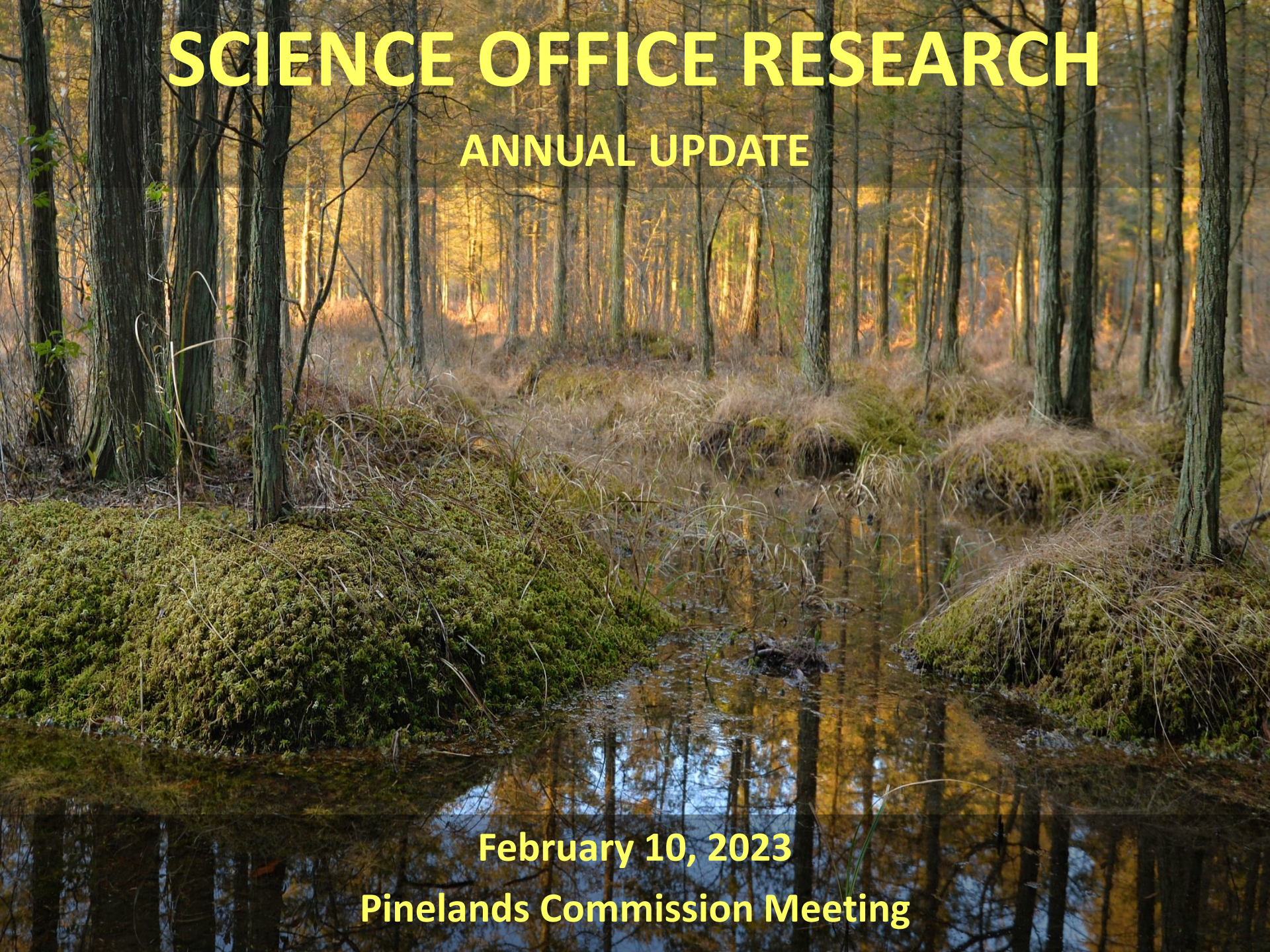


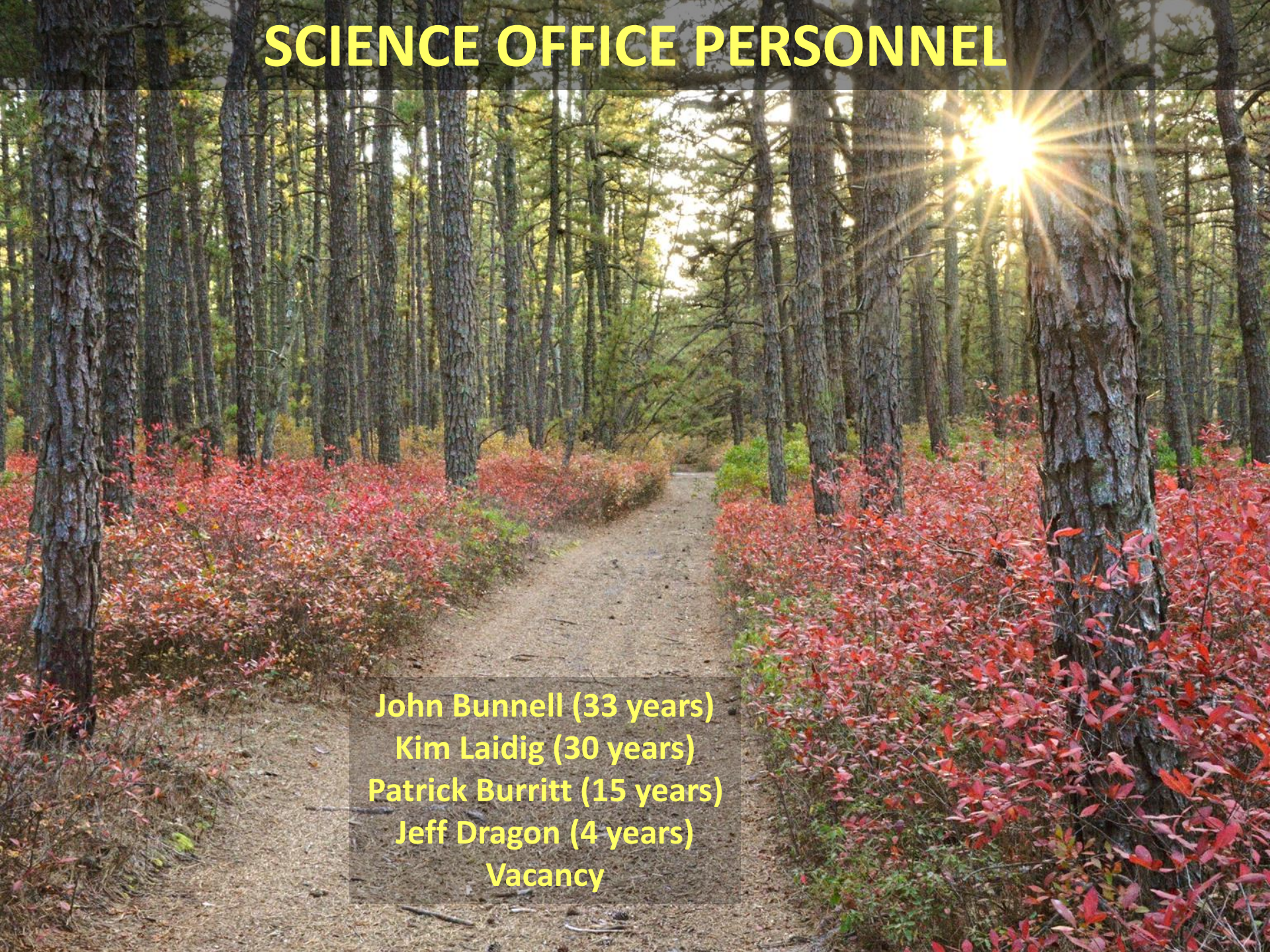
SCIENCE OFFICE RESEARCH

ANNUAL UPDATE

February 10, 2023

Pinelands Commission Meeting

SCIENCE OFFICE PERSONNEL



John Bunnell (33 years)
Kim Laidig (30 years)
Patrick Burritt (15 years)
Jeff Dragon (4 years)
Vacancy

PAST RESEARCH

Water Quality

Wastewater Treatment

Upland and Wetland Forests

Stream and Wetland Hydrology

Aquatic and Wetland Plants and Animals

Threatened and Endangered Species

Ecological Integrity Assessment

Landscape Assessments

Cranberry Agriculture

Utility Rights-of-way

ON-STREAM HABITATS

1990s - 2011

Upstream Land-use Activities

Development

Upland agriculture

Water-quality Degradation

Nutrient enrichment

Increased dissolved solids

Elevated pH

Altered Aquatic Communities

Non-native species invasion

KIRKWOOD-COHANSEY PROJECT

2002 - 2010

12 Studies

Hydrologic-framework Study - USGS
Hydrologic-assessment Study - USGS
Evapotranspiration Study - USGS
Hydrologic-modeling study - USGS
Stream Fish and Invertebrate Study - USGS
Nitrogen Laboratory and Field Study - Rutgers
Stream-habitat Study - PC
Swamp pink Study - PC
Pond-vegetation Study - PC
Frog-development Study - PC
Wetland-forest Study - PC
Landscape-application Study - Rutgers

