

Invasive lizards in Florida (i.e., Black & White Tegus in South Florida)

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National Park Service



Acknowledgments & Caveats

- Caveats
 - Views presented are my own
 - Combination of NPS + USGS efforts
- Funding:
 - Everglades National Park
 - USGS Greater Everglades Priority Ecosystem Science
 - USGS Invasive Species Program
- Coworkers/Colleagues
 - NPS = Tylan Dean
 - USGS = Emma Hanslowe, Amy Yackel Adams, Bob Reed
 - UF = Christina Romagosa
 - INTERNS!!



Non-native Reptiles & Amphibians in Florida

- 180 = non-native species reported in Florida
- 63 = reproducing populations
 - 4 frogs
 - 5 turtles
 - 1 crocodilian
 - 48 lizards
 - 5 snakes

Florida has more non-native reptiles *than anywhere else in the world.*

Krysko et al. 2016. IRCF Reptiles and Amphibians 23(2): 110-143



Non-native Reptiles & Amphibians in Florida

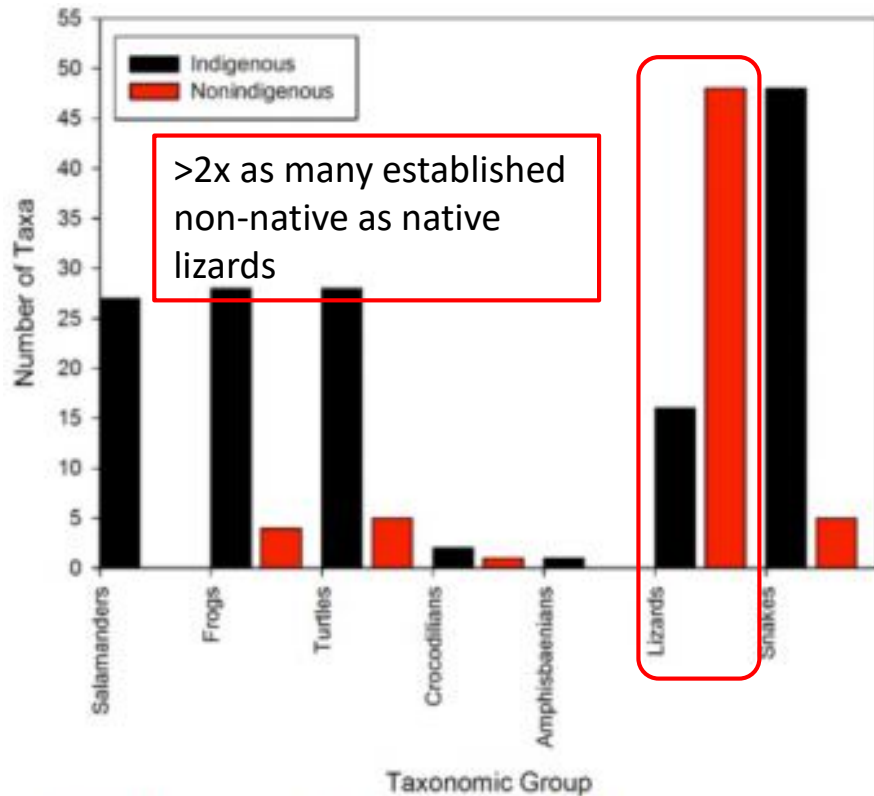


Fig. 38. Numbers of indigenous and established nonindigenous taxa among taxonomic groups.

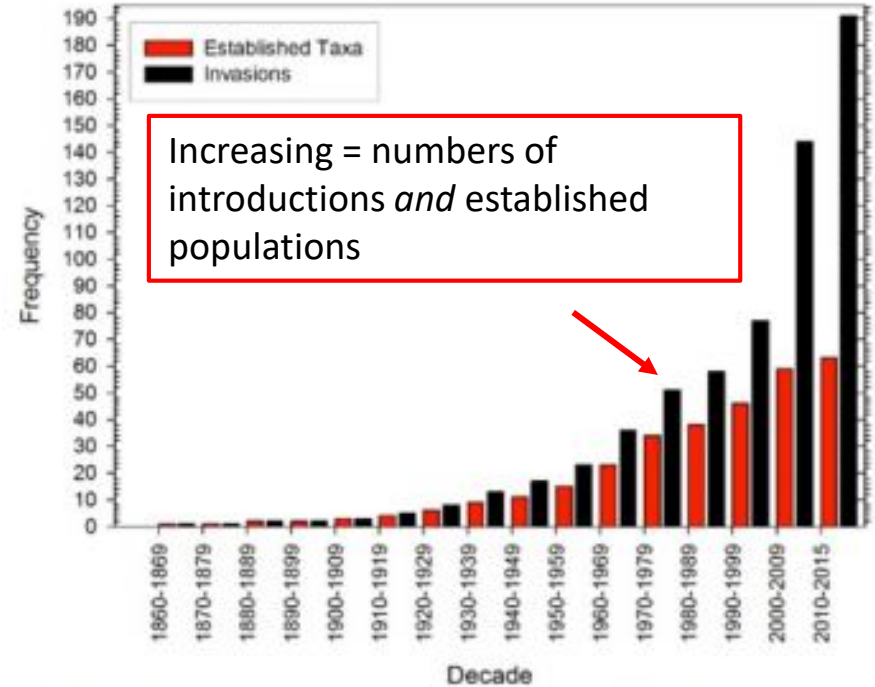
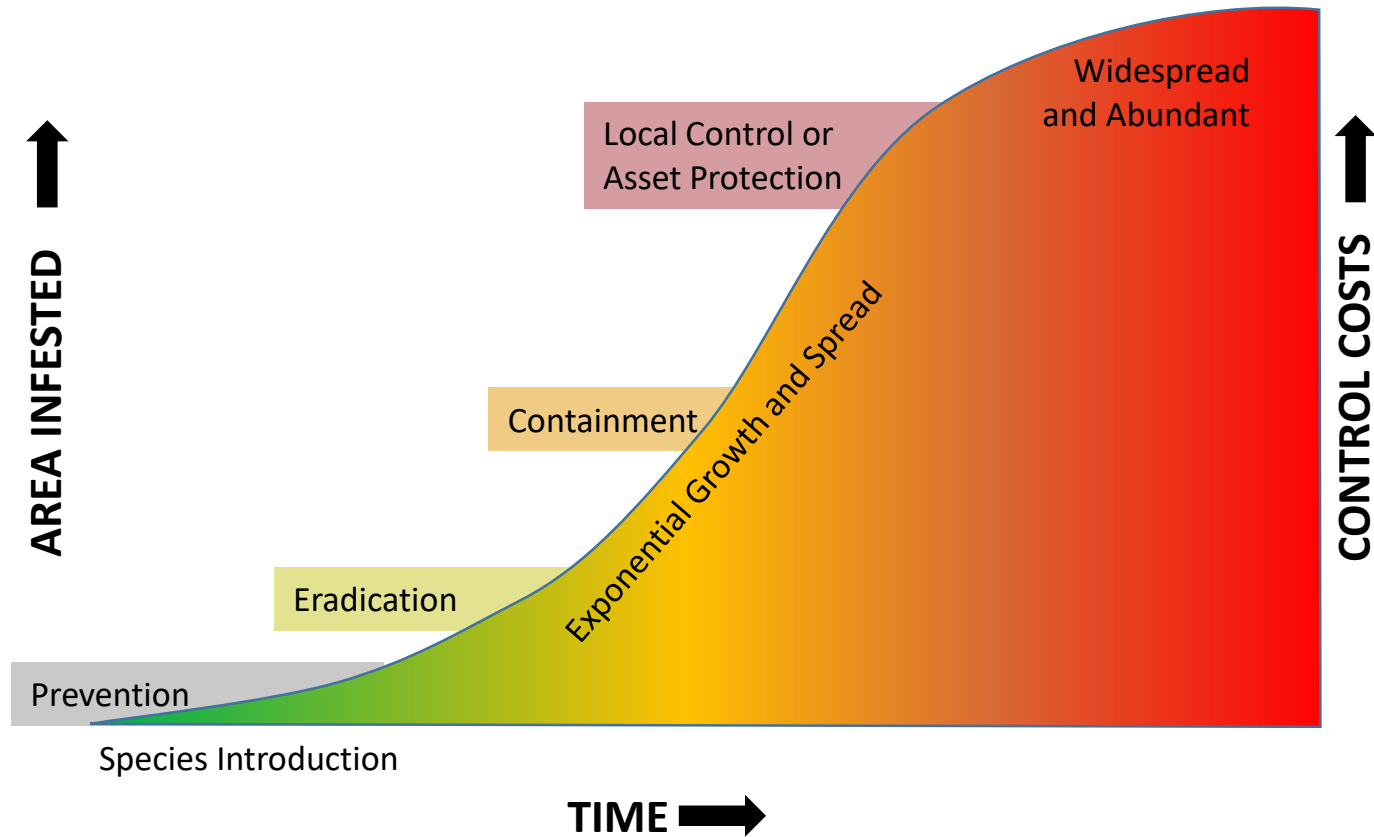
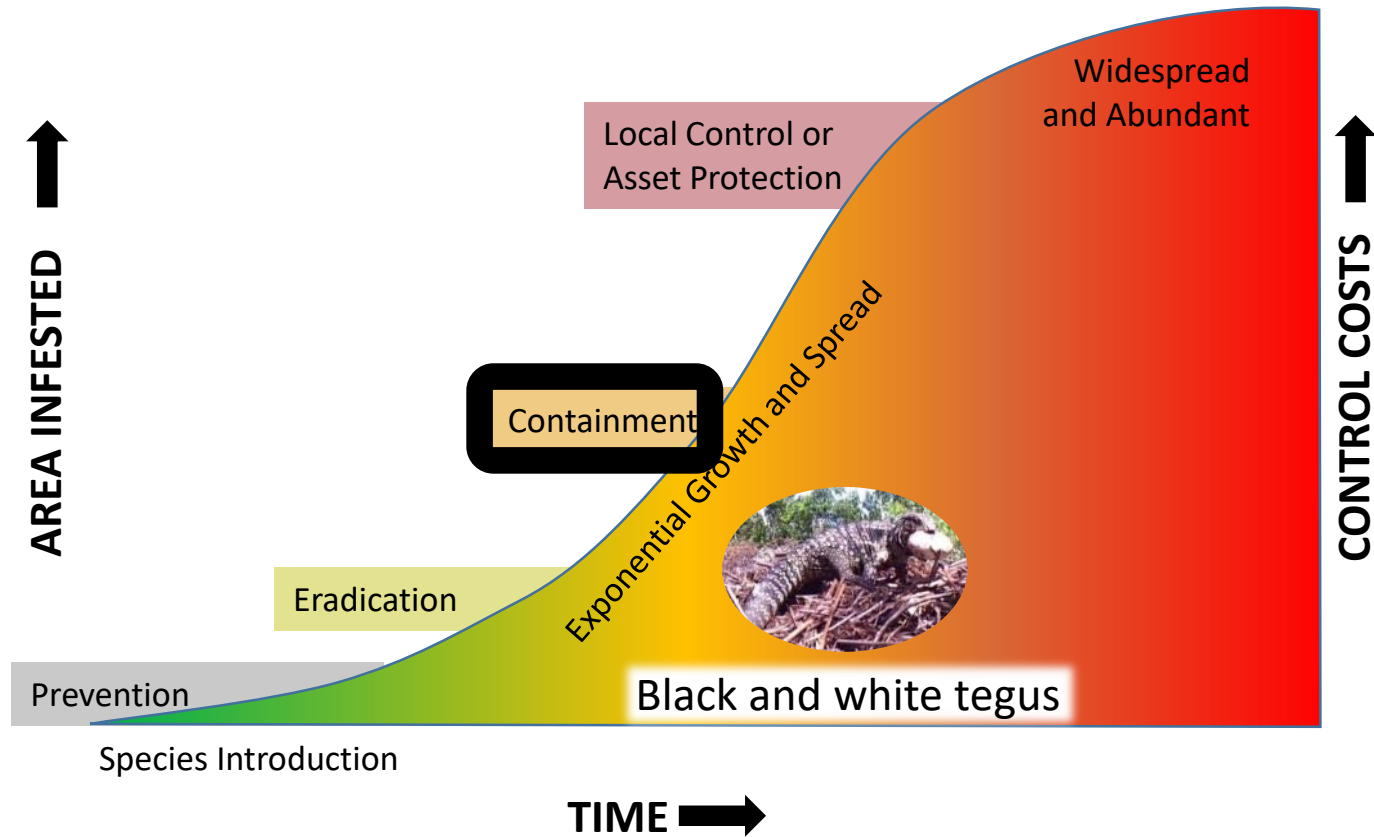


Fig. 37. Accumulation curves for the total number of independent introduction pathways ($n = 191$) of amphibian and reptile taxa and established taxa ($n = 63$) for each decade from 1860 through 2015. Note that establishment is calculated only once for each taxon using the first year it became established, and intercepted taxa ($n = 5$) are not included.

