Invasive ants in Hawaii and the Pacific: biogeography, ecology, and challenges in management and biosecurity

Paul Krushelnycky

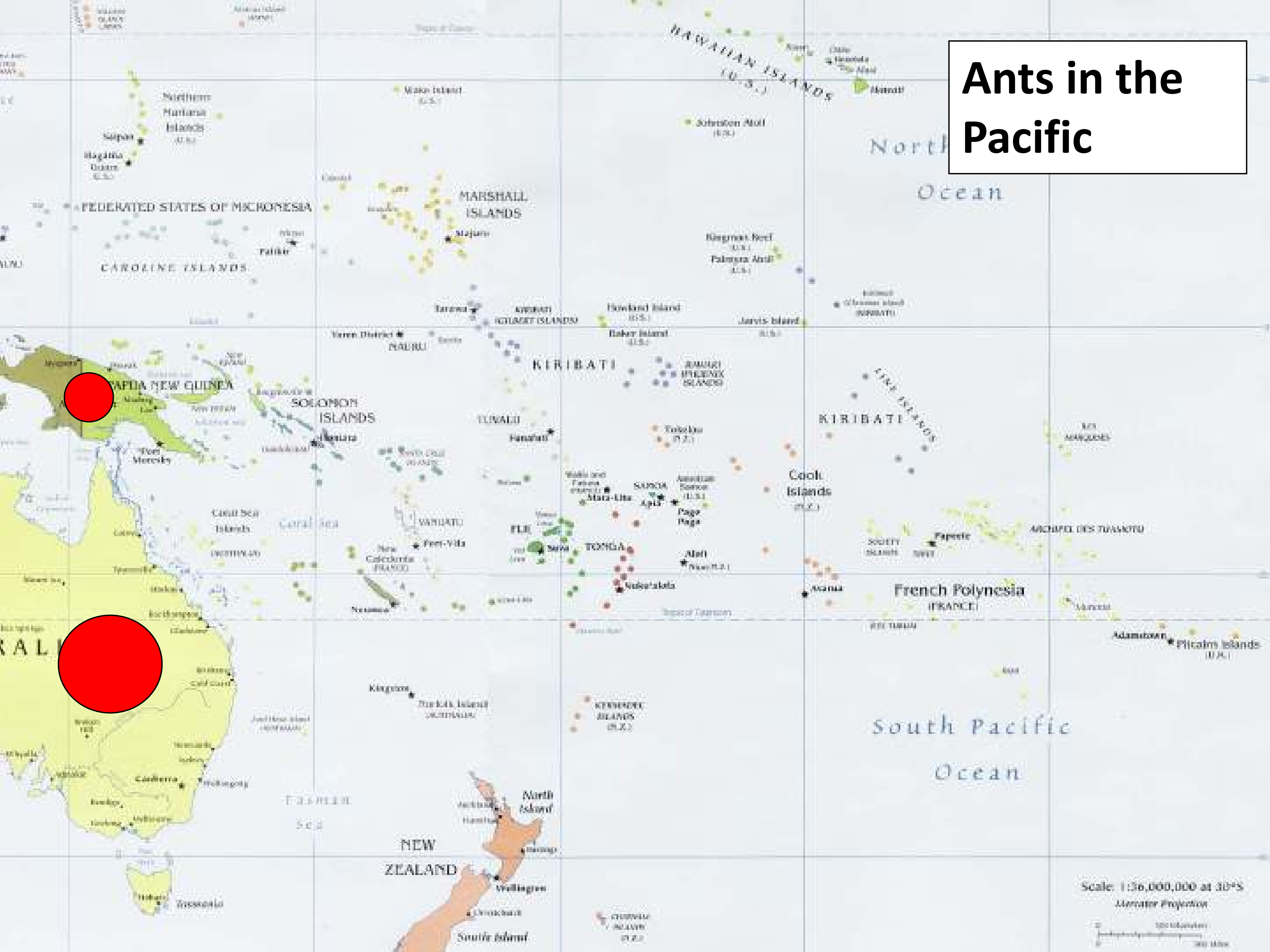
Dept of Plant and Environmental Protection Sciences, University of Hawaii, Honolulu, Hawaii

Invasive ants in Pacific

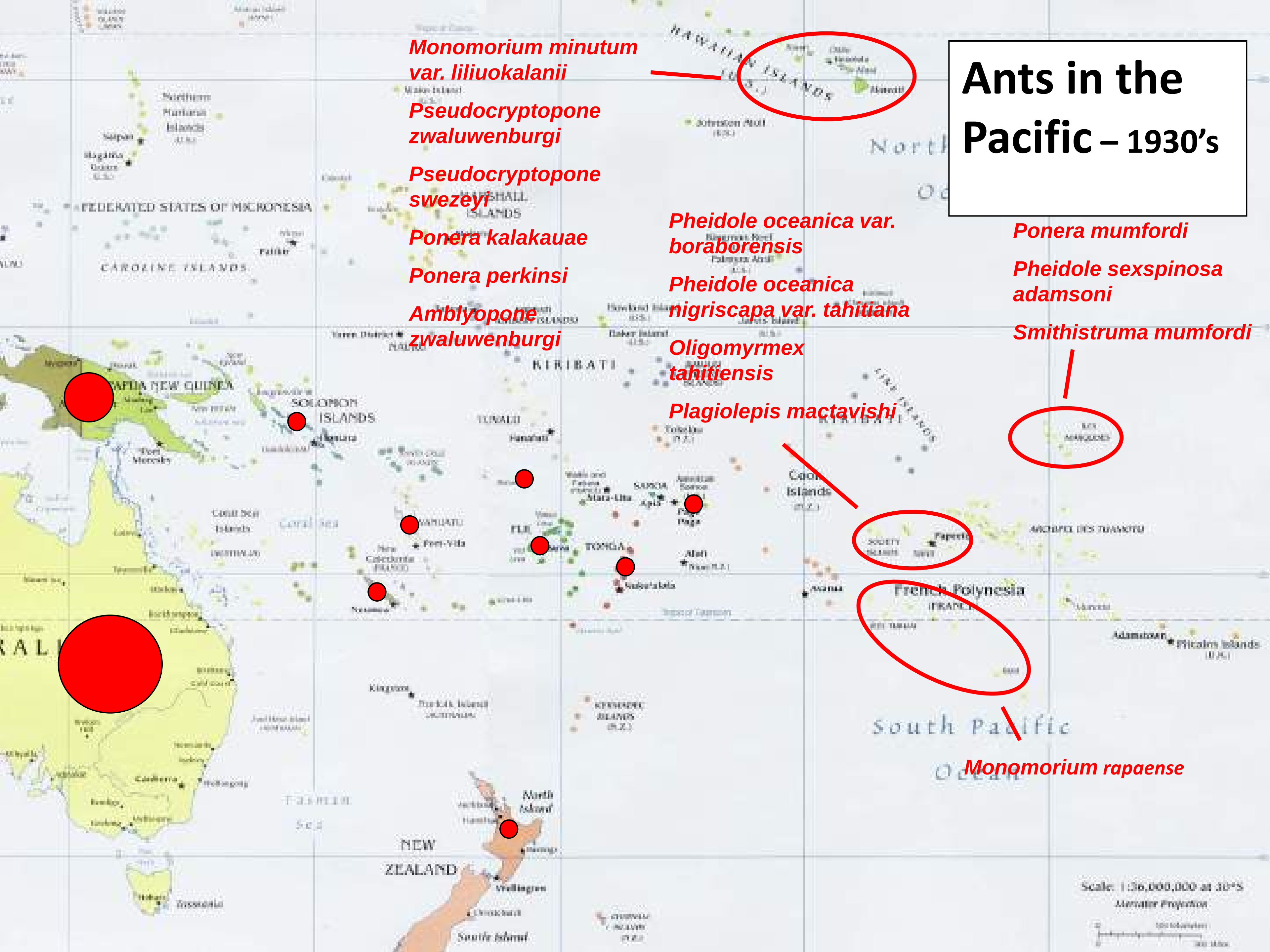
- Like everywhere else, impact quality of life, tourism, agriculture, and other sectors of the economy
- In Hawaii, largest economic impacts could be on tourism , in other island nations effects may be largest on small scale agriculture
- In addition to economic concerns, impacts on natural areas/native biodiversity can be very high on Pacific islands