OFF-STREAM HABITATS

2011 - 2022

Surrounding Land-use Activities

Development

Upland agriculture

↓

Water-quality Degradation

Nutrient enrichment

Increased dissolved solids

Elevated pH

↓

Altered Aquatic Communities

Non-native species invasion

RECENTLY COMPLETED RESEARCH

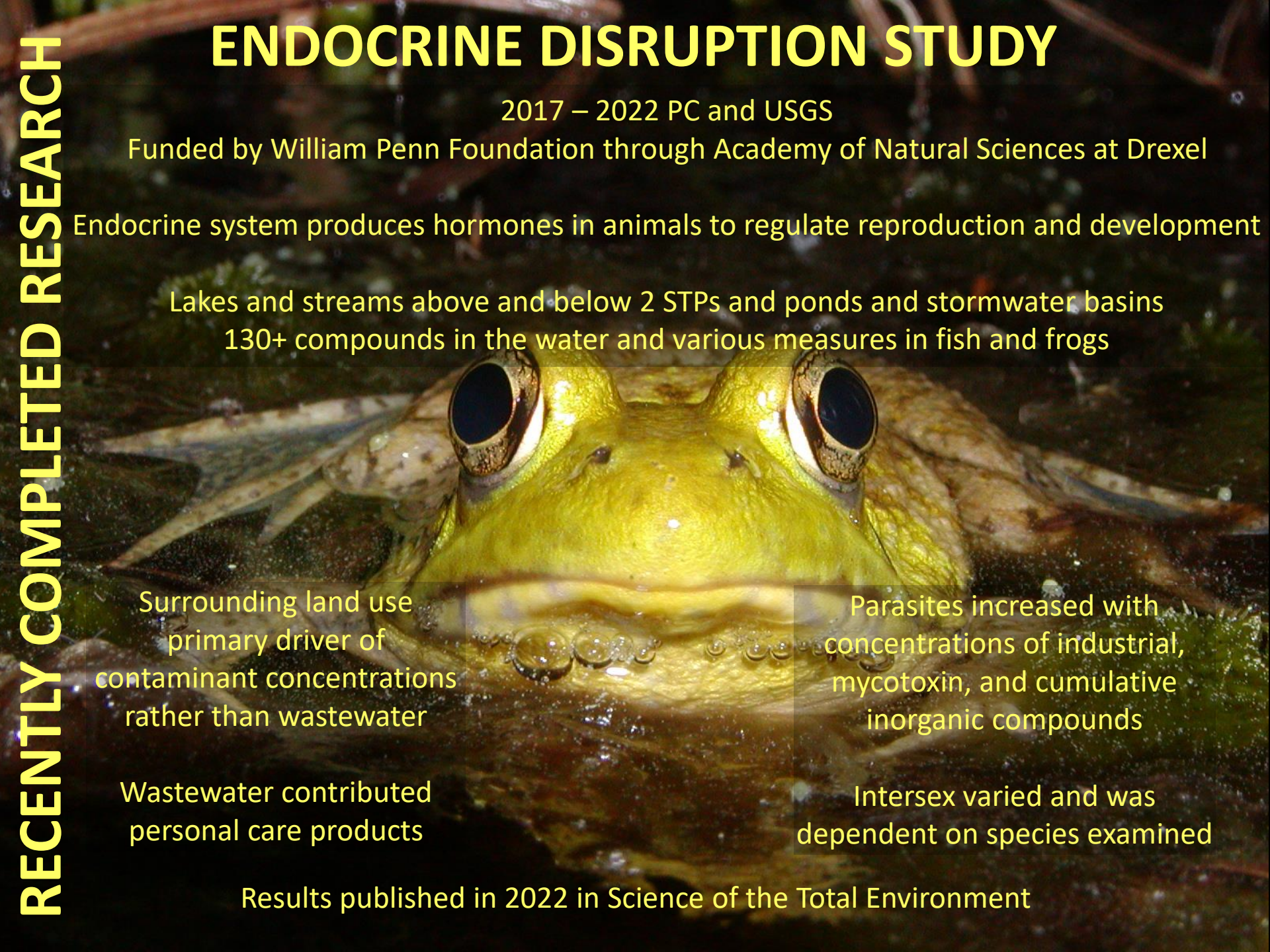
ENDOCRINE DISRUPTION STUDY

2017 – 2022 PC and USGS

Funded by William Penn Foundation through Academy of Natural Sciences at Drexel

Endocrine system produces hormones in animals to regulate reproduction and development

Lakes and streams above and below 2 STPs and ponds and stormwater basins
130+ compounds in the water and various measures in fish and frogs



Surrounding land use primary driver of contaminant concentrations rather than wastewater

Wastewater contributed personal care products

Parasites increased with concentrations of industrial, mycotoxin, and cumulative inorganic compounds

Intersex varied and was dependent on species examined

Results published in 2022 in Science of the Total Environment

RECENTLY COMPLETED RESEARCH

MICROORGANISM STUDY

2019 – 2022 EPA funded collaboration with PC, USGS, and NJDEP

Update 2007 stormwater basin mapping using 2017 aerial photography
Sampled 20 natural ponds, 20 excavated ponds, and 20 stormwater basins
Sampled water for pH, SC, nutrients, trace metals, and pesticides
Collected chlorophyll-a, phytoplankton, diatoms, zooplankton, and aquatic invertebrates

Found 190 new stormwater basins created from 2007 and 2017

Natural and excavated ponds were similar to each other
Compared to natural and excavated ponds, stormwater basins:
more surrounding developed land
more degraded water quality
greater number and concentration of pesticides
different plants and animals
source for nonnative and introduced species

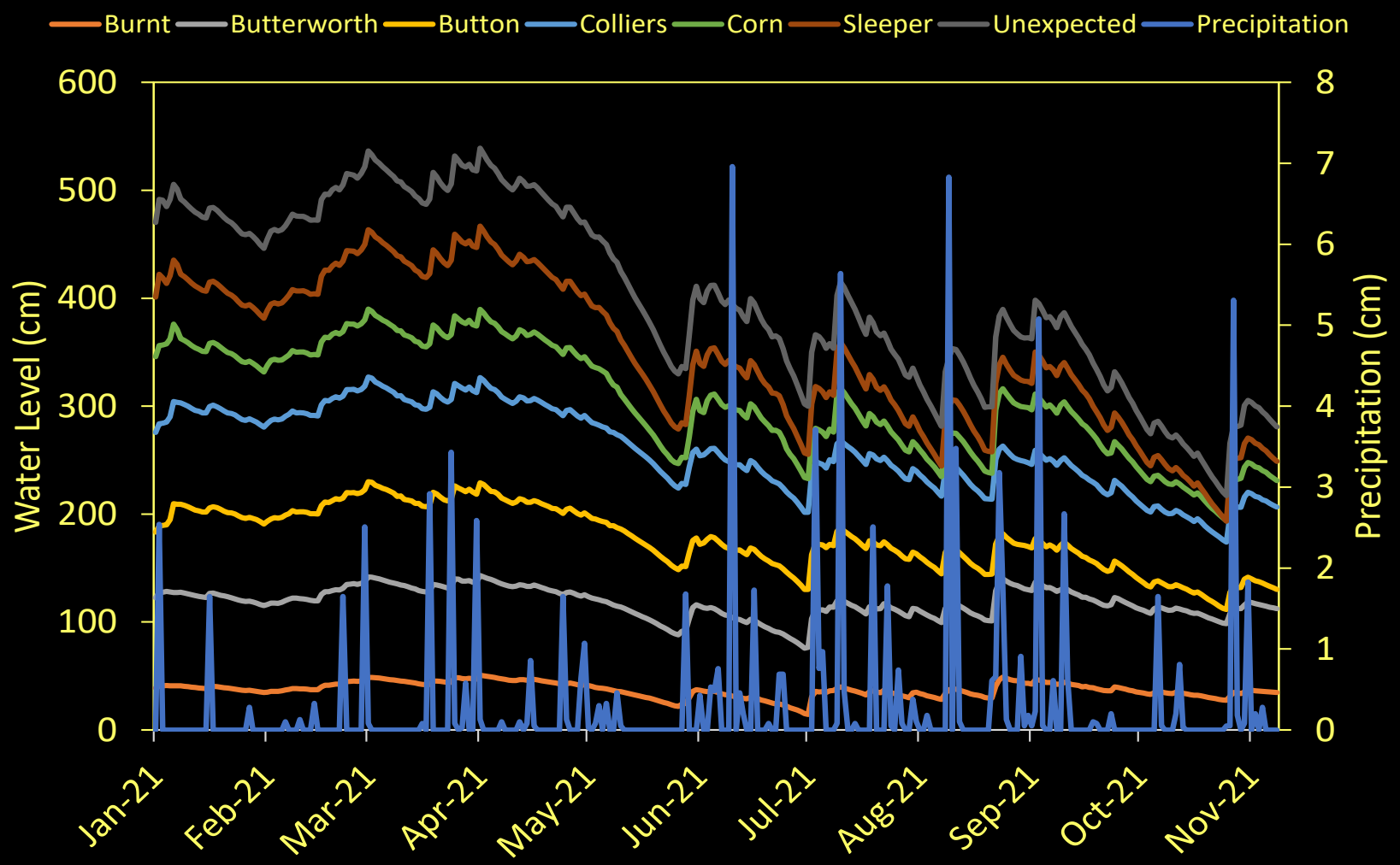

CURRENT RESEARCH
Water Level Monitoring
Pinelands-wide Monitoring
Frog and Toad Monitoring
Joint Corn Snake Study
Rare Snake Monitoring
King Snake Study
Snake Fungal Disease Monitoring
Corn Snake and King Snake Genetics
Box Turtle Study

WATER LEVEL MONITORING

NPS funded ongoing environmental monitoring

33 forest plots + 1 plot with data logger and 30 ponds + 7 ponds with data loggers

