks: Drivers of species roles (local scale)

Birds that are more abundant and frugivorous are more important in network

Plants that fruit longer, have higher nutrition and smaller seeds are more important in network



Seed dispersal networks



Native plants only dispersal by non-native birds

Interactions with native fruits

Manipulating social information to increase frugivory

Playback experiment

Control (1-hr)

- Find mature fruiting plant
- Observe bird foraging activity within 10 m
- Establish a baseline of frugivory

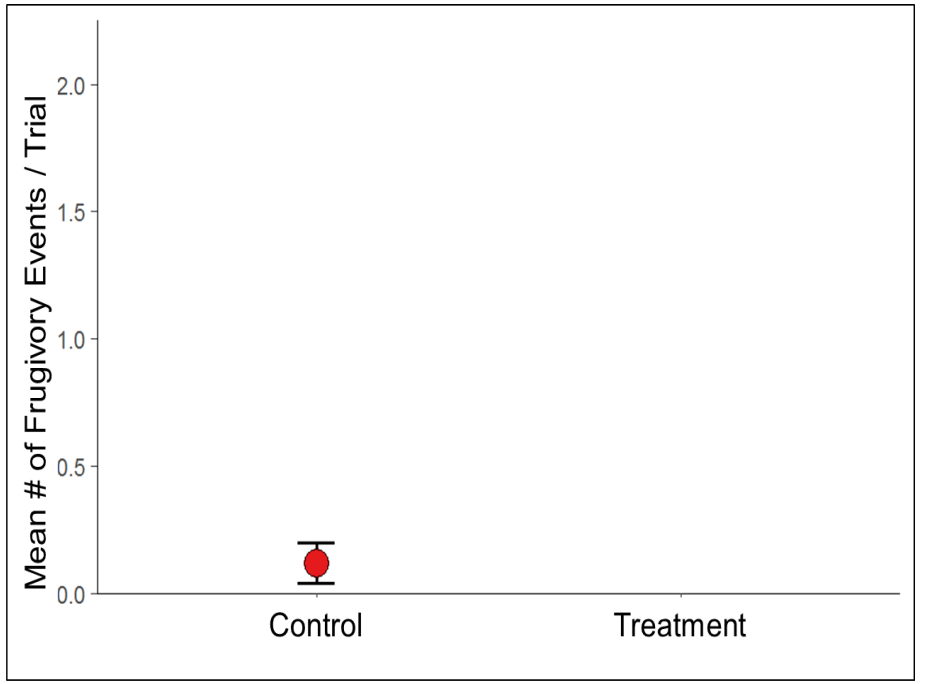
Treatment (1-hr)

- Broadcast bird vocalizations
- Four, 15-min tracks
- Randomized sequence
- 7 exemplars / track

Manipulating social information to increase frugivory

Birds came to fruiting plants in response to playback

Increased fruit consumption during playback



Hawaii Seed Dispersal Networks: Conclusions

- 100% of interactions are novel
  - 93% involve non-native fruit
- Novel SDNs present complex structure and specialization
  - Similar to native dominated communities
  - Core network species, both bird and plant, are all non-native
- Non-native birds are only dispersers of native plants
  - Facilitated frugivory via social information
- Management dependent species
  - Effective Army management and restoration activities

Acknowledgements

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Questions?