

A “gastropad” for gastropods: *a safe hang-out for snails*

AKA

Stabilization of rare Oahu snail populations
using predator exclusion structures



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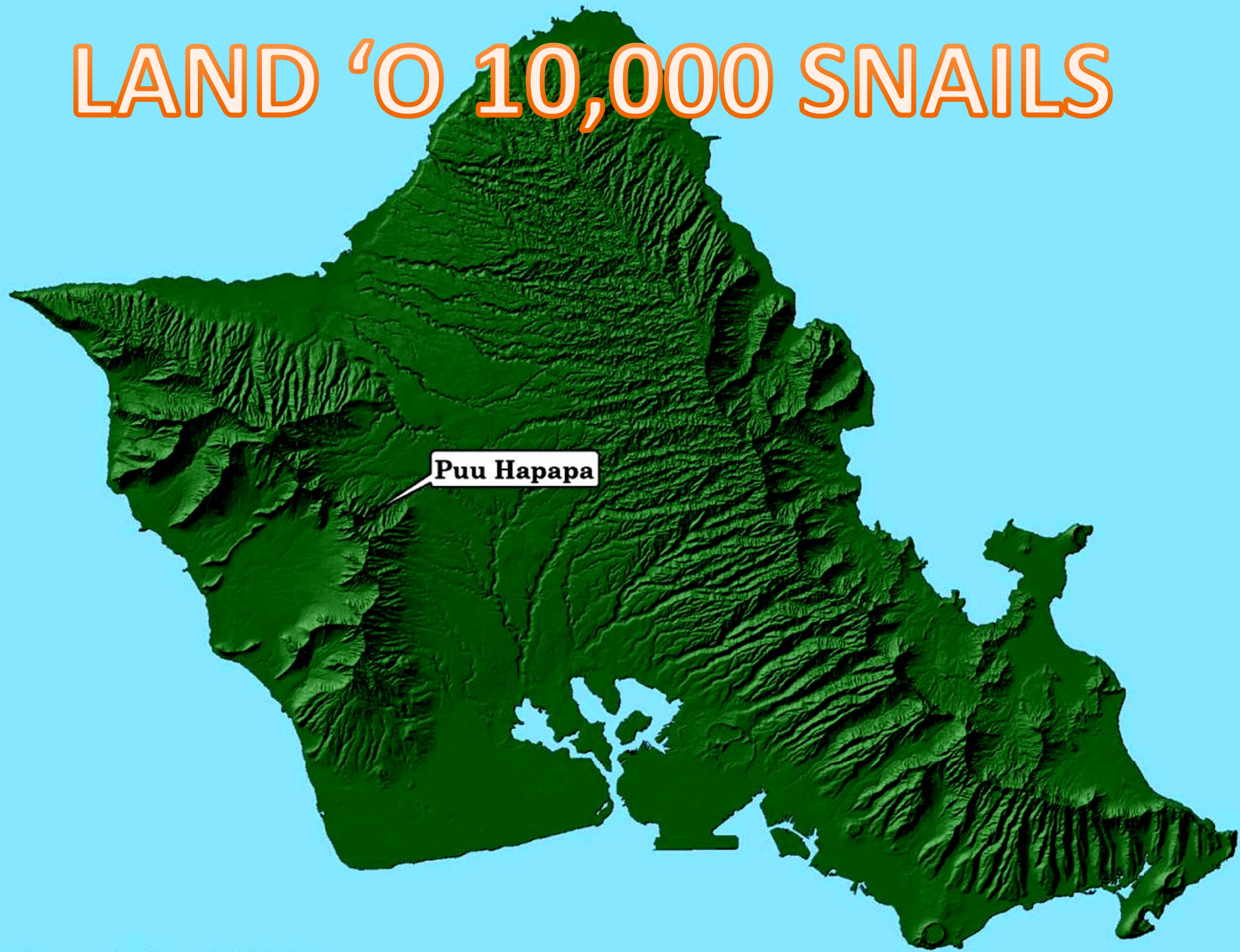
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Rare Snail Specialist