Photos © Alex Wild

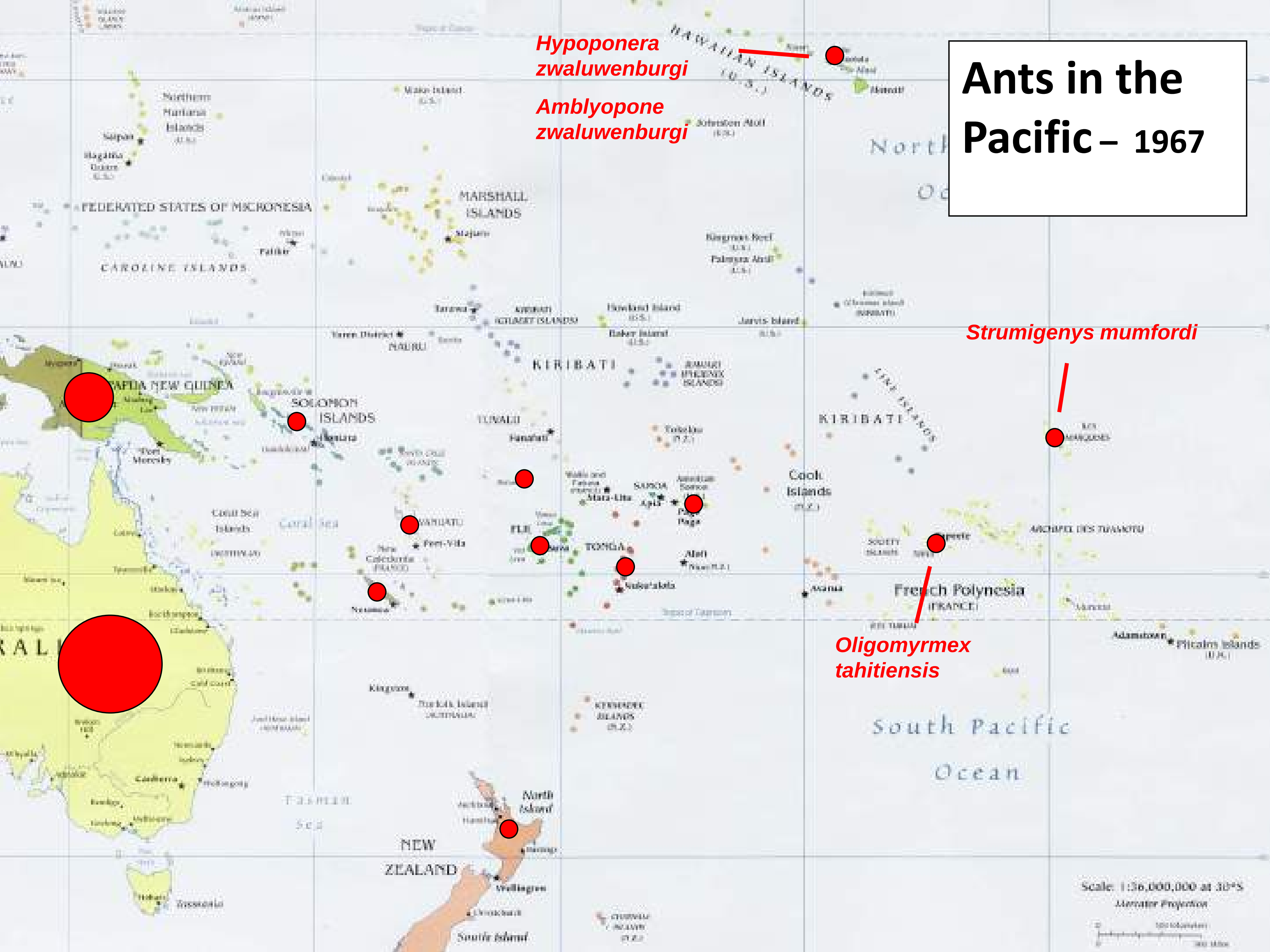
Ants in the Pacific

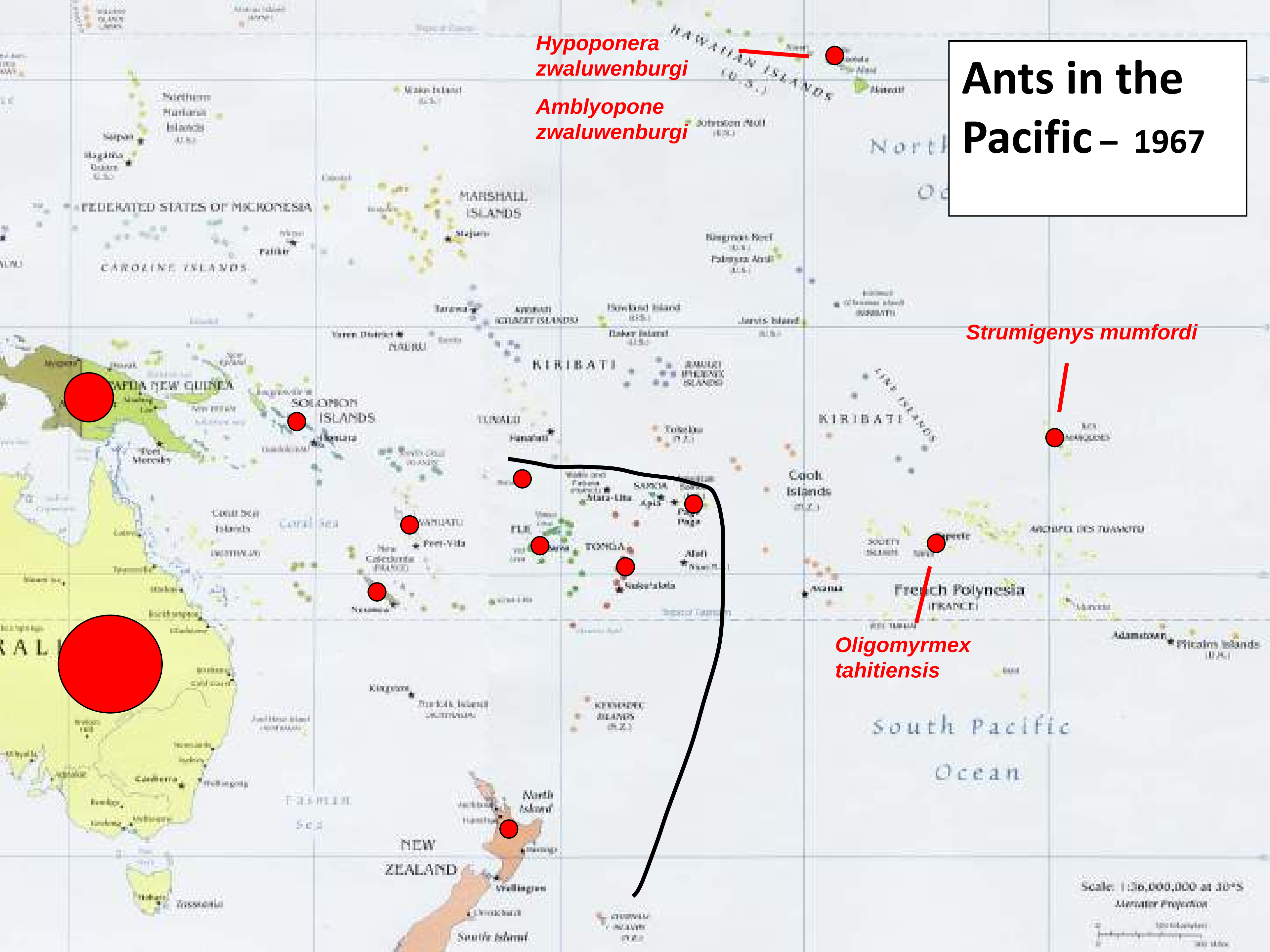


Ants in the Pacific – 1930's



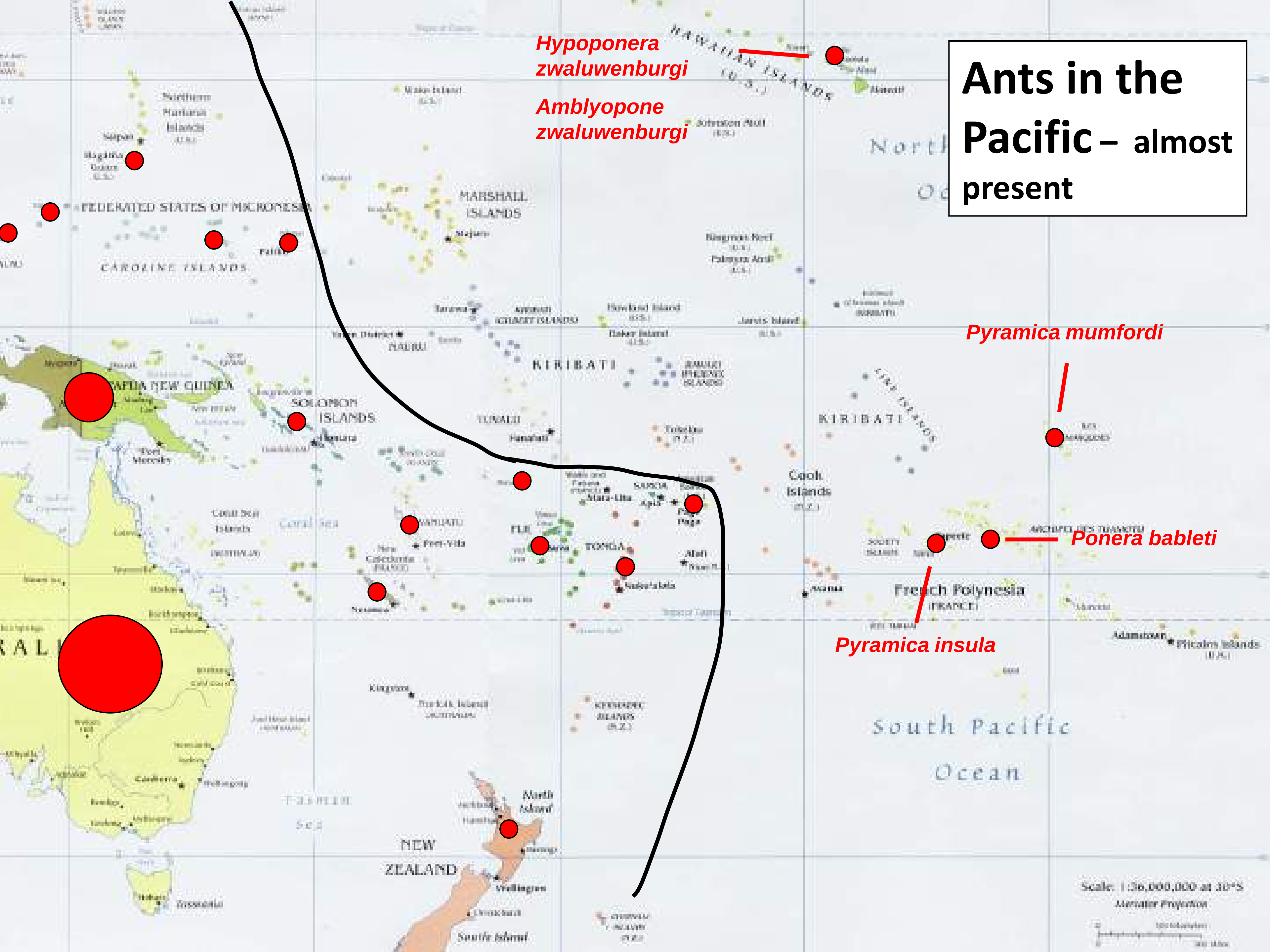
Ants in the Pacific – 1967



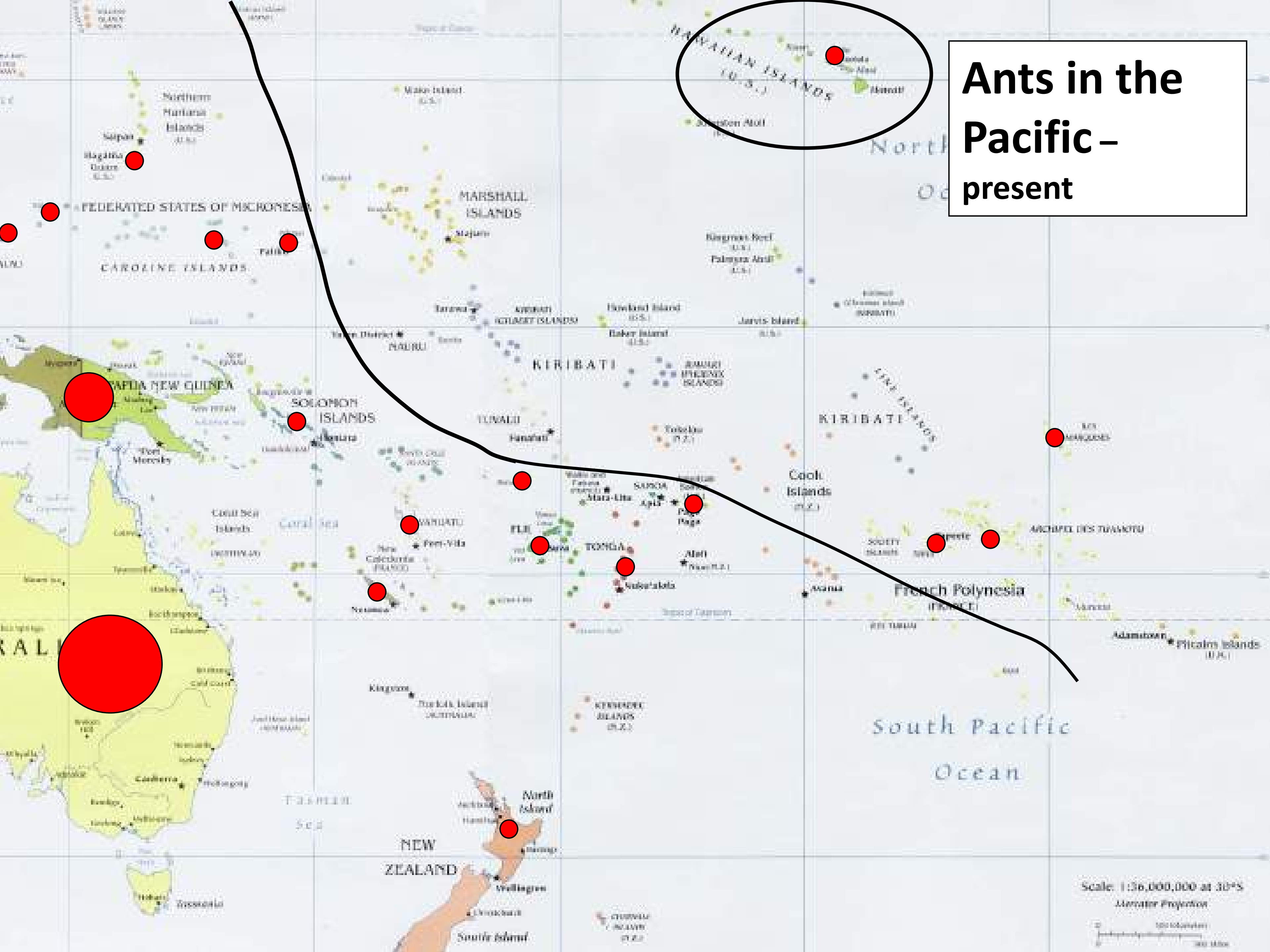


Ants in the Pacific – 1967
Hypoponera zwaluwenburgi
Amblyopone zwaluwenburgi
Strumigenys mumfordi
Oligomyrmex tahitiensis
HAWAIIAN ISLANDS (U.S.)
MARSHALL ISLANDS
FEDERATED STATES OF MICRONESIA
CAROLINE ISLANDS
KIRIBATI
PAPUA NEW GUINEA
SOLOMON ISLANDS
TUVALU
VANUATU
FIJI
TONGA
SAMOA
Cook Islands (N.Z.)
French Polynesia (FRANCE)
Coral Sea
Tasman Sea
NEW ZEALAND
North Island
South Pacific Ocean
Scale 1:36,000,000 at 30°S

Ants in the Pacific – almost present



Ants in the Pacific – present



Has potential implications for:

- number of invasive ant species that can establish
- impacts on native ants
- impacts on non-ant arthropods
- broader ecological effects

How many ant species can Pacific islands support?