INVASION CURVE



INVASION CURVE





Black and white tegus (*Salvatore merianae*)

- Large-bodied lizards
- Native to South America
- Mostly terrestrial, but excellent swimmers
- Diurnal
- Wintertime dormancy
- Spend nights and winters in burrows, etc.
- Clutch size large = 36 (20-54)
- Annual clutch, females attend
- Sexual maturity at 3-4 years
- Can live 10+ years



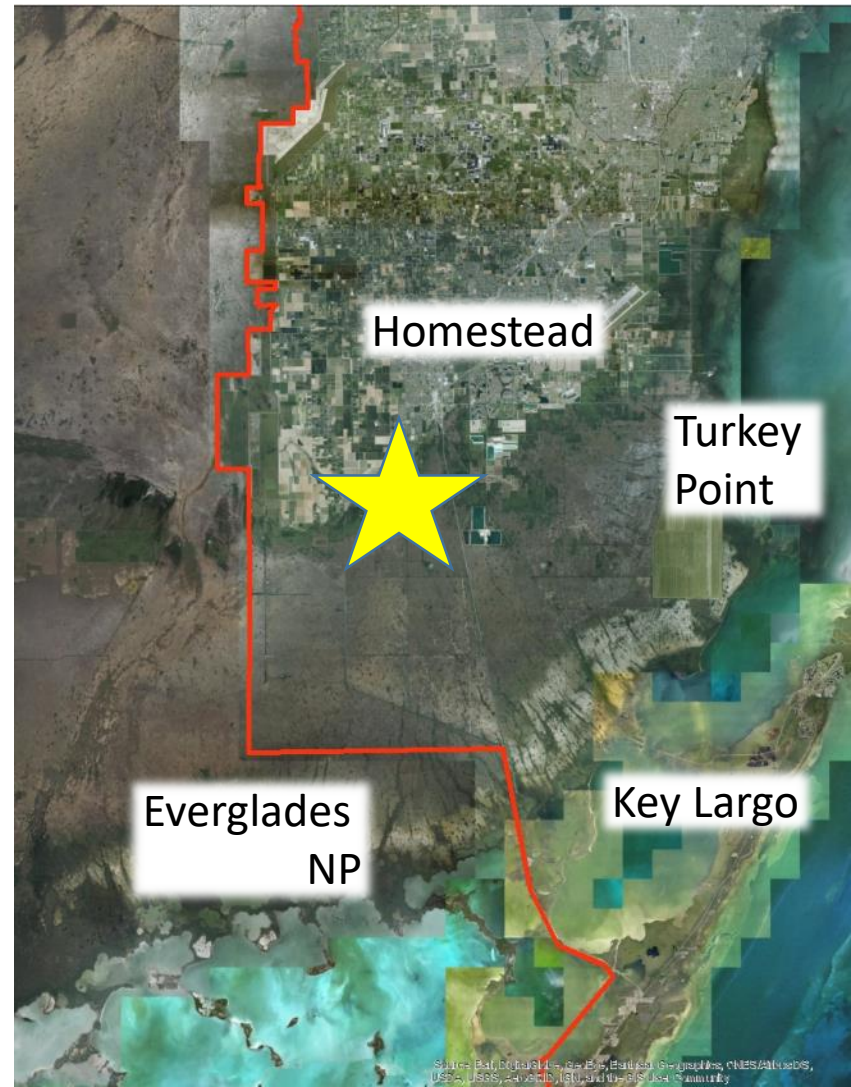
Black and white tegus (*Salvatore merianae*)

- Ecological impact is potentially broad
 - Habitat generalist – wild areas, in/near human habitation
 - Dietary generalist – animals, vegetation, fruit, eggs*
- Unregulated harvest in native range
 - Skin for purses, belts, etc.
 - Population monitoring since 1990s
 - No evidence of population decline



Black and white tegus (*Salvatore merianae*)

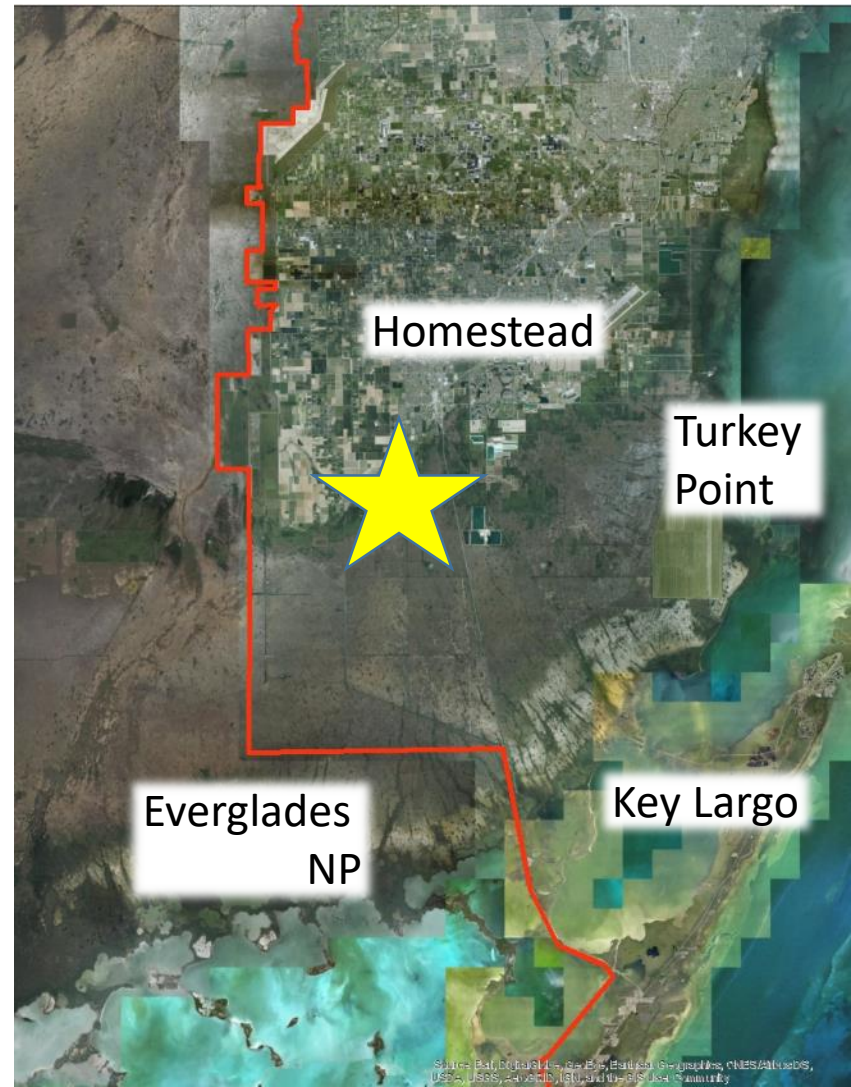
- First observed in 2008 near Homestead (south Miami-Dade)
- At risk:
 - Everglades National Park (sea turtles, Cape Sable seaside sparrow, American crocs)
 - Turkey Point (American crocs)
 - Key Largo (Key Largo woodrat)



Black and white tegus (*Salvatore merianae*)

Interagency trapping efforts

- 2012-present
- Commercial traps (e.g., for raccoons)
- Bait = chicken egg
- Many knowledge deficits for improved control





Research



Management



Research

Knowledge deficits* -- Containment

- Vital rates
 - Fecundity
 - Juvenile survival
- Juvenile dispersal
- Bait attraction / trap success



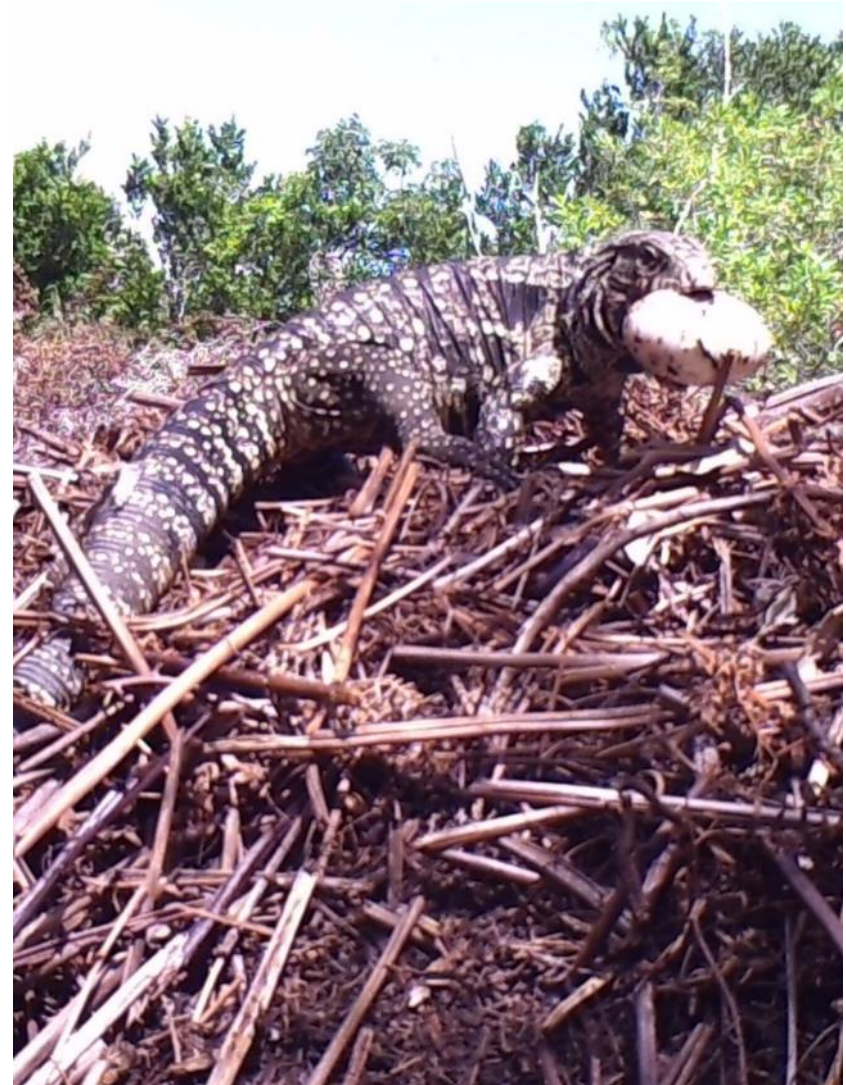
**these are just some of many*

Knowledge deficits* -- Containment

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- Bait attraction / trap success

Telemetry

Trap/bait trials



**these are just some of many*

Telemetry – Juveniles

- Dispersal/survival estimates
 - Release from nest sites
 - Radio-track 3-6 weeks
- Need external transmitter
- Glue attachment
 - Accommodates growth
 - Drop at shedding event
 - Skin shedding rates??



Telemetry – Juveniles

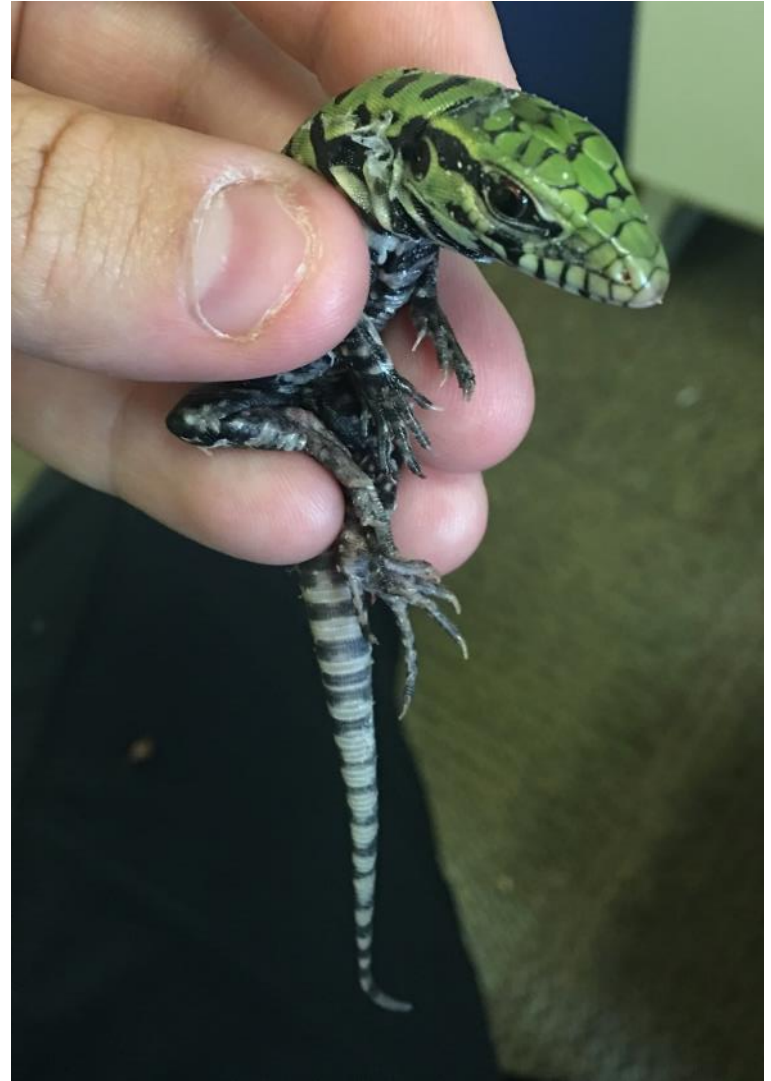
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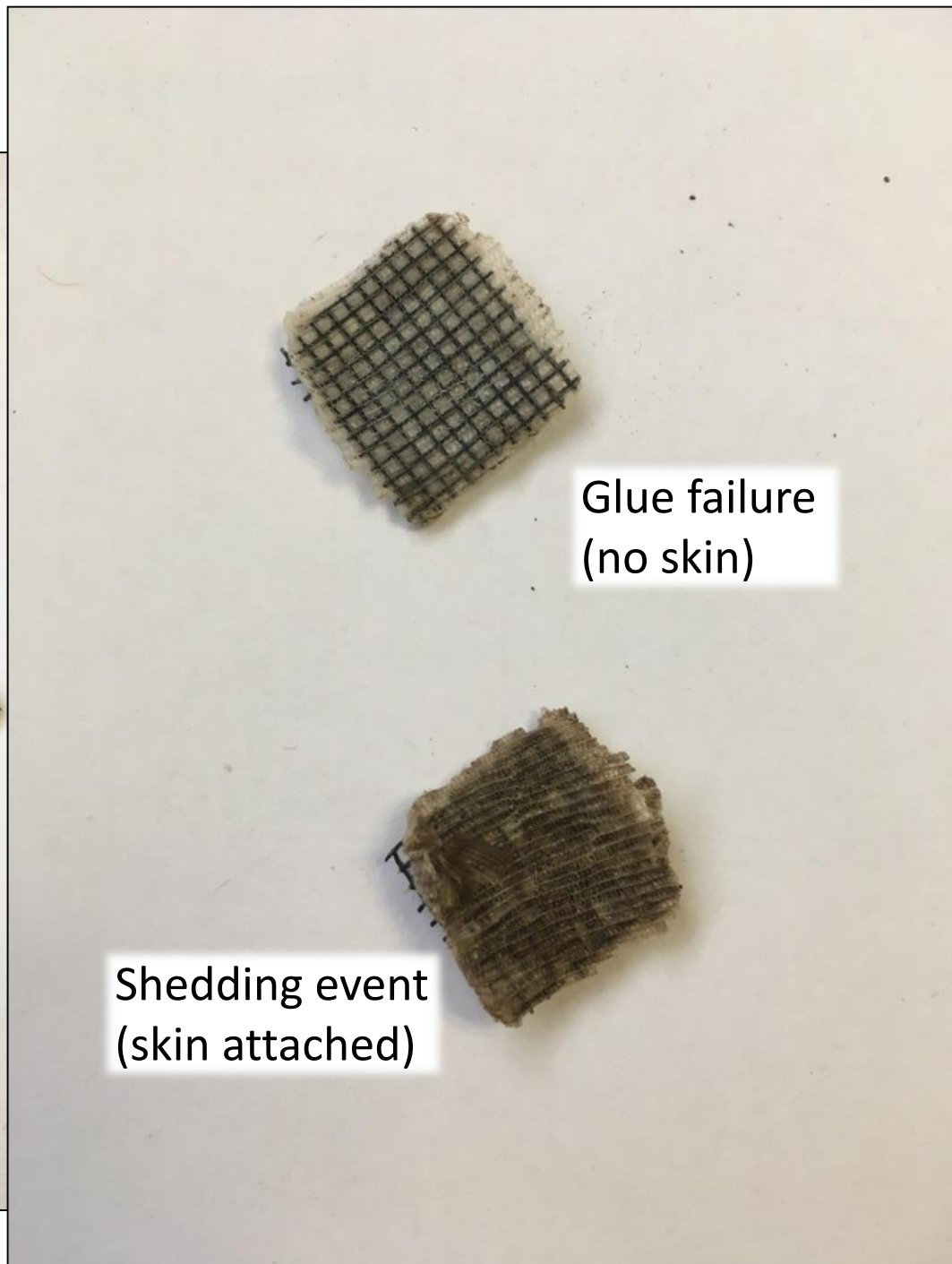
Problem



Shedding rates in juvenile tegus

- 24 captive, PIT-tagged juveniles
 - Outdoor enclosure
 - Food/water ad lib
- Glue mesh / ID label
 - Check daily
 - Re-apply 2x/week
- How long between skin sheds??
Need >3 weeks
- Is shedding rate associated with growth rate??