Research Specialist

Oahu Army Natural Resource Program

LAND 'O 10,000 SNAILS



Puu Hapapa

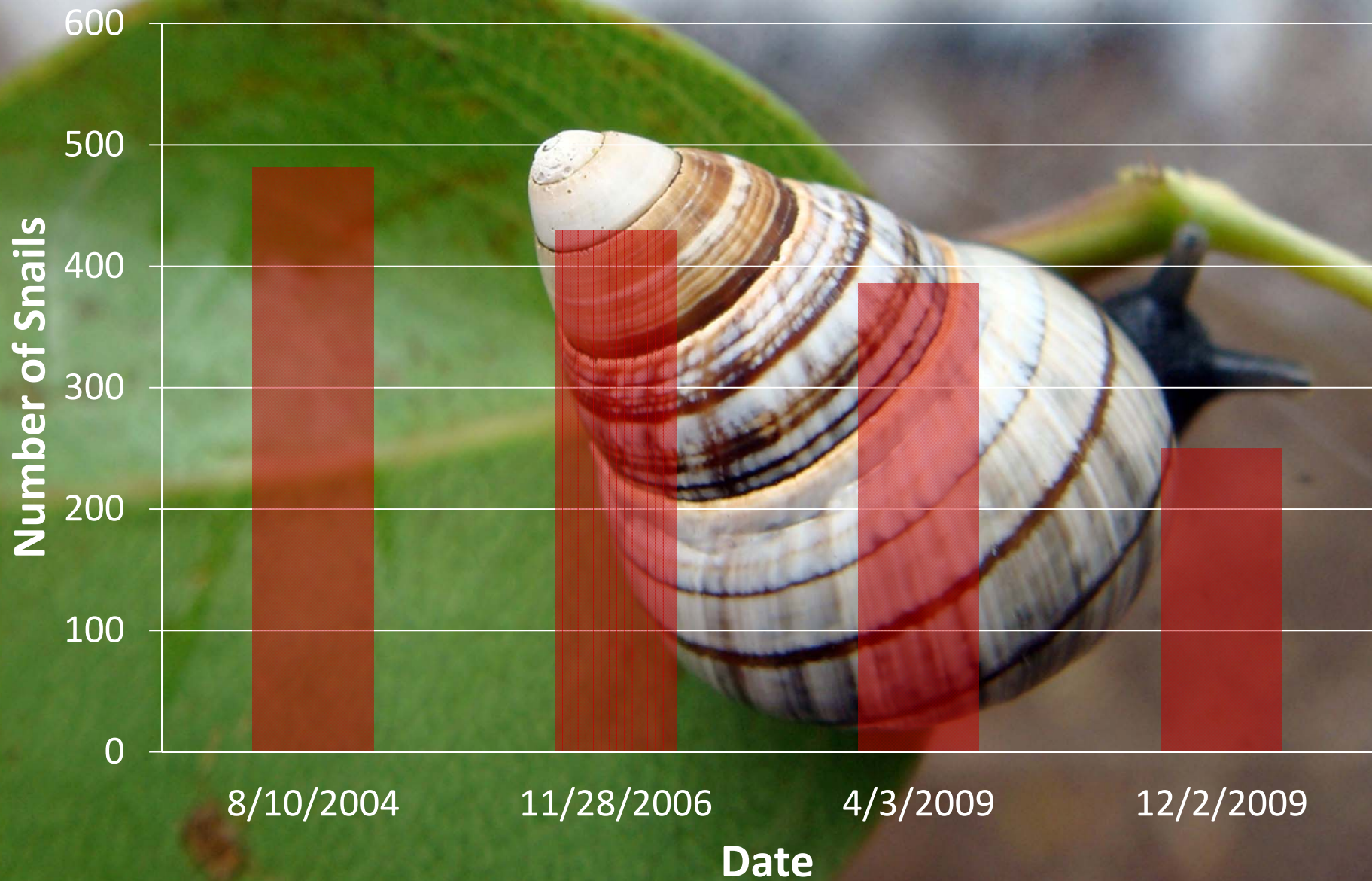
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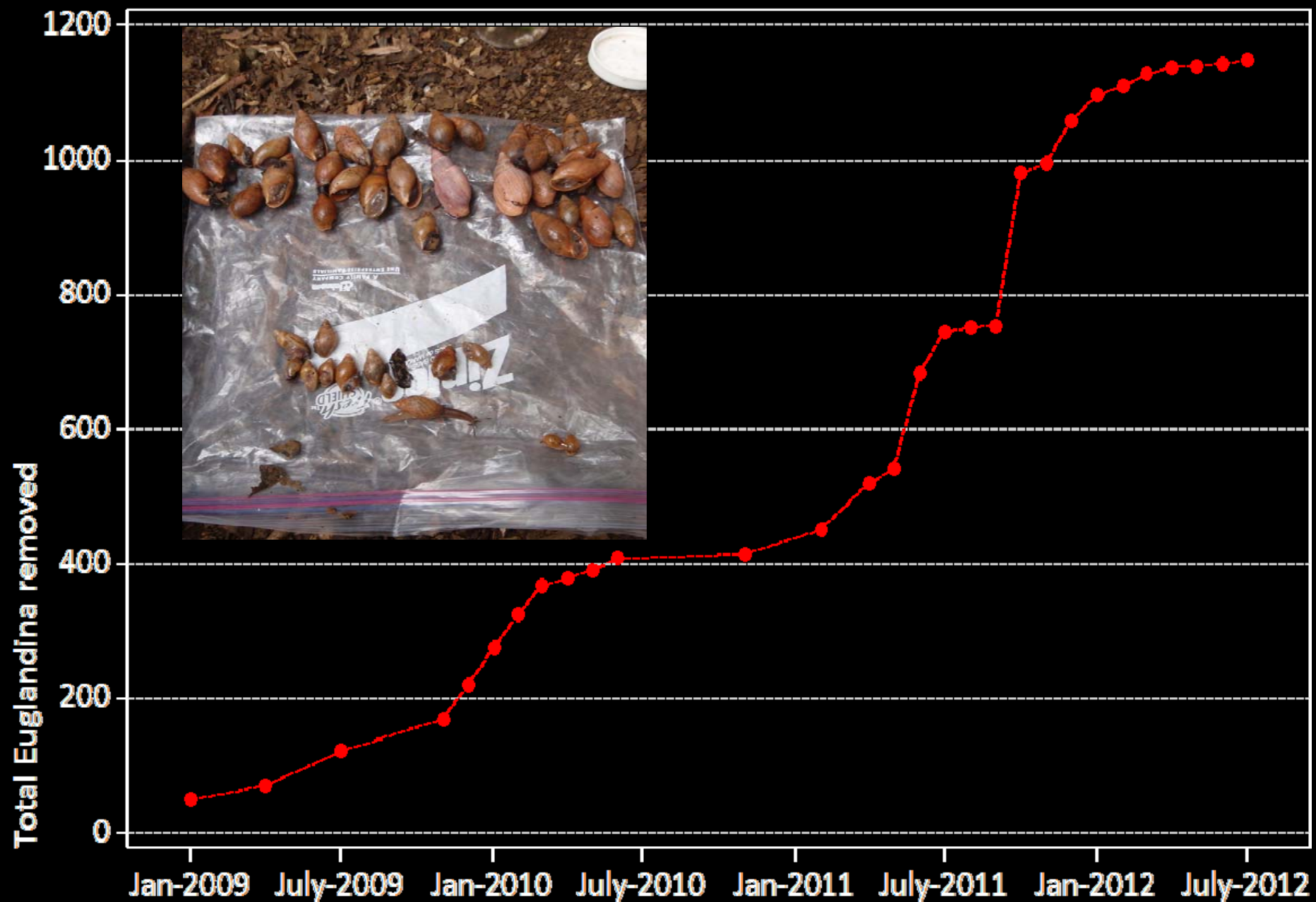
5,500