Currently:

Hawaiian Islands:
approx. 58 spp.

Society Islands:
approx. 52 spp.

Austral Islands:
approx. 31 spp.

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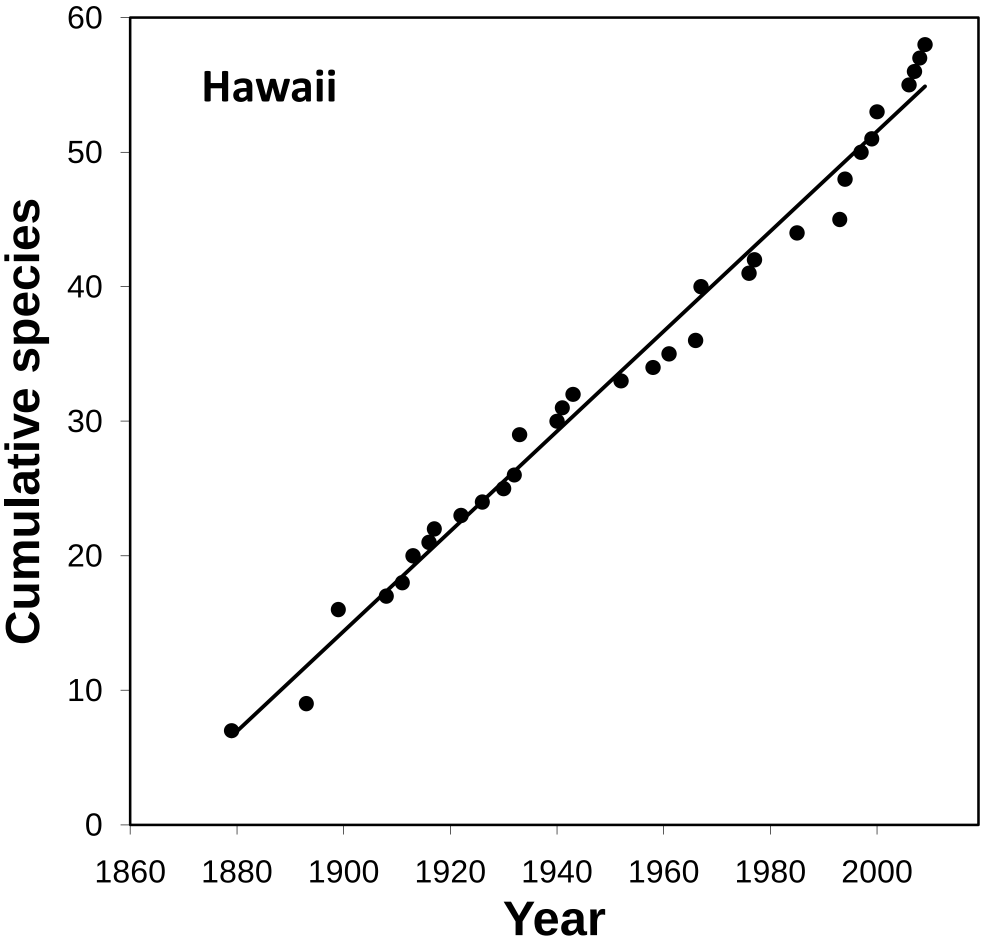


Impacts on native ants

- As in continental systems, impacts on native ants on Pacific Islands are likely to be severe

- Few endemic ant species appear to co-occur with invasive ants in lowland sites of Fiji (Ward and Beggs 2007) and Tonga (Wetterer 2002)

- Native ants strongly impacted by LFA in New Caledonia (e.g. Le Breton et al. 2005) and Galapagos (Clark et al. 1982)

Impacts on non-ant arthropods:
what is known from Hawaii

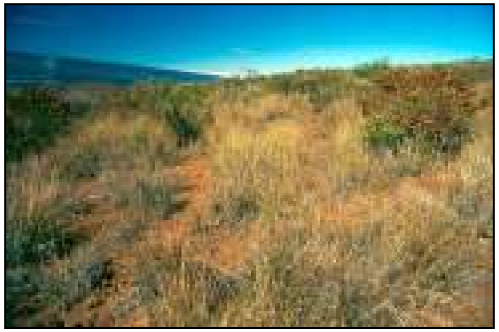
"…While in *Pheidole's* range, no matter how fine or how dense the forest may be, the endemic fauna…is entirely exterminated. This native fauna, especially of beetles, appears as if by magic, the moment the limit of range of *Pheidole* is reached."