~ 96 days



Shedding rates in juvenile tegus

- Captive ~96 days
- Growth rates
 - SVL = 0.23%/day
 - Mass = 2.0%/day
- Shedding events
 - Average 8.2 days (NOT GOOD)
 - Range 4-13 days (ALSO NOT GOOD)
- Shedding correlated with mass growth ($\rho = 0.41$; $p = 0.04$)
- Shedding not correlated with SVL growth ($\rho = 0.15$; $p = 0.46$)



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***Problem:
NOT SOLVED***





~ 96 days



Trapping success for small tegus

- Smallest capture prior to 2017 = 16 cm SVL
- Hatchling SVL is 8-9 cm
- Need trap for small tegus
 - Better management
 - Recapture telemetered animals
- Potential issues:
 - Trip plate insensitivity?
 - Escape through side mesh?
 - Escape through gaps in door?



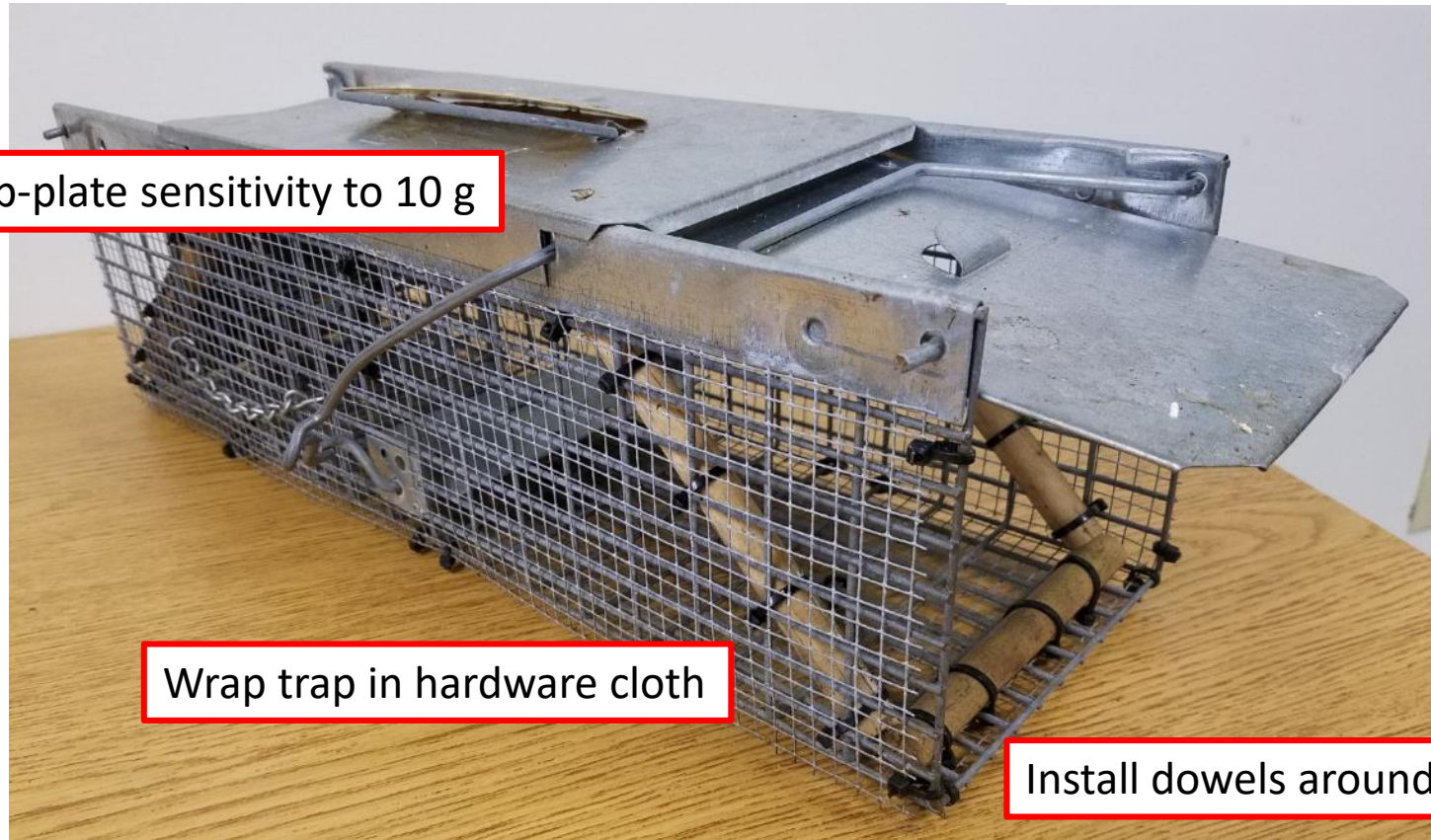
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Problem



Modify Havahart® 1025b



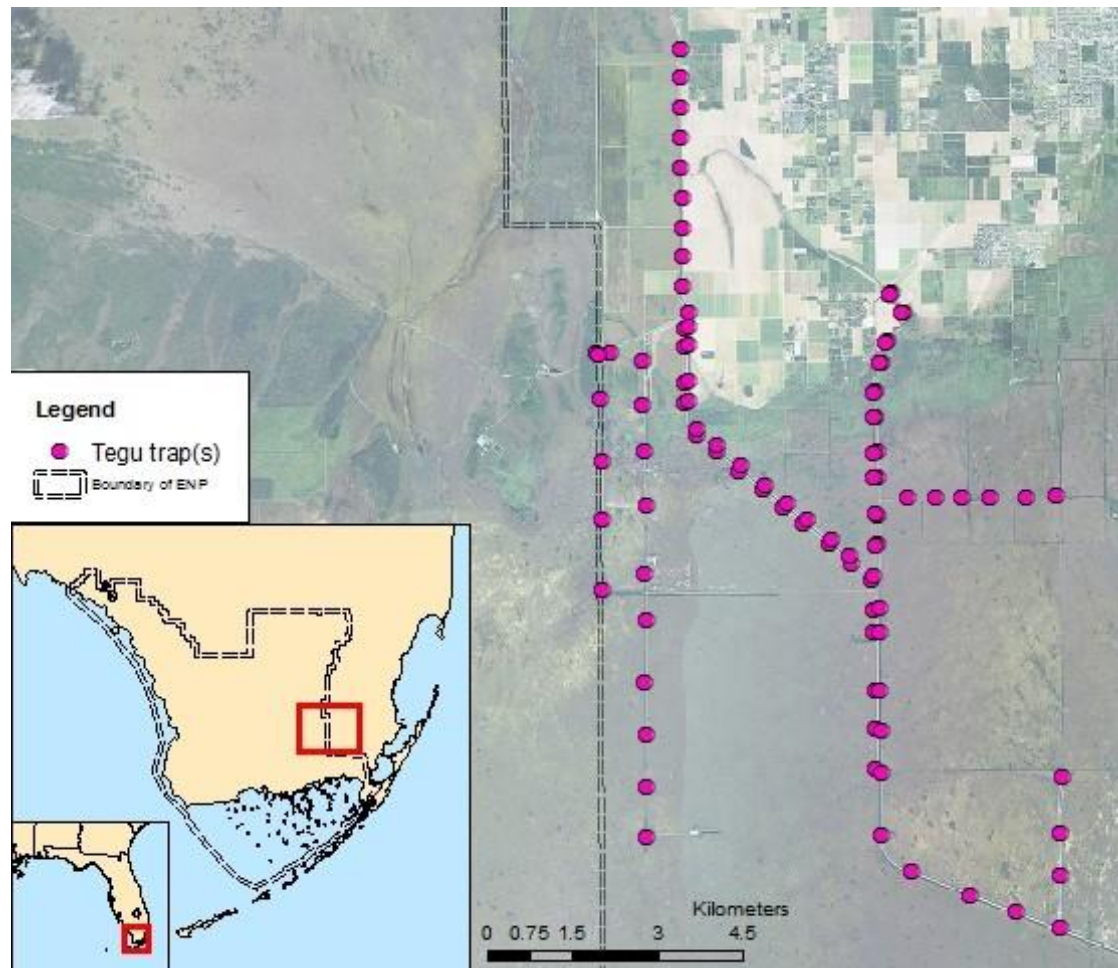
Adjust trip-plate sensitivity to 10 g

Wrap trap in hardware cloth


Install dowels around door gap

Trapping success for small tegus


- Install modified traps adjacent to regular traps
 - Havahart® 1088 (rabbits, skunks, etc.)
 - Havahart® 1089 (cats, raccoons, etc.)
- Bait with chicken eggs, cat food, or visual lures
- Check daily July – October 2016




Trap model	Description	Dimensions (cm)	# Tegus	# Trap nights	CPUE tegus	Size range of tegus (cm)	# Tegus < 16 cm SVL	Tegus < 16 cm SVL	CPUE tegus < 16 cm SVL
Havahart 1089	Single, falling-door, metal-wire trap with trip plate.	81 x 27 x 32	34	6371	0.0053	13.1 – 39.8	2	6%	0.00031
Havahart 1088	Single, falling-door, metal-wire trap with trip plate.	61 x 20 x 20	24	3579	0.0067	17.1 – 37.0	0	0%	0
Modified Havahart 1025B	1025B model with adjusted tension bar to increase sensitivity to ≤ 10 g, one door left shut, wooden dowels installed to block gaps between doors, and 1-cm hardware cloth attachment	46 x 13 x 13	69	5168	0.013	9.0 – 30.6	17	25%	0.0033

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Havahart 1089	Single, falling-door, metal-wire trap with trip plate.	81 x 27 x 32	34	6371	0.005	13.1 – 39.8	2	6%	0.0003
Havahart 1088	Single, falling-door, metal-wire trap with trip plate.	61 x 20 x 20	24	3579	0.007	17.1 – 37.0	0	0%	0
 Modified Havahart 1025B	1025B model with adjusted tension bar to increase sensitivity to ≤ 10 g, one door left shut, wooden dowels installed to block gaps between doors, and 1-cm hardware cloth attachment	46 x 13 x 13	69	5168	0.013	9.0 – 30.6	17	25%	0.0033

Modified traps caught small tegus and were better at catching tegus in general

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Modified traps didn't catch the largest size classes, though

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***Problem:
SOLVED***

Tegu baits

- Chicken eggs
 - Seem to work
 - Easy / inexpensive
 - Suitable for all situations?
- Other potential baits
 - Cat food
 - Visual lures
 - Many others...



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Problem



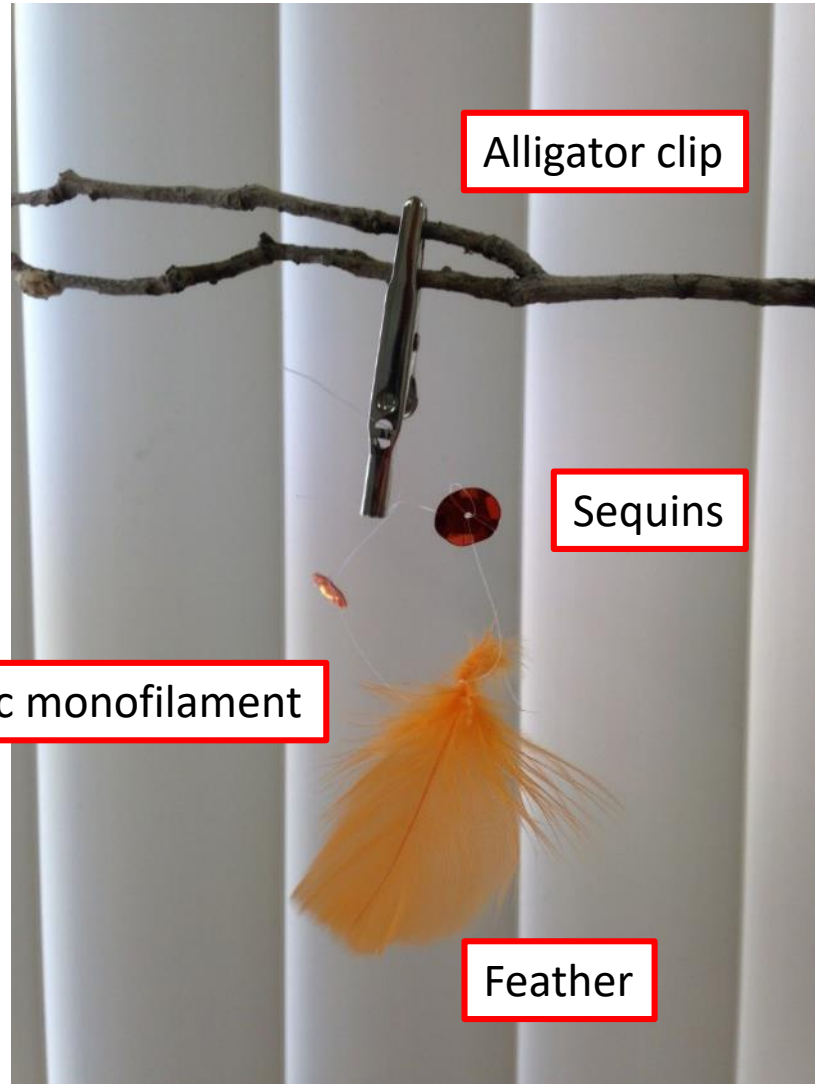
Tegu baits

- Tested
 - Whole, raw chicken eggs
 - Cat food (canned Fancy Feast®)
 - Visual lures
 - Feather
 - Sequins
 - Plastic monofilament
 - Alligator clamp
- Deployed July – October



Visual lure

?



