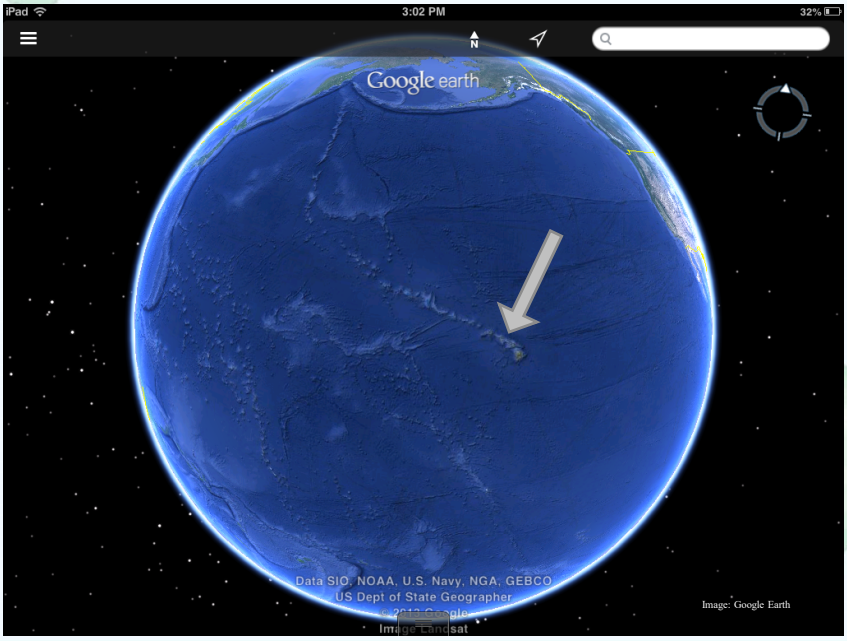
A tale of two pests: examples from the battle against invasive species in Hawai‘i

Christy Martin
University of Hawai‘i-Pacific Cooperative Studies Unit (PCSU)
Coordinating Group on Alien Pest Species
christym@hawaii.edu

Outline:

- Overview of the natural history of Hawai‘i
  - Native species
  - Non-native species
  - Invasive species & why they MATTER
- Coqui (*Eleutherodactylus coqui*) in Hawai‘i
- Little Fire Ants (*Wasmannia auropunctata*) in Hawai‘i
- Summary

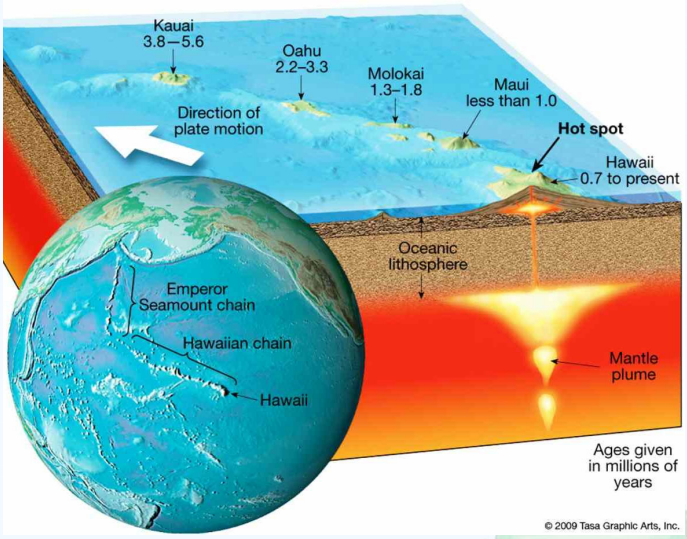
The Hawaiian Archipelago is pretty remote…



Isolation has been a challenge, but it is also a tremendous opportunity. The Hawaiian Islands are physically the most isolated islands on Earth. For millions of years, the Pacific ocean has functioned like a moat, surrounding the islands, ensuring that only a few species arrived, carried by wind, under their own power, hitchhiking on other species, or via the ocean.

The extreme isolation of the islands and a wide variety of environments has led to astounding levels of endemism – today about 39% of all species found are endemic.

- The Hawaiian Islands were formed when lava poured out of two holes in the Pacific plate—"hot spots".
- The Pacific plate moves slowly northwest and the islands move with it.



