Use of eDNA to determine Burmese python occupancy rates in tree islands

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Are pythons particularly attracted to tree islands where wading birds are breeding?

Tricolored Heron nest with chick (Nick Vitale)

Wading birds: ecological indicators of the Everglades

Great Blue Heron (Nick Vitale)

Green Heron (Nick Vitale)

Wading birds: ecological indicators of the Everglades

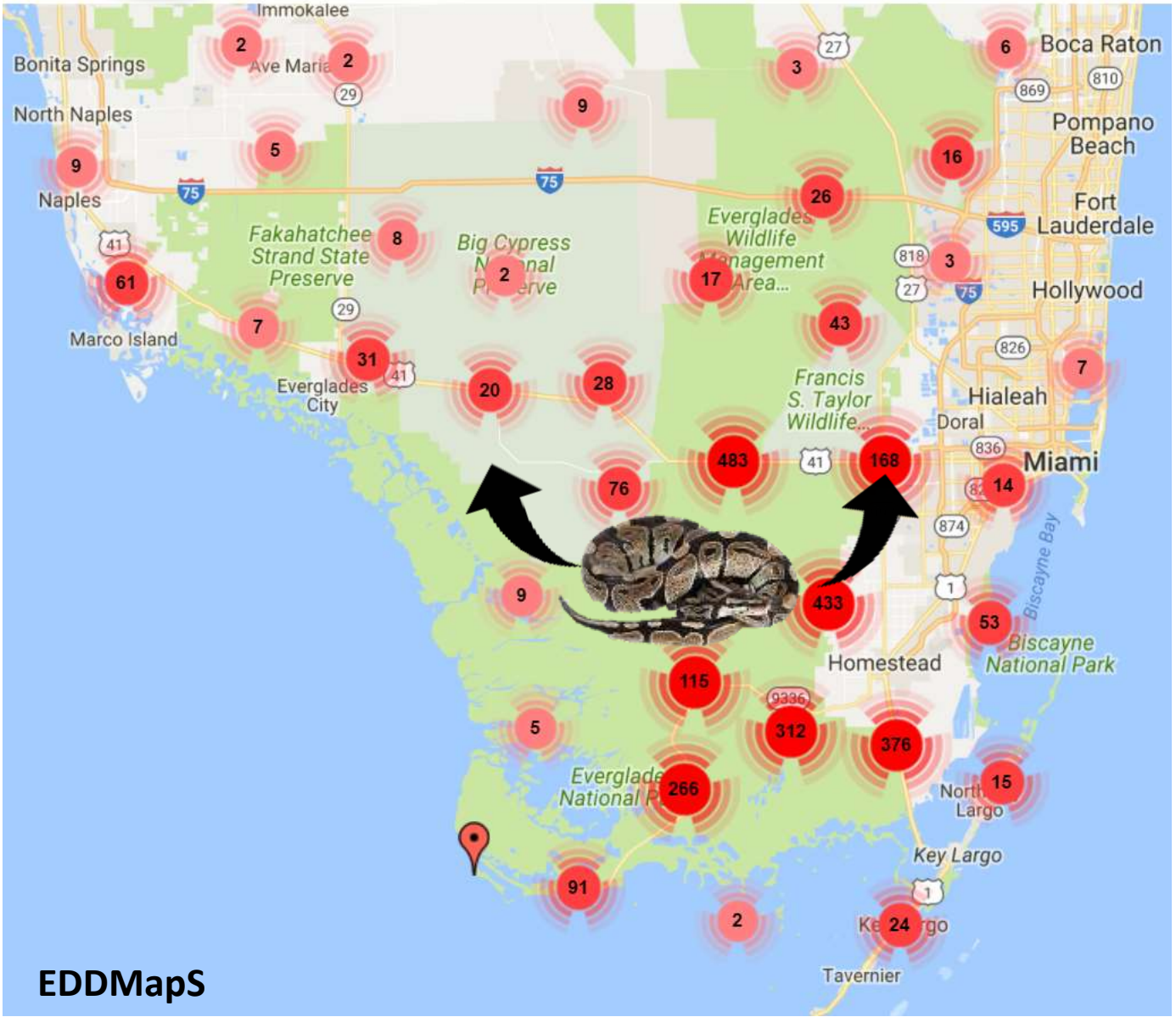
The Everglades: a mosaic of tree islands, sloughs, and ridges

Aerial view of a White Ibis colony (2016)

Foraging wading birds

Wading birds historically limited by hydrology and prey availability in the Everglades