Bait type	# Trap nights	# Tegus	Tegu CPUE	# Non-targets	Non-target CPUE
Cat food	969	11	0.011	11	0.011
Visual lures	833	2	0.0024	8	0.0096
Chicken eggs	3425	57	0.017	21	0.0061

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Cat food	969	11	0.011	11	0.011
Visual lures	833	2	0.0024	8	0.0096
Chicken eggs better (not significantly) than cat food. Visual lures did not work.					
Chicken eggs	3425	57	0.017	21	0.0061

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Chicken eggs also catch fewer non-targets

Bait type	# Trap nights	# Tegus	Tegu CPUE	# Non-targets	Non-target CPUE
Cat food	969	11	0.011	11	0.011
Visual lures	83				0.096
Chicken eggs	3425	57	0.017	21	0.0061

***Problem:
Sort of SOLVED***

fewer non-targets

Tegu baits

- Traps are 0.5 km apart
- How can we increase attraction radius?
- A tegu may have to come very close to a chicken egg for it to work.
- Important for low-density populations (e.g., EDRR in new areas)



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- Important for low-density populations (e.g., EDRR in new areas)

FERMENTED EGG OIL!?



Trial: Fermented egg oil

Bait Type	Captures	Trap nights	CPUE
Egg	11	1349	0.0082
Egg + Fermented Egg Oil	3	673.5	0.0045

Fermented egg oil does not improve capture rates.

Trial: Fermented egg oil

Bait Type	CPUE
Egg	0.0082
Egg + Fermented Egg	0.0045

***Problem:
NOT SOLVED***

Fermented egg oil does not improve capture rates.



Research

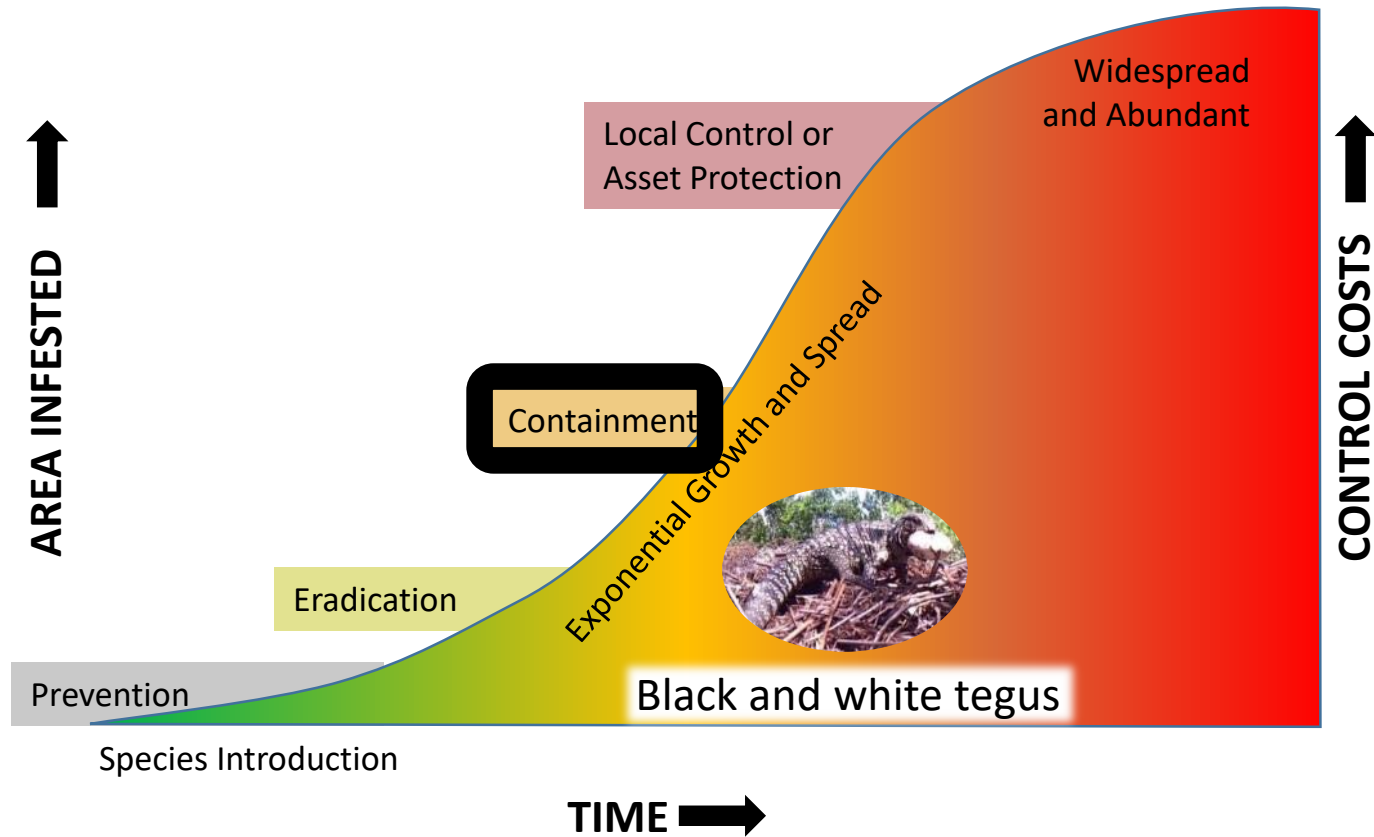


Management



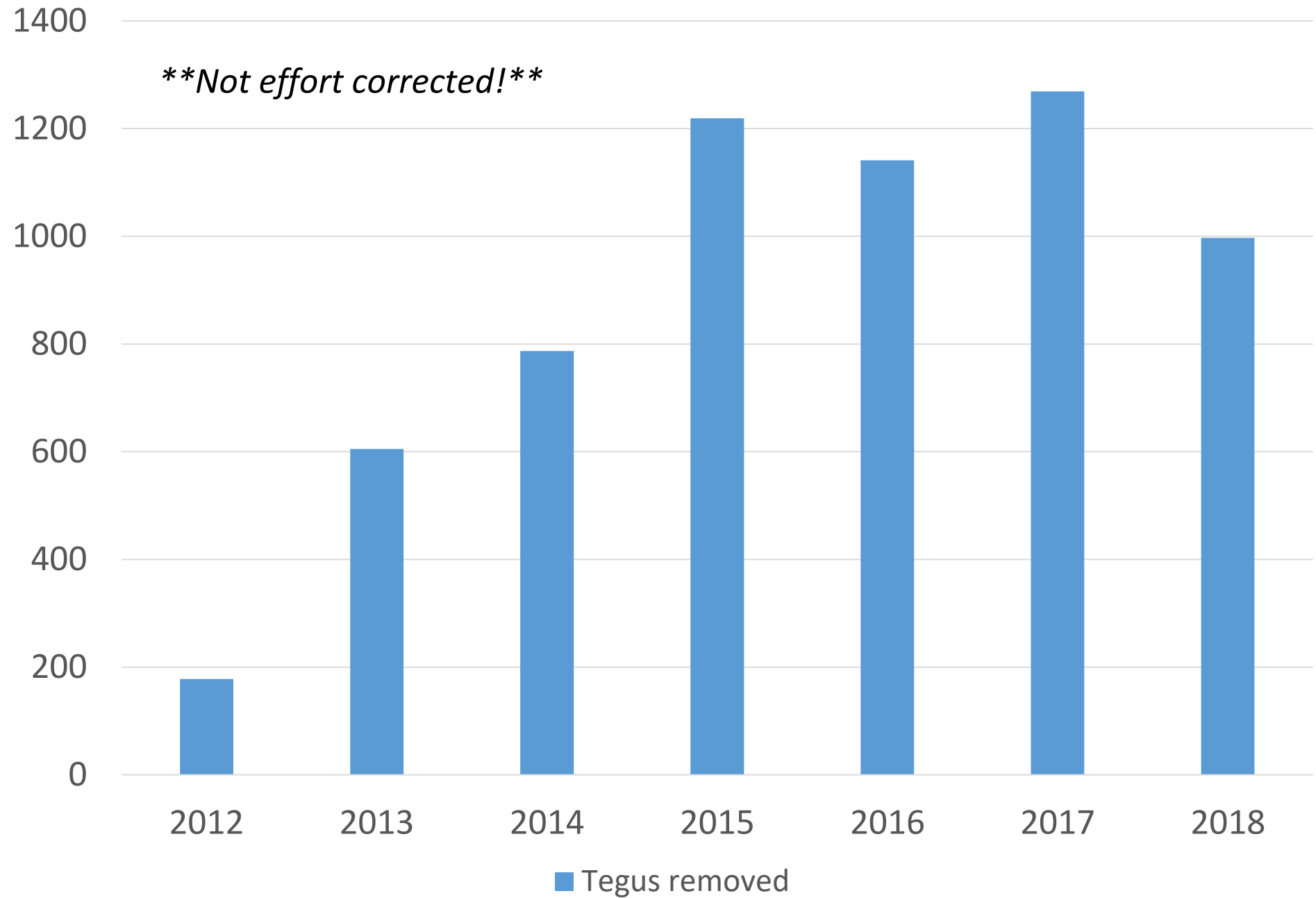
Management

INVASION CURVE



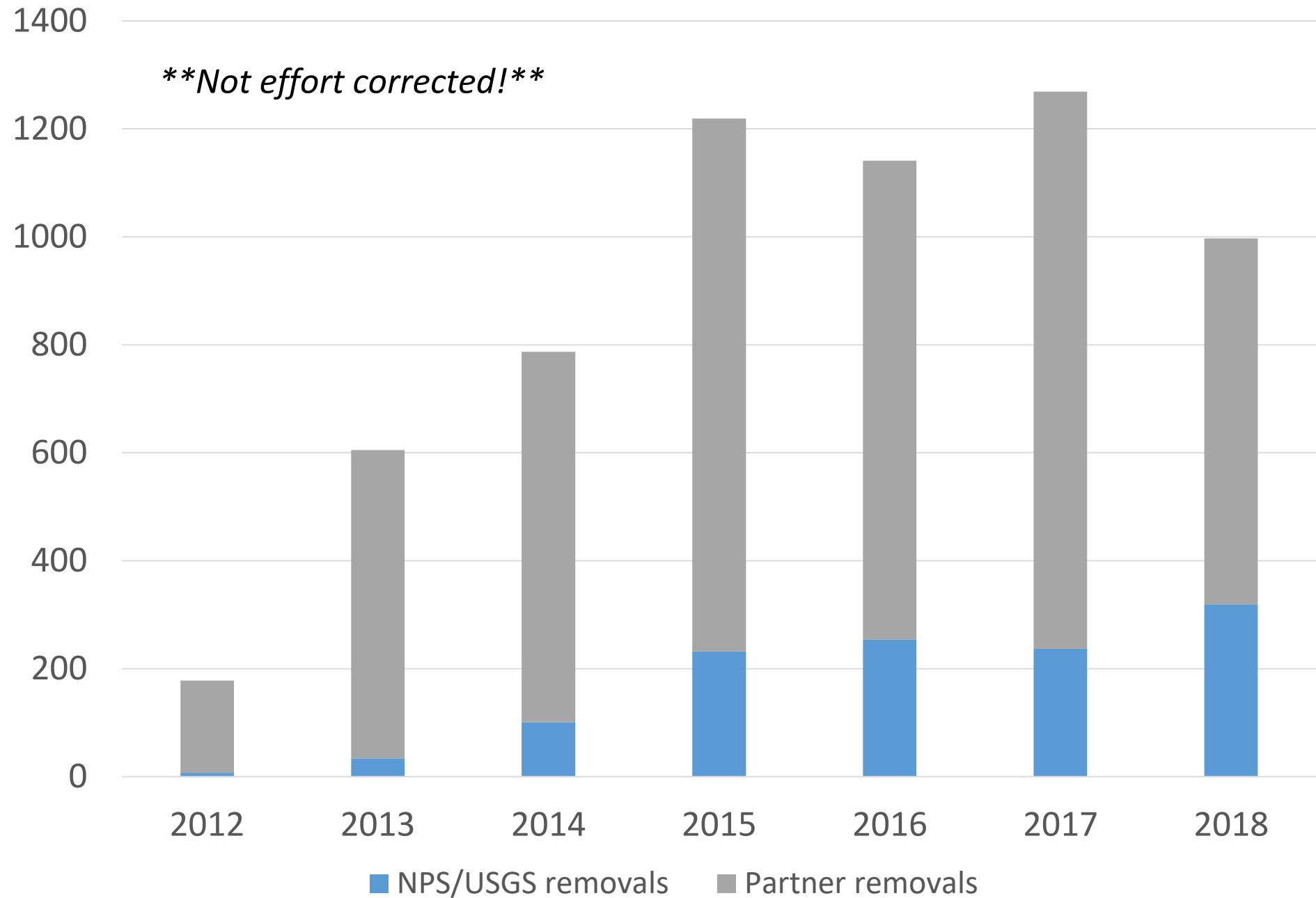
Annual tegu removals (all partners)