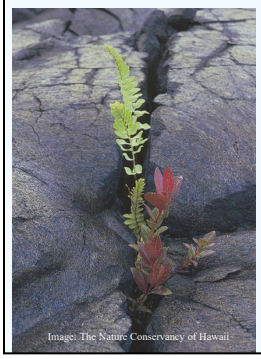
- The Hawaiian Islands were never attached to a continent and there was no "land bridge" for plants and animals to get to HI.

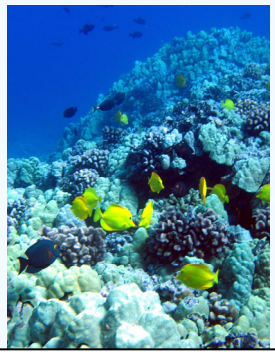
Hawaii's First Arrivals—via the three W's

Some seeds, spores, insects, and even spiders arrived on the **wind**.

Wings: Very few migratory birds, but a few birds flew or were blown off course. They also carried seeds in and on them.

Some seeds floated here on ocean currents or **waves**. Ocean currents also carried algae, and the eggs and larval stages of fish, invertebrates, and even freshwater stream species.





Some seeds, spores and insects arrived on the wind.

A few birds flew or were blown off course. In them or stuck to their feathers were more seeds.

Some seeds managed to float here on ocean currents or waves. Ocean currents also carried larval forms of fish, invertebrates, algae, and even our freshwater stream species.

Examples of change over time

These honeycreepers are all descended from original colonists that flew or were blown across the ocean millions of years ago.

Slowly, over uncountable generations, birds spread out into different areas, different habitats, and they started eating different foods.

With millions of years came slow, incremental changes.

Estimated that the ancestral rosefinch colonists arrived in the Hawaiian Islands (from Asia) sometime between 7.2 and 5.8 million years ago (mya), leading to 56 known species of honeycreepers

https://insider.si.edu/2011/10/smithsonian-scientists-collaborators-determine-the-evolutionary-family-tree-for-the-hawaiian-honeycreepers/

Note the curved bill of the ‘i‘iwi…

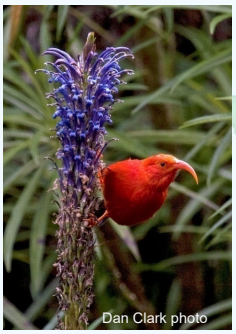
And the curved flower of the trematolobelia…

This trematolobelia is just one of 125 species of lobelioids that are believed to have arrived with the Gardner Pinnacles and French Frigate Shoals were high islands. Through DNA testing, these 125 species descended from one original colonist.

They fit perfectly. The curved bill allows the `i`iwi to feed on the nectar, and the plant benefits from being pollinated.

70 + million years ago →

Plants and animals arrive & thrive



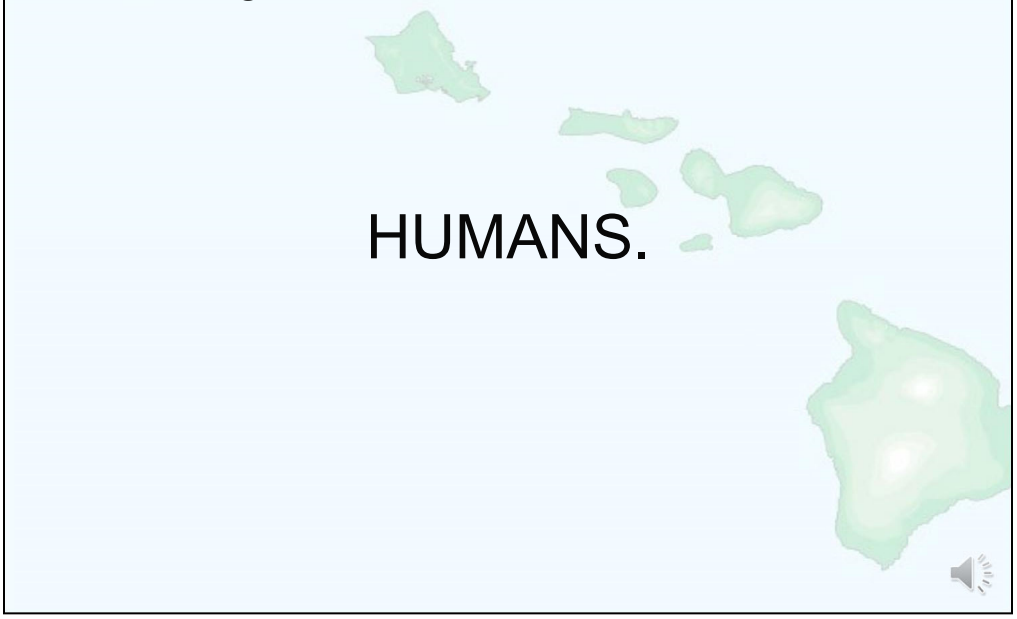
isolation
wide variety of habitats
millions of years
changes over time