Burmese pythons: novel apex predators of the Everglades

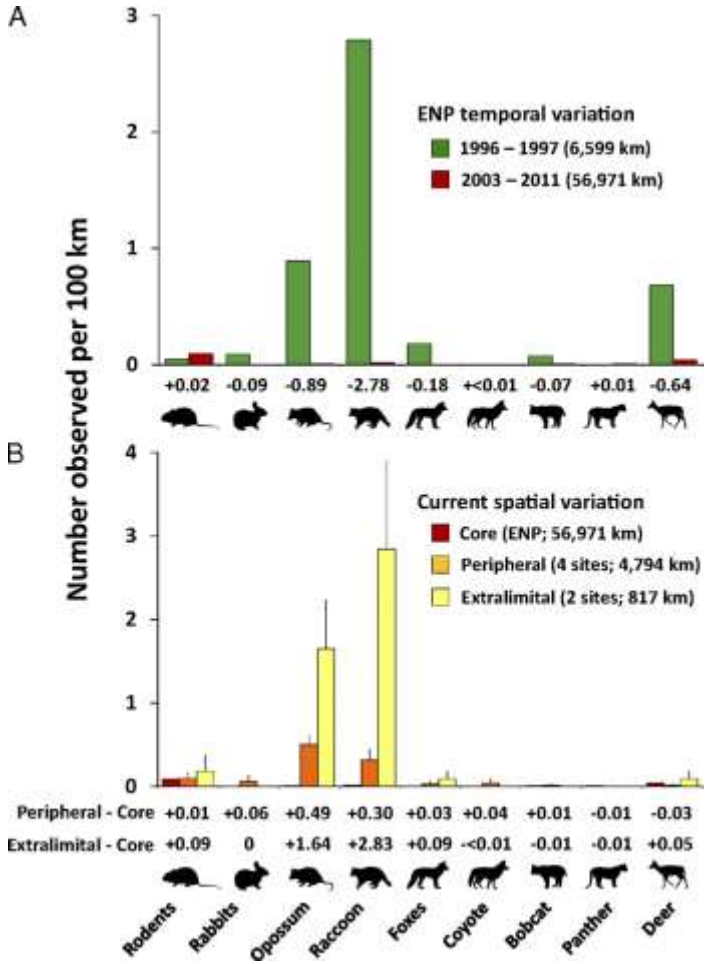


Tree islands: python common-use area (Hart et al. 2015)

Everglades slough: python core-use area (Hart et al. 2015)

Burmese pythons: novel apex predators of the Everglades

Temporal and spatial variation in mammal abundances:



Dorcas et al. 2012

Wading birds consumed by pythons:

Dove et al. 2011

Burmese pythons: novel apex predators of the Everglades

What is the magnitude of the threat pythons pose to breeding wading birds?

Predator ability	• Sit-and-wait AND active predators • Mobile in aquatic environs • Arboreal
Predator motivation	• Preferred prey ↓↓ = diet shift to birds? • Nesting colonies = dense aggregation of prey calories
Prey vulnerability	• Birds potentially naïve • Tree islands = common-use area for pythons • Python sightings in active breeding colonies

Hypothesis: Burmese Pythons are directly causing a reduction in long-legged wading bird reproductive success in the Everglades

Prediction 1: Pythons are depredating wading bird nests.

Prediction 2: Python occupancy rates are higher on tree islands containing wading bird colonies compared to islands without breeding birds.

eDNA – environmental DNA

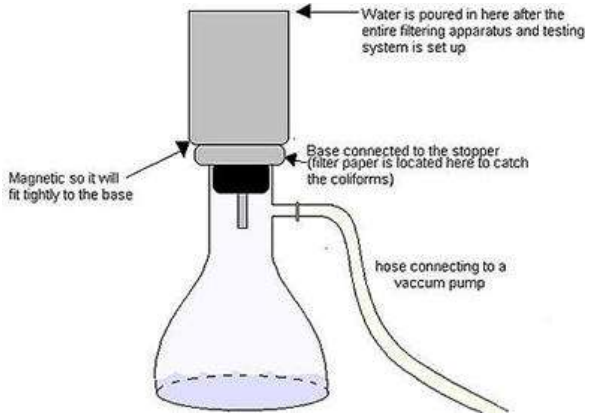
- Pythons are readily aquatic
- eDNA sources are: feces, saliva, sloughed-off skin cells, scales, dead animals
- **Python detection probabilities using eDNA: >= 91 %**

Hunter et al. 2015 Environmental DNA (eDNA) Sampling Improves Occurrence and Detection Estimates of Invasive Burmese Pythons

eDNA – environmental DNA

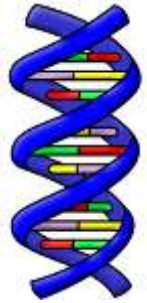
The analysis process:

1 L sample



Filter water and isolate DNA

Run digital droplet PCR (ddPCR) on extracted DNA

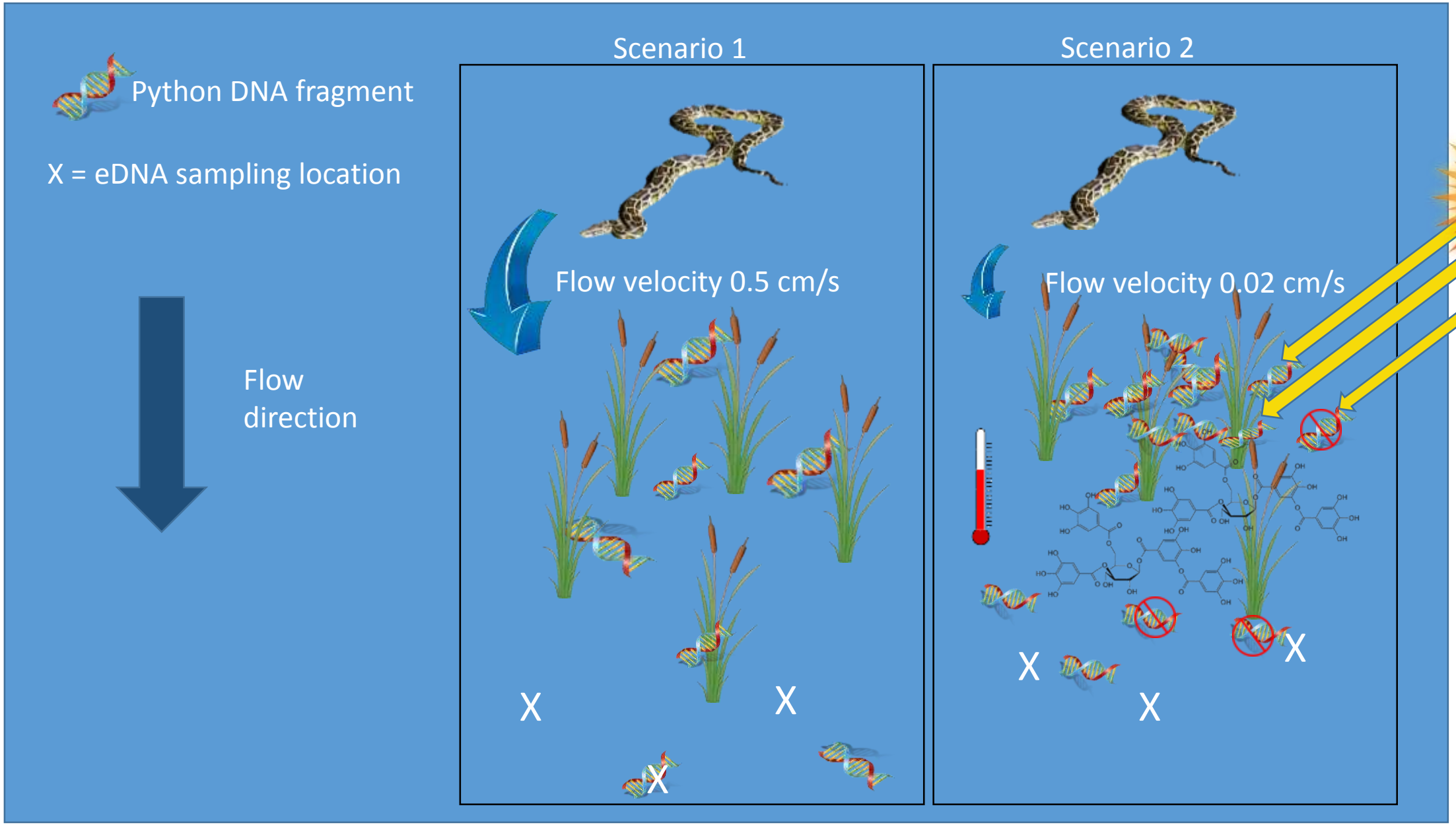


ddPCR is incredibly sensitive and can amplify tiny amounts of python DNA

$$Y_{ij}|A_{ij} = a_{ij} \sim \text{Binomial} \quad (K, \quad a_{ij}p)$$
$$A_{ij}|Z_i = z_i \sim \text{Bernoulli} \quad (z_i\theta_i)$$
$$Z_i \sim \text{Bernoulli}\ (\psi)$$

The hierarchical model calculates occupancy estimates, taking into account imperfect detection and PCR error