*****Not effort corrected!*****



Annual tegu removals (all partners)

*****Not effort corrected!*****



N



Homestead/Florida City

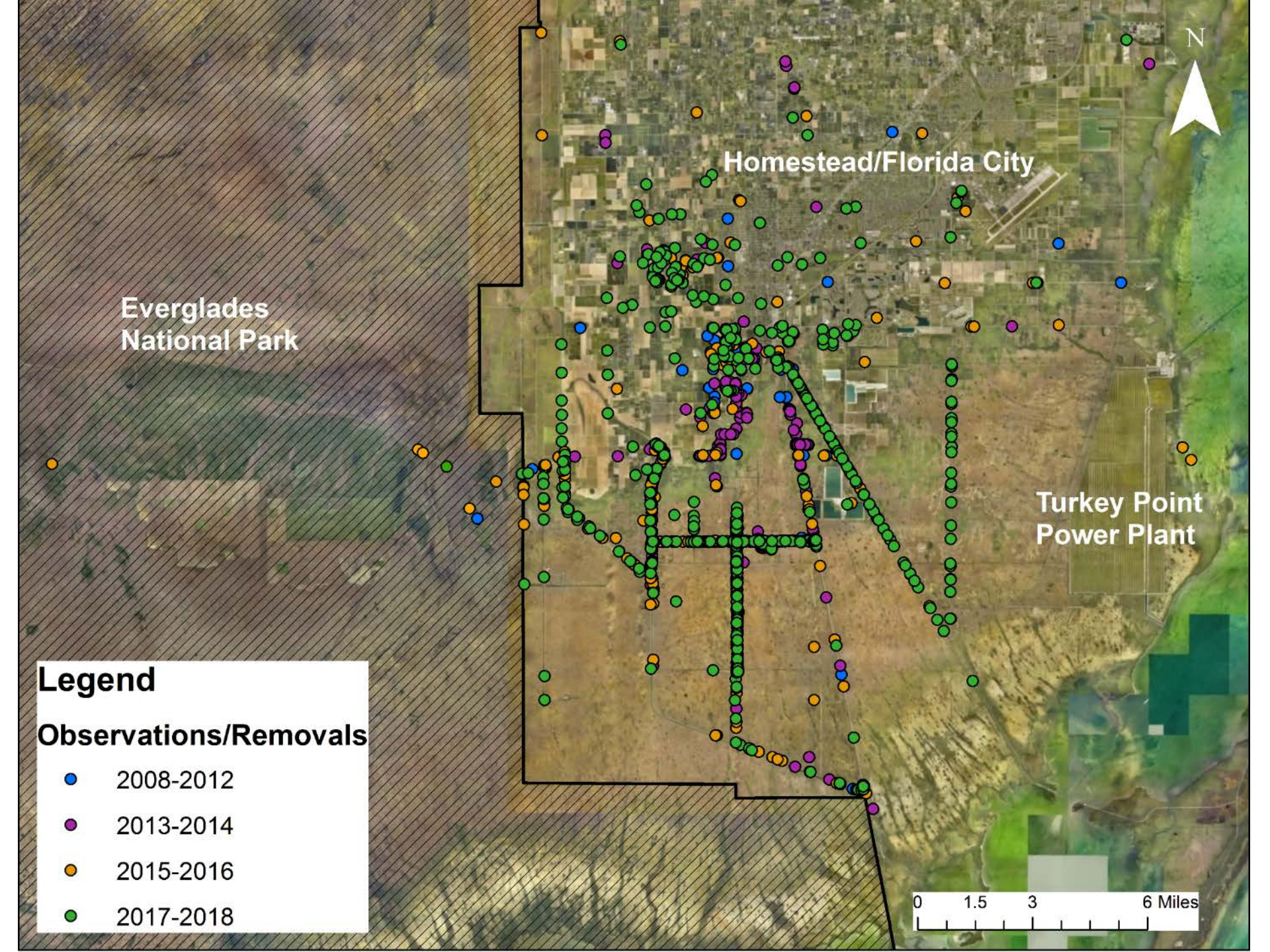
Everglades
National Park

Turkey Point
Power Plant

Legend

Observations/Removals

- 2008-2012
- 2013-2014
- 2015-2016
- 2017-2018



**USGS / NPS
Tegu-trap array 2018**

Live traps = 90

● EVER

● L-31W

● AERO

● C-111N

● C-111S

● C-111E

● C-110

⊕ Camera traps = 20

----- ENP

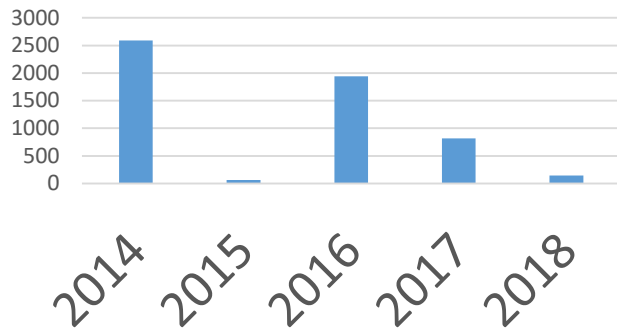


0 0.75 1.5 3 4.5 6
Kilometers

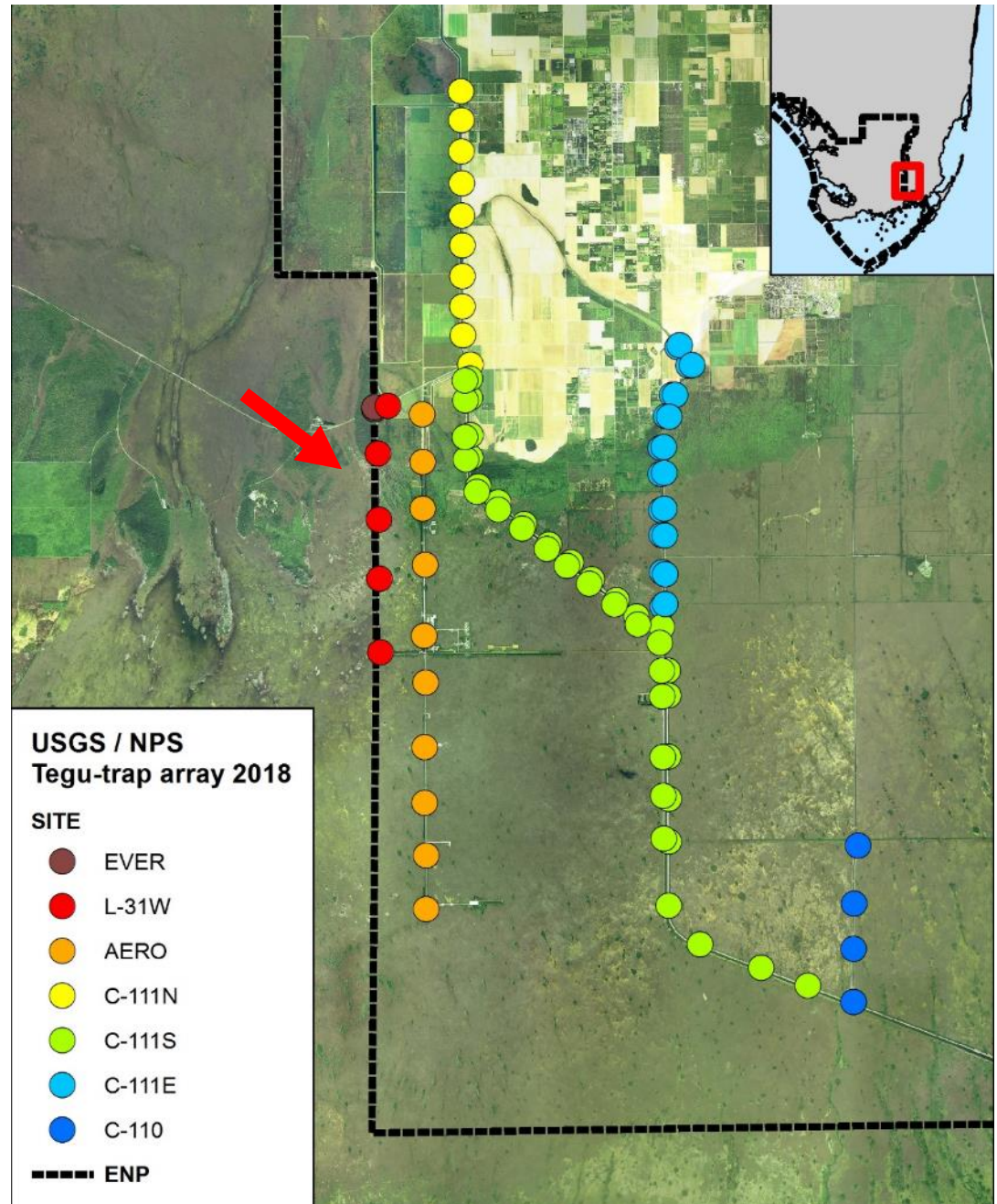
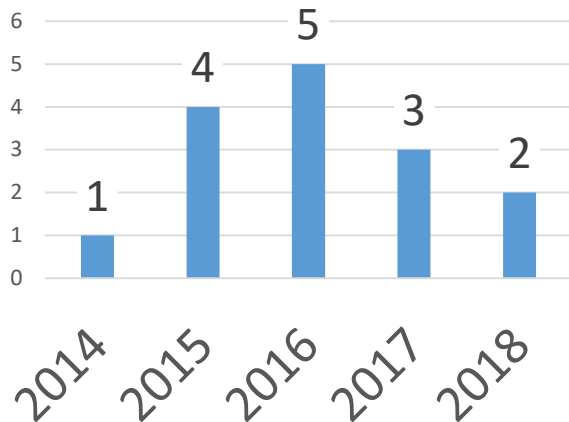


L-31W traps

NIGHTS

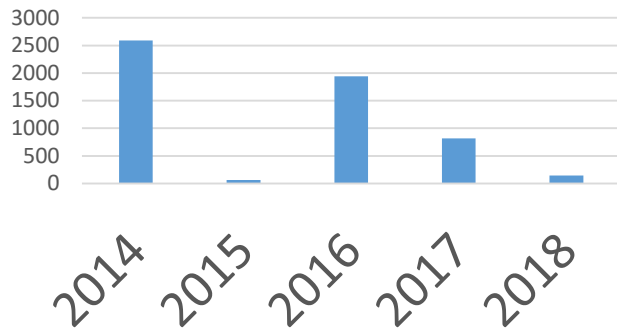


TEGUS

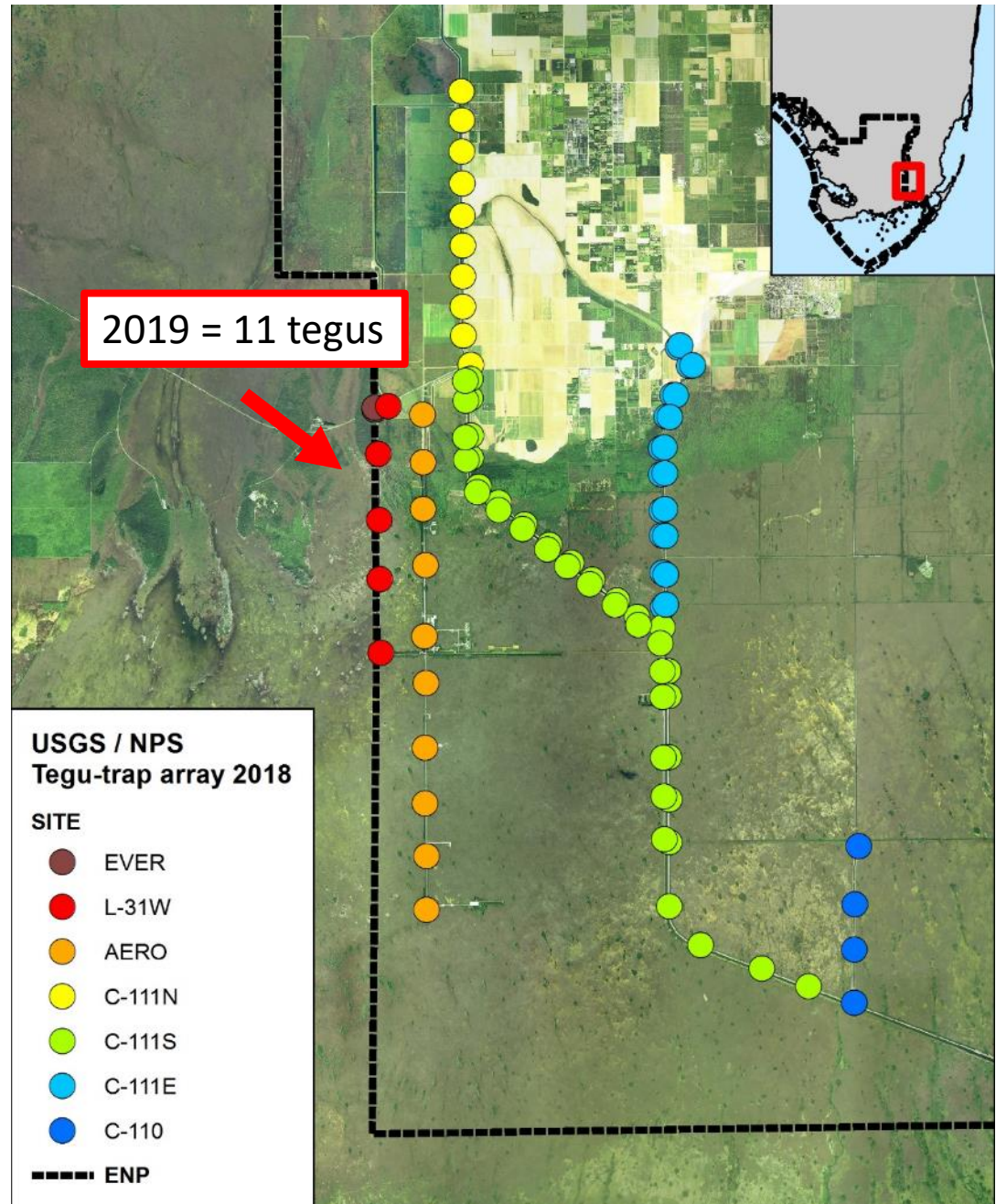
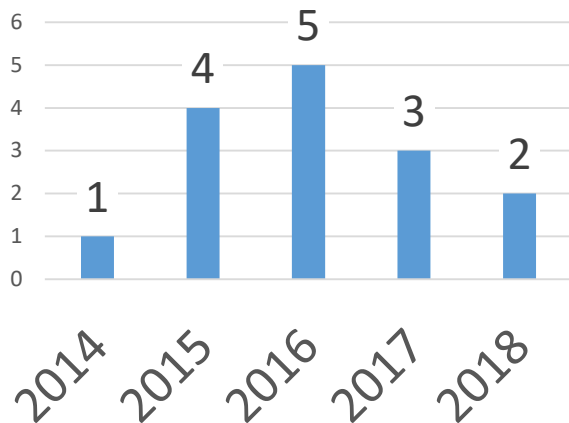


