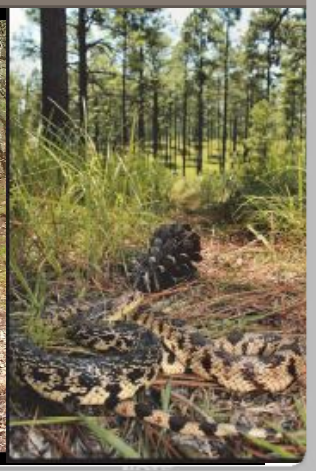
EMERGING TOOLS FOR MANAGEMENT OF ENDANGERED SPECIES ON FEDERAL LANDS

Jinelle Sperry, PhD; ERDC-CERL

Federal Environmental Symposium



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DISCOVER | DEVELOP | DELIVER

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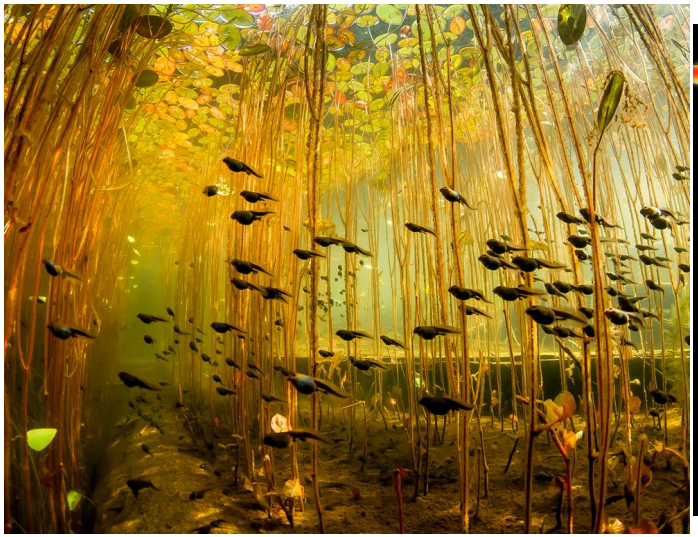
Surveys for at-risk wildlife species

- Conventional species surveys can be time-intensive and costly
  - Permitting constraints
  - Access issues
  - Cryptic species

Emerging technologies for wildlife surveys and management

- Molecular tools – environmental DNA (eDNA)
  - Technology description
  - Successful implementation
  - Challenges
- Remote cameras and image analyses software
  - Technology description
  - Challenges
  - Implementation (TBD)
- Conspecific attraction
  - Description of methods
  - Successful implementation
  - Challenges

What is eDNA?



Organisms are continually shedding DNA into their environment

This environmental DNA (eDNA) can be harnessed

And the information contained therein can be harnessed

General eDNA Process

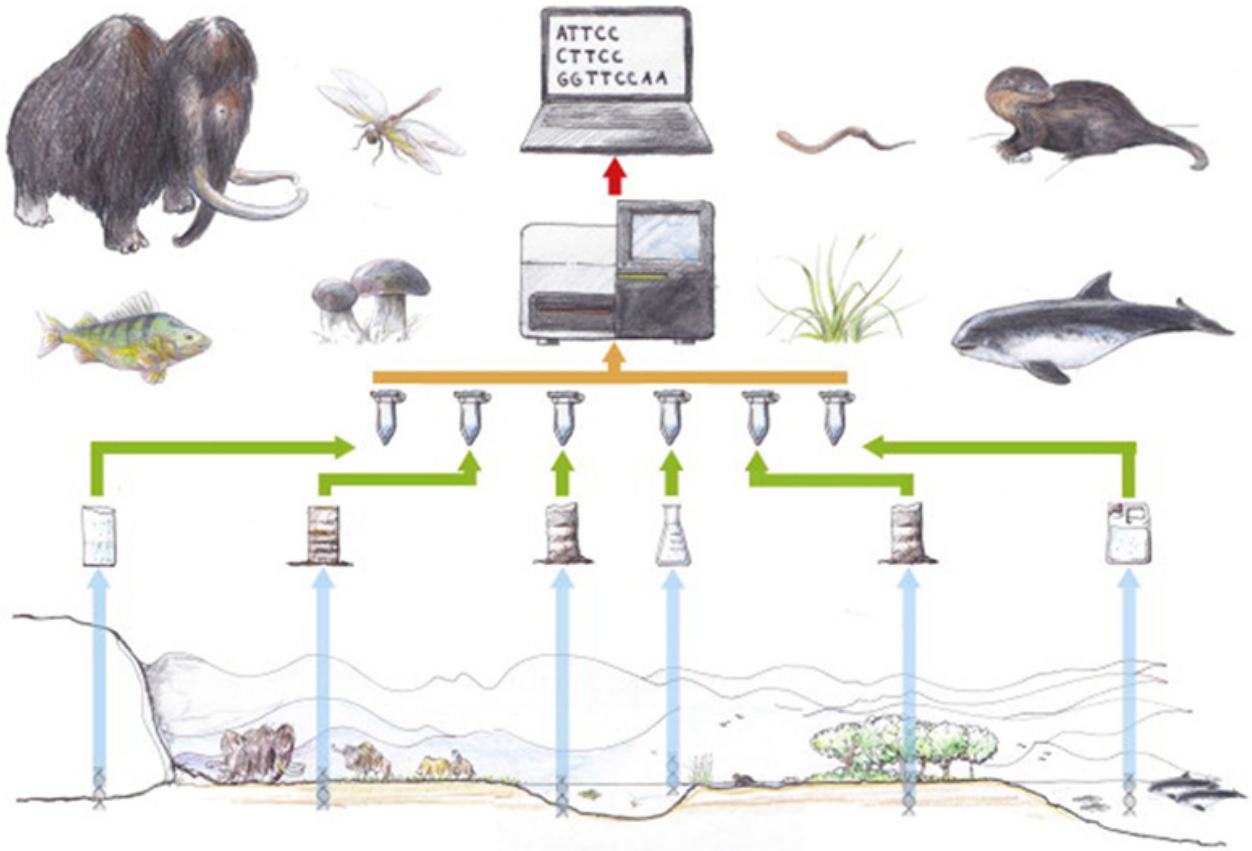


Image by Lars Holm

Alligator Snapping Turtles on Fort Polk, LA

Alligator Snapping Turtle (AST)