R.C.L. Perkins, 1913

Invasion Sites


Puu O Ili


Pohakuloa


Ahumoa

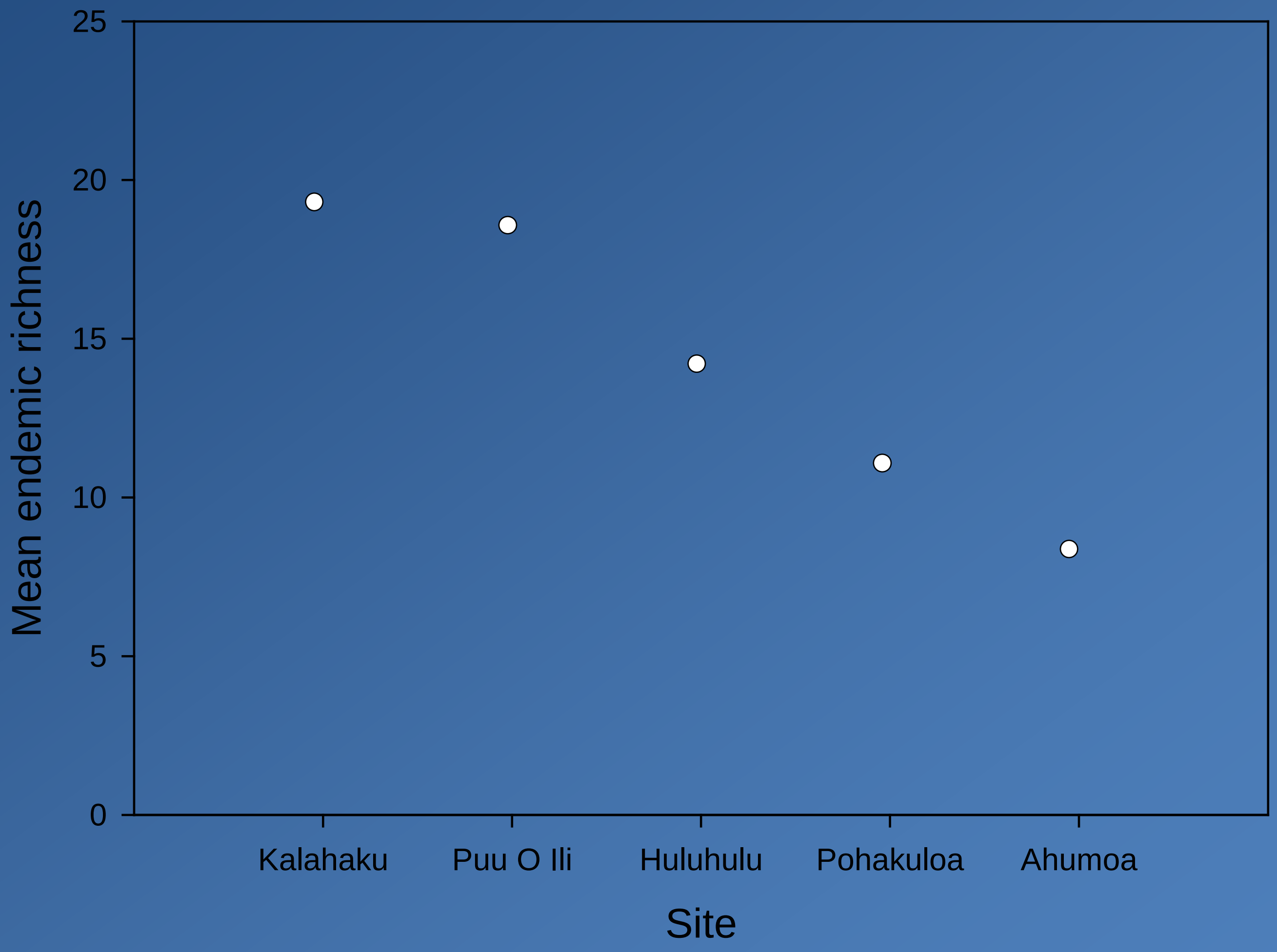

Kalahaku


Huluhulu

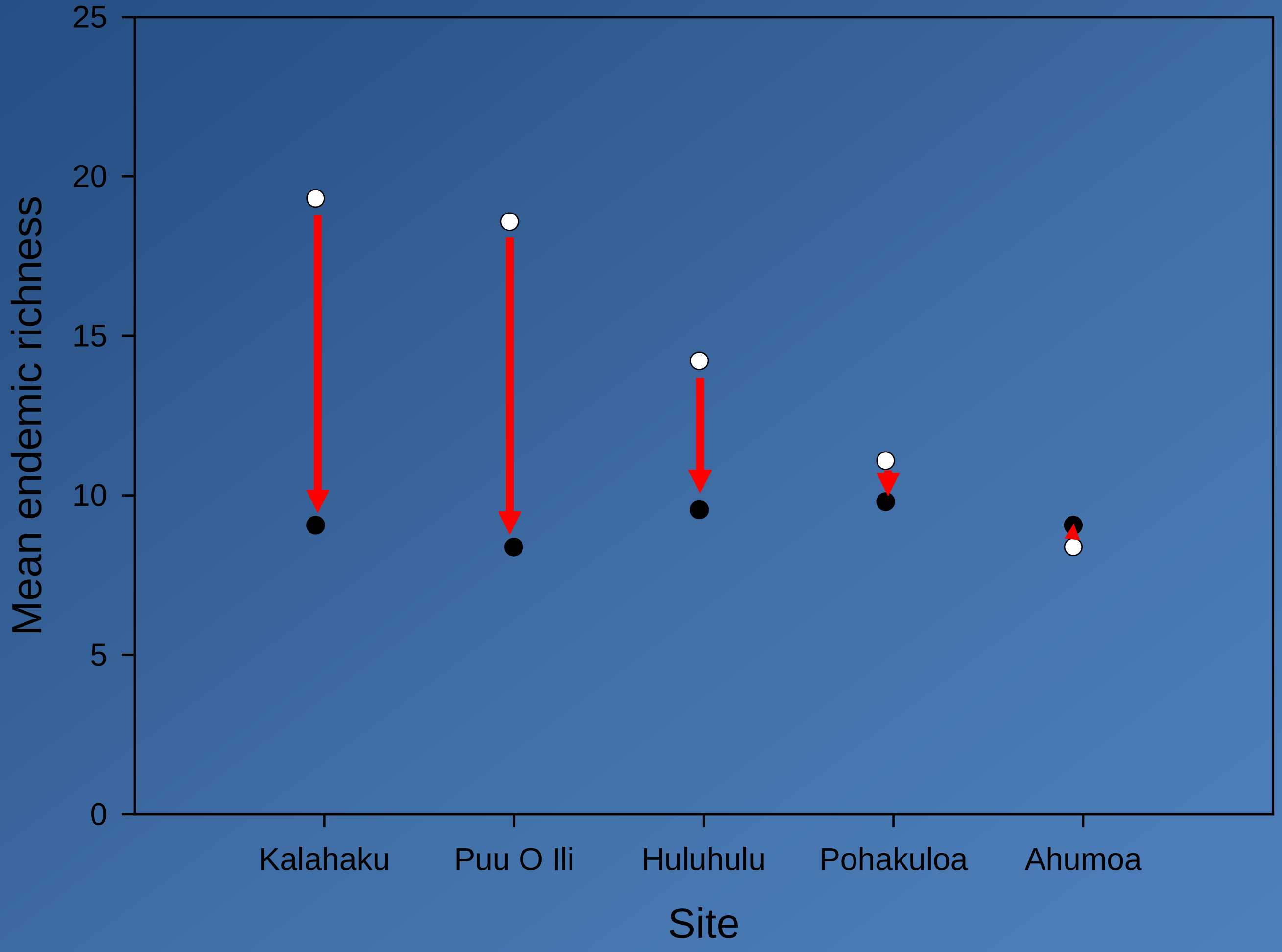

Maui


Hawaii Island

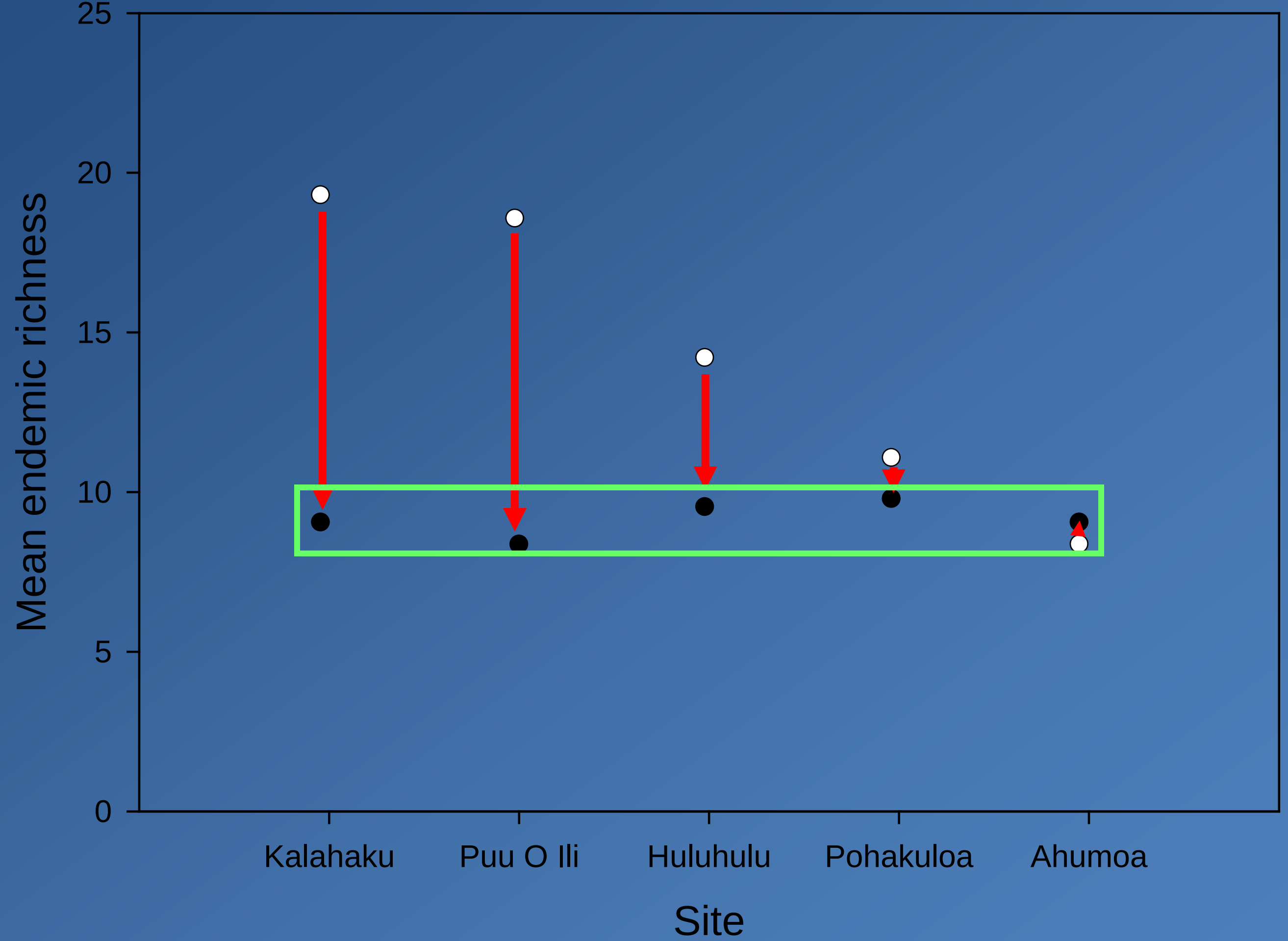
Uninvaded Endemic Richness



Invaded Endemic Richness



Invaded Endemic Richness

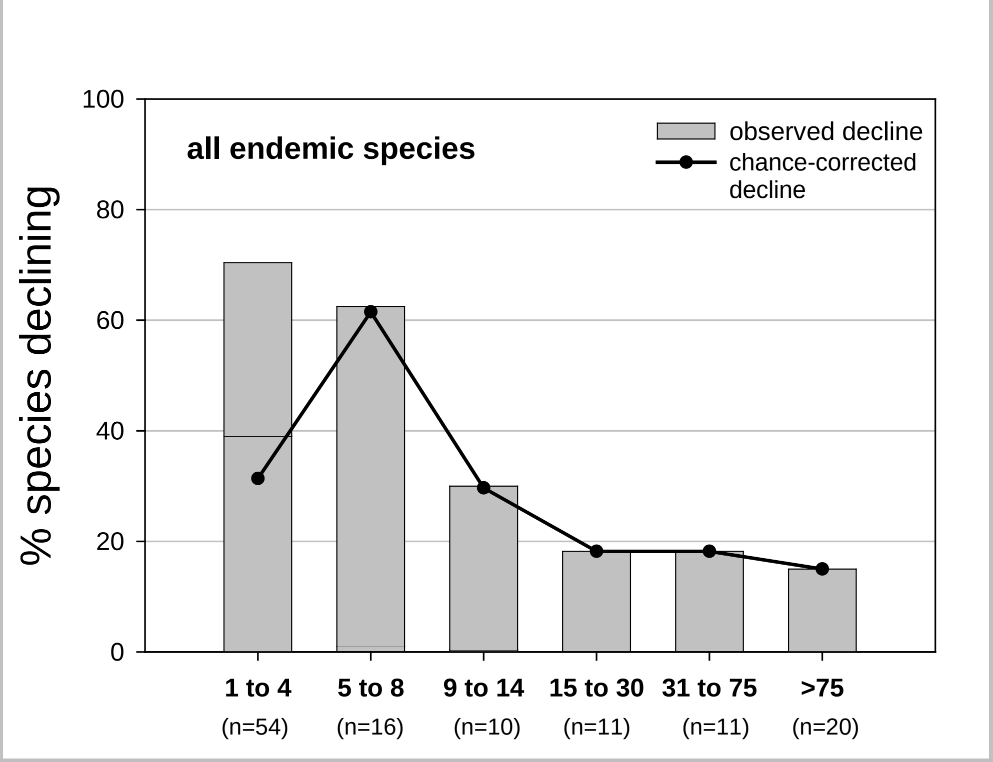


Which species are impacted?

- Examined 300 species, endemic & introduced
- Endemic species more vulnerable than introduced species
- Rare endemic preditors at greatly increased risk