11,000 Meters

Achatinella decline at Puu Hapapa



Cumulative number of Euglandina removed from Puu Hapapa





“Snail jail” from the 1990’s

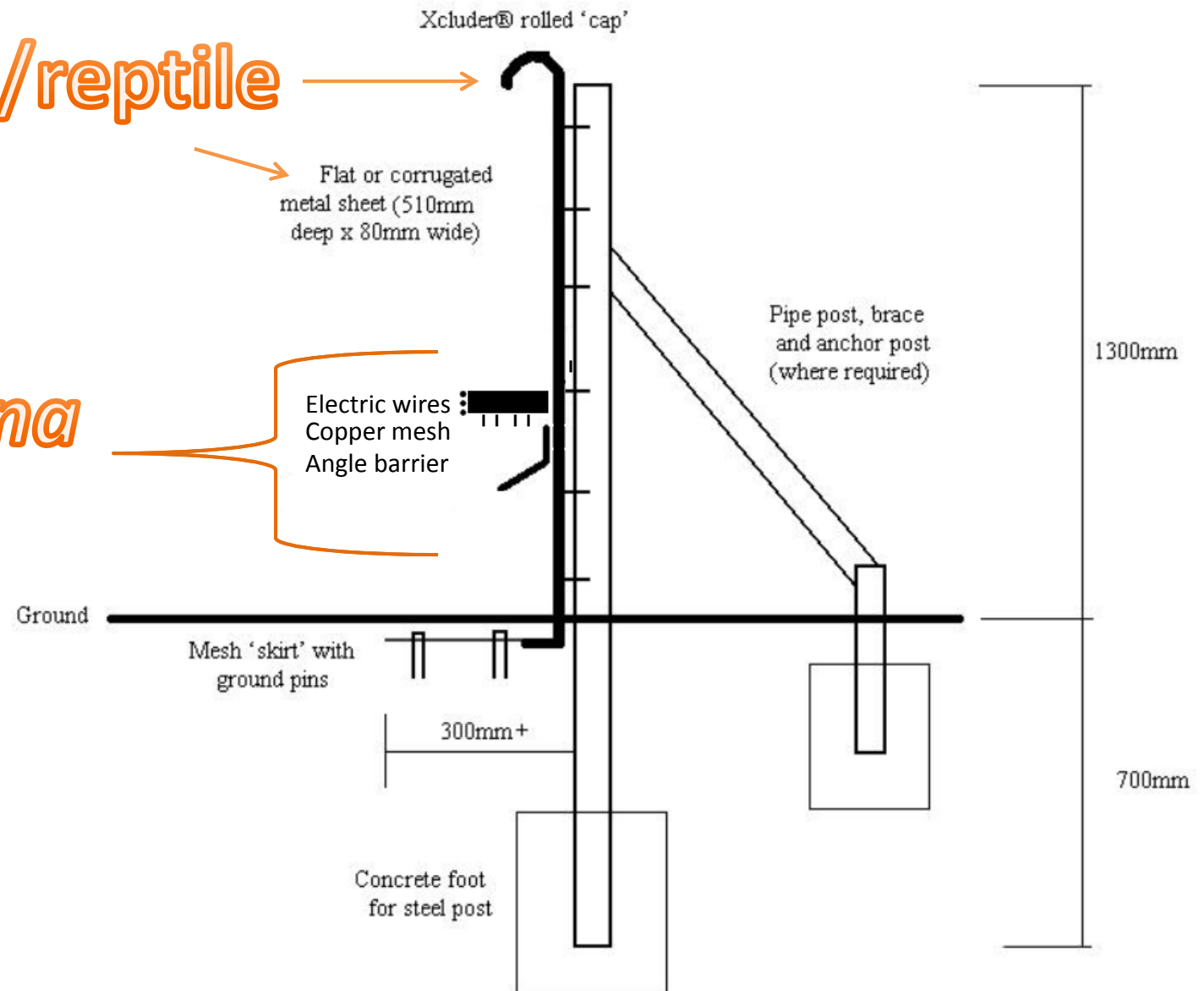


**Map removed to
protect rare resources**

Fence design

Mammal/reptile
barriers

Euglandina
barriers



First defense: angle barrier



Cleaning the angle barrier



Second defense: copper mesh



Third defense: Electricity



Rodent defense: hood

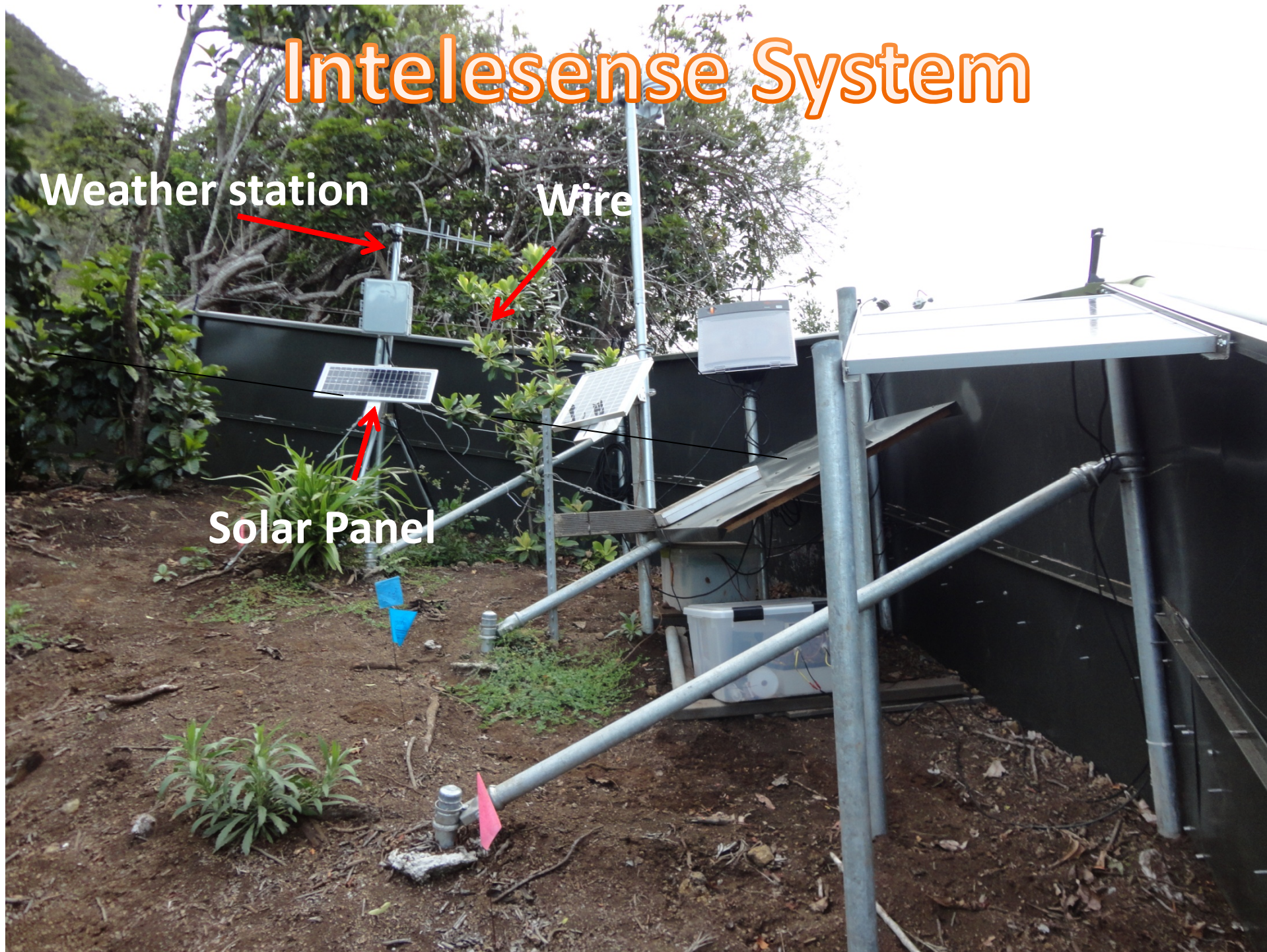


Intelesense System

Weather station

Wire

Solar Panel







Fence co\$t

Description	Cost in dollars
Xcluder contract for construction of fence including materials	100,000
OANRP costs for clearing, predator removal, site preparation	135,444
Additional hardware	8,017