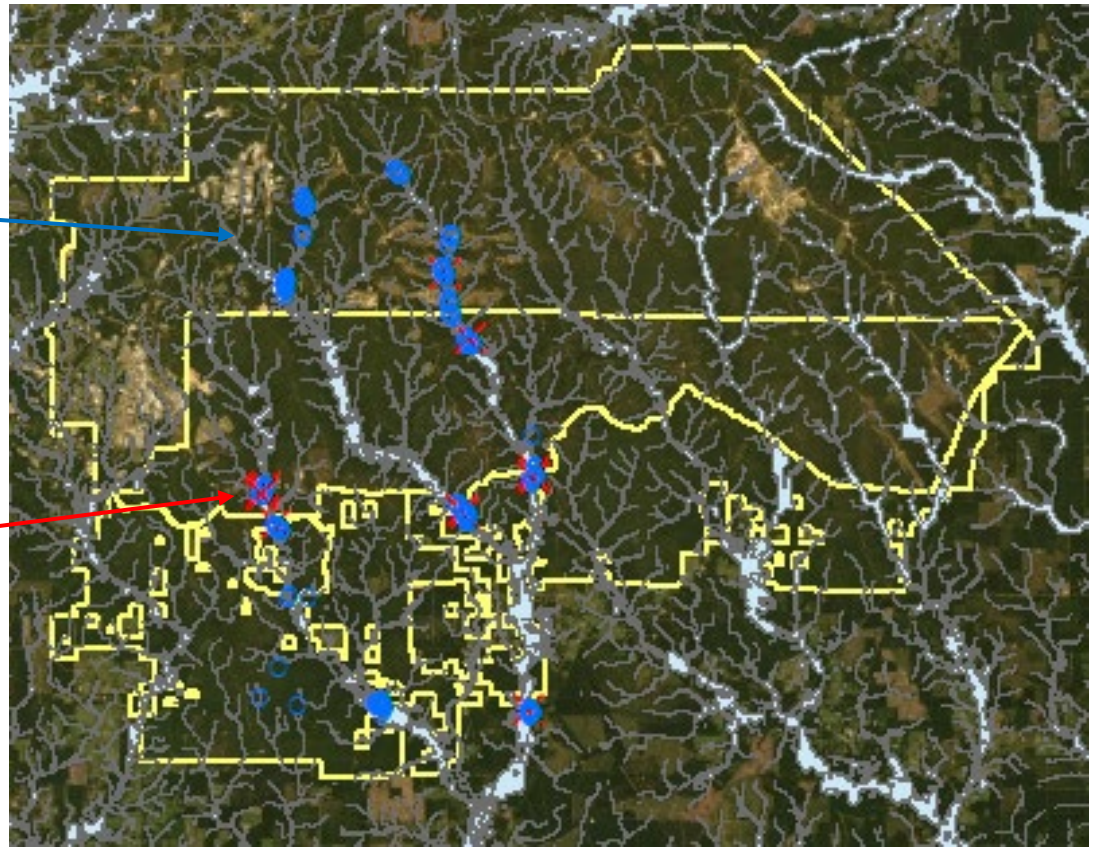
- Petitioned for federal listing
- Almost entirely aquatic
  - Difficult to survey
  - Aquatic traps
- Present on Fort Polk but unknown distribution

Alligator Snapping Turtles on Fort Polk, LA

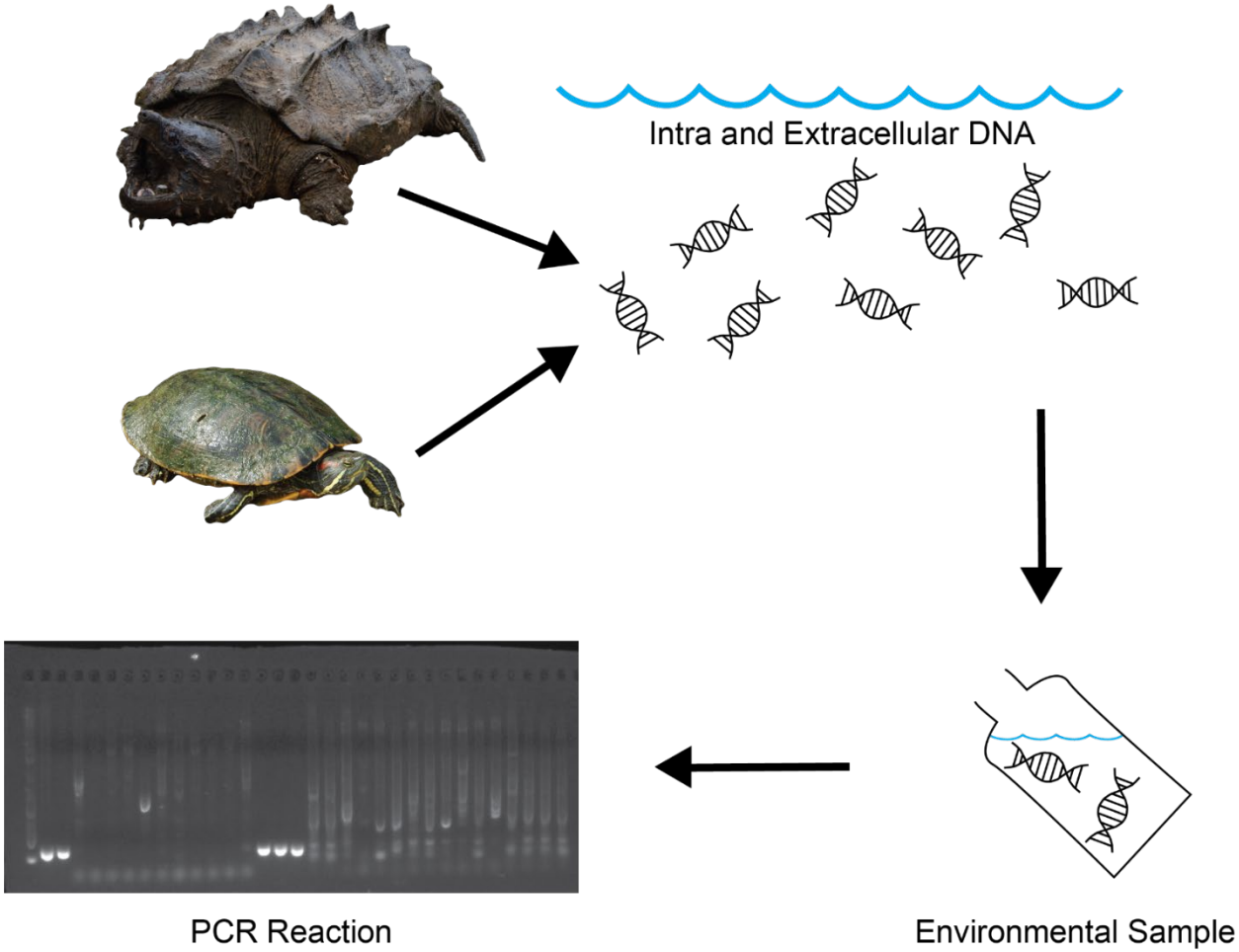
- Trapping effort (2013 – 2014)
  - 6 traps per site; 2,750 trap nights
  - 14 turtles captured in 3 streams