L-31W traps

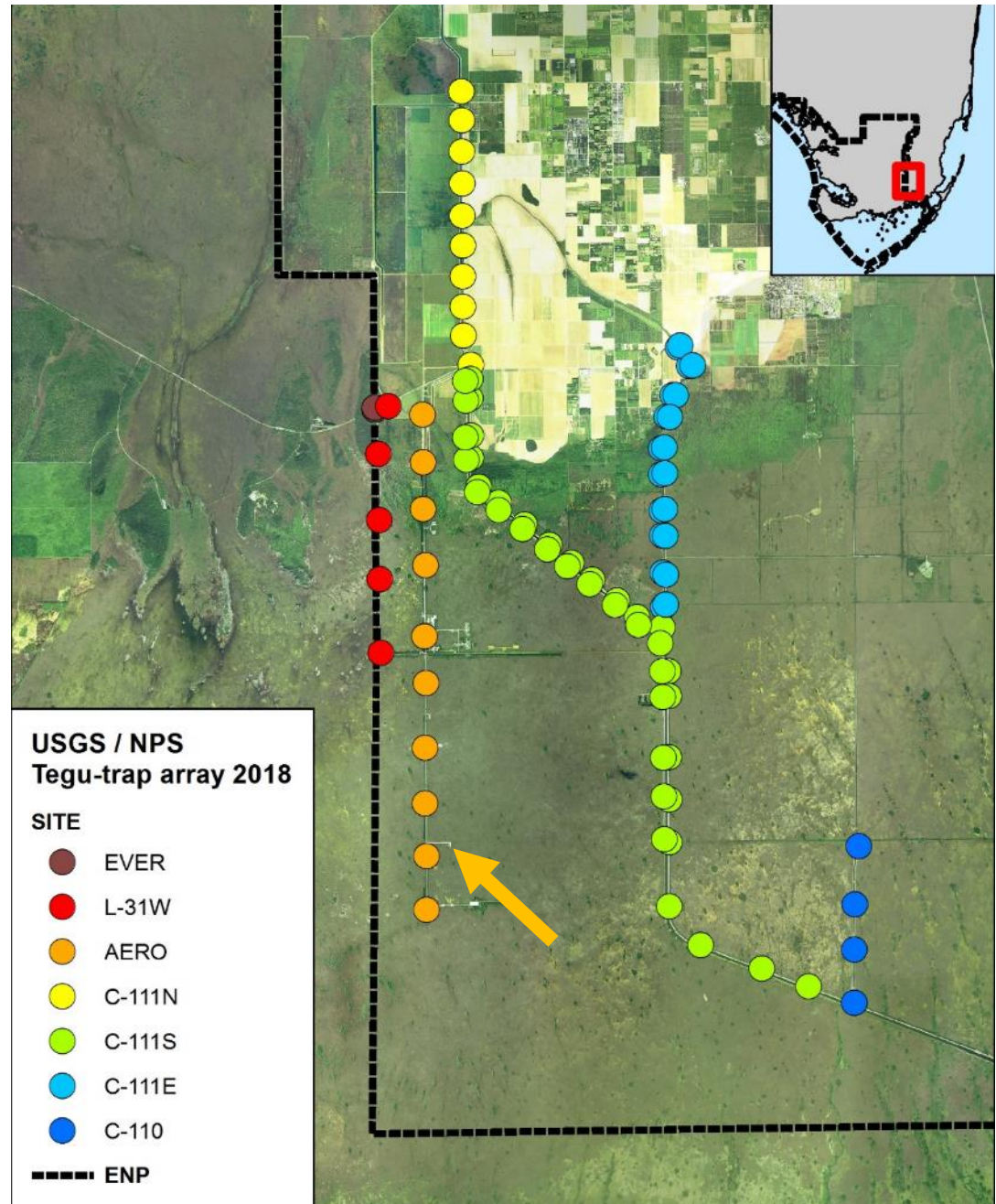
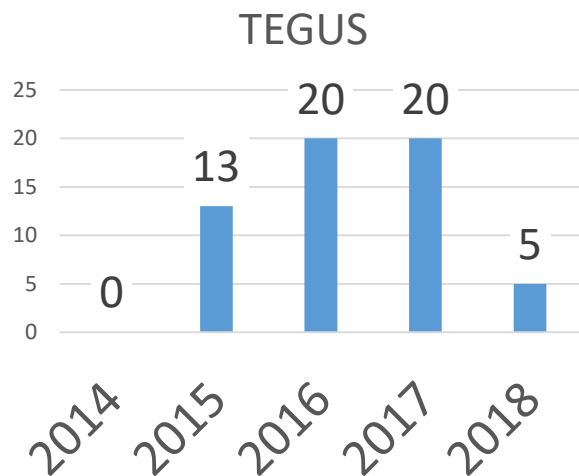
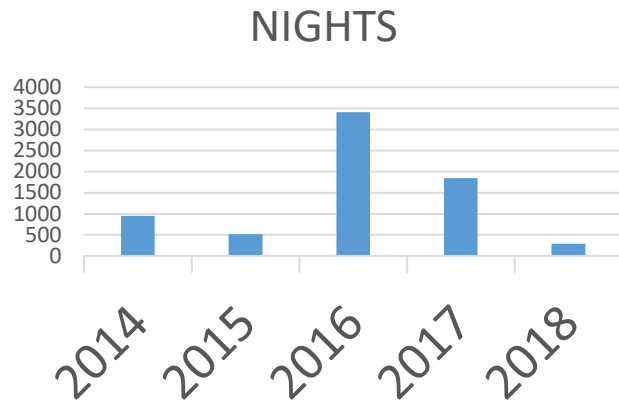
NIGHTS



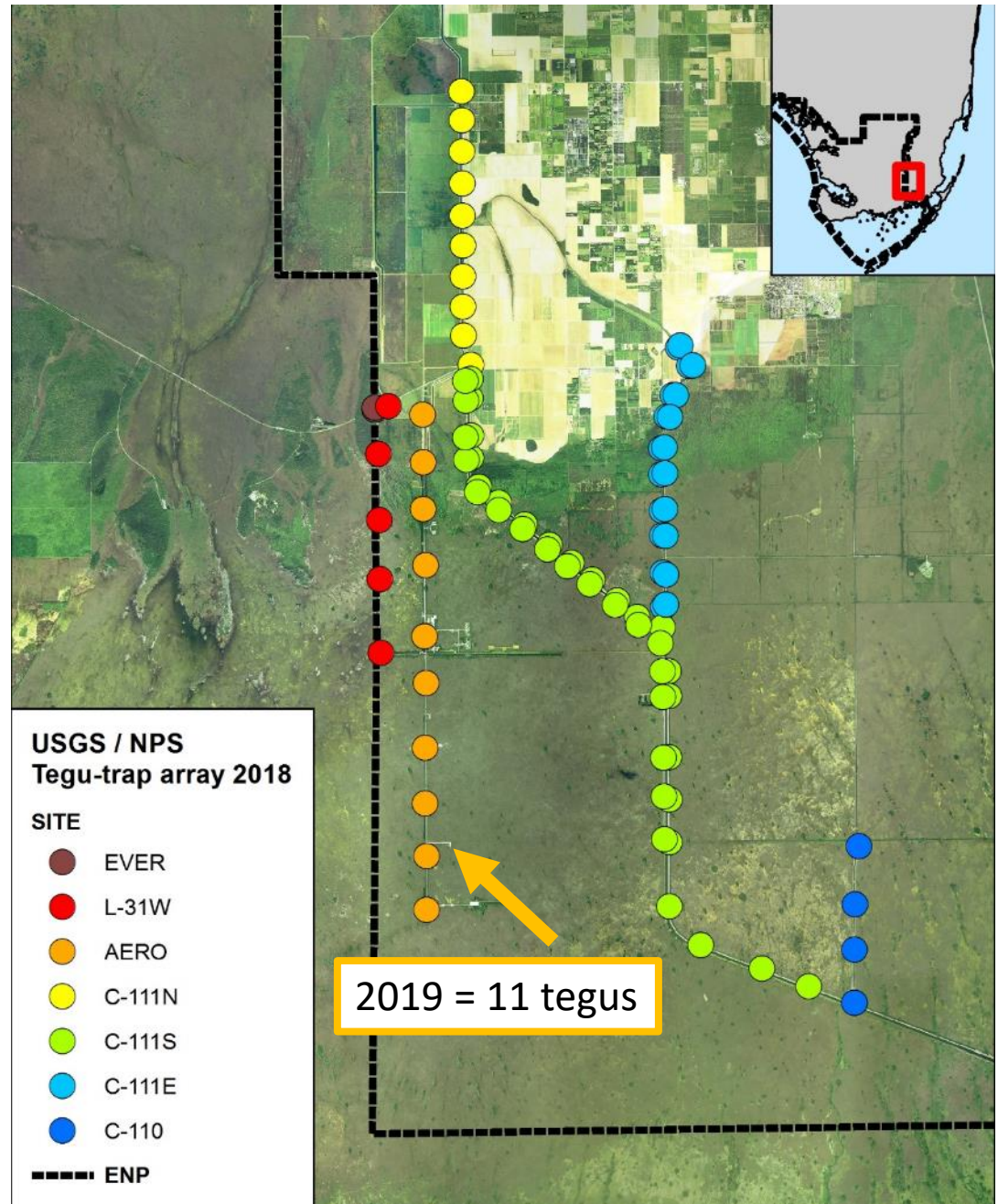
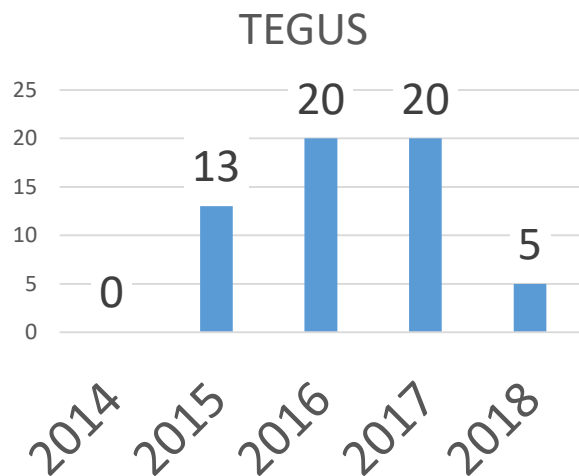
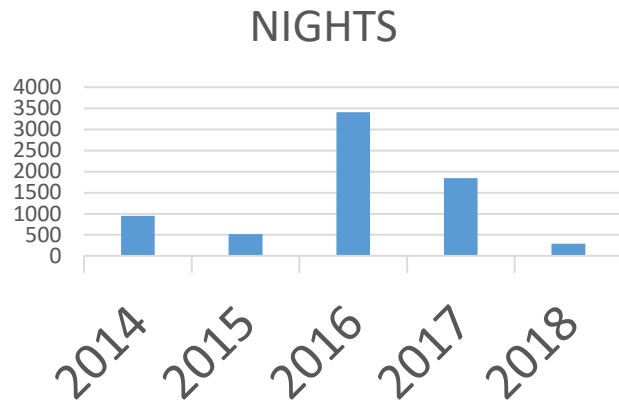
TEGUS