Key factors influencing DNA detection



Average flow rate: 0.36 cm/s

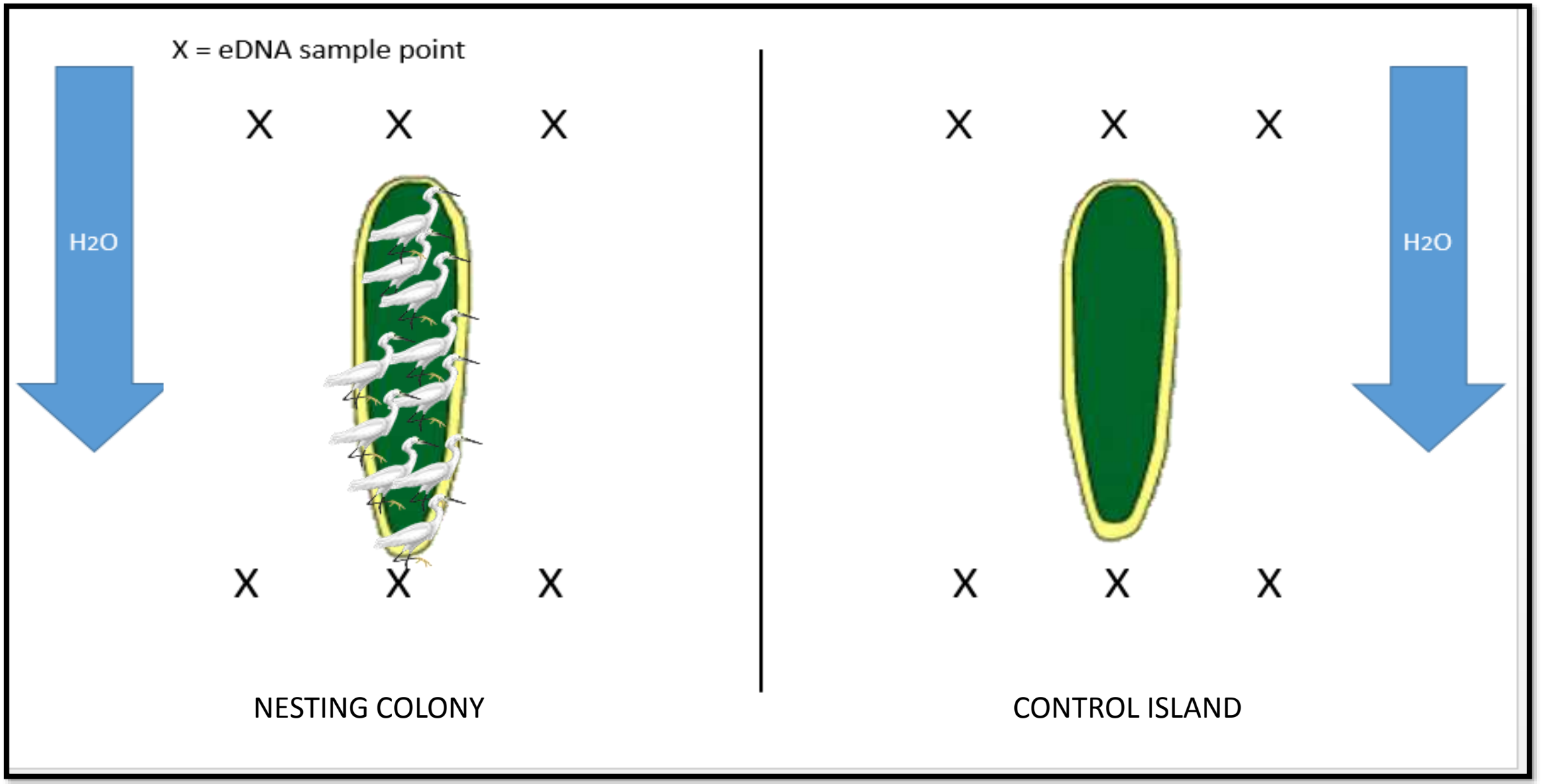
Maximum DNA lifespan: ~25 days

Daily distance traveled: 311 m/day

Total distance traveled: 7,776 m (4.83 miles)