\+

Nearly 20,000 native species

Native species = plants and animals that arrived at a location without the help of people or our conveyances, and all of the descendants of those colonists

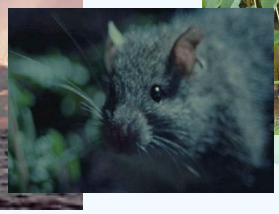
And then…
Hawaii got an incurable case of…

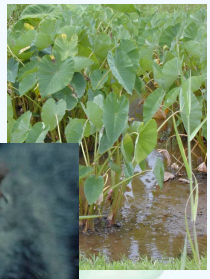


HUMANS.

70 million years ago

Polynesian Voyagers arrive, est. 1,100 AD





Kalo
Coconut
Kukui
Noni
Moa
Dog
Geckos
Polynesian pig
Polynesian rat
(and more)

1000 years ago

- First non-native species (a species that becomes established through our conveyances or as the result of our actions)
- A few became invasive (a non-native species whose introduction does or is likely to cause economic or environmental harm or harm to human health)

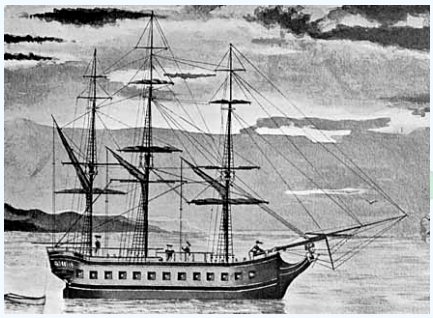
Current estimate is that Polynesians arrived areound 1100 AD, nearly 1,000 years ago. For hundreds and hundreds of years prior to Western contact in 1778, Hawaiian land use and resource distribution was centered on the “ahu`pua`a” system, or watershed-based mountaintop to outer reef pie-shaped wedges that could provide nearly self-sufficient resource units for the inhabitants. Self-contained units required resource management. The Kapu system and belief that the upper mountains were the realm of the gods, and therefore off limits also limited impacts.

70 million years ago

1000 years ago

242 years ago

Capt. Cook & Western Contact, 1778



- Arrival of est. 500 non-native species
- Some non-native species benign or even beneficial, but others became invasive including goats, European boars, mosquitoes & diseases