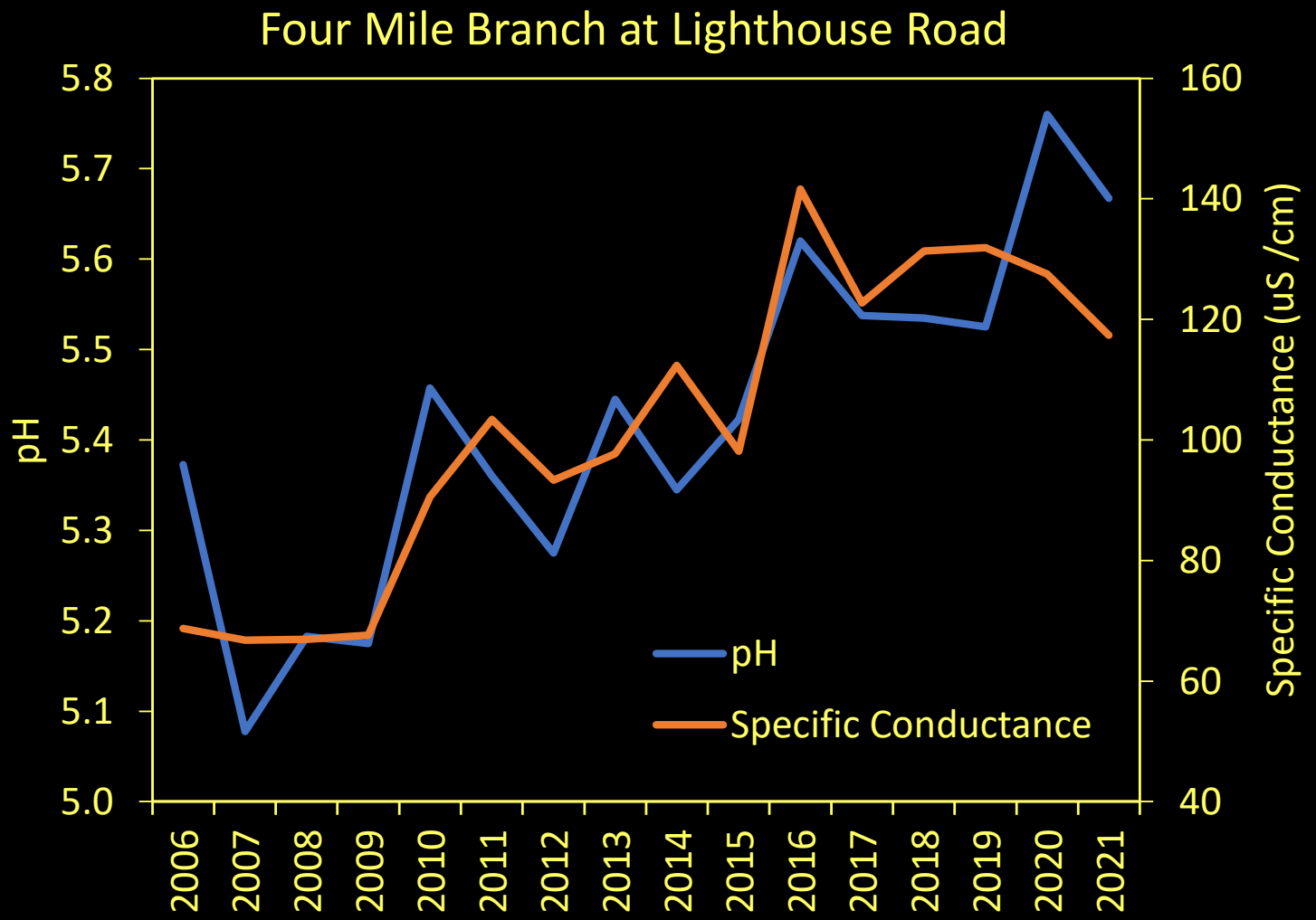
CURRENT RESEARCH



PINELANDS WIDE WQ MONITORING

CURRENT RESEARCH

NPS funded ongoing environmental monitoring
47 stream sites sampled in April, June, August, and October annually
to monitor changes in pH and specific conductance



ANNUAL FROG AND TOAD SURVEYS

NPS funded ongoing environmental monitoring

Annual spring calling surveys for frogs and toads at 22 ponds in the Mullica River Basin

CURRENT RESEARCH

Vocalization surveys at 22 ponds in March, April, May, and June

Count the number of individual frogs and toads of each species calling

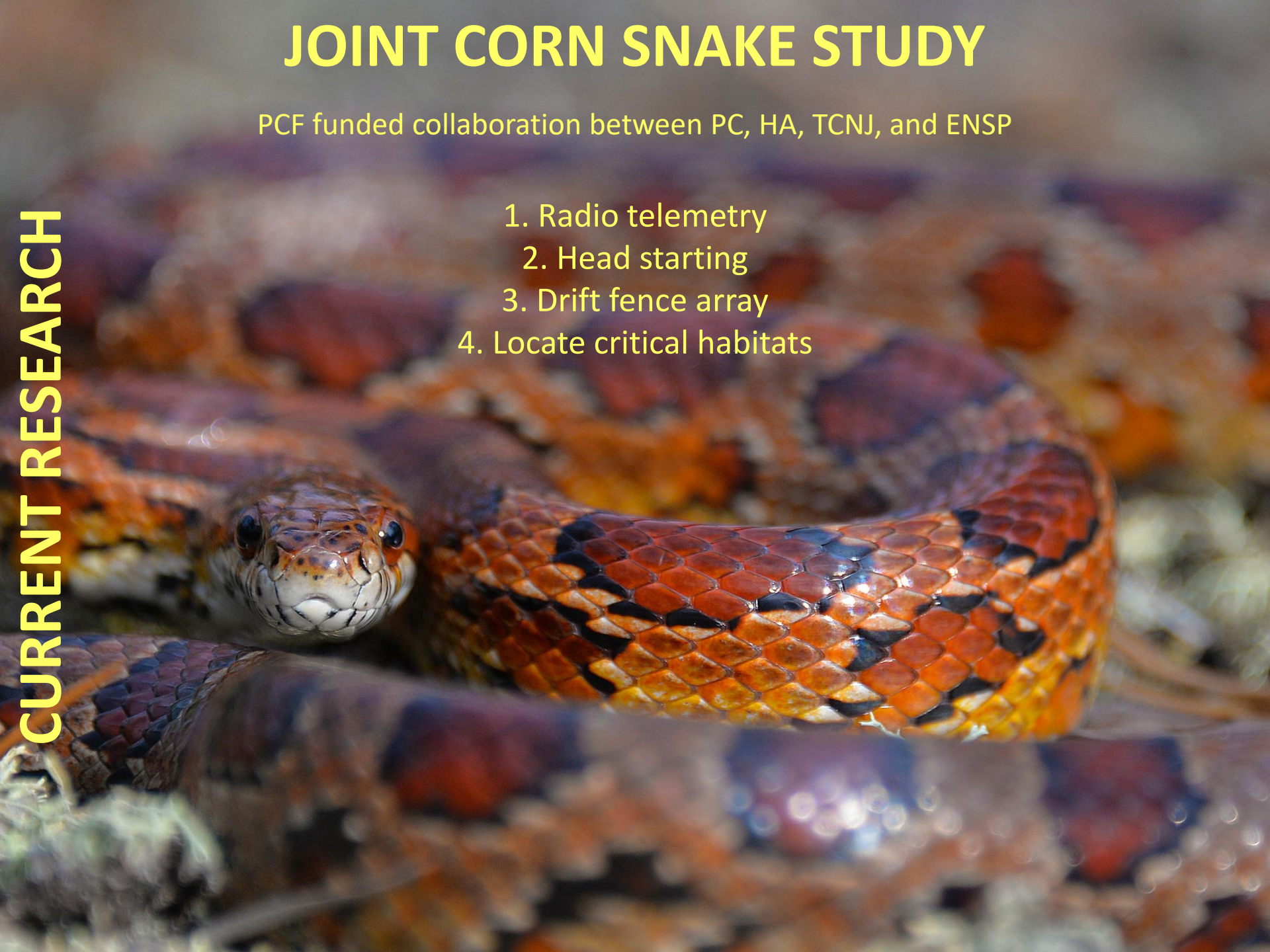
Over 30 years of data to analyze for changes over time