No AST Capture

AST Capture



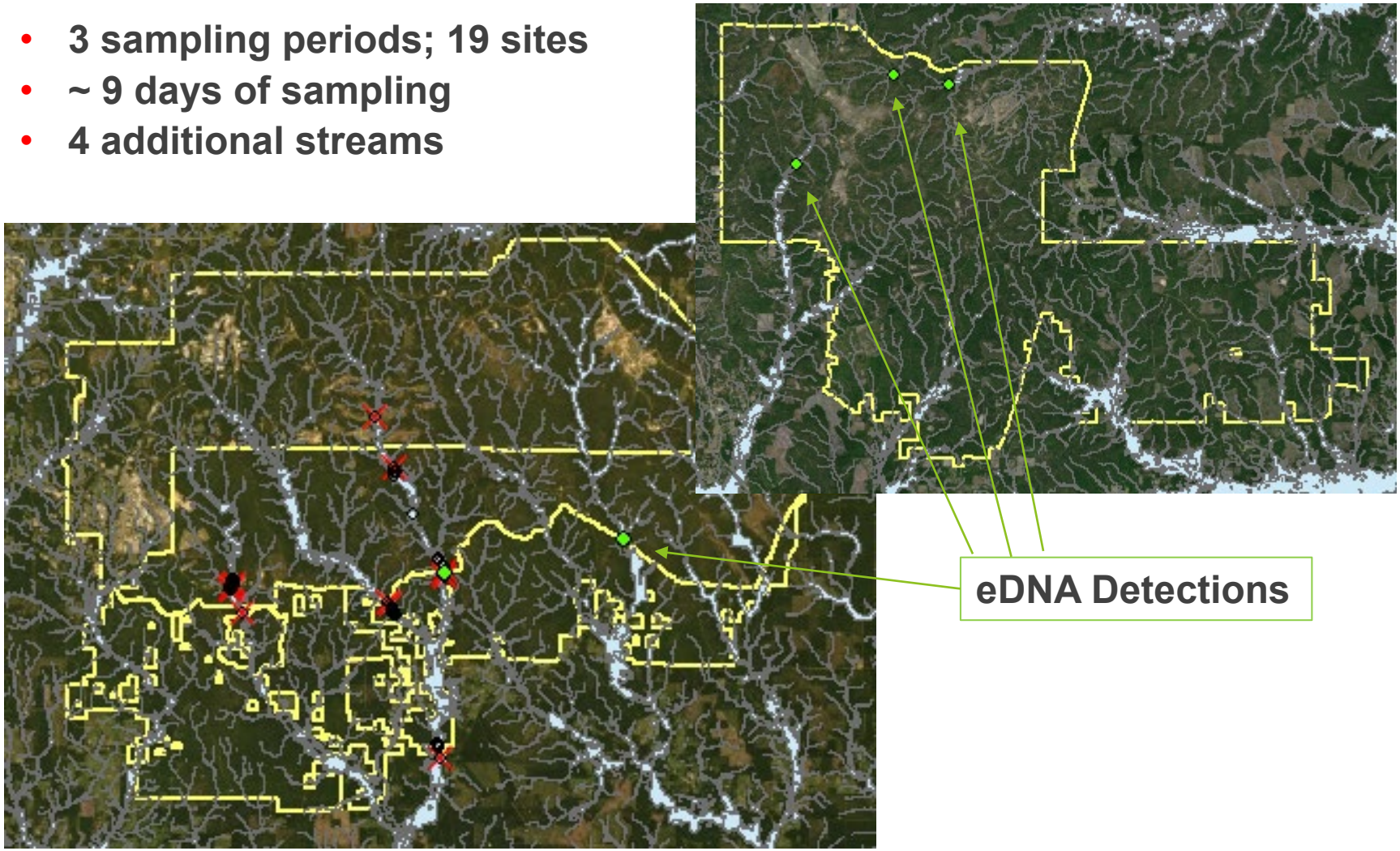
eDNA for Alligator Snapping Turtles on Fort Polk



eDNA for Alligator Snapping Turtles on Fort Polk

eDNA for AST on Fort Polk

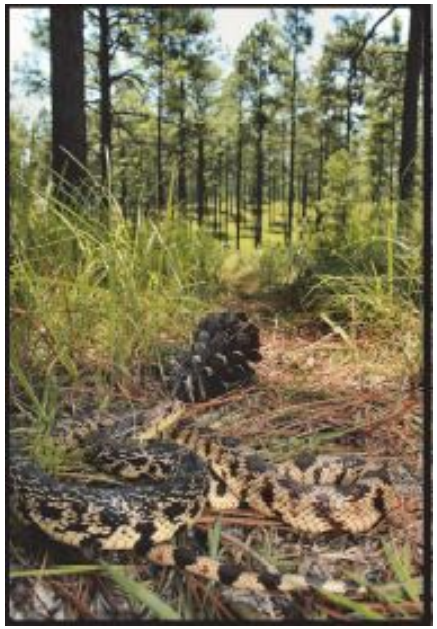
- 3 sampling periods; 19 sites
- ~ 9 days of sampling
- 4 additional streams



Louisiana Pine Snake on Fort Polk, LA

Louisiana Pine Snake (LPS)

- Historic populations in TX and LA
  - Current trapping records only from 4 populations
- Cryptic species, difficult to survey
  - 80% of locations in gopher burrows
- Distribution predictions based on soils