- Spiders, beetles, to lesser extent psocids and moths, at increased risk
- Body size not important, but population density is

Which species are impacted?

- Among all endemic species, 57 to 65% are at increased risk to undergo “drastic” population decline



Which species are impacted?

For many groups, impacts were highly variable:

- among different species in the same order
- and among different populations of the same species

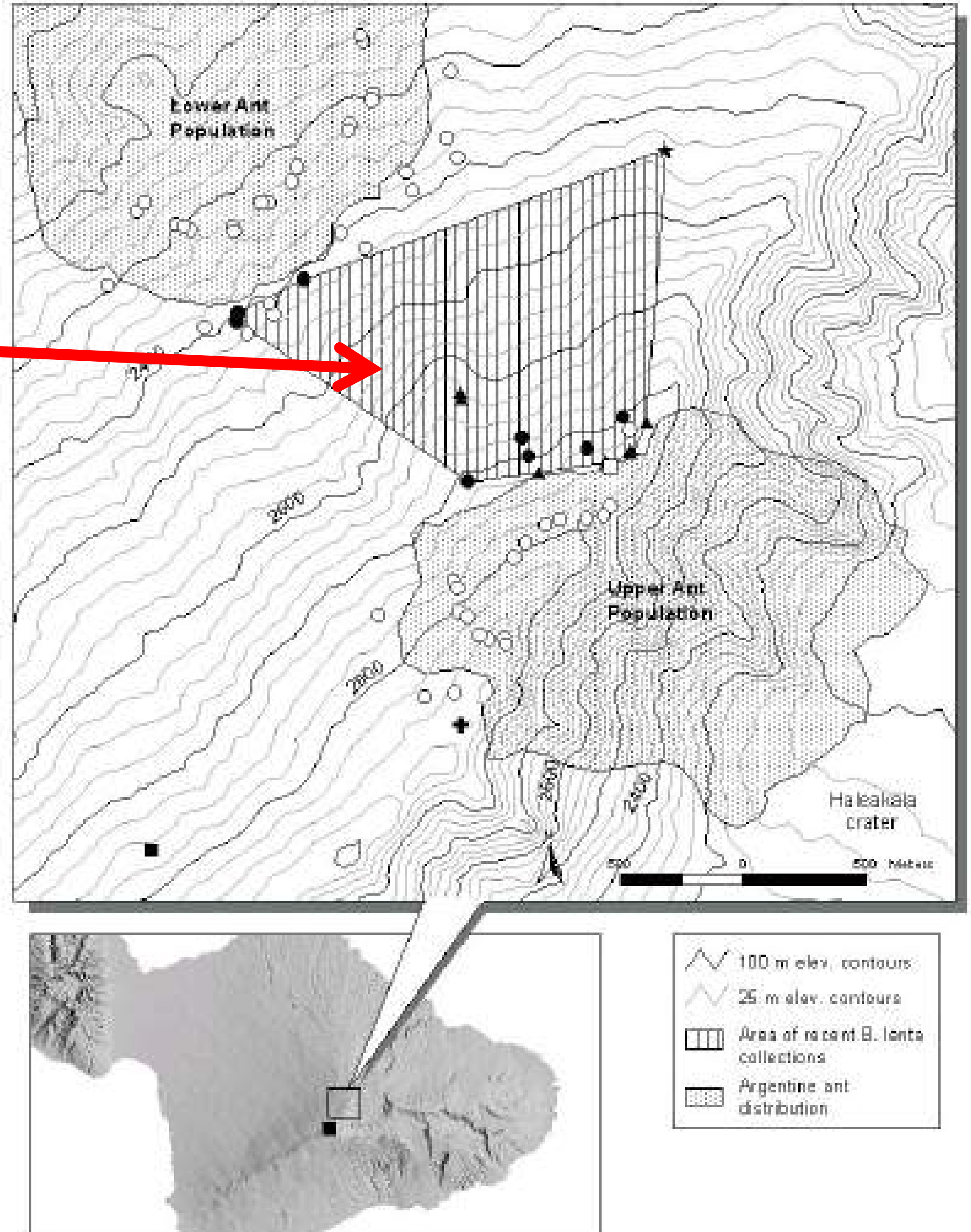
Context-dependency important for these groups;