JOINT CORN SNAKE STUDY

PCF funded collaboration between PC, HA, TCNJ, and ENSP

CURRENT RESEARCH

1. Radio telemetry
2. Head starting
3. Drift fence array
4. Locate critical habitats

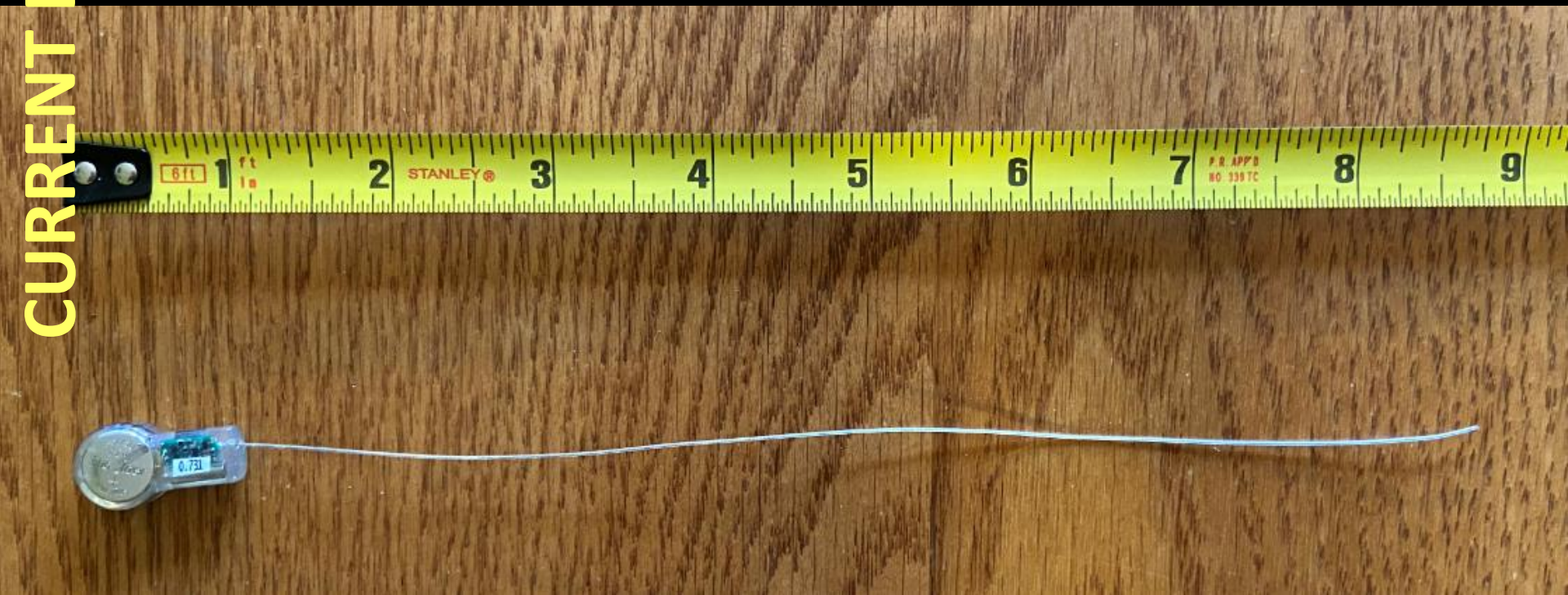


JOINT CORN SNAKE STUDY

1. Radio telemetry

CURRENT RESEARCH

Capture snakes and surgically implant radio transmitters



JOINT CORN SNAKE STUDY

1. Radio telemetry

CURRENT RESEARCH

Located snakes 2 – 3x per week in 2017 – 2019

Environmental, habitat, and behavioral data

Activity range and habitats used

Timing of nesting, shedding, and denning

Location of dens, nests, and shed sites

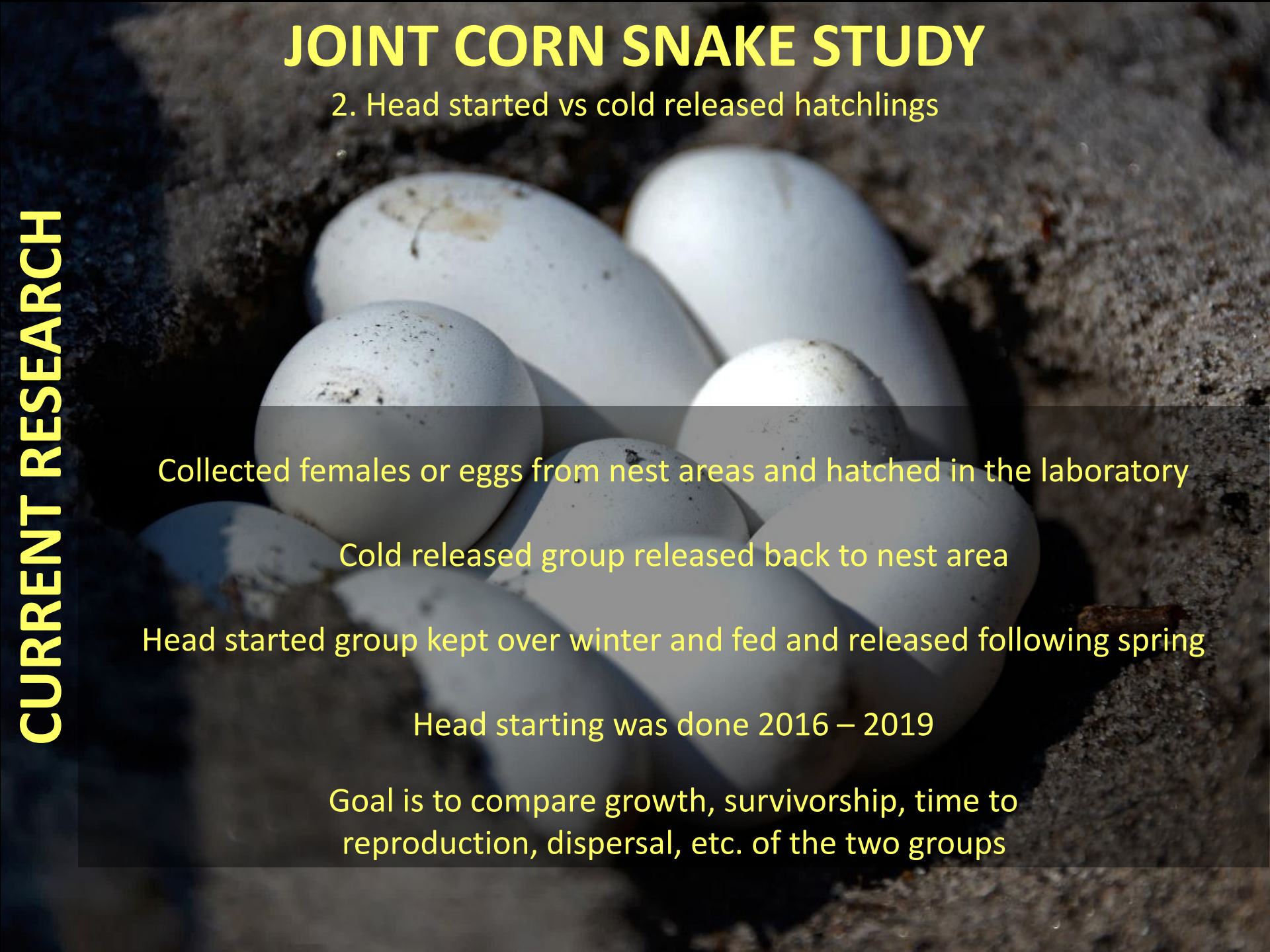
Before and after prescribed burning

Analyze data in 2023

CURRENT RESEARCH

JOINT CORN SNAKE STUDY

2. Head started vs cold released hatchlings



Collected females or eggs from nest areas and hatched in the laboratory

Cold released group released back to nest area

Head started group kept over winter and fed and released following spring

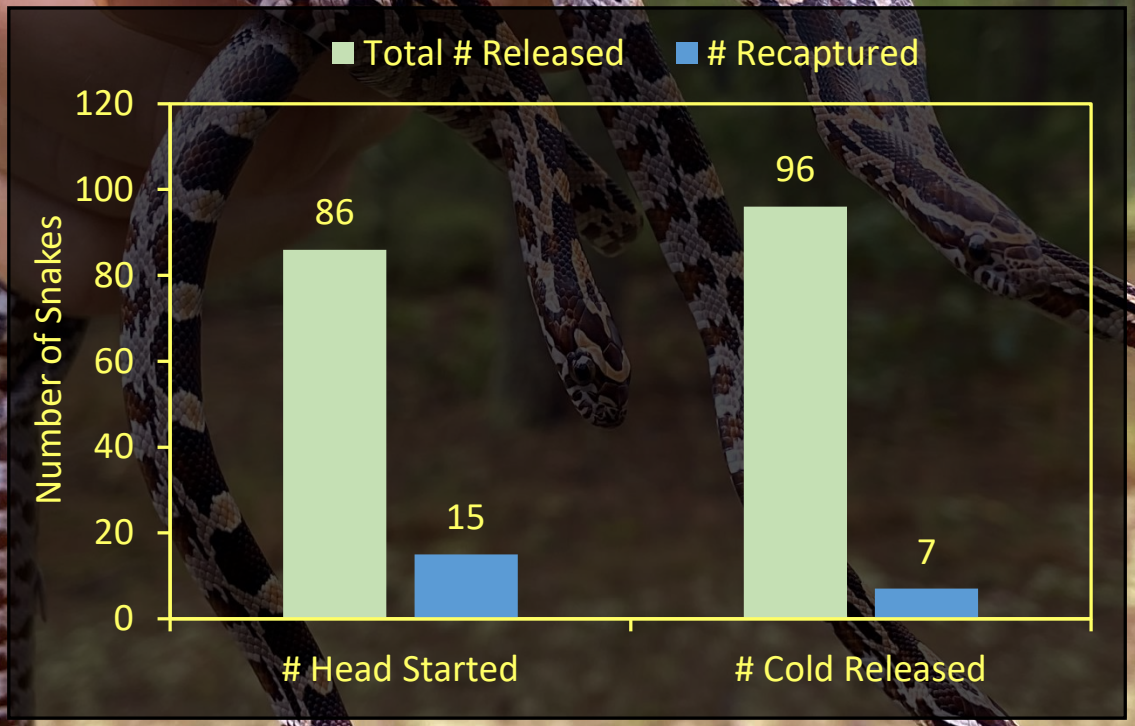
Head starting was done 2016 – 2019

Goal is to compare growth, survivorship, time to reproduction, dispersal, etc. of the two groups