Total cost to date (2009-2012)	243,461







Outline

- Introduction – why needed? Broad consensus, predators main threat
- 4 structures, long term solutions, though not permanent
- Puu Hapapa Release – new direction for snail lab-Rotation system
- Monitoring
- Latest threat -Jackson's Chameleon
- Preliminary results: home range, shell digestion, public awareness
- Potential control strategies? Permanent solutions



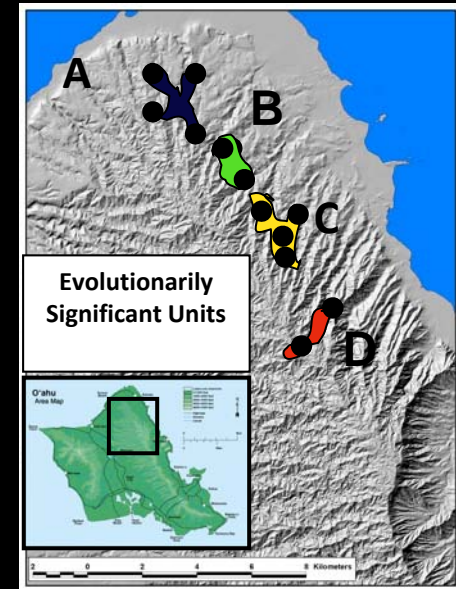
Ecology of invasive predators “know your enemies”



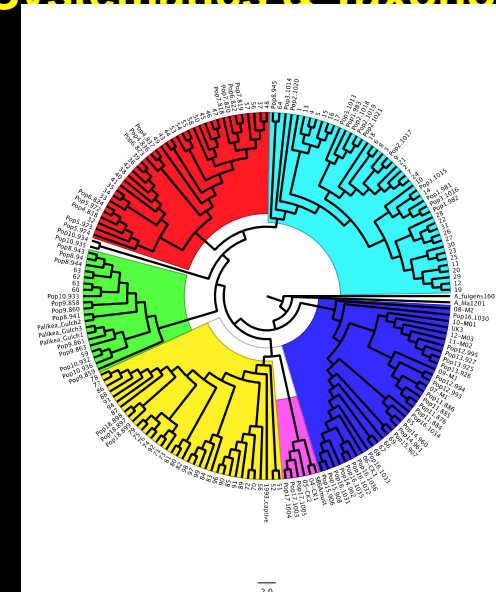
Captive Breeding



Conservation Genetics & Phylogeography



Systematics & Taxonomy



Lab: we have 12 species and about 850 *Achatinella* snails in captive propagation