Taxonomic resolution can be important for accurately understanding effects

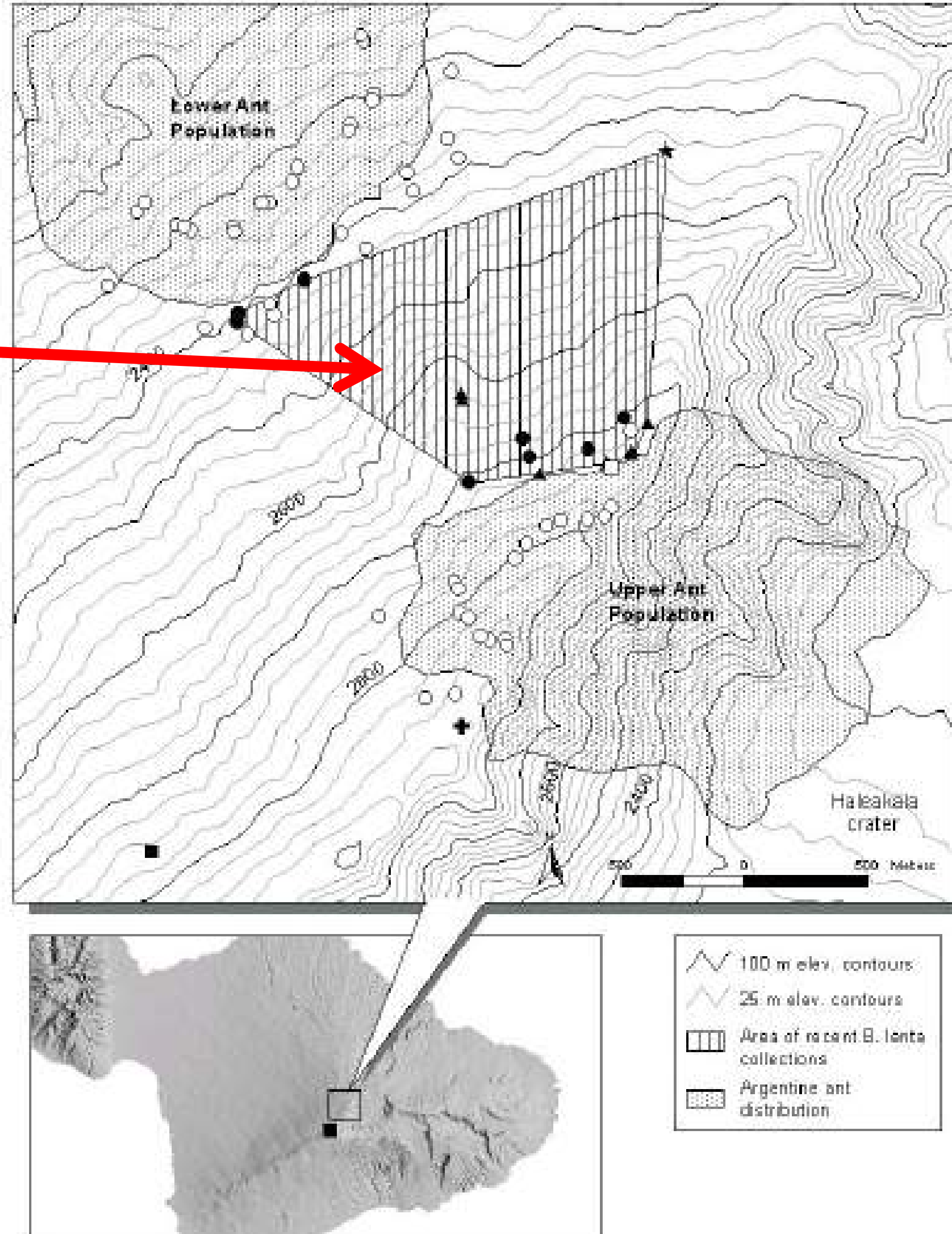
On islands, potential for species extinction is considerably higher

- very high levels of species endemism
- often very restricted ranges


1.0


Lower Ant Population
Upper Ant Population
2600
2800
Haleakala crater
500
0
500 Meters
100 m elev. contours
25 m elev. contours
Area of recent B. lenta collections
Argentine ant distribution

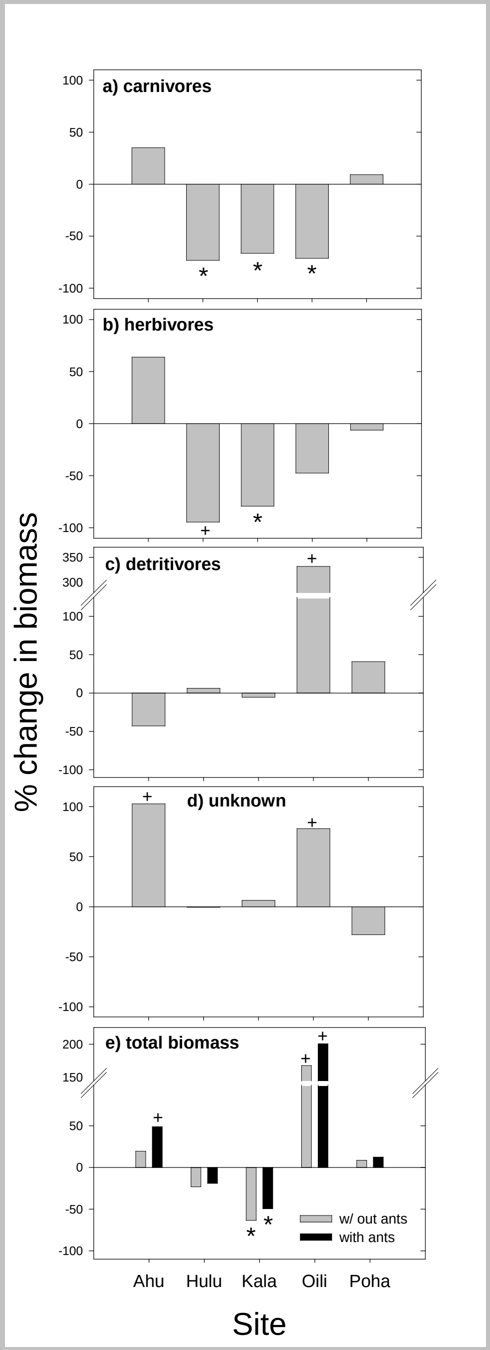

1.0


Lower Ant
Population
Upper Ant
Population
2600
2800
Haleakala
crater
500 0 500 Meters
100 m elev. contours
25 m elev. contours
Area of recent B. lenta collections
Argentine ant distribution

Ecosystem Effects

- Large, but unpredictable, effects on both trophic structure and total biomass in these communities

- May signal dramatically different effects on energy flow and ecosystem function



Ecosystem Effects

Pollination of plants:

- Ants may impact pollination through harassment of pollinators on flowers

- May reduce seed set by preying upon and reducing pollinator populations in an area

Effects on pollination?

- Lori Lach found that Argentine ants, big-headed ants and YCA all visited flowers of native ohia trees with high frequency

- The presence of big-headed ants deterred visitation by native yellow-faced bees

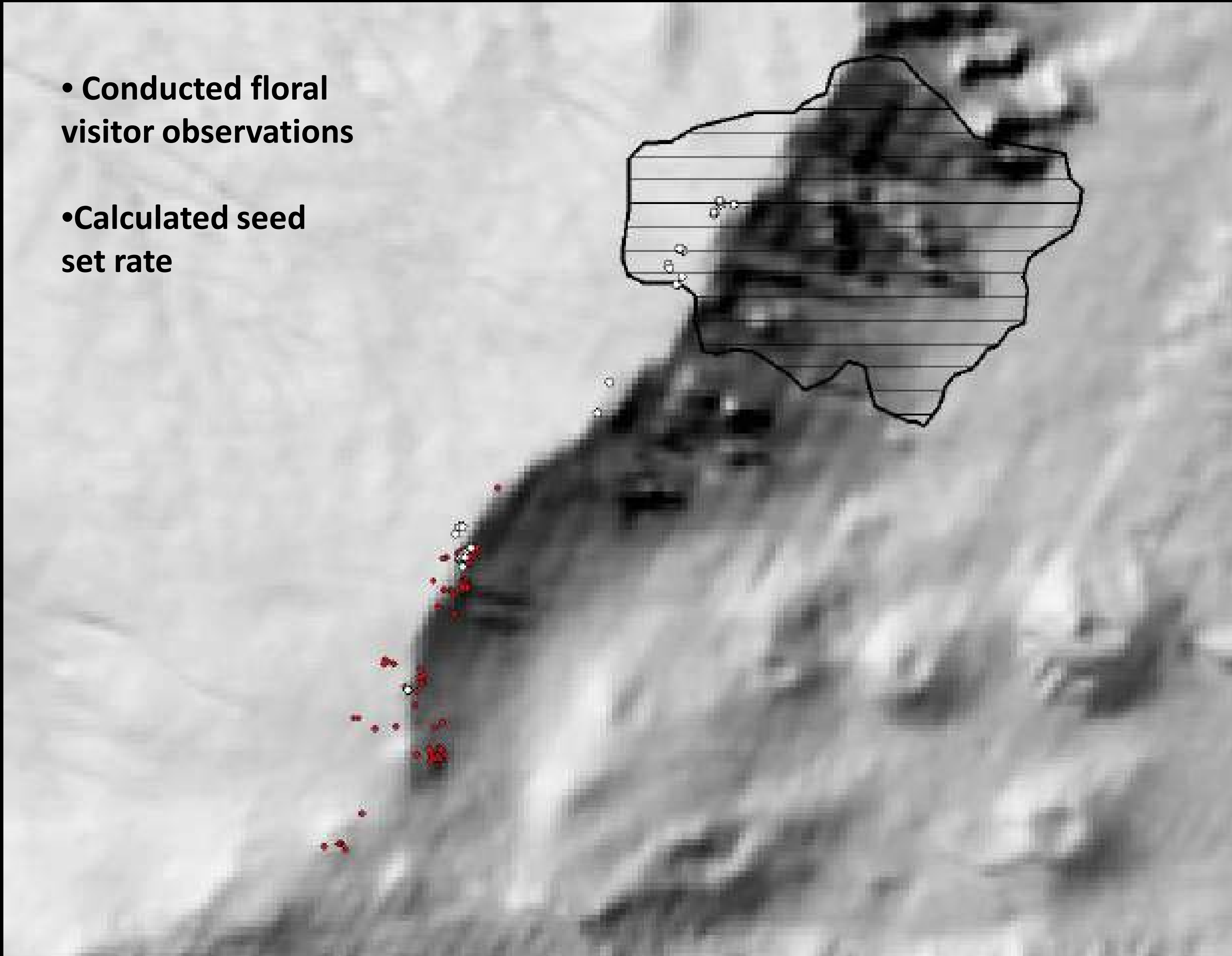
- Invasive ants may compete with native bees for nectar resources

Photo: Philip Thomas

- However effects on seed set rate for ohia trees were not apparent

Effects on pollination?