JOINT CORN SNAKE STUDY

2. Head started vs cold released hatchlings

CURRENT RESEARCH



JOINT CORN SNAKE STUDY

3. Drift Fence trapping and cover study

CURRENT RESEARCH

4 Drift fences:
1,800 ft
800 ft
255x255 ft
150x225 ft

82 box traps, 82 plywood, 82 metal, added 12 pitfall traps

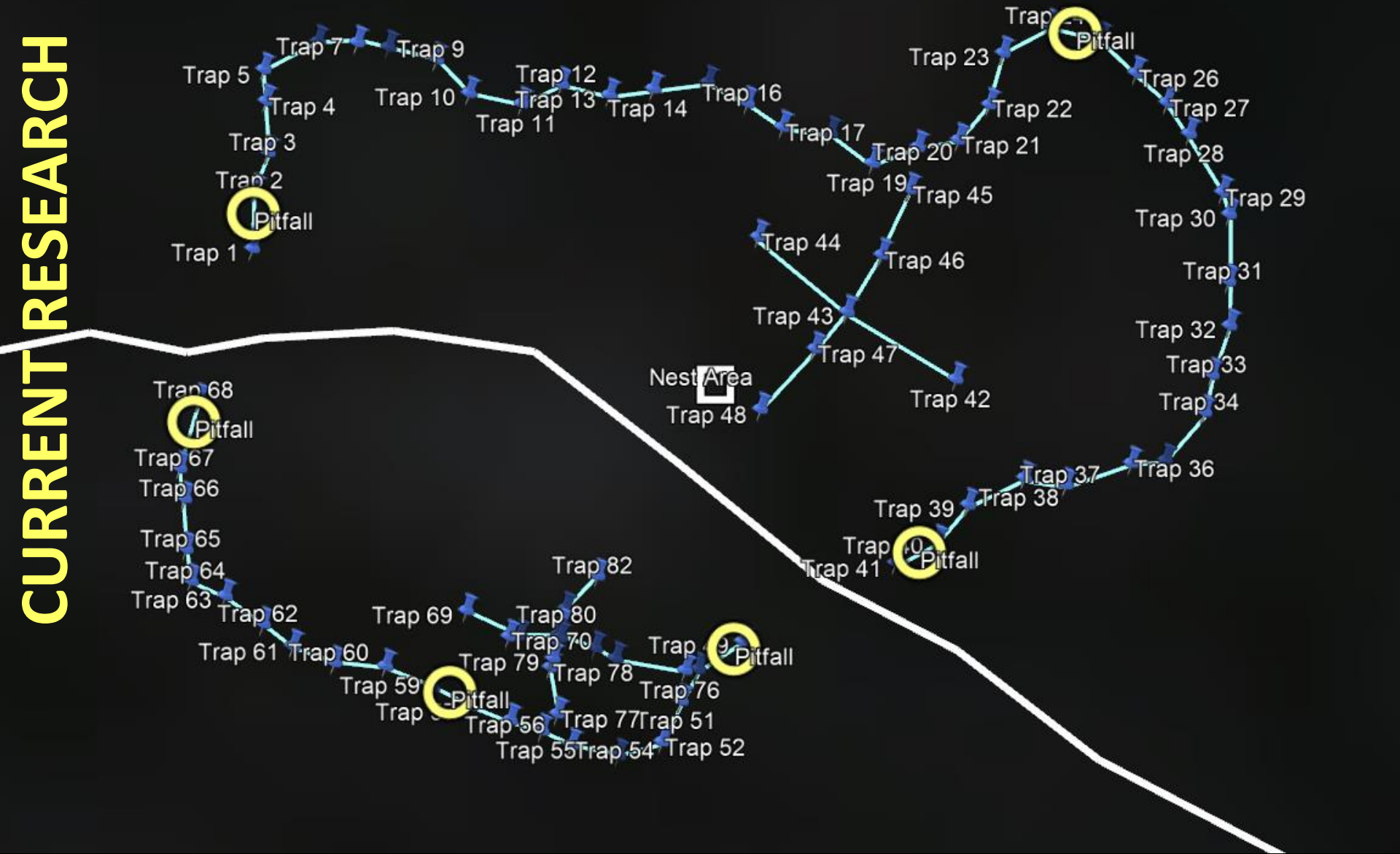
Spring – Fall
2019 – 2022

Goal: capture hatchlings and assess survey methods

JOINT CORN SNAKE STUDY

3. Drift Fence trapping and cover study

CURRENT RESEARCH



JOINT CORN SNAKE STUDY

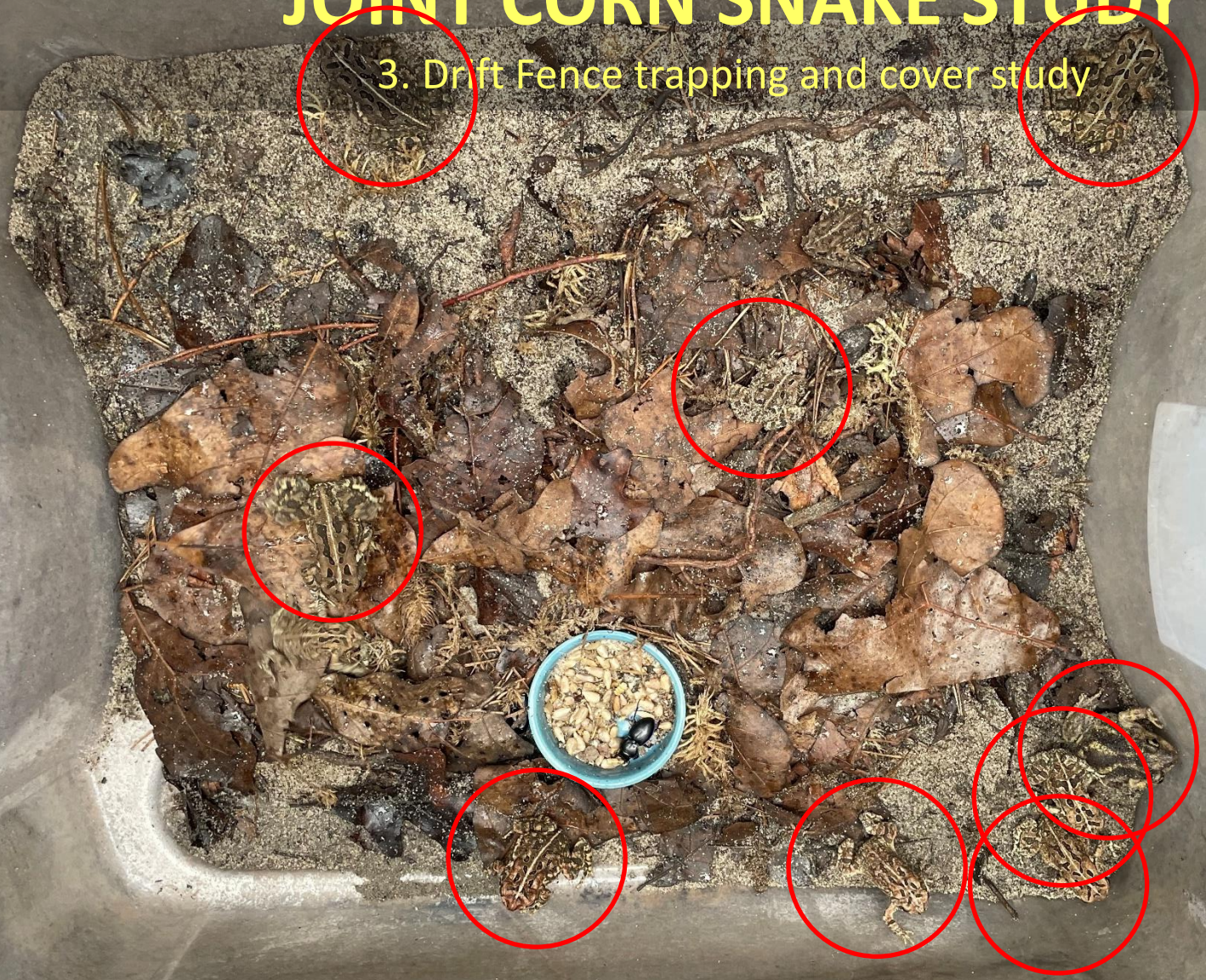
3. Drift Fence trapping and cover study

CURRENT RESEARCH

JOINT CORN SNAKE STUDY

3. Drift Fence trapping and cover study

CURRENT RESEARCH



Added 12 pitfall traps in 2021 and removed in early 2022

JOINT CORN SNAKE STUDY

3. Drift Fence trapping and cover study

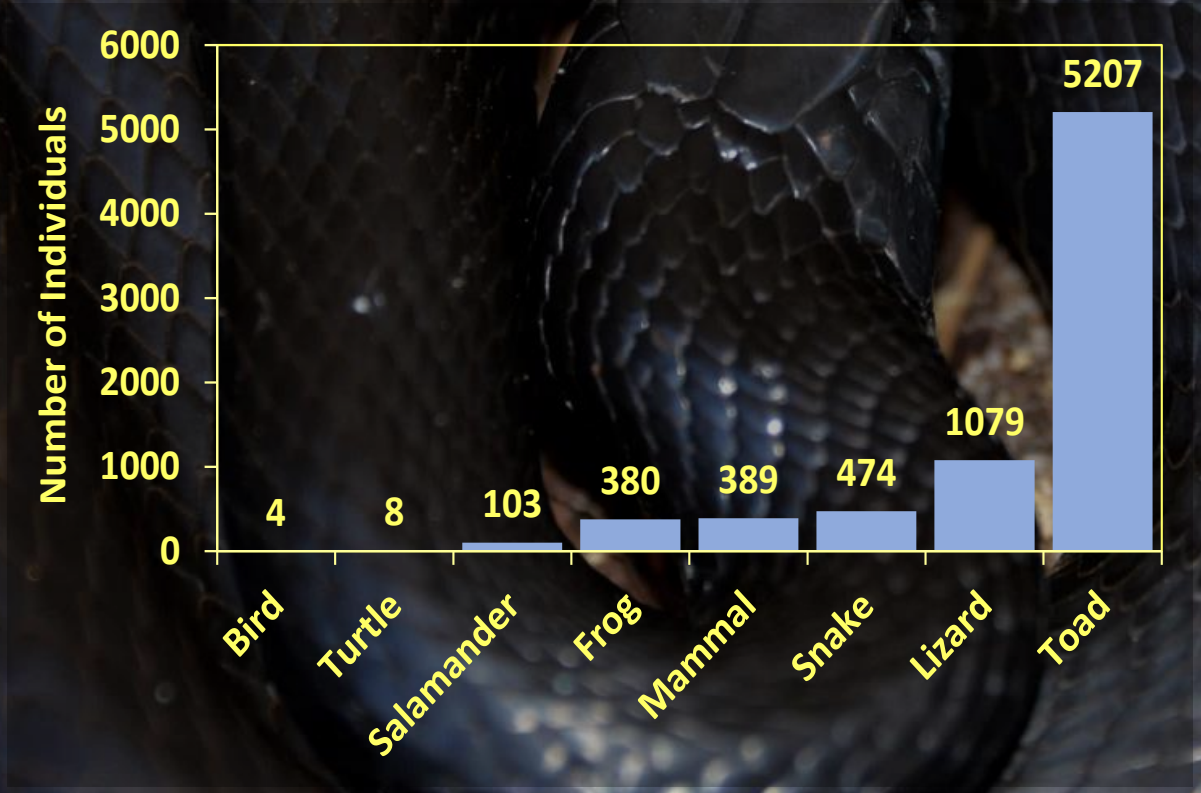
CURRENT RESEARCH

Wood and metal cover associated with each box trap

JOINT CORN SNAKE STUDY

3. Drift Fence trapping and cover study

CURRENT RESEARCH



PRELIMINARY DATA

Total of 7,644 animals

37 different animal species

JOINT CORN SNAKE STUDY

3. Drift Fence trapping and cover study

CURRENT RESEARCH

DRAFT Number of individuals observed at the drift fenced array (* = threatened species and ** = endangered species)						
Species	Pitfall	Metal	Board	Forest	Box trap	# individuals
Eastern king snake					1	1
Northern brown snake					1	1
Northern scarlet snake					1	1
Eastern worm snake		1			2	3
Timber rattlesnake**		1			2	3
Eastern hognose snake		1		1	7	9
Northern pine snake*			1		8	9
Eastern garter snake		1		2	16	19
Northern water snake	1			1	21	23
Eastern ribbon snake	1			2	29	32
Rough green snake			1	18	23	42
Northern black racer		1	7	6	48	62
Corn snake**	4	15	22	3	23	67
Southern ringneck snake	3		1		72	76
Northern redbelly snake	1				125	126
Total # of individuals	10	20	32	33	379	474