Aerojet traps

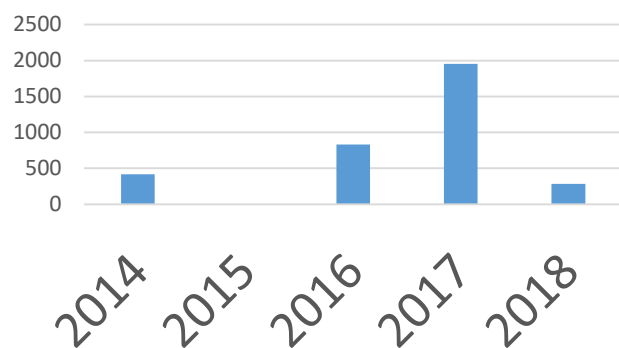


Aerojet traps

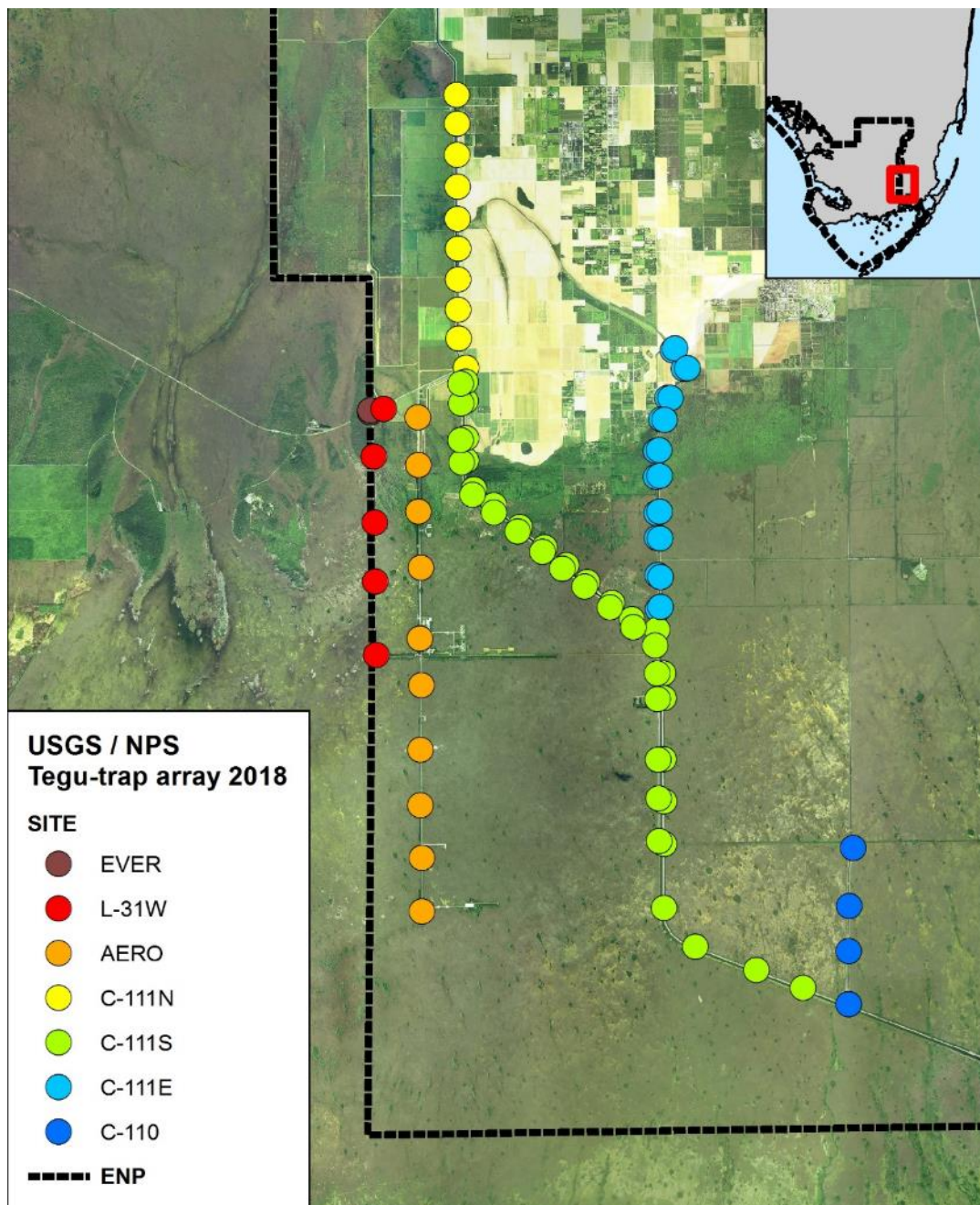
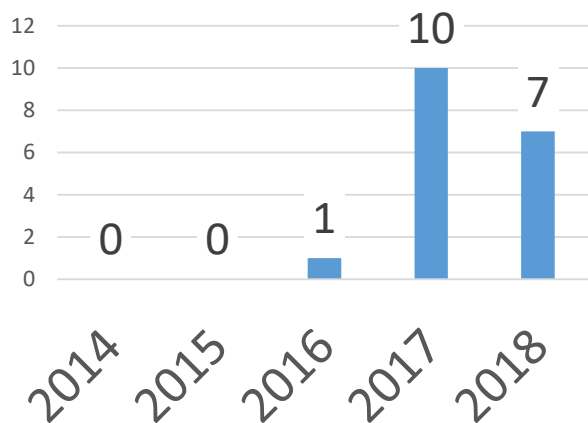