Capt. Cook arrival January 18, 1778

70 million years ago…

1000 years ago

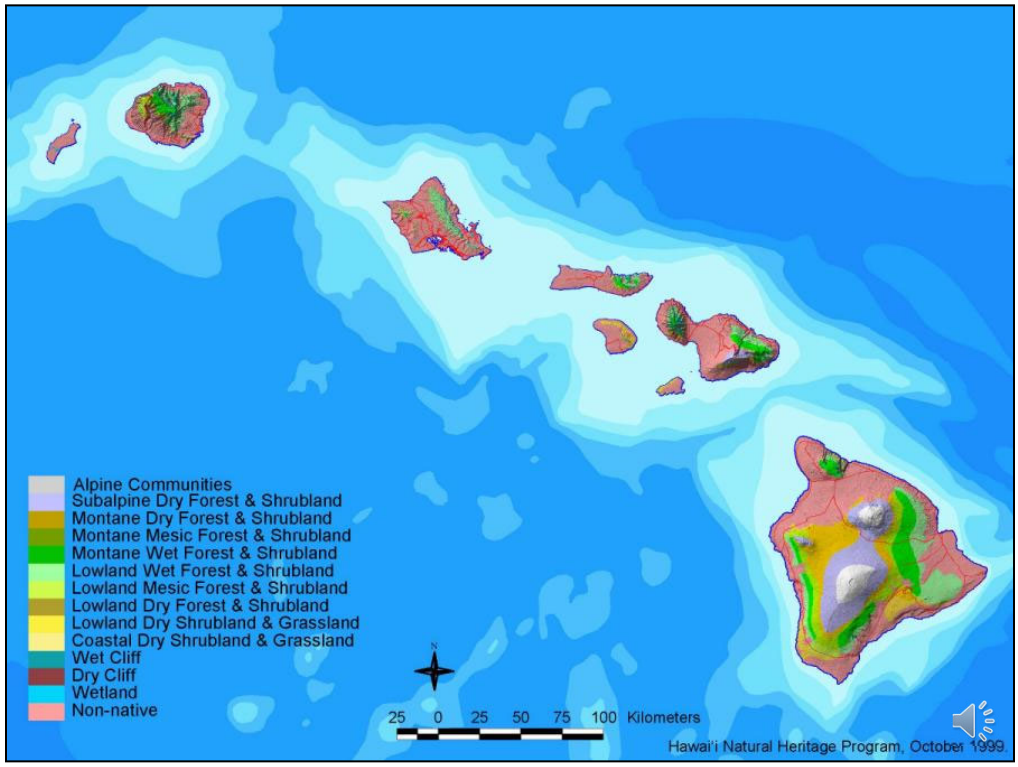
242 years ago

10 y/a

Today: 1.4 mil. residents + 8+ mil. visitors

- 90% of food & most consumer goods imported
- 10,000+ plant species introduced; 200+ damaging ecosystems
- 418 new marine/brackish water species
- Hawaii went from 0 to 40 land & fresh water reptiles, 0 to 6 amphibians (including coqui), 20+ insects/year (the Kahului Airport Risk Assessment found average of one new pest/day!), and 0 to 57 ant species

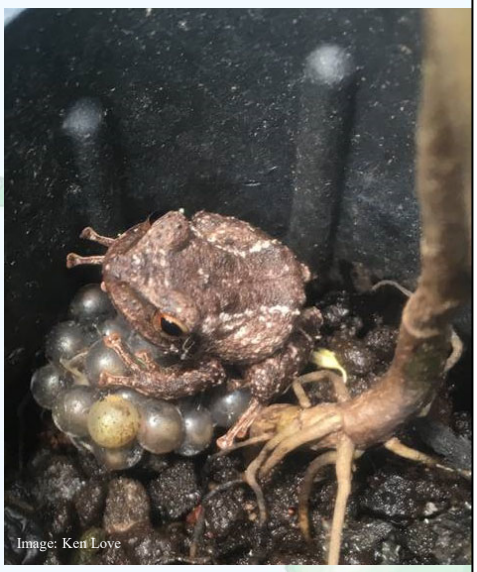
Numbers compiled largely from Bishop Museum species lists and reports. Kahului Airport Risk Assessment (average of 1 new invertebrate or plant pathogen found per day during the inspection period, using extra inspectors during the inspection blitz). See https://www.hawaiiag.org/PQ/KARA20Report20Final.pdf



So the glass is either half empty…or half full, depending on how you choose to look at it.

Coqui: small frogs, big problems

- Native to Puerto Rico, introduced in the late 1980s via the nursery trade
- Lack of effective predators & competition, abundant food and habitat = 20,000+ coqui/hectare
- 114,000 prey items/ha/night (20-30% native insects & invertebrates)
- Increase nutrient availability in native forests favor invasive plant species
- Males call @ 90 decibels, dusk to dawn



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Coqui: small frogs, big problems

- **1998**: USDA NWRC begins studies toxicants (90 chemical products, 170 formulations. 8 were effective)
- **Caffeine** (2%): **2001-2002** EPA approved for emergency use but not approved due to public health concerns.
- **Citric Acid** (16%): **2002** Citric acid was identified as an effective alternative. Exempt from EPA regulation
  - 97% effective with direct contact (tough in the forest!)
  - Phytotoxic for some plants, high cost
- **Hydrated Lime** (6%): **2005** EPA granted a Section 18 Quarantine Exemption permit for 3-years. Not renewed due to "widespread misuse and caustic effects"
- **Sodium bicarbinate** (USP1 & 25% slurry): **2008** effective but research & registration not continued

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- Pers. Comm., Dr. Earl Campbell, 2020

Even Real Estate companies have something to say about coqui frogs.