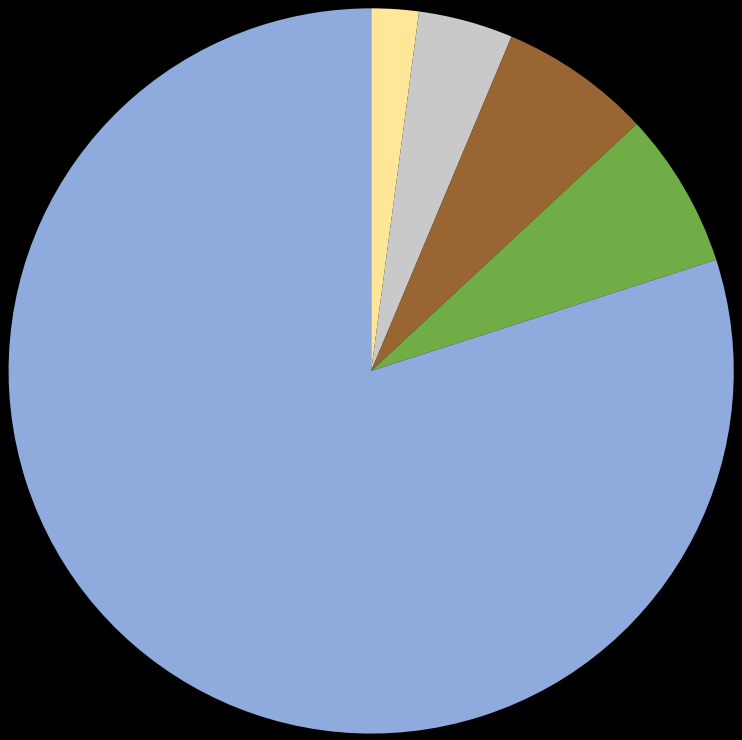
15 species of snakes

JOINT CORN SNAKE STUDY

3. Drift Fence trapping and cover study

CURRENT RESEARCH

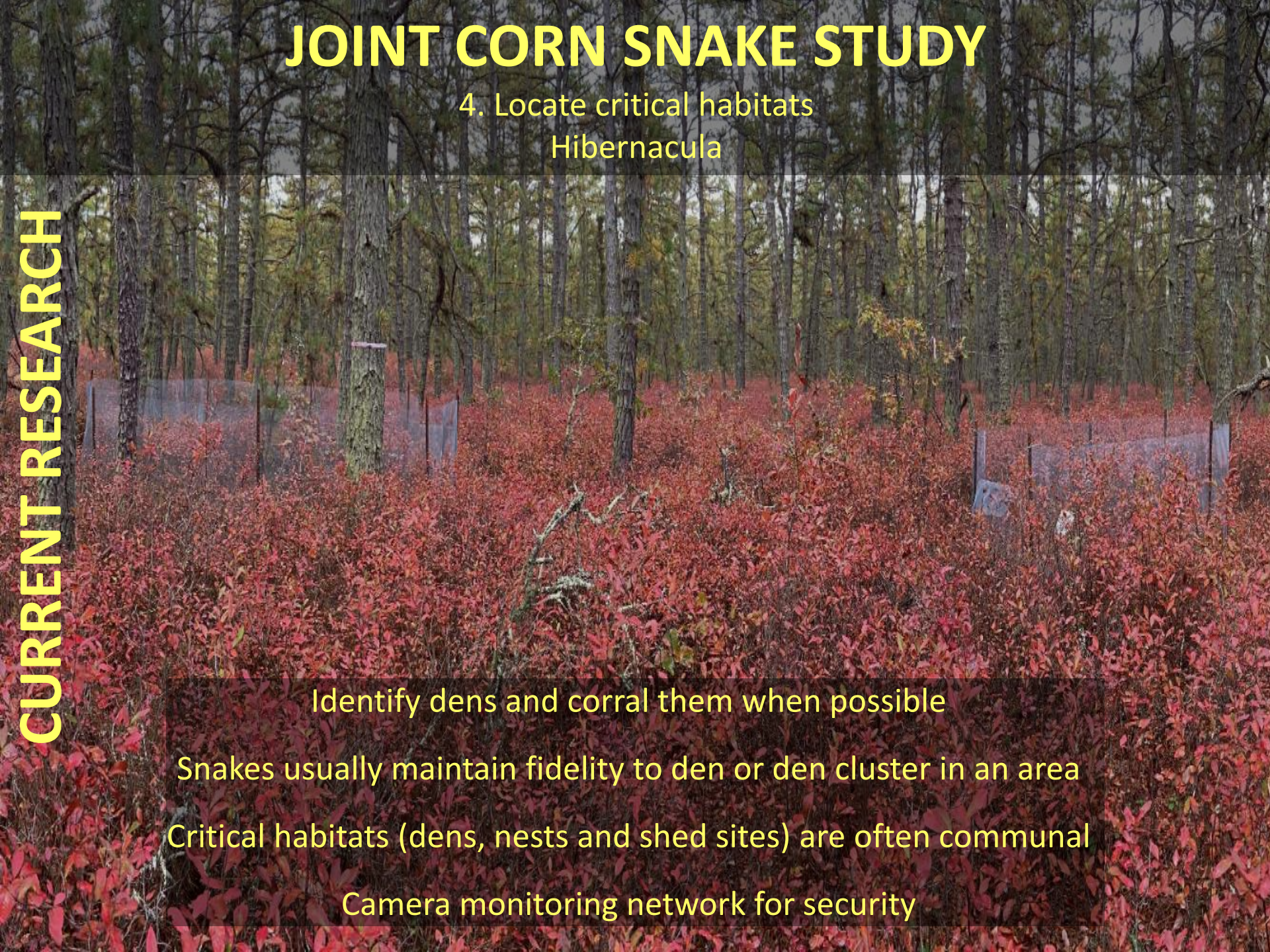
Distribution of all animals observed at drift fence array



JOINT CORN SNAKE STUDY

4. Locate critical habitats
Hibernacula

CURRENT RESEARCH



Identify dens and corral them when possible

Snakes usually maintain fidelity to den or den cluster in an area

Critical habitats (dens, nests and shed sites) are often communal

Camera monitoring network for security

CURRENT RESEARCH

JOINT CORN SNAKE STUDY

4. Locate critical habitats
Hibernacula

Modified den corral for near roads and trails

CURRENT RESEARCH

JOINT CORN SNAKE STUDY

4. Locate critical habitats
Shed logs and shed trees

Found numerous shed stations

Many are communal shed stations

Built 2 shed tree corrals, but are removing them due to the inability to check them frequently

CURRENT RESEARCH

JOINT CORN SNAKE STUDY

4. Locate critical habitats

Nest areas

16 corn snake nest areas


JOINT CORN SNAKE STUDY
4. Locate critical habitats
Nest areas
CURRENT RESEARCH
7 corn snake nest areas are communal and used by multiple snakes

RARE SNAKE MONITORING

CURRENT RESEARCH

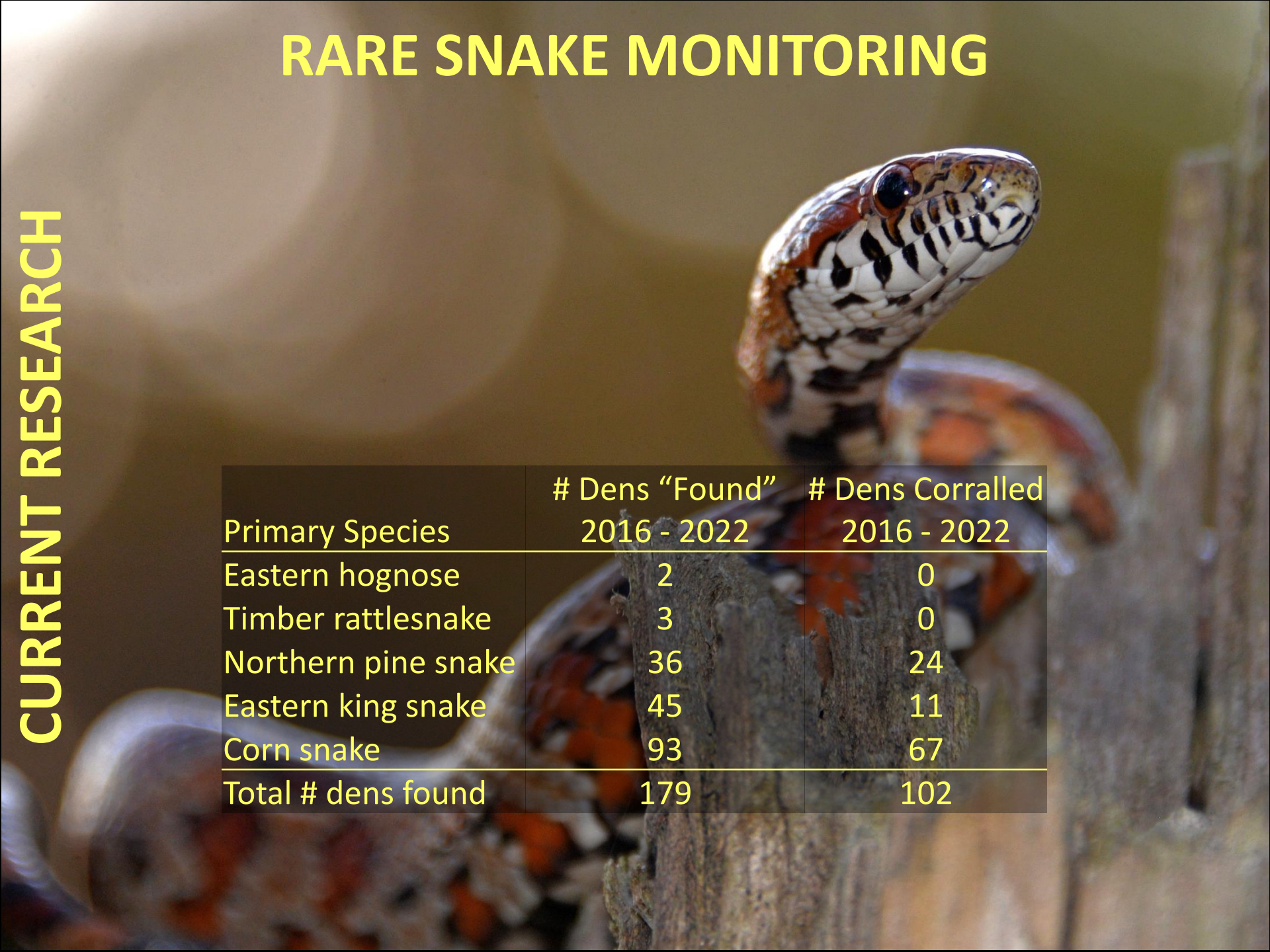
Little data exists on rare snake trends in the Pinelands