- **Silverswords are obligate outcrossers, depend on insect pollination**
- **Some results suggest that Argentine ants severely reduce yellow-face bee populations at Haleakala**
- **Ant threats to silverswords has been a frequent justification/funding draw for ant control efforts**



- **Conducted floral visitor observations**

- **Calculated seed set rate**

- Native yellow-faced bees accounted for 85% of floral visits
- Visitation rate was about 50% lower in ant-invaded area, but this may just be the result of a natural gradient in bee numbers
- Lower visitation rate did not translate into lower seed set rate

Effects on pollination?

• In both Hawaiian cases, ants did not appear to impact seed set rate

• But plants with other life history traits could be more affected, or effects may become stronger as invasion progresses

• Rare plants with specialized pollinators may be more likely to suffer decreased reproduction when ants invade

Photo: Dennis Hansen

Seed set rate of *Roussea simplex*, pollinated by blue-tailed day-gecko, strongly reduced by invasive *Technomyrmex albipes* on Mauritius

Other Ecosystem Effects

- Big-headed ants, tropical fire ants, and YCA have all been found to impact seabirds in Hawaii

- Seabirds are important route by which marine-based nutrients enter islands

- Are other well-known examples elsewhere, such as YCA alteration of plant communities via red crab predation on Christmas Island

Ant management in Hawaii

- "If there are no native ants, shouldn't ants be managed everywhere?"
- Appropriateness of management project depends on what is possible and what is practical, from perspectives of regulatory limitations as well as biological, economic and value considerations

Photos © Alex Wild

Ant management in Hawaii

- Is a shortage of effective commercial products in the US for many invasive ant species
- Label language on commercial products tend to be quite specific and therefore fairly restrictive
- Many management projects must therefore currently operate under an EUP, which limits total trial area to 10 acres (4 ha)

Photos © Alex Wild

Ant management in Hawaii

Ants are more or less ubiquitous below about 3000-4000 ft elevation, so management/eradication efforts tend to be restricted to:

Offshore islets

Ant management in Hawaii

LFA on Maui

New/incipient populations

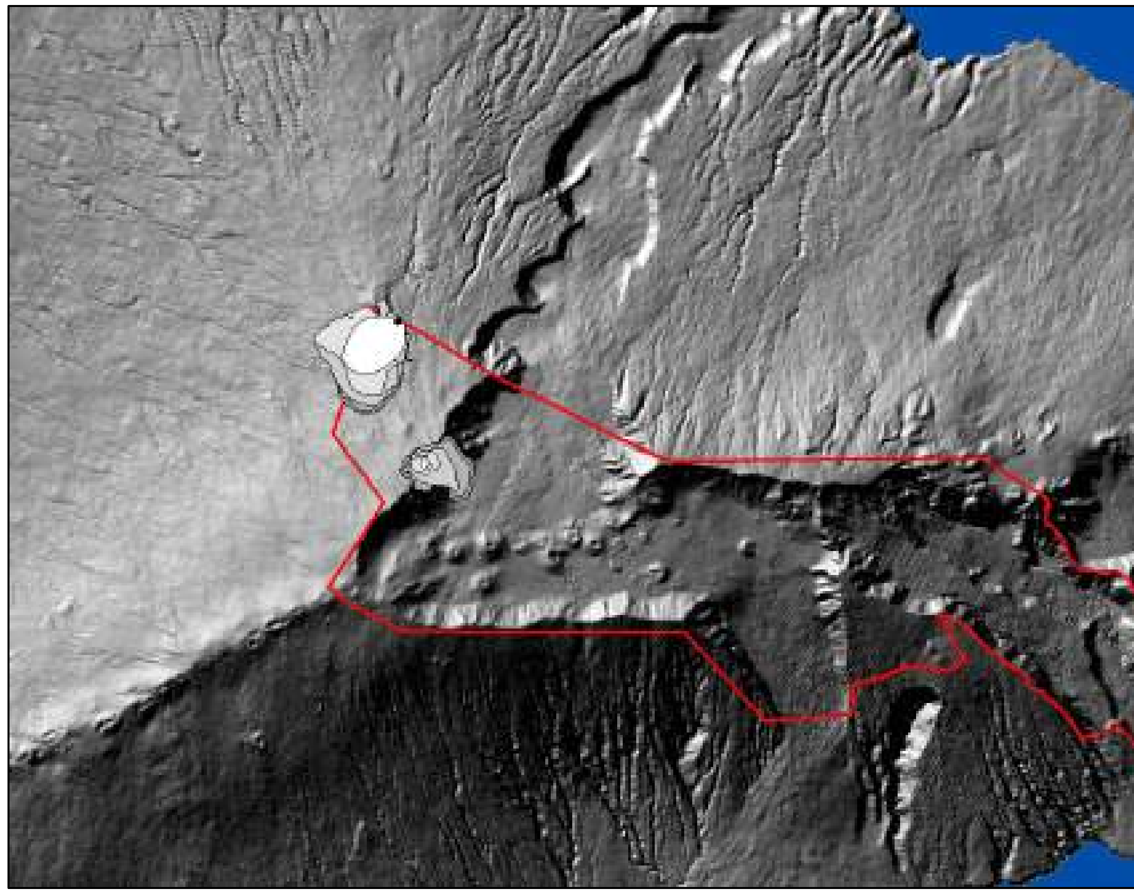
Ant management in Hawaii

Some discrete upland populations

Solenopsis geminata eradicated, has remained absent for almost 4 years

Ant management in Hawaii

Some discrete upland populations



Argentine ants in Haleakala National Park

Biosecurity challenges in Hawaii and the Pacific

• Hawaii greatly strengthened is quarantine procedures regarding ants in 2002 due to changes in USDA and HDOA policy, but still only act on commodities possessing ant species that are "not already established and widespread in Hawaii"

• The difficulty of correctly identifying cryptic and taxonomically confusing species leaves an important gap in the biosecurity policies of Hawaii and most of the rest of the Pacific

Biosecurity challenges in Hawaii and the Pacific

Technomyrmex albipes – 1911

Biosecurity challenges in Hawaii and the Pacific

Technomyrmex vitiensis – 1911

Technomyrmex difficilis – 1994

Technomyrmex albipes – 1997

Arrival of *T. difficilis* and *T. albipes* correlates with large outbreaks of pest “white-footed ants” in the 1990’s and 2000’s in Hawaii

Biosecurity challenges in Hawaii and the Pacific

Technomyrmex vitiensis – 1911

Technomyrmex difficilis – 1994

Technomyrmex albipes – 1997

Technomyrmex pallipes – 2007

Biosecurity challenges in Hawaii and the Pacific

Tapinoma sessile

Technomyrmex pallipes

A mis-identification and mix-up between these two species led us to initially believe that *Tapinoma sessile* was established at at least 3 distant locations on 2 islands for at least 2 years. In reality, only one known location, first detected last summer.

Thank you!

- Ben Hoffmann, CSIRO and Sumitomo for organizing the workshop

- Sheldon Plentovich, Stephanie Joe, Jaap Eijzenga, Cas Vanderwoude and others at HDOA for sharing data on ant projects and distributions in Hawaii

- Alex Wild, Forest and Kim Starr, Philip Thomas and others for use of photos