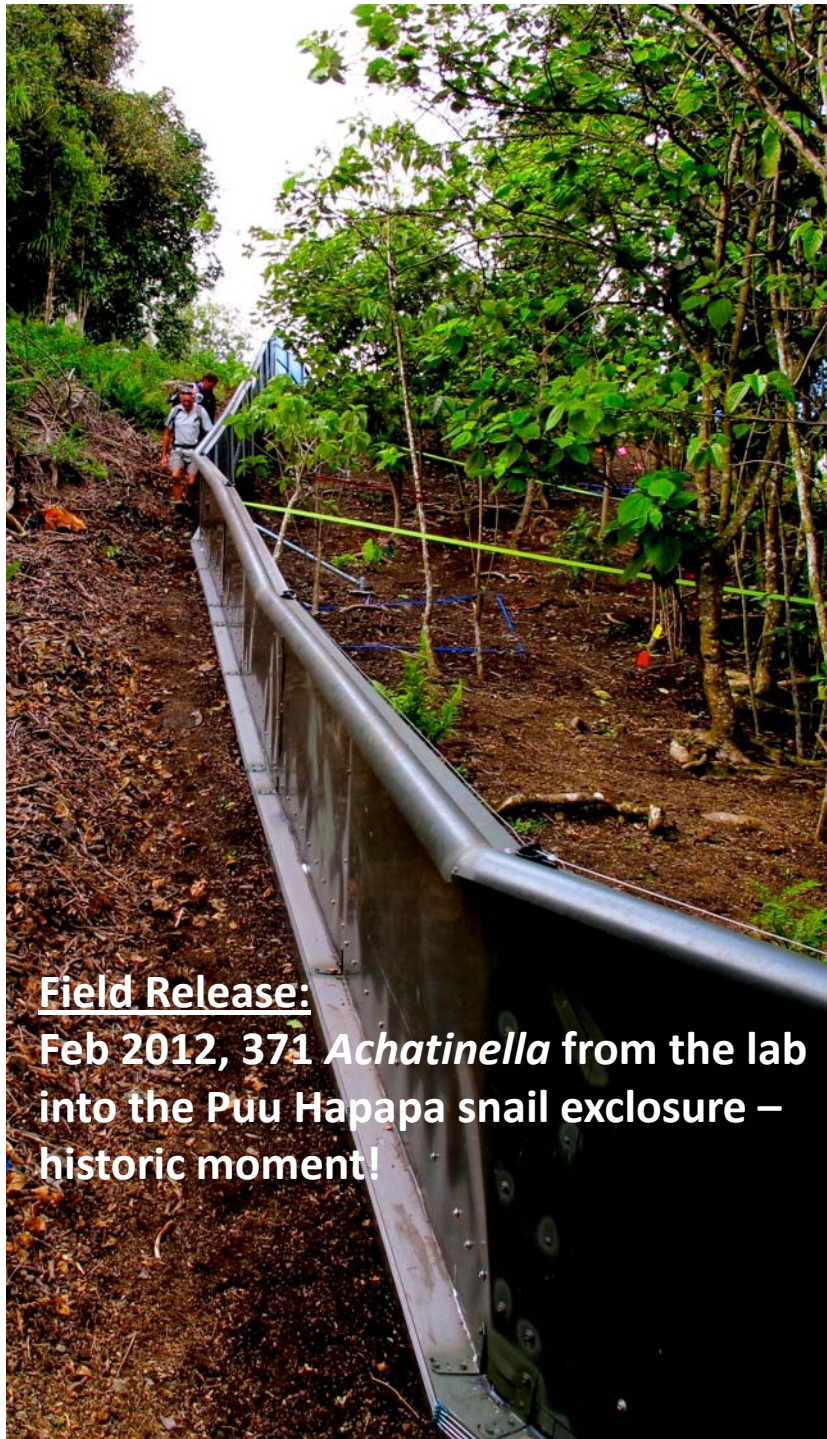
Water supply, controlled temp /light



7 Environmental chambers



Provide a mix of native tree leaves and cultured leaf fungus



Field Release:
Feb 2012, 371 *Achatinella* from the lab
into the Puu Hapapa snail enclosure –
historic moment!



- Puu Hapapa exclosure: ~ 435 *Achatinella mustelina* plus *Catinella* (Succineidae), *Auriculella ambusta* (Achatinellidae), *Cookeconcha* (Endodontidae), *Philonesia* (Helicarionidae), future: *Laminella* (Amastridae).
- Critical habitat inside, endemic plants, insects, spiders, many extremely rare

Intellisense system with photovoltaic electric fence, perimeter integrity sensor, weather conditions, real time video.



Release February 8 & 21, 2012

Monitoring

- Plan calls for 3 times per quarter
- Ground shell plots plus surveys outside of the two release zones
- Mean number of snails observed = 88
- Cumulative shell count = 22
- Success!



Feb 21, 2012

Despite establishment for decades (1972), impact first documented 2010

- 12 chameleons – Puu Kumakalii
- dissection revealed endemic snails and insects in gut



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ORIGINAL PAPER

A reptilian smoking gun: first record of invasive Jackson's chameleon (*Chamaeleo jacksonii*) predation on native Hawaiian species

Brenden S. Holland · Steven L. Montgomery · Vincent Costello

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Abstract Here we report the first conclusive evidence of an introduced reptile (*Chamaeleo jacksonii*) feeding on Hawaiian taxa, including 11 snails in four endemic genera from two families, including four individuals of an endangered species (*Achatinella mustelina*), and native insects in five genera. Native Hawaiian invertebrates were discovered in the dissected stomachs of wild caught Jackson's chameleons collected from June to November 2009 on the island of Oahu. Although Jackson's chameleons were introduced to the Hawaiian Islands in the early 1970s, ecological impacts have never been documented. Of particular concern is the fact that chameleons have previously only rarely been found in native Hawaiian habitat, although 12 were recently collected in a mid-elevation native forest, an area that is not likely to be suitable for their long-term persistence, but that is adjacent to higher elevation pristine forest where endemic prey are abundant and favorable climatic conditions exist for chameleon persistence. One concern is that Jackson's chameleons may be undergoing a range expansion into upper elevation pristine forests. If chameleons reach and establish populations in these areas, devastating impacts to the native ecosystem are possible. A thorough understanding of the impacts of chameleons on Hawaiian fauna will require additional evaluation and sampling, but dissemination of this discovery in a timely fashion is important as it provides new information regarding this threat. Monitoring and collection of chameleons is ongoing, particularly in native Hawaiian forest habitats at mid and upper elevations (600–1,300 m).

Keywords *Achatinella mustelina* · Oahu tree snails · *Auriculella* sp · Impacts of introduced predators · Conservation · Native Hawaiian insects

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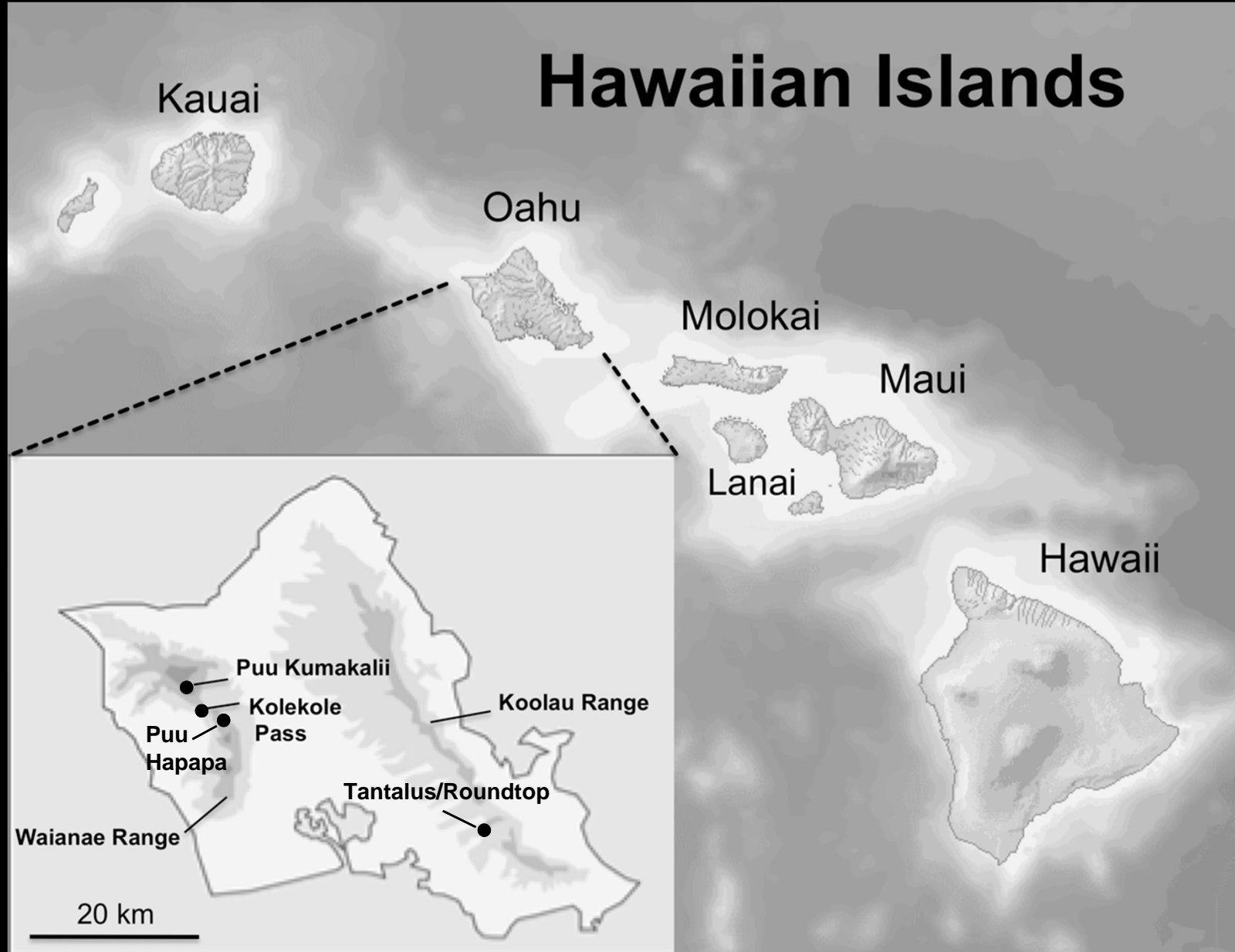
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Hawaiian Islands