Louisiana Pine Snake on Fort Polk, LA

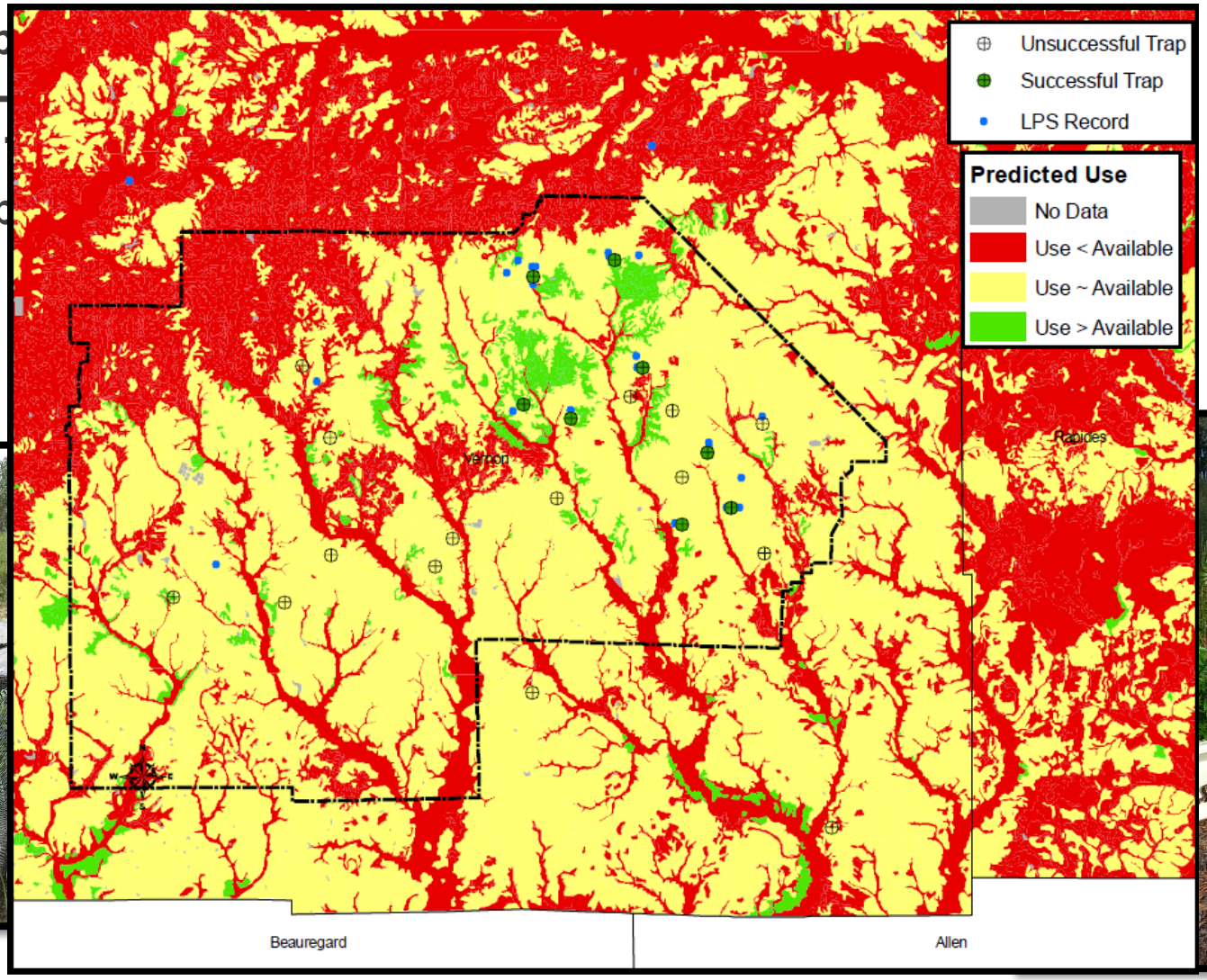
LPS Trapping Efforts

- **2000 – 2018**
- **~25 – 75 traps per year; 46,623 trap days**
- **15 captures (1:3,330)**

Louisiana Pine Snake on Fort Polk, LA

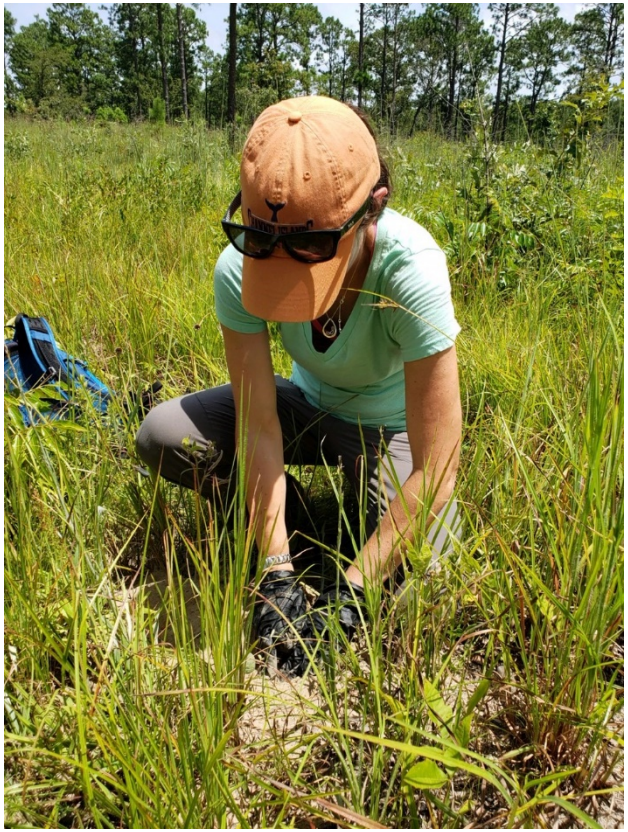
LPS Trap

- **2000 –**
- **~25 –**
- **15 cap**

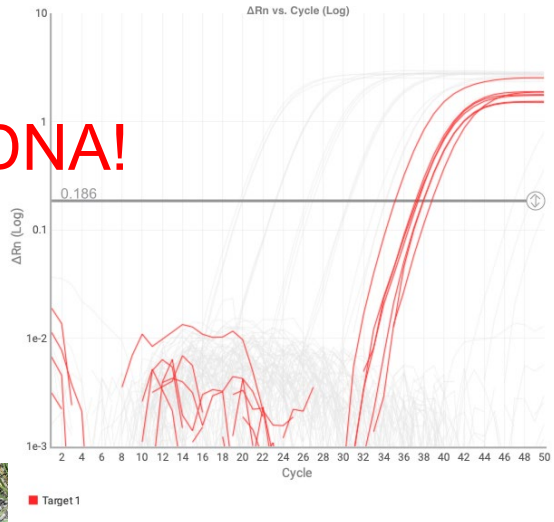


eDNA for Louisiana Pine Snake

- Developed species-specific primers and probe
- Tested soil from burrows with known snakes
- Tested soil from snake release site



Detected LPS DNA!