Corrals are a non-invasive method to census snakes

No physical disturbance to dens or hibernating snakes

RARE SNAKE MONITORING

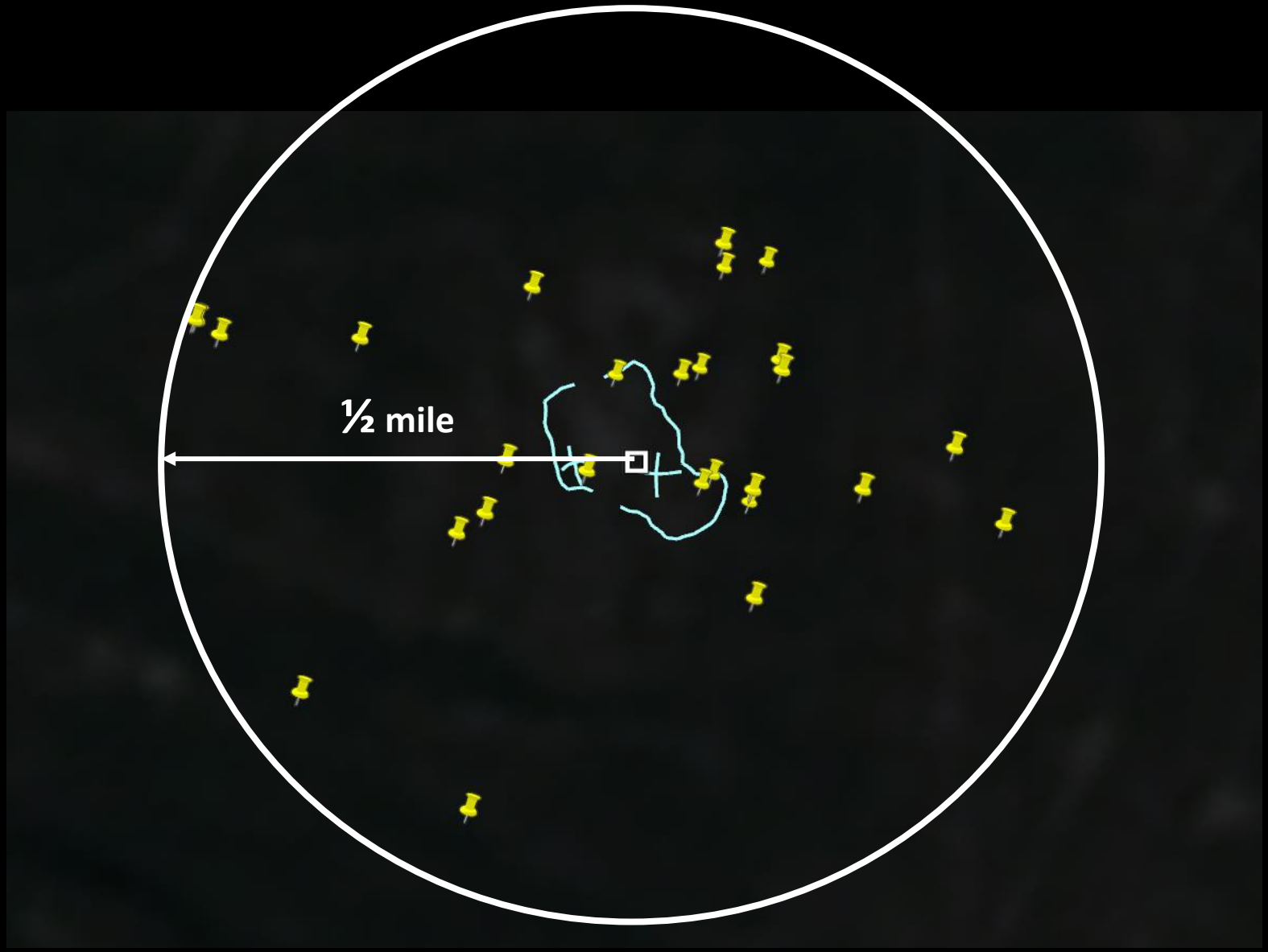
CURRENT RESEARCH



Primary Species	# Dens "Found" 2016 - 2022	# Dens Corralled 2016 - 2022
Eastern hognose	2	0
Timber rattlesnake	3	0
Northern pine snake	36	24
Eastern king snake	45	11
Corn snake	93	67
Total # dens found	179	102

RARE SNAKE MONITORING

CURRENT RESEARCH



CURRENT RESEARCH

RARE SNAKE MONITORING

2016 - 2022

Species	Total	Non-hatchlings	Hatchings	Recaptured
Eastern ribbon snake	1	1		
Northern water snake	1	1		
Northern scarlet snake	2	2		
Rough green snake	5	5		1
Timber rattlesnake	5	5		
Black rat snake	6	6		
Eastern garter snake	6	6		
Eastern milk snake	18	18		3
Eastern hognose snake	55	26	29	1
Northern black racer	109	102	7	14
Eastern king snake	187	86	101	36
Northern pine snake	441	269	172	59
Corn snake	990	405	585	179
Grand Total	1826	932	894	293

KING SNAKE STUDY

EPA funded collaboration with PC, HA, and TCNJ

CURRENT RESEARCH

Listed as SC for threats, declines, unknown NJ status

2019-2022 field work
2023 data analysis and writing

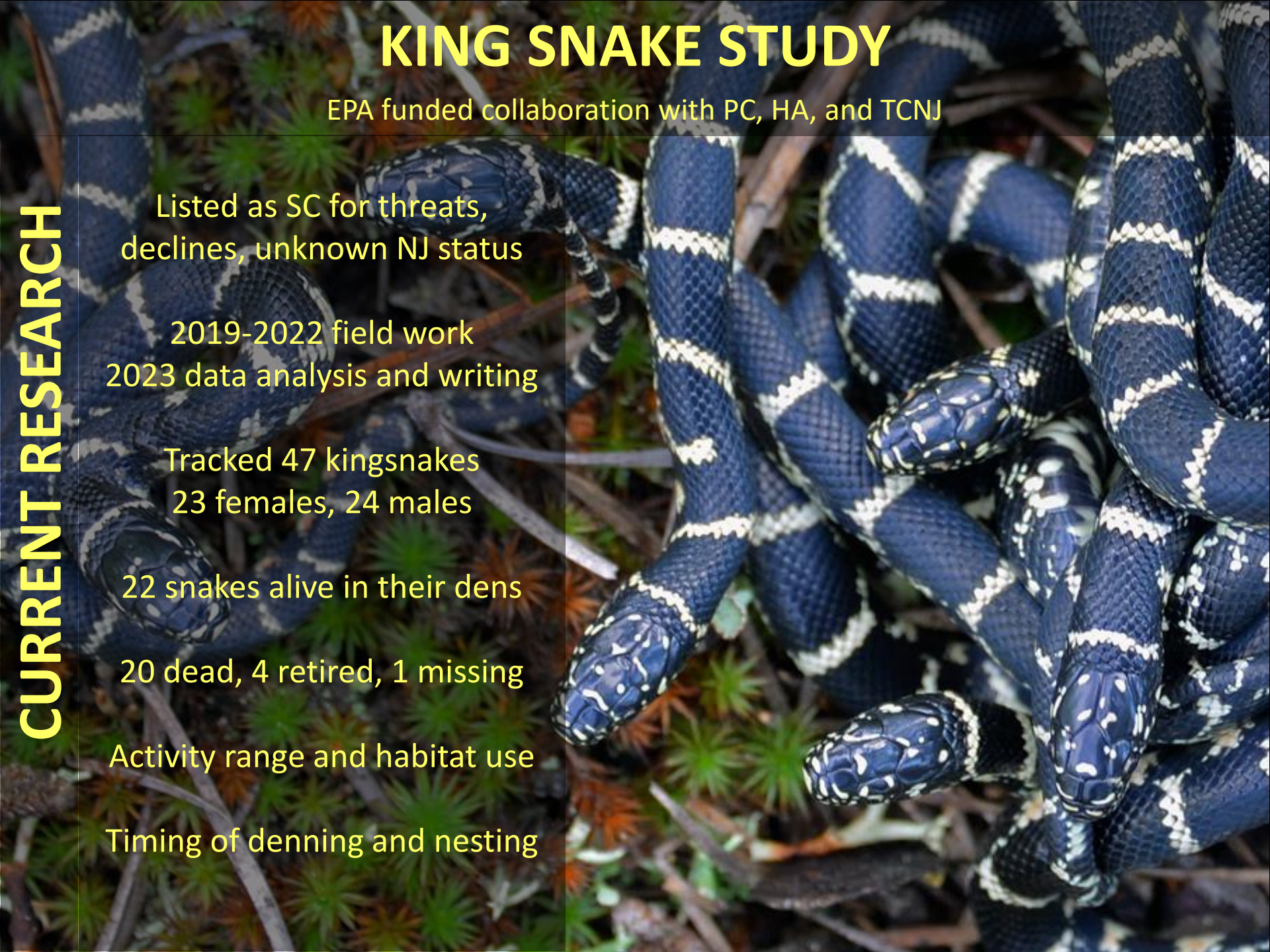
Tracked 47 kingsnakes
23 females, 24 males