Part 1: Laboratory experiments

Objectives:

- estimate *Achatinella* shell digestion rates
- determine prey preference under lab conditions



Part 2: Field studies

Objectives:

- habitat utilization : patchy distribution due to pet owner release – different habitat, different range size?
Will they “head for the hills”?
- determine prey preference in different environments
(gut content analysis)

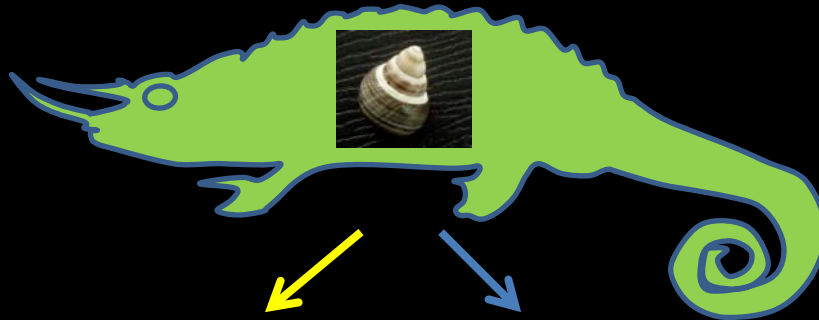


Part 1: Laboratory experiments



- Shells and chameleons were measured & weighed
- Shell to chameleon size ratio was standardized
- *Achatinella mustelina* shells were force-fed to Chameleons

Part 1: Laboratory experiments



Fed insects daily

Not fed insects

3 Days

4 Days

* 5 Days

* 7 Days

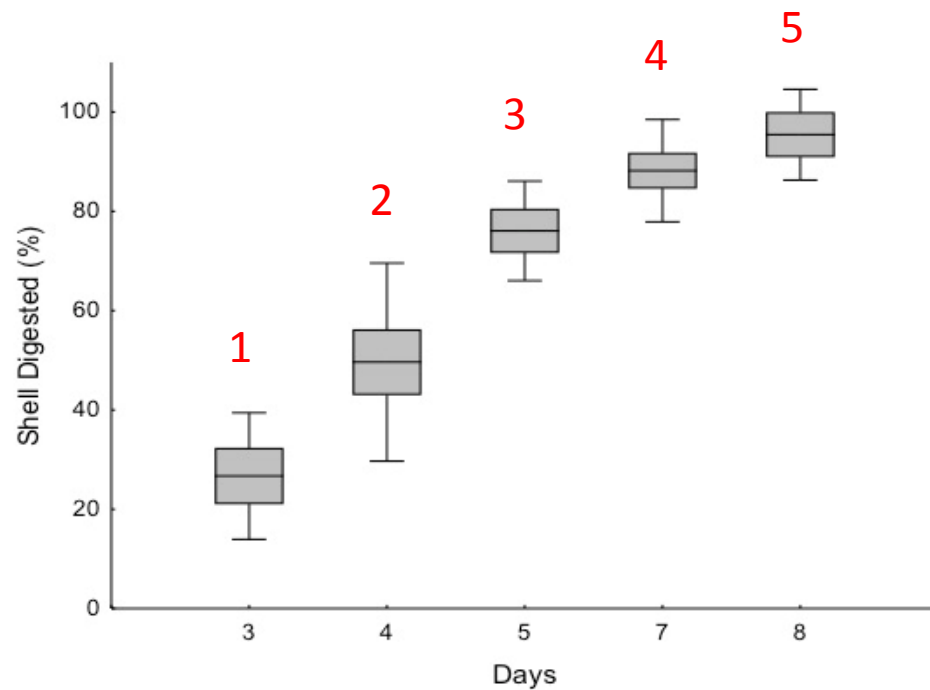
* 8 Days

Dissection

- Shell position in gut
- Shell weight
- Shell condition

Note:

- Digestion only occurs in the stomach, not in the intestine.
- Time shells remain in gut depends on feeding conditions.



Percent shell mass digested vs time

Box: mean and SD, Whiskers: SE.
Numbers represent different categories (post-hoc ANOVA, Tukey test, $p < 0.01$)



Auriculella uniplicata



- Jackson's Chameleons completely digested *Achatinella* shells in 8 days
- We can now estimate time of ingestion by shell condition

Part 2: Estimation of Home Range Area

Objective: To assess habitat utilization by Jackson's Chameleons using active radio transmitters, GPS receiver, GIS software.

Radio-telemetry:

- Technology allows the remote measurement and reporting of information of interest to system operator using hand-held receiver.