Summary: Molecular tools for sampling

Advantages:

- Can be extremely cost-effective
- Allows sampling in areas with access issues
- Potential to detect cryptic species

Challenges:

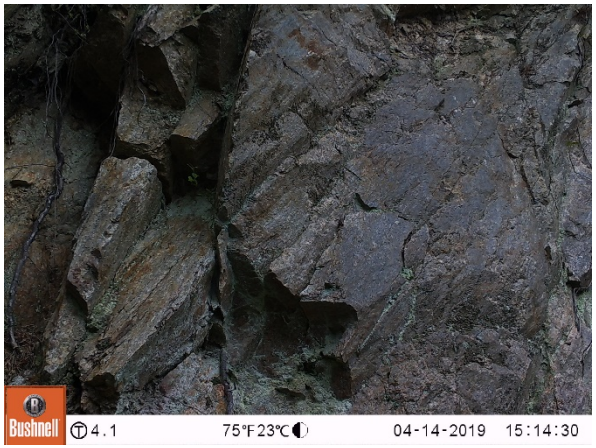
- Effectiveness is species-specific
  - Primarily aquatic species (but LPS!)
- Does not provide individual or demographic data
- Development of assay can be expensive
- Success dependent on study design and execution
  - Need info on life history
  - Potential for contamination (false positive)
    - Clean techniques and controls
  - Potential for false negative
    - Replicates

Emerging technologies for wildlife surveys and management

- Molecular tools – environmental DNA (eDNA)
  - Technology description
  - Successful implementation
  - Challenges
- Remote cameras and image analyses software
  - Technology description
  - Challenges
  - Implementation (TBD)
- Conspecific attraction
  - Description of methods
  - Successful implementation
  - Challenges

Remote cameras for wildlife surveys

- Extensively used over several decades
  - Surveys for target species
  - Community monitoring
  - Multi-species interactions
    - Plant-animal interactions, predation
  - Documenting use of target areas



Challenges: Remote Cameras

- Effectiveness varies by species
- Typically cannot get individual data
  - Coat pattern analyses
- Incredibly large amount of data (terabytes)
- Prohibitive post-processing time/effort
  - False triggers

Remote camera images post-processing: Technology Tools

- Citizen Science
  - Zooniverse
  - eMammal
- Image management software
  - Adobe Bridge
- Image analyses software
  - Motion Meerkat (Weinstein 2014)
  - Deep Meerkat
- Deep learning (AI) algorithms

Image Management Software: Adobe Bridge

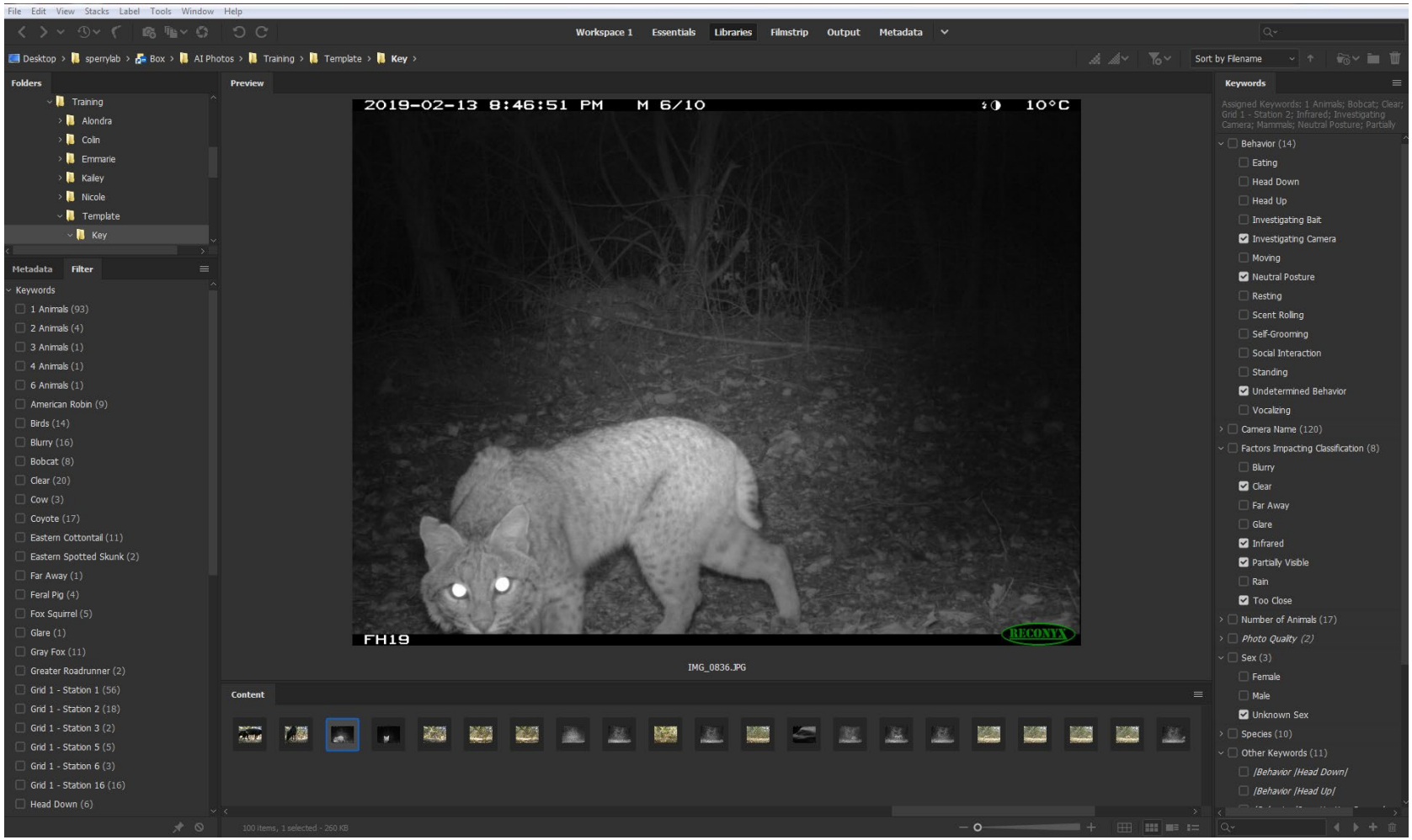
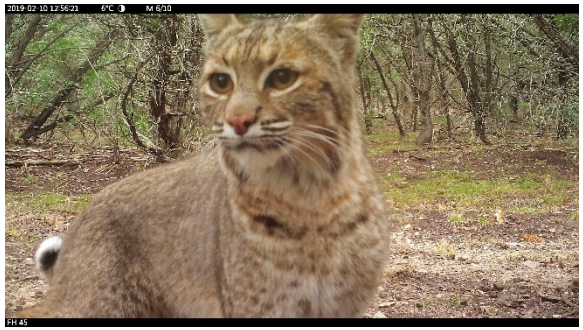


Image Analyses Software: Meerkat



metric	MotionMeerkat	DeepMeerkat
True positive (TP) rate (%)	31.6%	18.3%
True negative (TN) rate (%)	39.6%	43.6%
False positive (FP) rate (%)	23.8%	37.0%
False negative (FN) rate (%)	5.1%	1.0%
Accuracy (TP + FP) %	71.2%	61.9%