With vegetative drag: 3,888 m (2.42 miles)

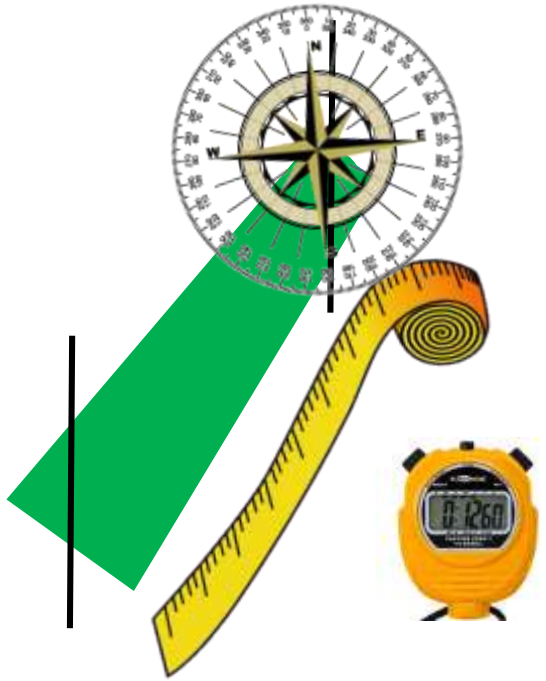
Initial Study Design



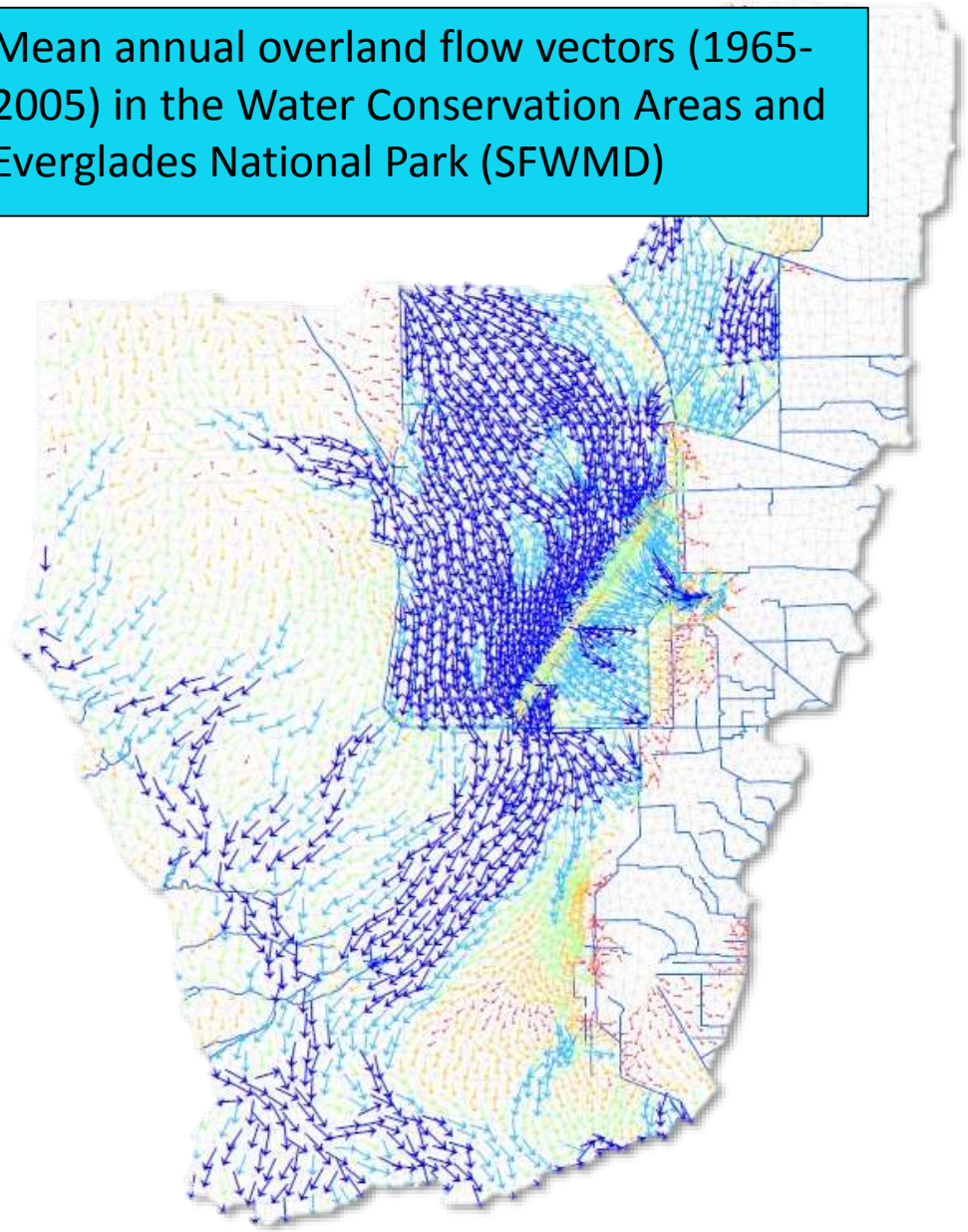
Testing flow rate and direction in + around tree islands