Each tag has a unique frequency,
4 month battery



Antenna has a range
of ~ 300 m



Compact, battery
powered receiver

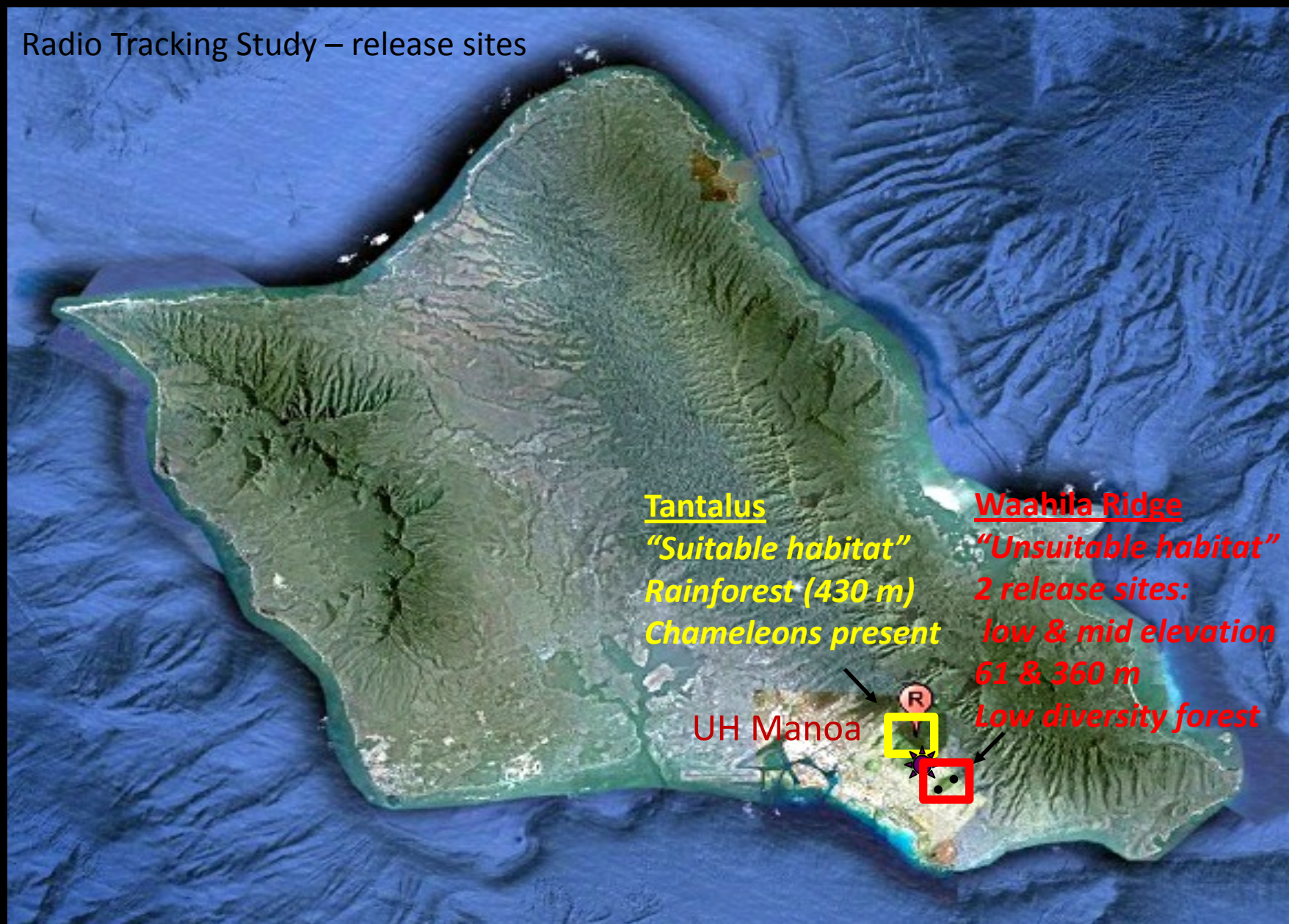


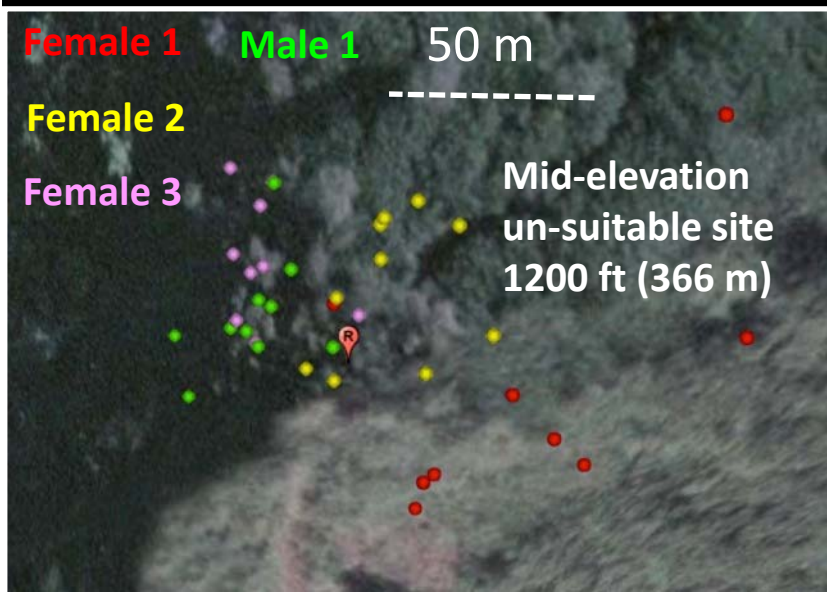
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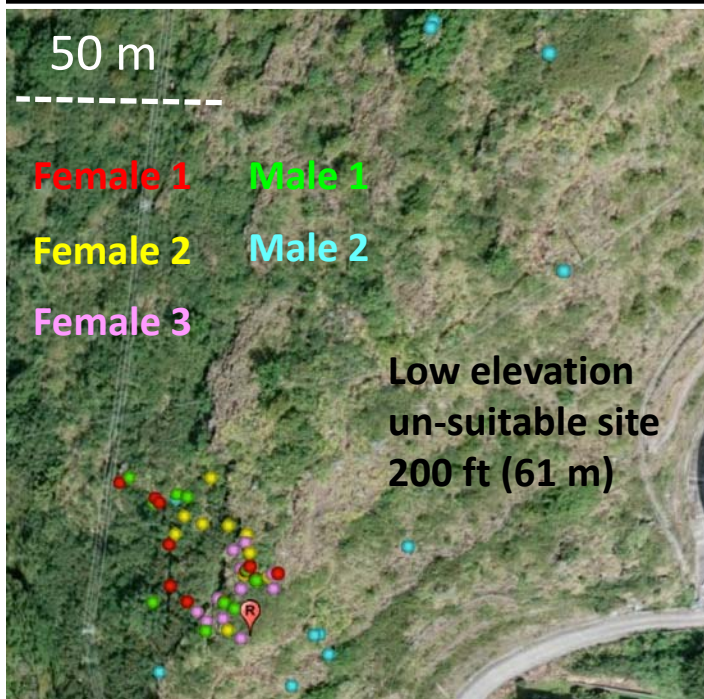
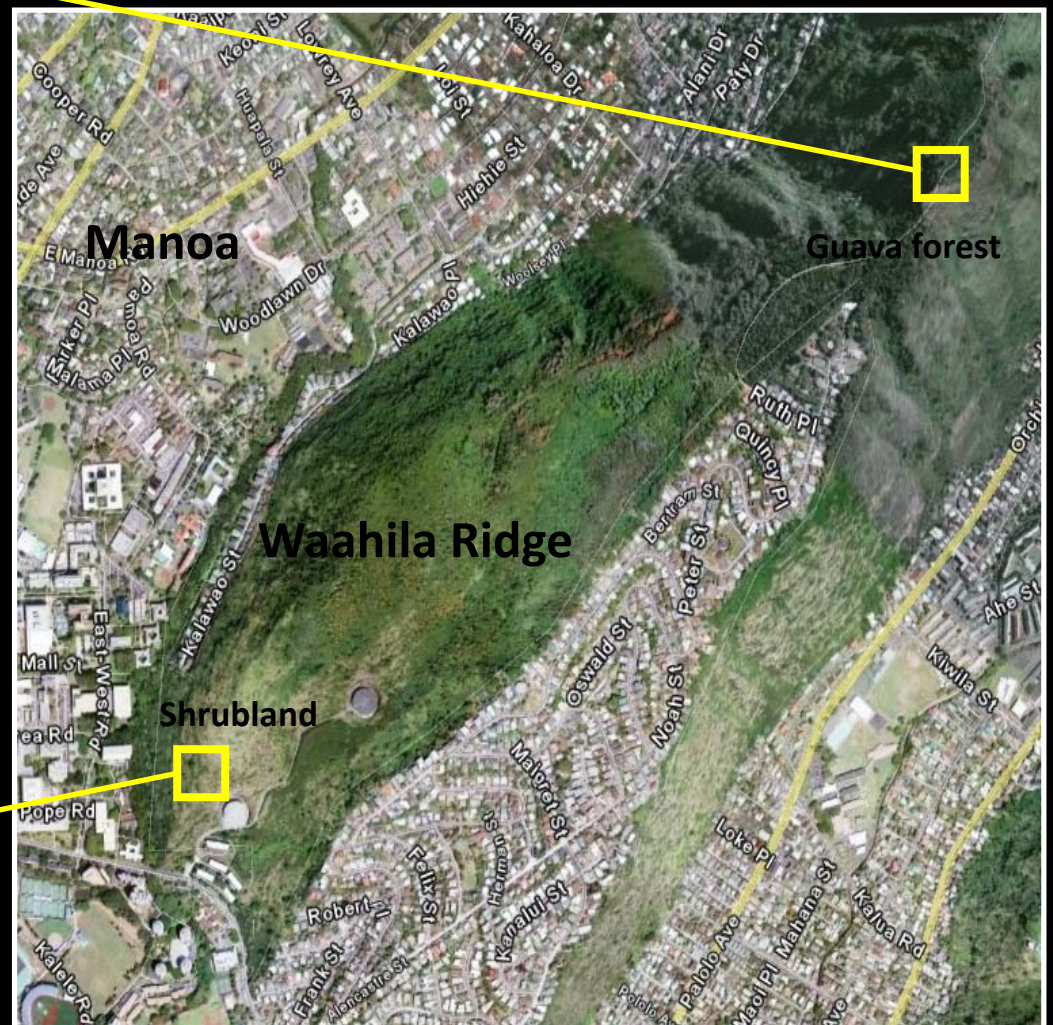
Jackson's Chameleons with active transmitters glued on their backs

Radio Tracking Study – release sites





No established populations



- Each home range <110 m radius
- Non-overlapping home ranges
- Males tended to move longer distances
- Longest daily distances covered within first 3 days

Male 1 Female 1
Male 2 Female 2
Male 3

50 m

Tantalus

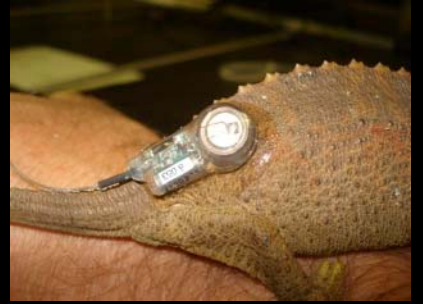
Rain Forest Site

Higher diversity,
complexity, 25 m
canopy

ID	Origin	Max. Dist. From release site	Daily distance first 3 days (exploratory)	Daily distance after 3 days (HR)	Home Range
Male 1	Tantalus	107.6	11.34 m (SE: 1.1)	3.07 m (SE: 0.31)	311.8 m ²
Male 2	Tantalus	40.4	12.6 m (SE: 1.5)	3.2 m (SE: 0.51)	222.5 m ²
Male 3	Tantalus	29.5	34.2 m (SE: 7.0)	6.5 m (SE: 0.53)	383.3 m ²
Female 1	Tantalus	46.7	13.62 m (SE: 2.0)	3.2 m (SE: 0.48)	220.3 m ²
Female 2	Waianaes	21.3	9.01 m (SE: 1.31)	3.6 (SE: 0.61)	216.1 m ²



Conclusions



- In “suitable habitat” (Tantalus) chameleons have uniform, smaller, non-overlapping ranges – stay put
- Unsuitable habitat, extended exploratory phase, but maximum distance from release point ~300 m in one month: Habitat-dependent? (prey, water, cool).
- Wander, but no “head for the hills” behavior observed
- Important implications for both impact assessment and control strategy for this species
- If anthropogenic release can be controlled, there may be a chance of localized manual eradication – outreach

School lab tours and lectures



Please do not release
Jackson's chameleons!

It is illegal, and Jackson's chameleons cause environmental damage by eating native Hawaiian species.

If you have a pet chameleon and no longer wish to keep it, please either euthanize it in a humane fashion (you can put it in the freezer) and dispose of it, or deliver to us live at the University of Hawaii (337 Henke Hall), or a State of Hawaii Department of Agriculture or Department Land and Natural Resources office.

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Trap/poison

Conceptual *Euglandina*
trap: "wheel of death"
idea

Concentrated bait
strips