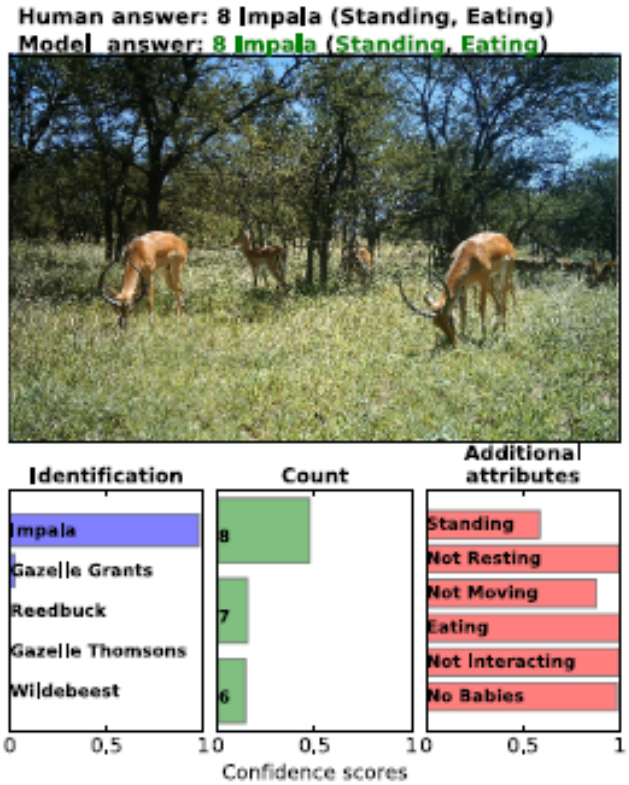
Image Analyses Software: Meerkat

Software classification

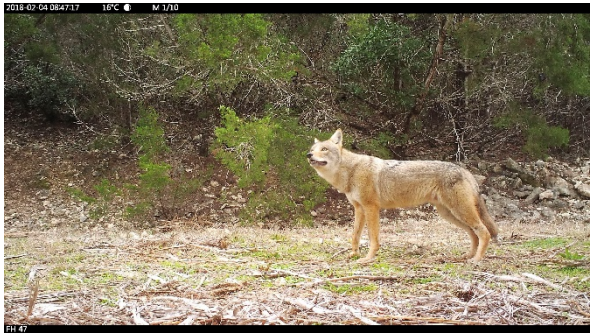
Missed snake detection

Image Analyses: Deep Learning

- Norouzzadeh et al. 2018; PNAS
- 3.2 million images
- Developed deep learning algorithms for image analyses
  - Species identification
  - Number of individuals
  - Behavior
- 94% accuracy
- Transfer learning algorithms provided



Summary: Remote cameras and image analyses



Advantages:

- Can be extremely cost-effective
- Allows sampling in areas with access issues
- Potential to detect cryptic species

Challenges:

- Effectiveness is species-specific
- Does not provide individual or demographic data
- Post-processing can be prohibitive
    - Software can improve processes
- Success dependent on study design and execution
    - Need info on life history
        - E.g. baited, trails, etc.

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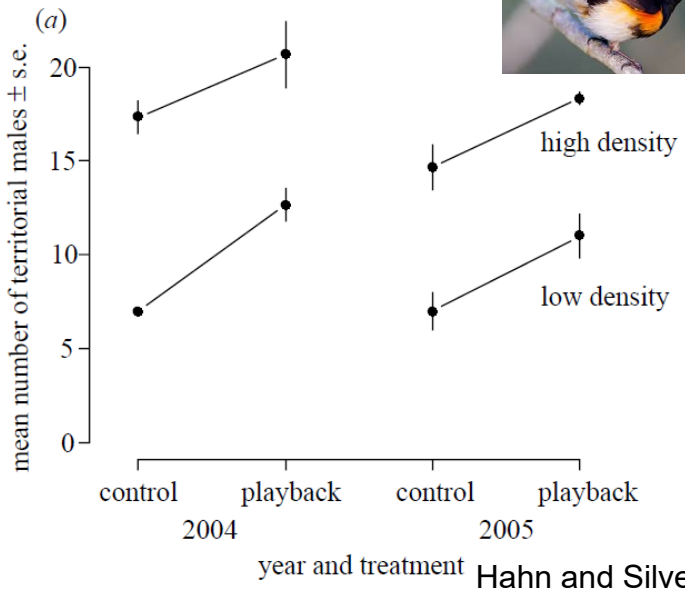
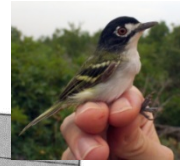
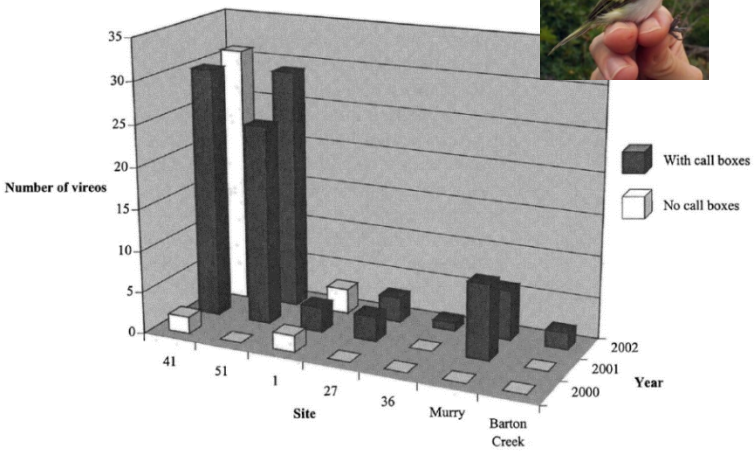
Conspecific Attraction as Management Tool

- Conspecific attraction = tendency for individuals to settle near others of their own species
- Conspecific attraction as a management tool
- Effective for species that rely on acoustic information