Large scale dye trial to visualize how water exits a tree island (December 2016)

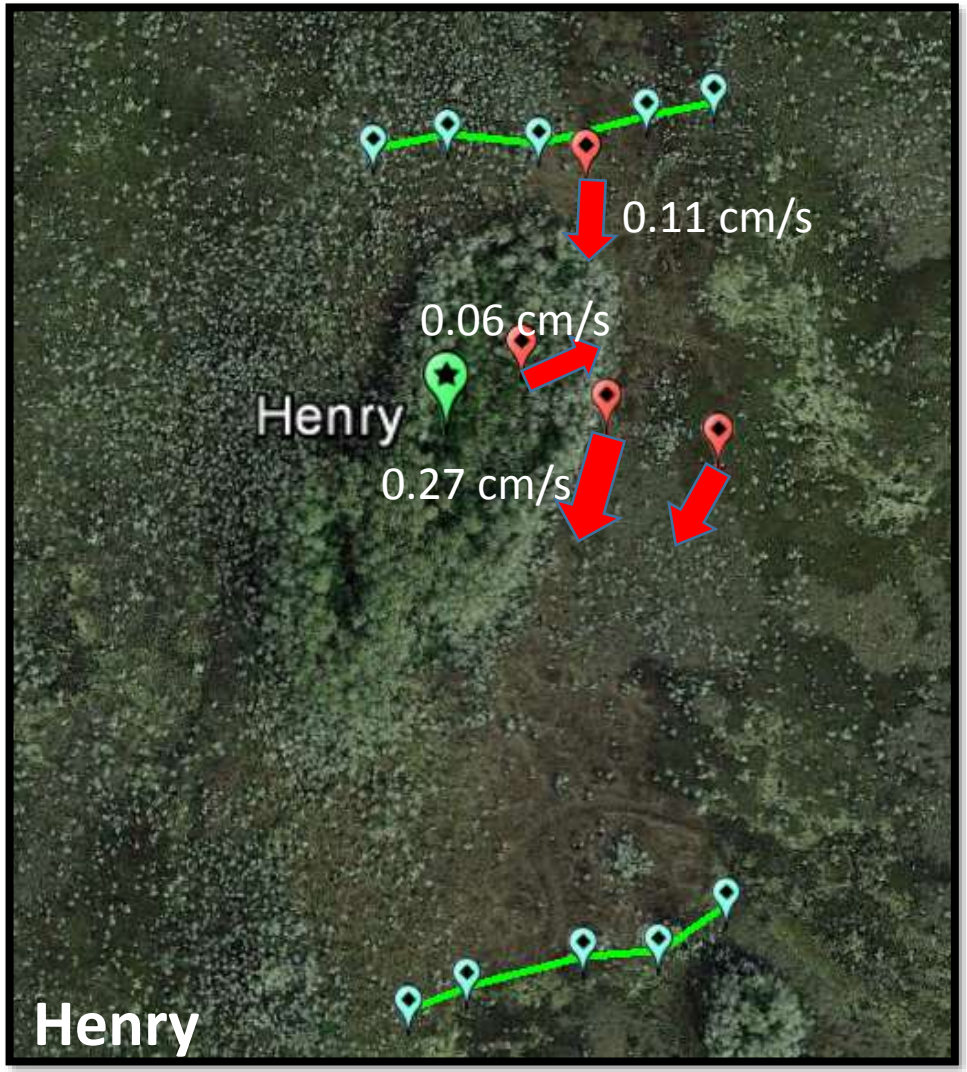
Biodegradable fluorescein dye

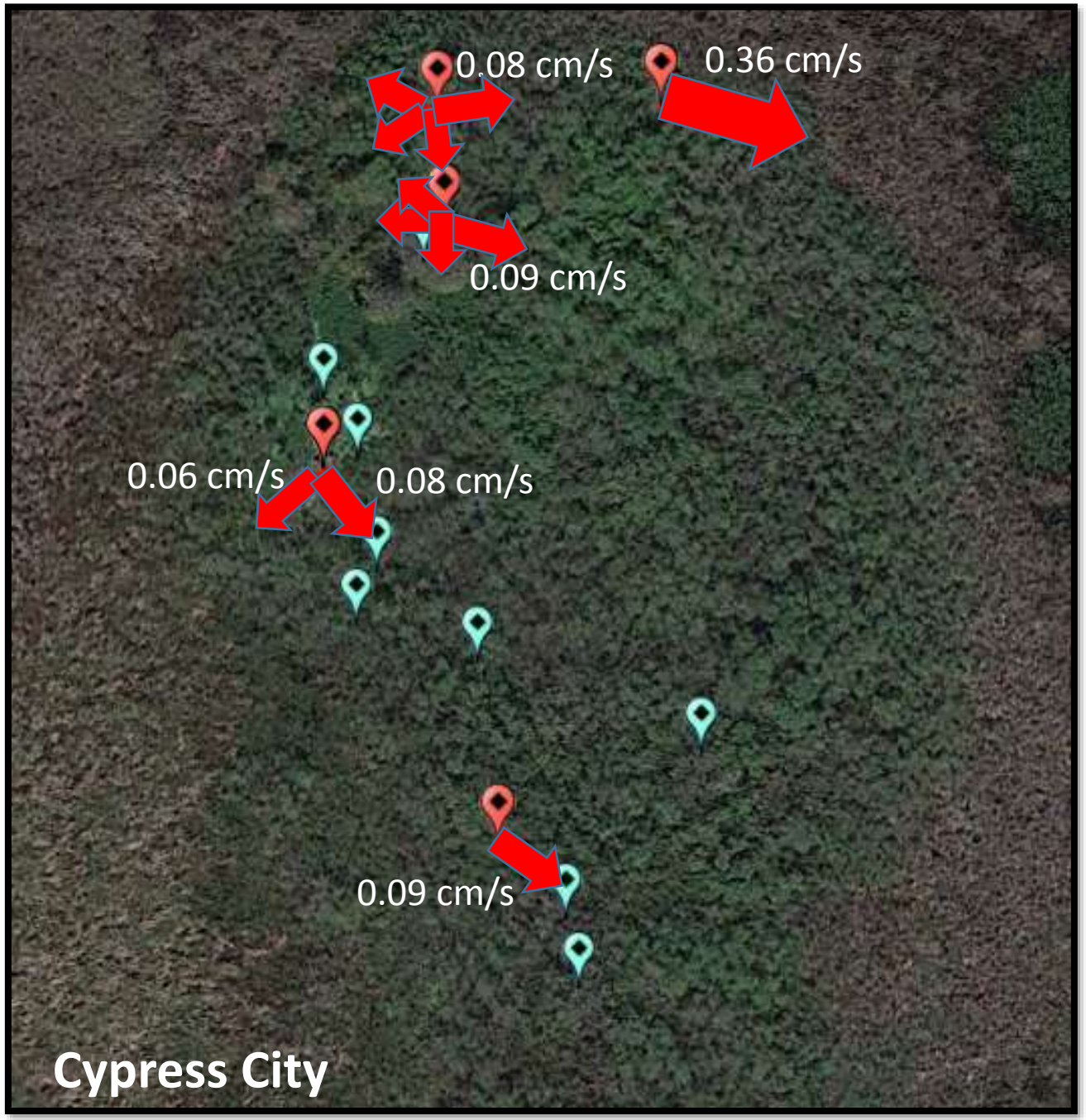


Mean annual overland flow vectors (1965-2005) in the Water Conservation Areas and Everglades National Park (SFWMD)