LFA: small ants, big problems

- Native to South & Central America, first report in Hawai‘i in 1999, likely via the nursery trade
- Lack of effective predators & competition, abundant food and habitat = 20,000 LFA/m^2 (200m ants/hectare, 3-D)
- Reduce biodiversity, habitat
- Harm plants by farming aphids & other sap-sucking insects
- Sting people and domestic and wild animals
- Cause est. $174 mil/year damages on Hawai‘i island

References:

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- Donna J. Lee, Michael Motoki, Casper Vanderwoude, Stuart T. Nakamoto, PingSun Leung, Taking the sting out of Little Fire Ant in Hawaii, Ecological Economics, 10.1016/j.ecolecon.2015.01.010, **111**, (100-110), (2015).

LFA: small ants, big problems

- **1999**: HDOA surveys confirm presence on 3 properties on Hawai‘i island.
- **Granular applications** (hydramethylnon, methoprene, pyriproxyfen, others): **1999-2007, 57+** sites across the island and one on Kaua‘i
- **1999** UH CTAHR Dr. Arnold Hara tests control methods until retirement 2015
- **Problems discovered: LFA nesting in trees**
  - No granular application for trees
  - No formulations of non-granular baits that could be applied to trees, nor food crops, nor organic crops
  - No approved application method
- **2009** HDOA & UH PCSU established Pacific pest ant position, hired Dr. Cas Vanderwoude Hawai‘i Ant Lab

Additional References:

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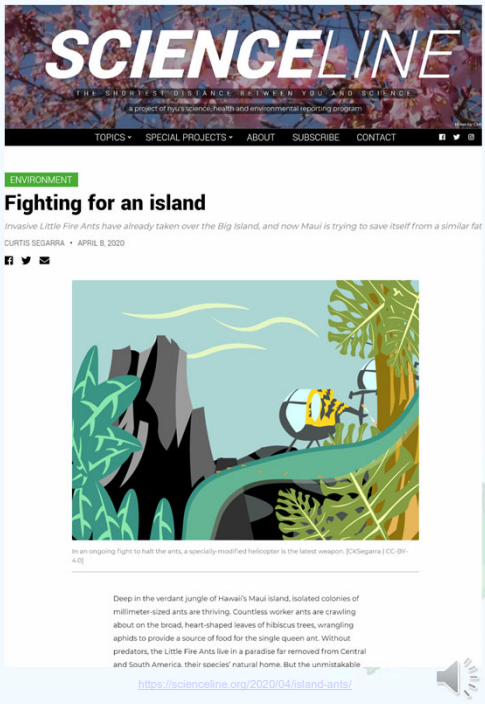
LFA: small ants, big problems

- Gel-baits, incl. Tango ((S)-Methoprene)
- The Master Blaster
- The “Spackler of Death”
- The Ant-stinguisher
- The Anti-Gator

All images by Cas Vanderwoude, Hawai‘i Ant Lab
For more info, see www.littlefireants.com

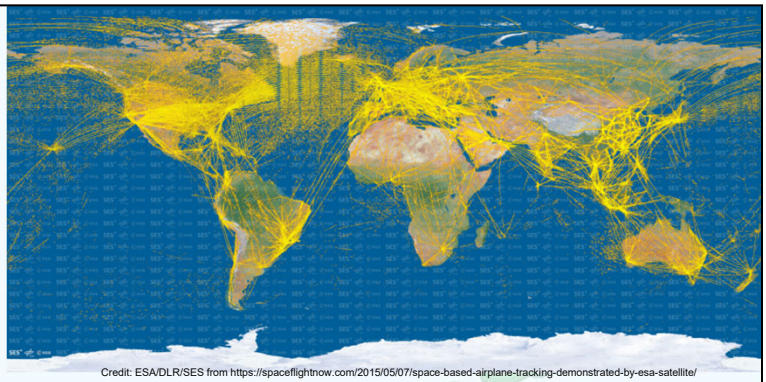
Pers. Comm., Dr. Cas Vanderwoude, 2020

Brooke Mahnken, Maui Invasive Species Committee: **"The vegetation is just too dense, and the region too large — over 50 acres — to walk in and spray pesticide…. A helicopter may seem dramatic and expensive, but it's really the only way to treat the ants in Nahiku."— Scienceline**



You know it's important when you decide that the best option is to use a helicopter.