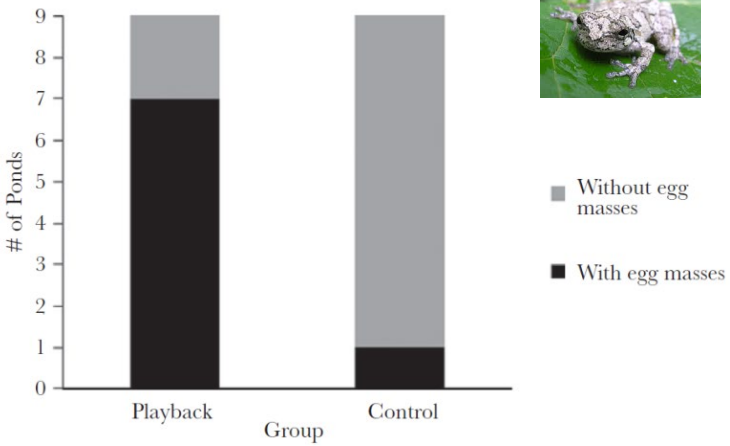
Hahn and Silverman, 2006



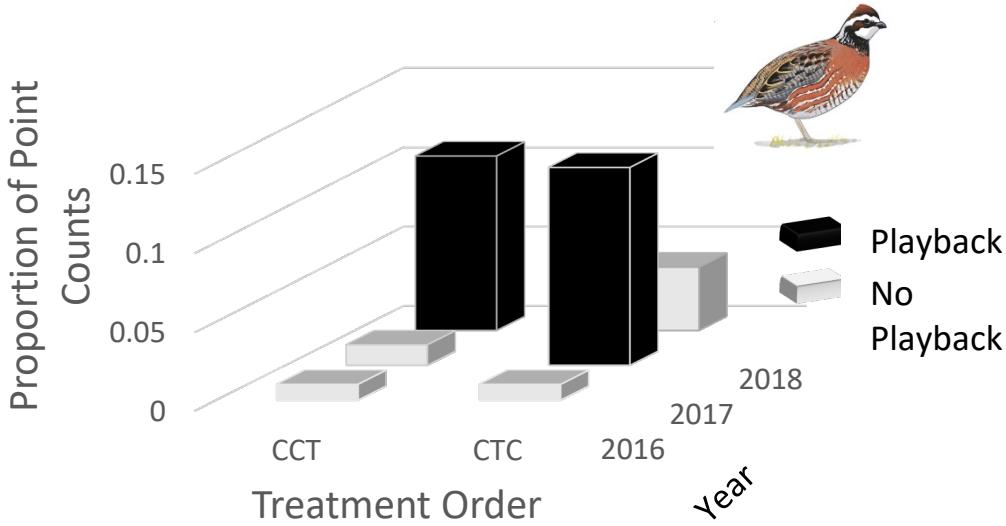


Ward and Schlossberg, 2004

Conspecific Attraction as Management Tool: Amphibians and Game Birds



Buxton et al. 2015



Conspecific Attraction for Critical Mutualisms: Hawaii Ecology

- Extreme examples of invasion and extinction
  - 10,000 endemic species
  - 0.25% of landbase in US
    - 75% of extinctions
  - 5,000 non-native species
- Majority of native plants dependent on avian seed dispersal

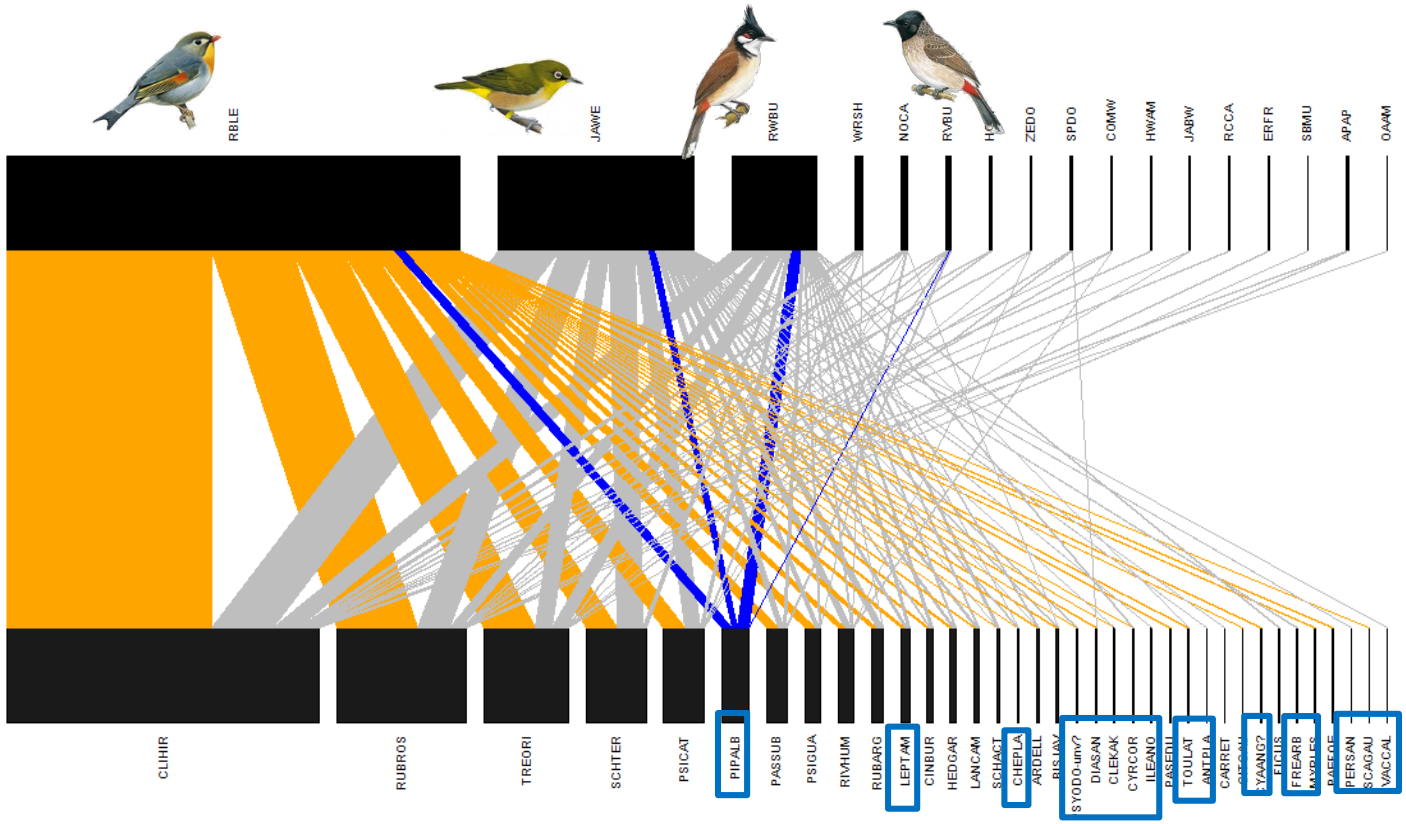
Complete loss of native plant-disperser interactions

Are non-native invasive frugivores replacing roles of extinct natives?