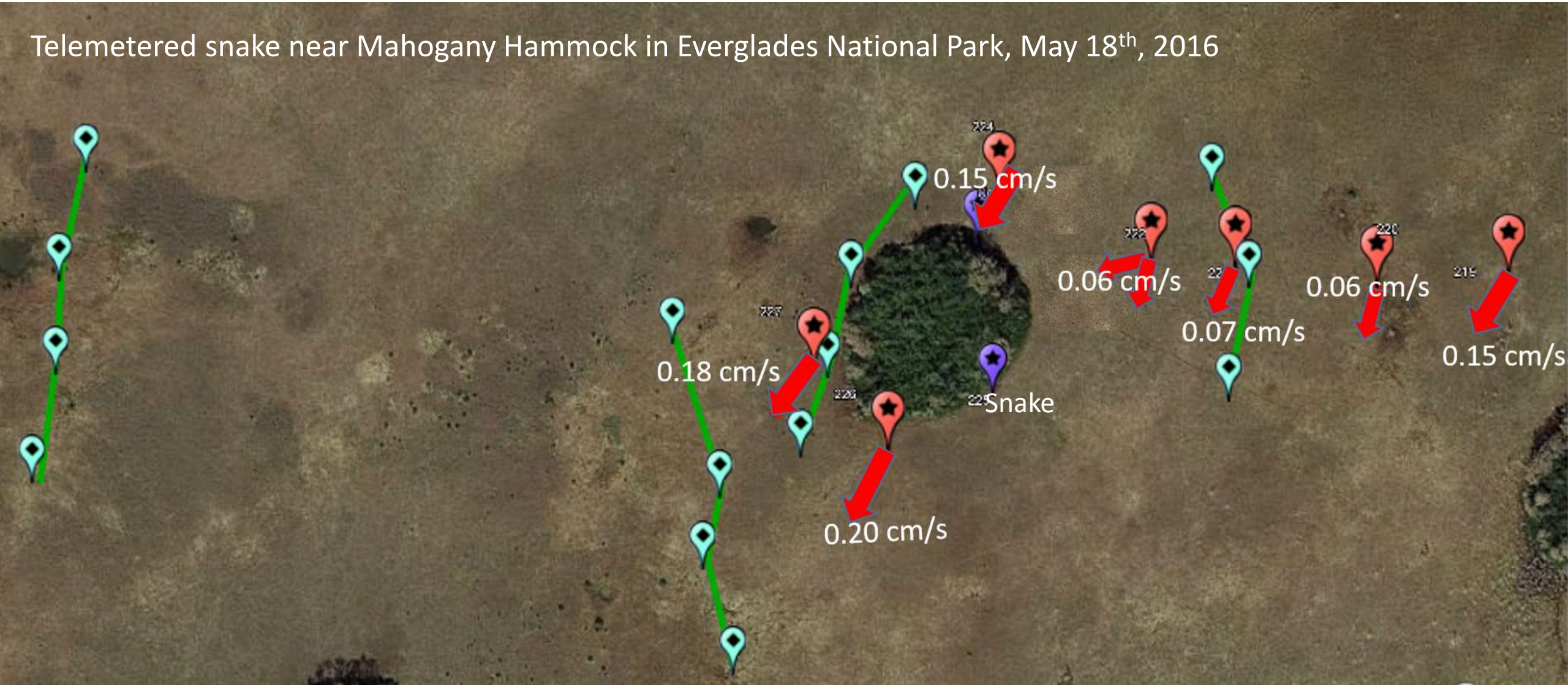


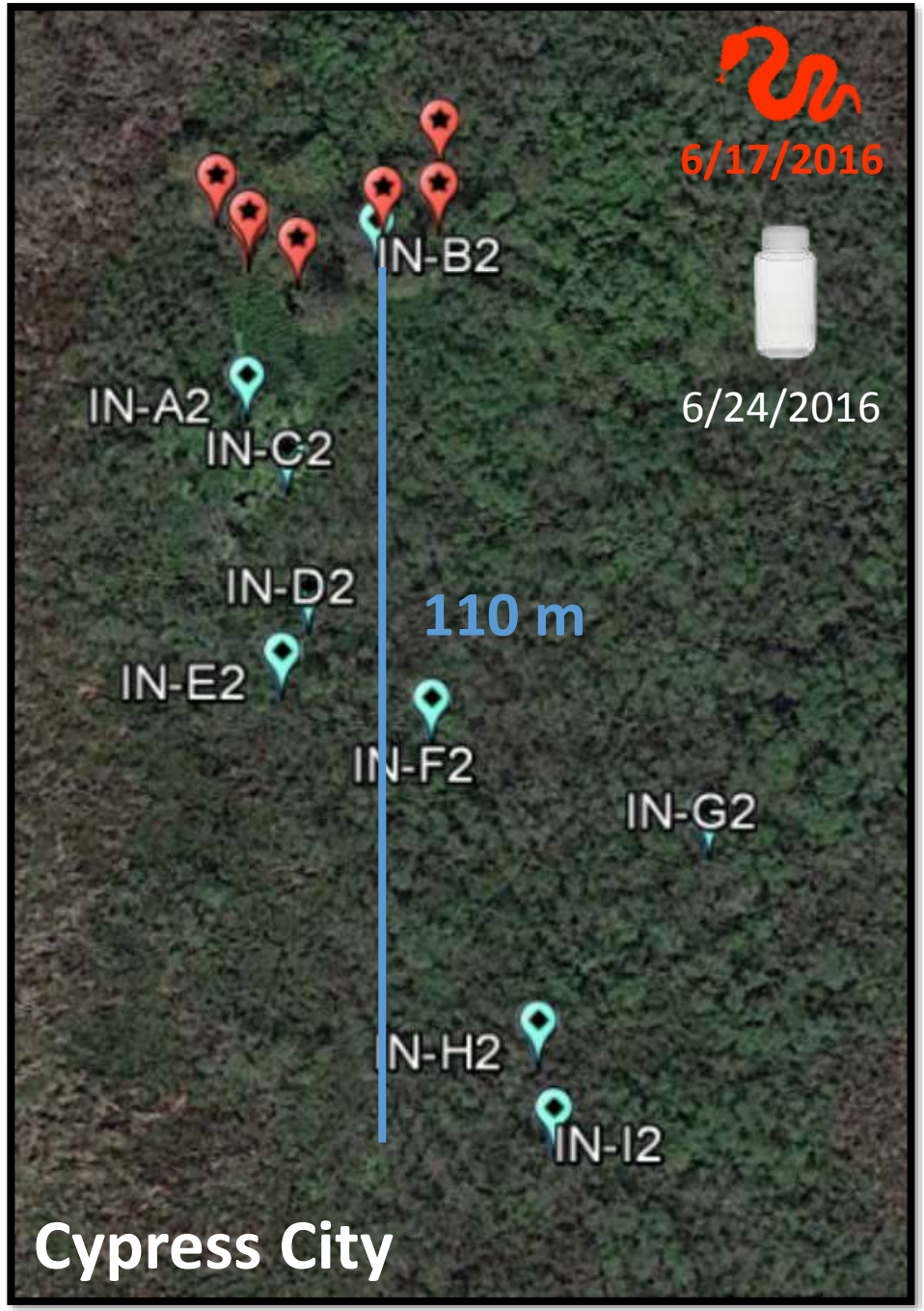
Flow vectors + sampling points

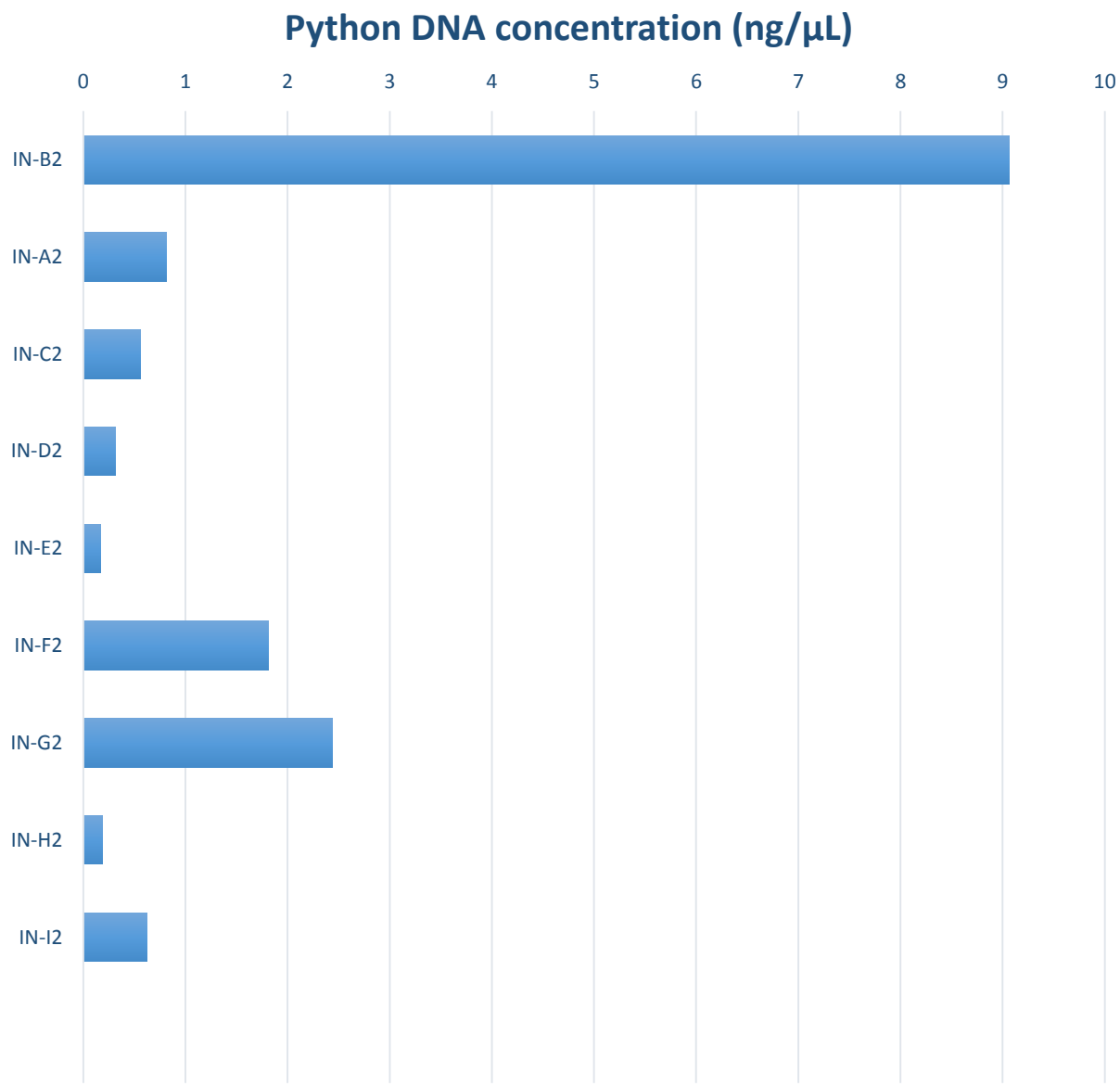




Telemetered snake near Mahogany Hammock in Everglades National Park, May 18th, 2016




6/17/2016
IN-B2
6/24/2016
IN-A2
IN-C2
IN-D2
110 m
IN-E2
IN-F2
IN-G2
IN-H2
IN-I2
Cypress City


Python DNA concentration (ng/µL)
0
1
2
3
4
5
6
7
8
9
10
IN-B2
IN-A2
IN-C2
IN-D2
IN-E2
IN-F2
IN-G2
IN-H2
IN-I2

Conclusions

- Flow direction is consistent with historical flow vectors
- Flow within islands is variable in rate and more diffuse
- Sampling water within islands is more accessible than sampling within island tail
- In inundated islands, preliminary results suggest we can utilize flow to detect DNA downstream of the source point(s) within islands

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- Our sponsors:

Questions?