C-111N traps

NIGHTS

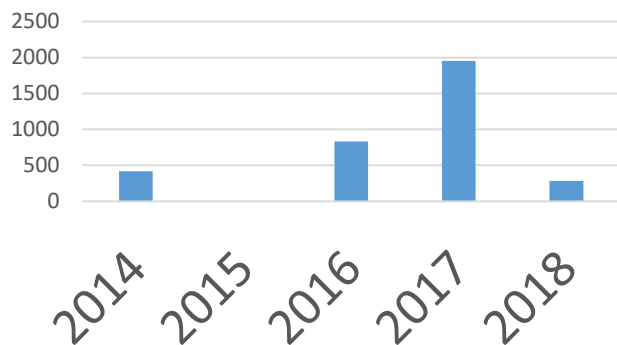


TEGUS

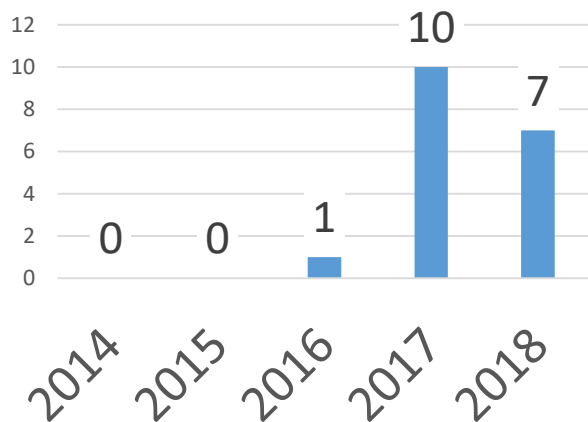


C-111N traps

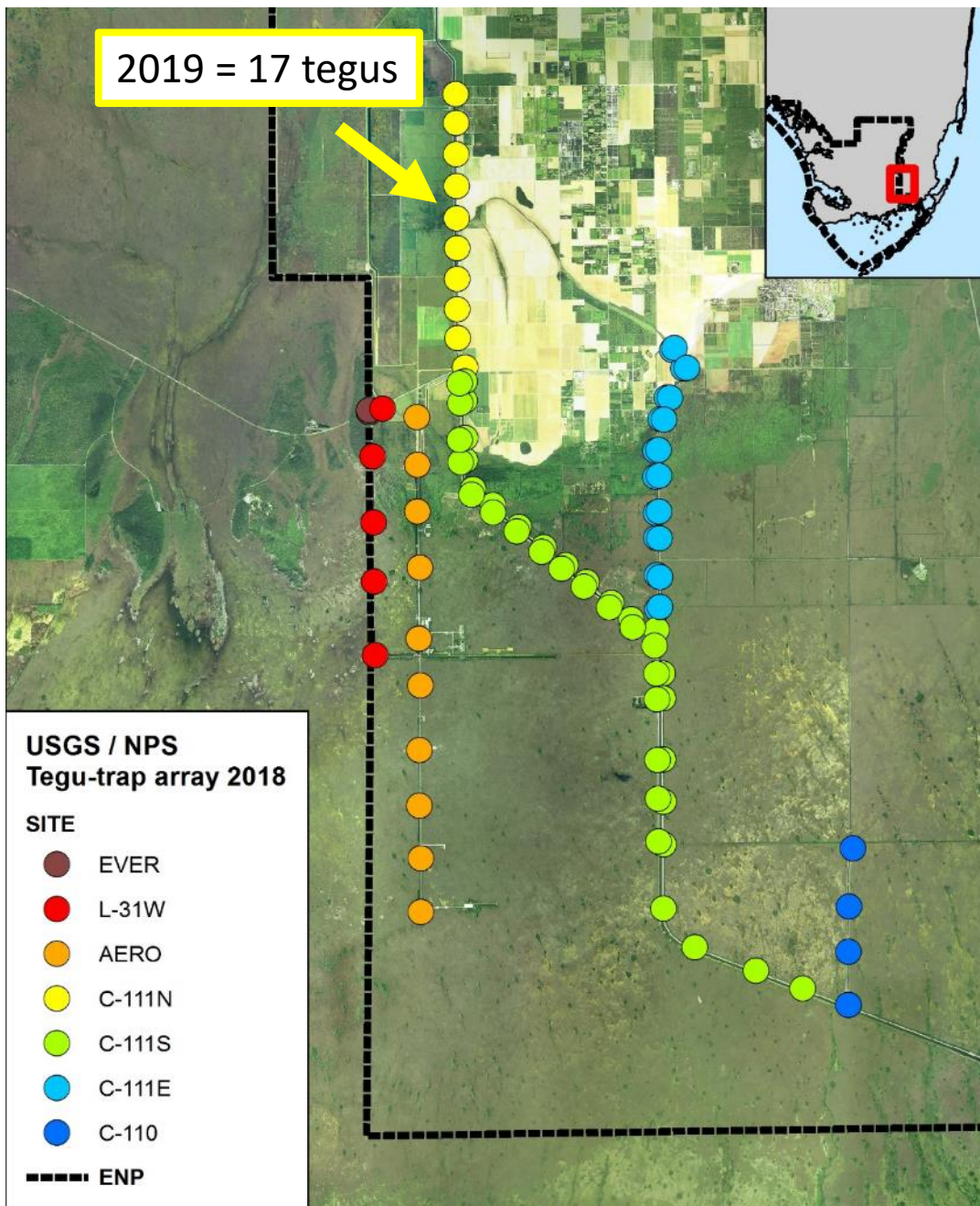
NIGHTS

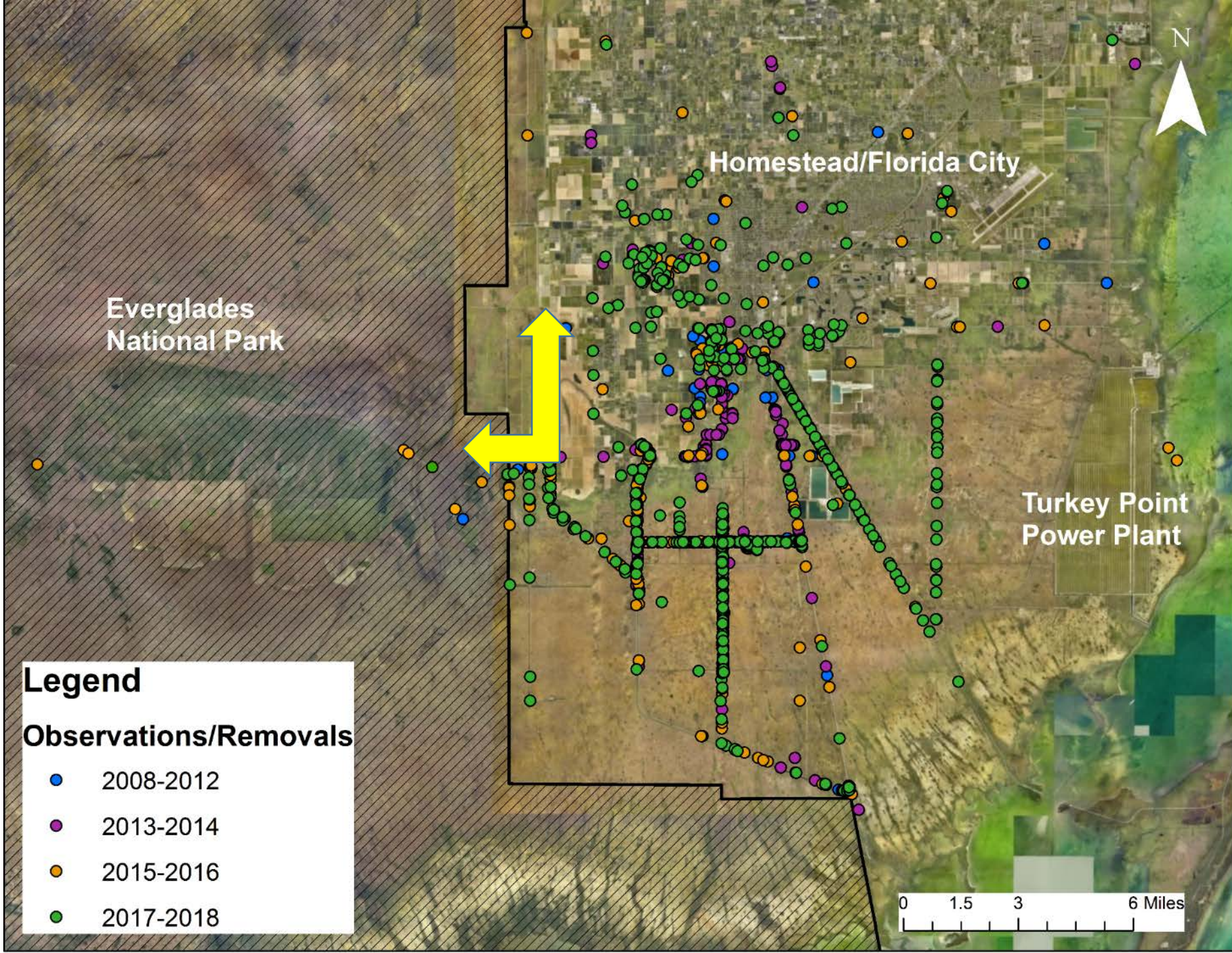


TEGUS

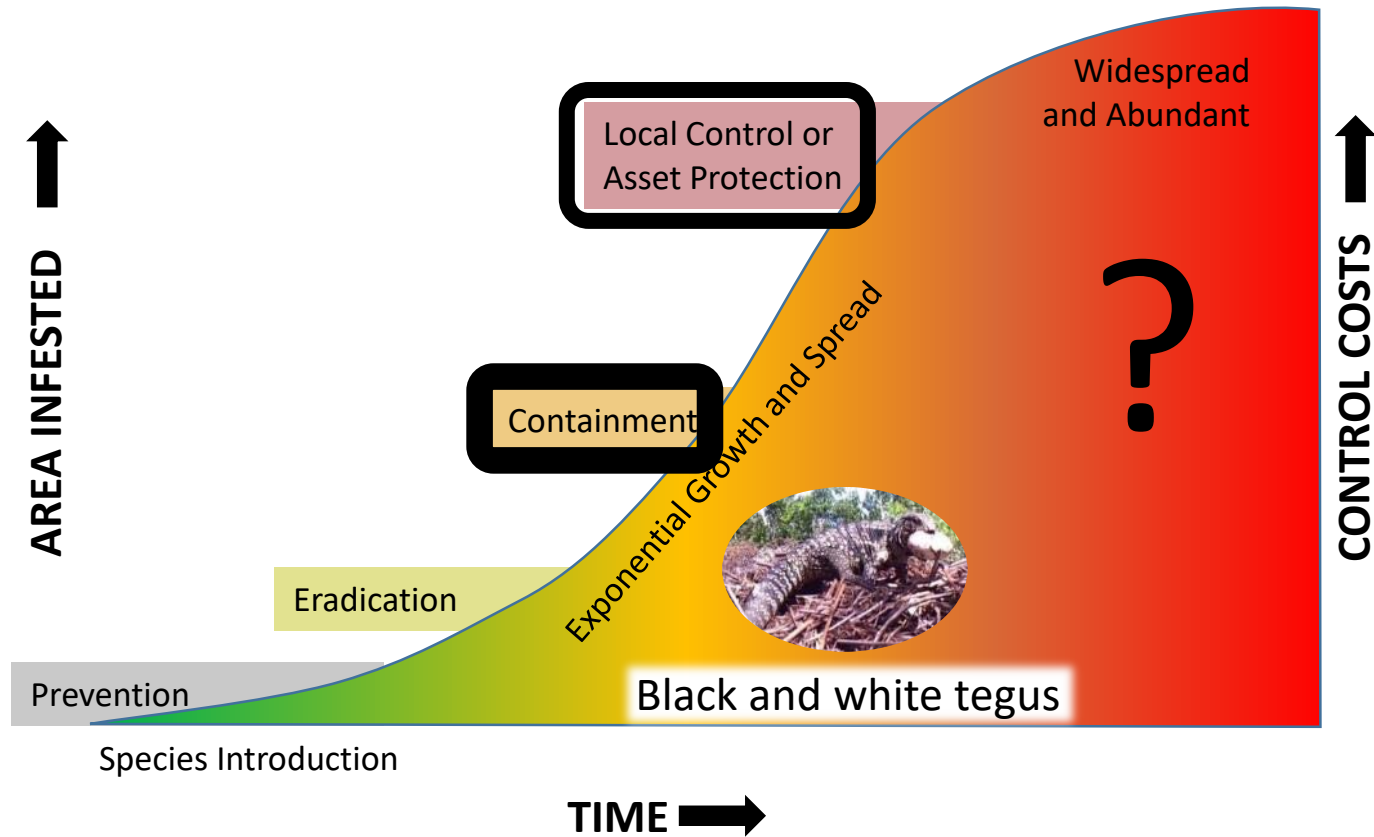


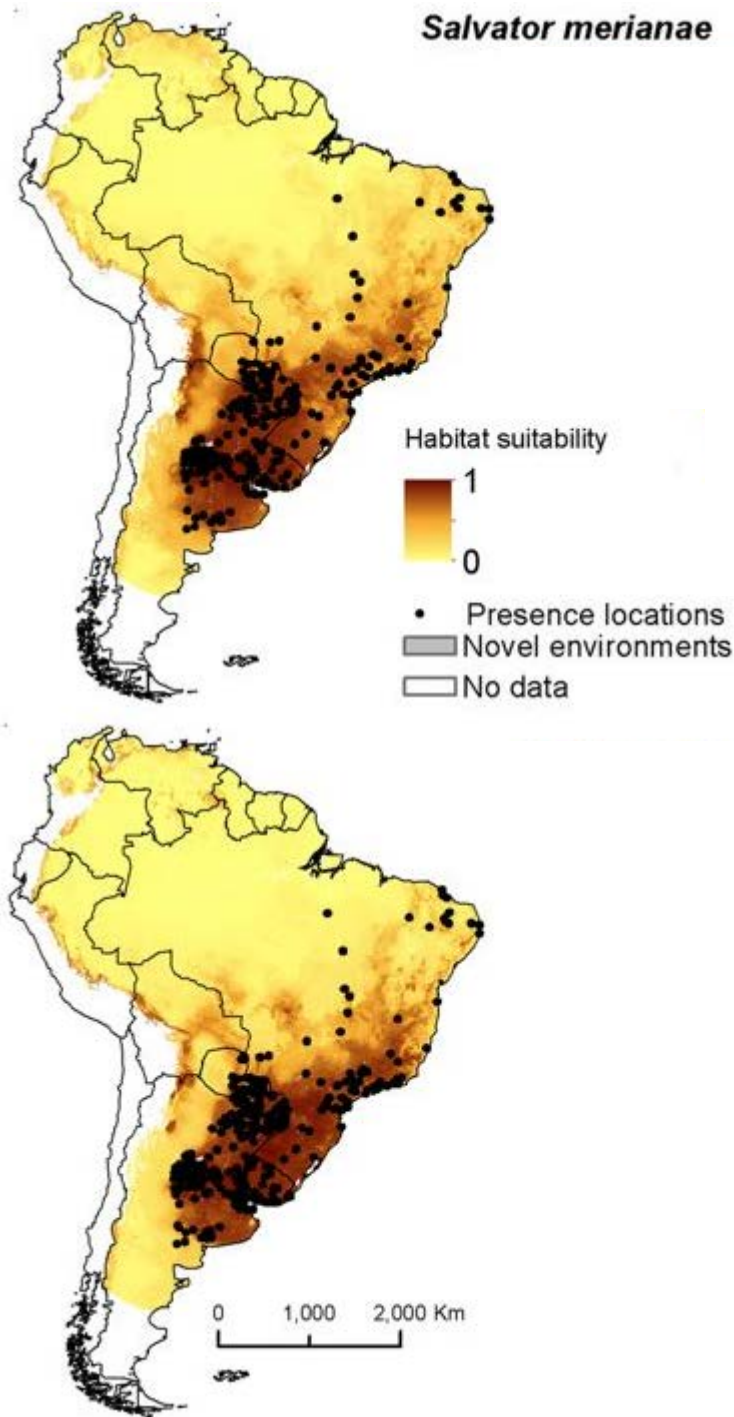
2019 = 17 tegus





INVASION CURVE





Modeling the distributions of tegu lizards in native and potential invasive ranges

Received: 31 October 2017

Accepted: 25 June 2018

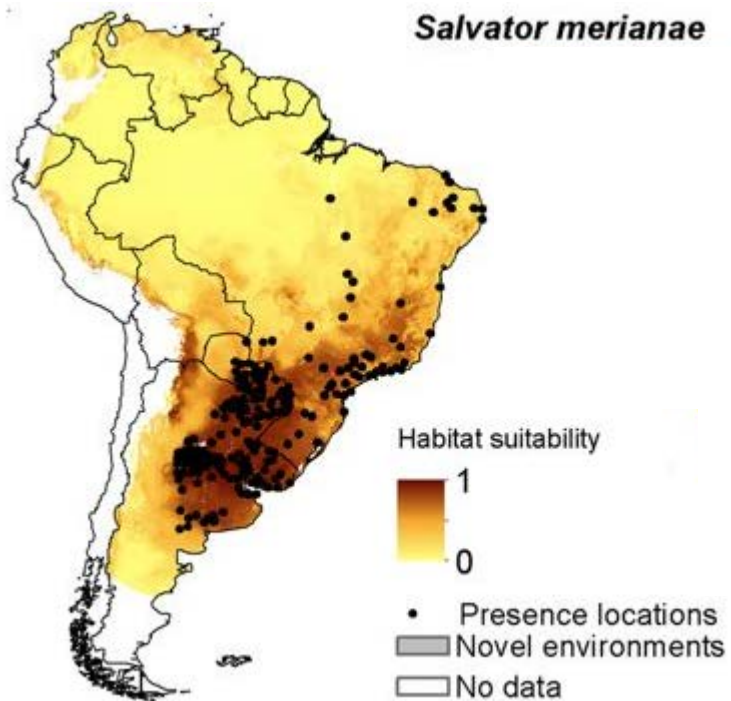
Published online: 05 July 2018

Catherine S. Jarnevich¹, Mark A. Hayes^{2,6}, Lee A. Fitzgerald³, Amy A. Yackel Adams¹, Bryan G. Falk^{4,7}, Michelle A. M. Collier^{4,7}, Lea' R. Bonewell¹, Page E. Klug^{1,8}, Sergio Naretto⁵ & Robert N. Reed¹

- Goal = identify what areas in North America might be at risk
- Generates species distribution models, which are hypotheses
- Native-range experts verified native-range records
- Identified environmental non-correlated variables important to tegu biology
- Extrapolated to North America using 5 models (ultimately, ensemble)

Salvator merianae

Random background



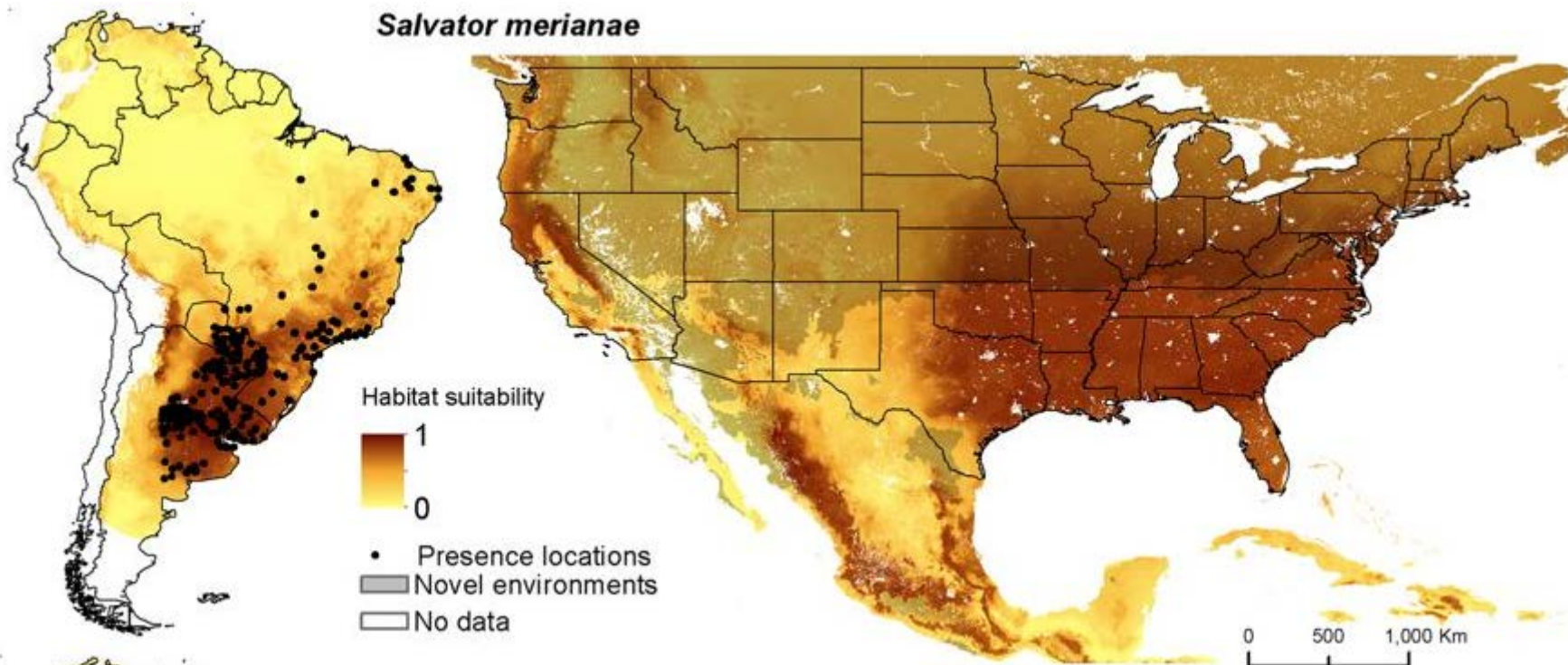
Targeted background



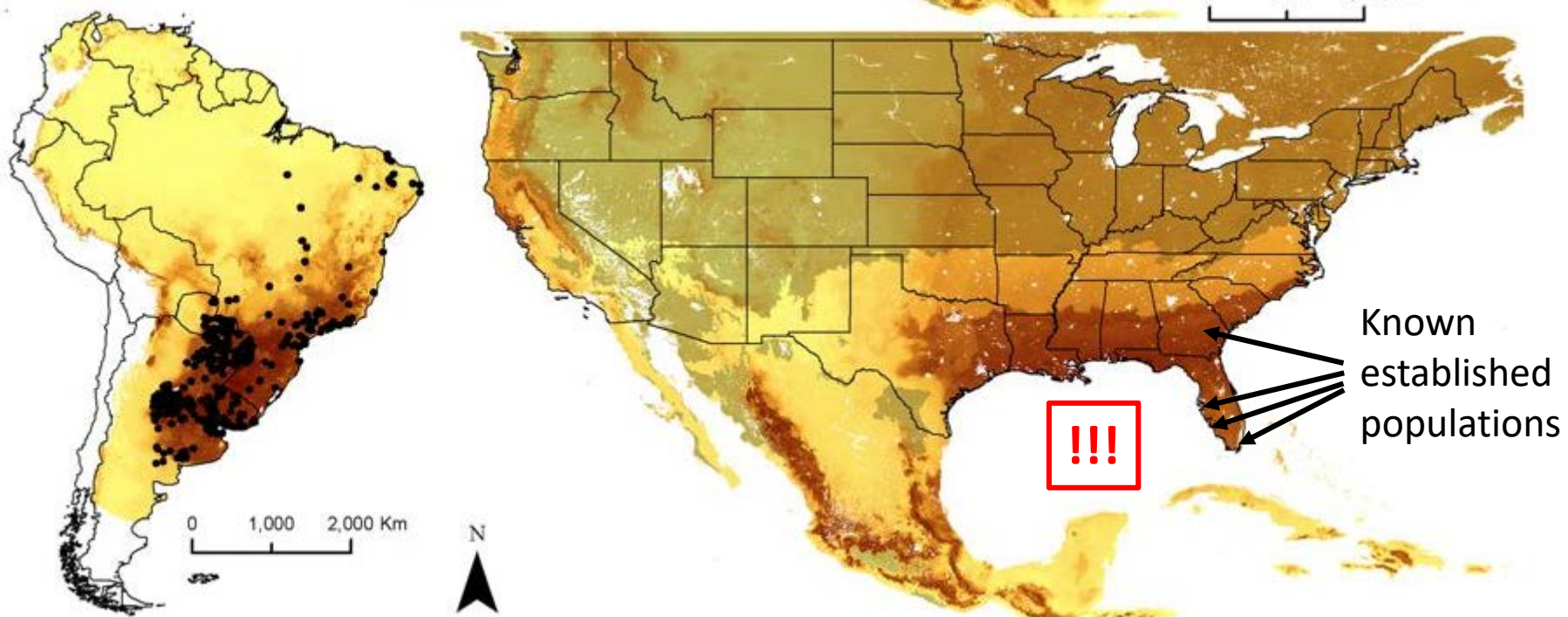
?

Salvator merianae

Random background



Targeted background



Annual Tegu Removals (Trapped)