Extinctions

Introductions

Hawaii Ecology: Seed dispersal networks

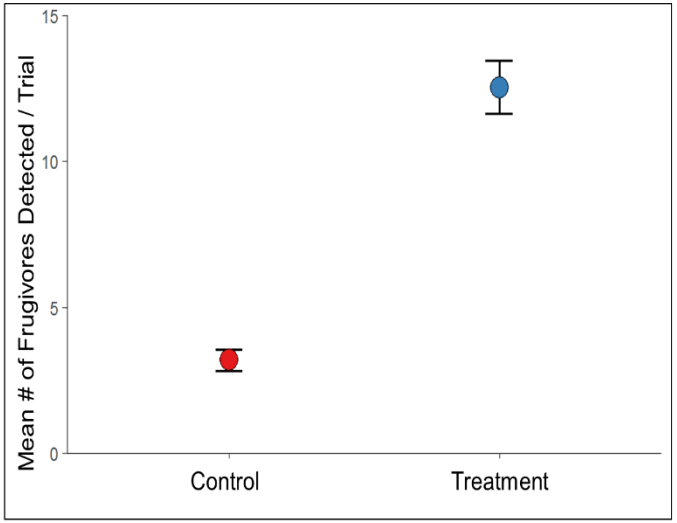


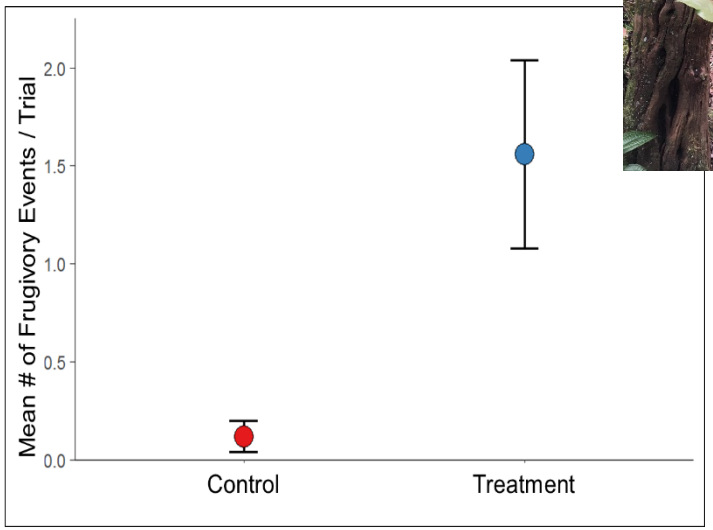
Vizentin-Bugoni et al. 2019; Science

Hawaii Ecology: Interactions with rare plants

Conspecific Attraction for Critical Mutualisms

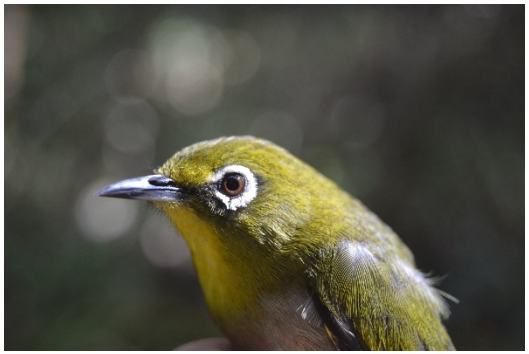
Birds came to fruiting plants in response to playback





MacDonald et al. 2019; Ecol. App.

Summary: Conspecific Attraction as Management Tool

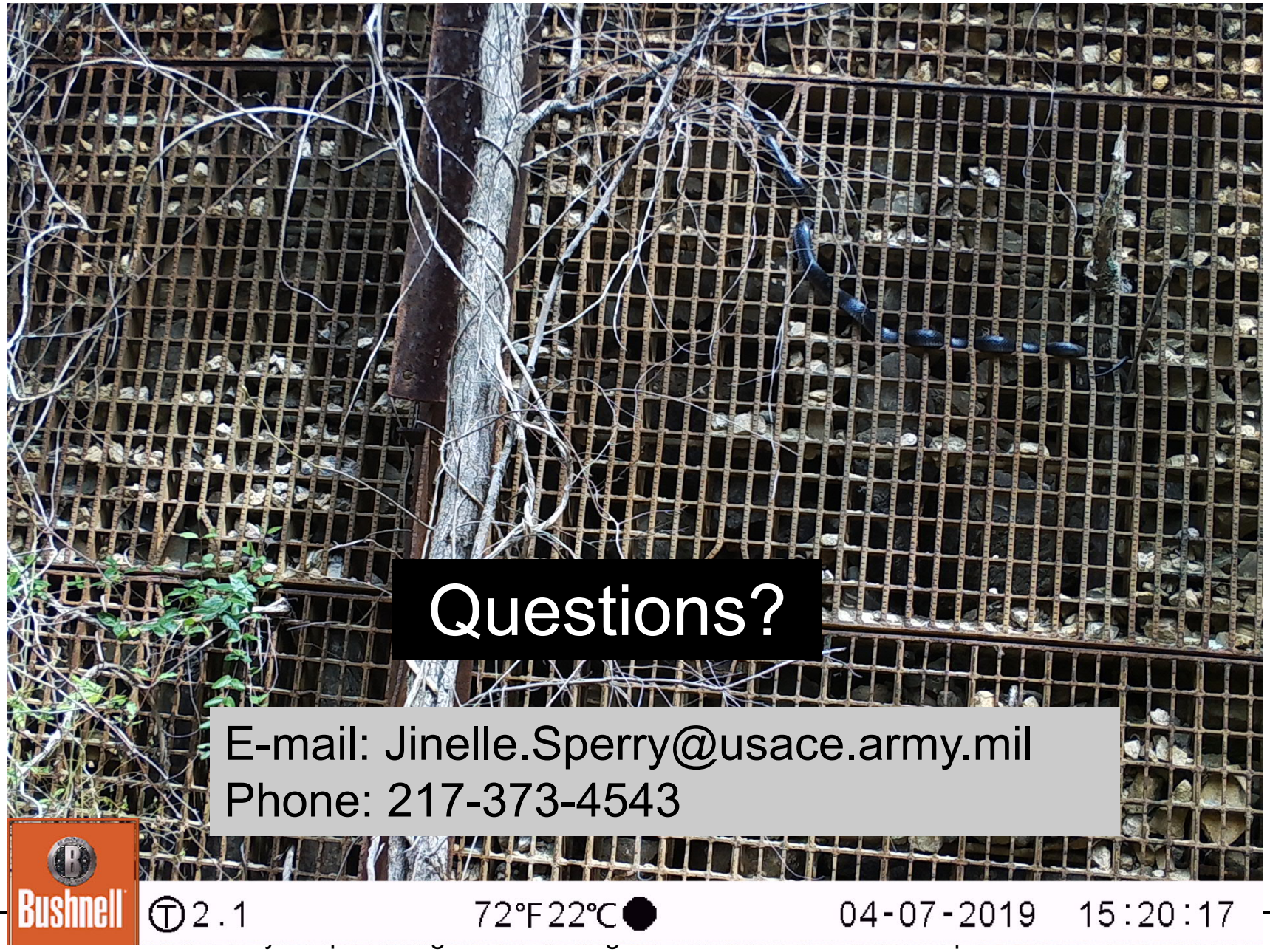


Advantages:

- Can be extremely cost-effective
- Reduced latency to colonization of habitat
- Facilitated frugivory of focal plants

Challenges:

- Effectiveness is species-specific
    - Species that communicate acoustically
- Success dependent on study design and execution
    - Need info on life history
    - Potential for population sink



Questions?

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