Lessons



Credit: ESA/DLR/SES from https://spaceflightnow.com/2015/05/07/space-based-airplane-tracking-demonstrated-by-esa-satellite/

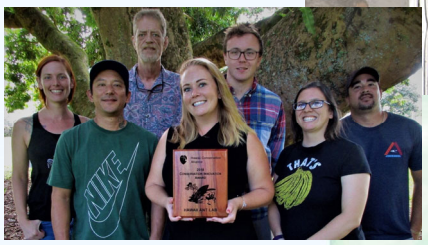
- Prevention & control measures must be prioritized before they can impact society, ecosystem function, T&E species, etc. **Please continue to help get tools in the toolbox**.
- **Relationships** are IMPORTANT
- Be ready for the unpredictable: From 2000-2005, 1/4 of non-native species occurrences were novel, linked not just to trade increases, but also the **incorporation of new source regions,** likely as a consequence of **expanding trade networks, and environmental change**.

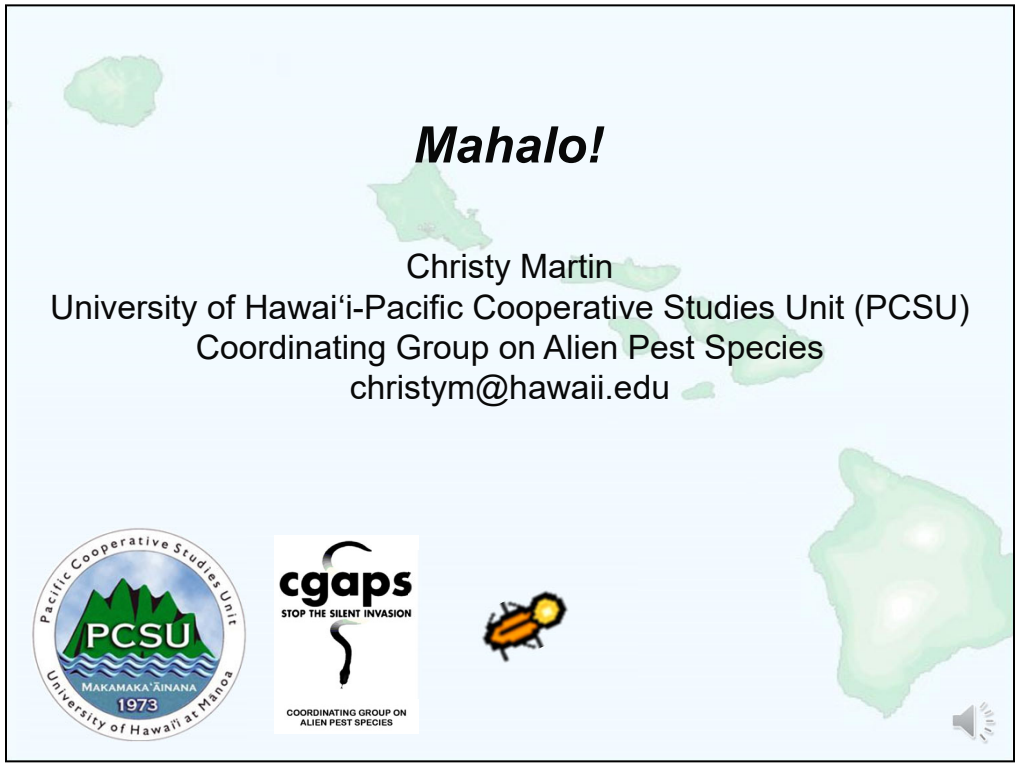
Global rise in emerging alien species: Proceedings of the National Academy of Sciences Mar 2018, 115 (10) E2264-E2273; DOI:10.1073/pnas.1719429115

The challenges are daunting!
But great people love a good challenge.

Particular thanks to:

- Drs. Earl Campbell, Will Pitt (USDA APHIS NWRC-Hilo)
- Dr. Arnold Hara, Cooperative Extension (UH CTAHR)
- Dr. Cas Vanderwoude & Hawai‘i Ant Lab (UH-PCSU)
- USDA ARS (numerous)
- HDOA, DLNR, HISC, Invasive Species Committees of Hawai‘i





I ran out of time, but thank you to the ACS once again for this opportunity, and thank you for your interest! Please feel free to contact me with any questions. Mahalo!