22 snakes alive in their dens

20 dead, 4 retired, 1 missing

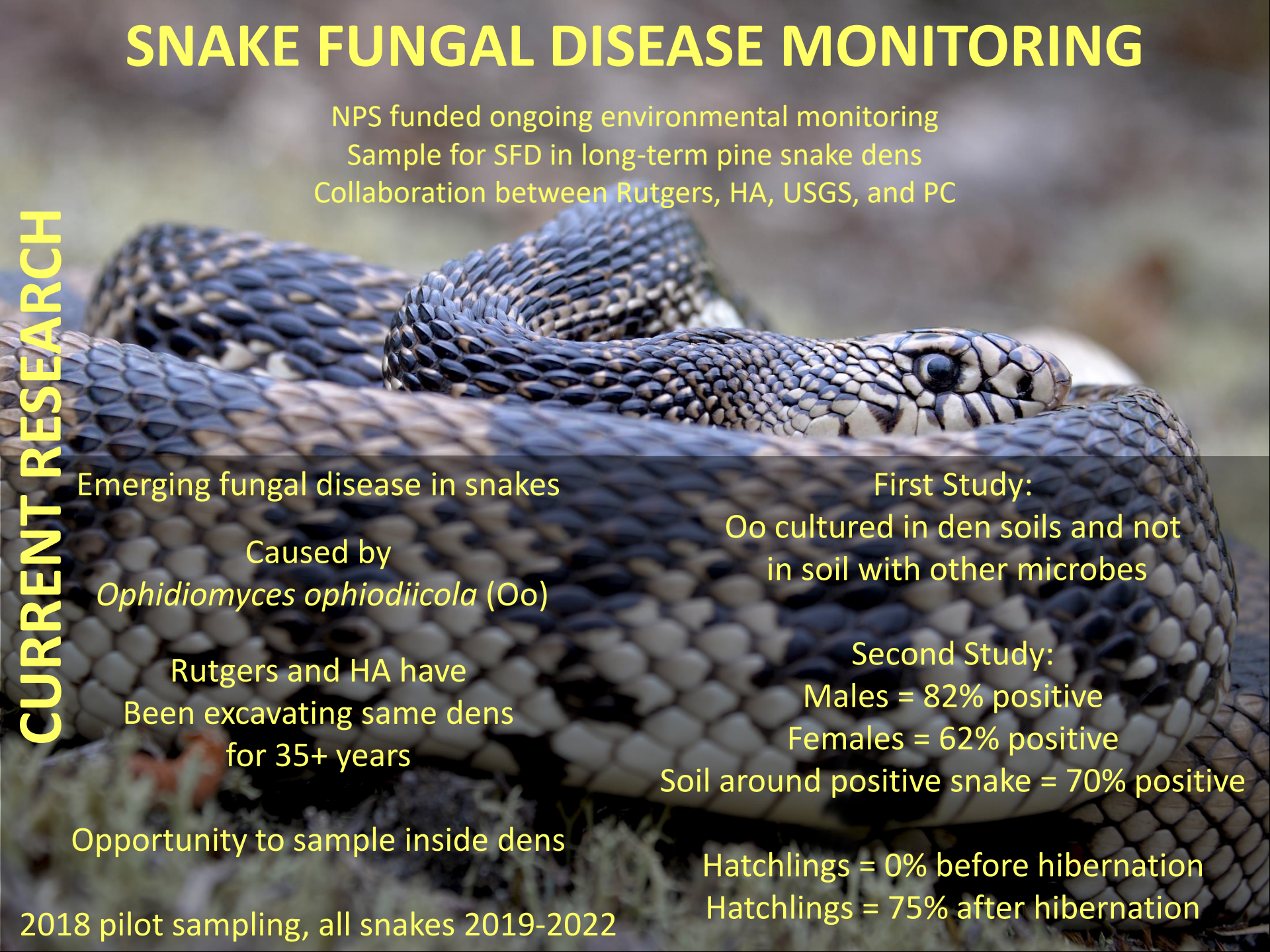
Activity range and habitat use

Timing of denning and nesting



SNAKE FUNGAL DISEASE MONITORING

NPS funded ongoing environmental monitoring
Sample for SFD in long-term pine snake dens
Collaboration between Rutgers, HA, USGS, and PC



CURRENT RESEARCH

Emerging fungal disease in snakes

Caused by
Ophidiomyces ophiodiicola (Oo)

Rutgers and HA have
Been excavating same dens
for 35+ years

Opportunity to sample inside dens

2018 pilot sampling, all snakes 2019-2022

First Study:
Oo cultured in den soils and not
in soil with other microbes

Second Study:
Males = 82% positive
Females = 62% positive
Soil around positive snake = 70% positive

Hatchlings = 0% before hibernation
Hatchlings = 75% after hibernation

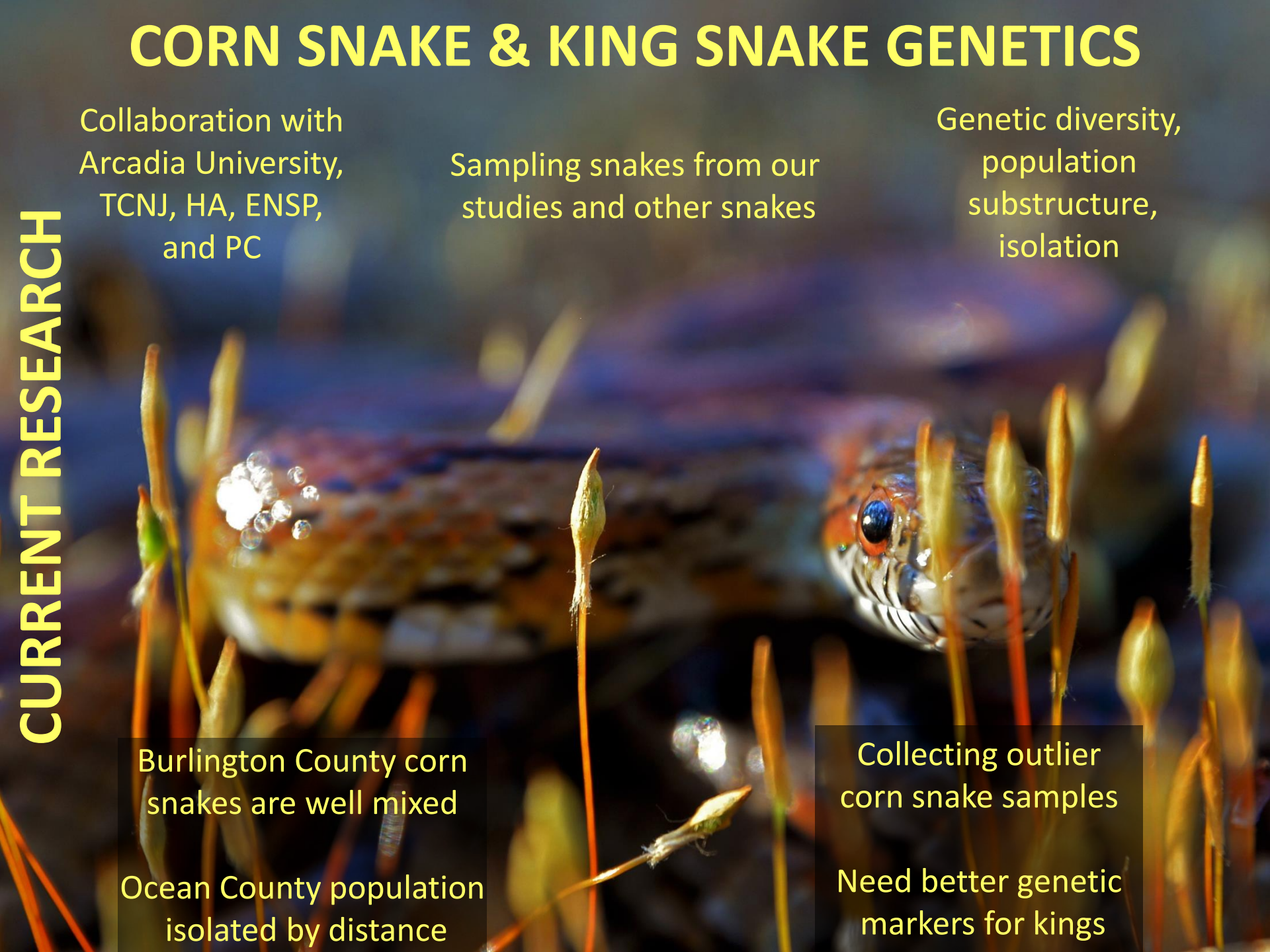
CORN SNAKE & KING SNAKE GENETICS

CURRENT RESEARCH

Collaboration with Arcadia University, TCNJ, HA, ENSP, and PC

Sampling snakes from our studies and other snakes

Genetic diversity, population substructure, isolation



Burlington County corn snakes are well mixed

Ocean County population isolated by distance

Collecting outlier corn snake samples

Need better genetic markers for kings

EASTERN BOX TURTLE STUDY

NEW RESEARCH

Listed as SC for threats, declines, and unknown NJ status

PCF & DEP funding

Activity range, behavior, habitat use, nesting sites, and dens

Monitor turtles in burned and unburned areas

Tracked turtles in 2021-2022

36 hibernating, 1 killed, and 2 missing

March 1st start date for full study

GO

EAGLES!

QUESTIONS?

WHAT WE LEARNED ABOUT DRIFT FENCE

Caught a variety of animal species at the fence

Fence arrays with traps can capture large and small snakes

Corn snakes can crawl over a 3-foot drift fence

No doubt pine snakes can climb over a 3-foot drift fence

Artificial cover worked well for corn snakes but not for pine snakes

Recommend that drift fence arrays be installed properly

Recommend increasing the height of fences to 4-foot silt fence

Recommend regular fence maintenance to maintain fence integrity

Recommend that corn snakes be surveyed in all pine shrub oak habitats

Recommend adding cover boards and searching for shed sites during surveys

Recommend random drift fence inspections by regulators

Yet compare box traps, pitfall traps, wood cover, and metal cover

Analyze data and write it up in 2023

WHAT WE LEARNED SO FAR

COMMUNAL ASPECTS

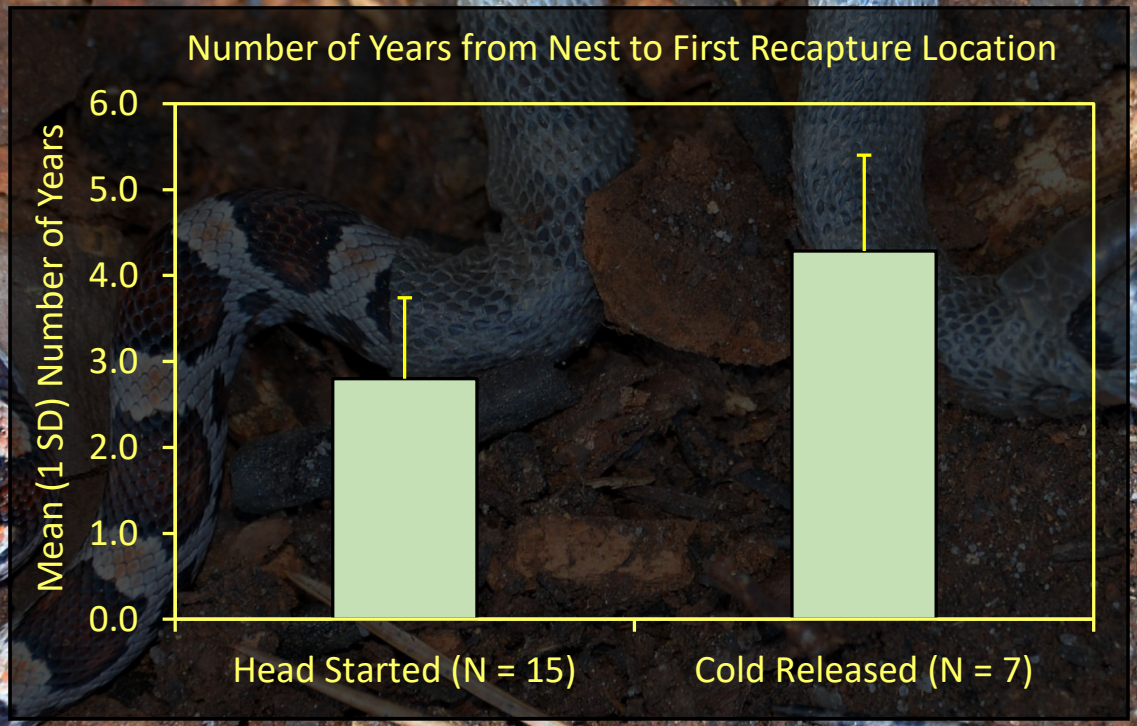
Upland snake dens are often in clusters
If one snake likes a spot, others likely do too
Dens, nests, and shed sites are usually communal

Corn snakes are very secretive and hard to find even when present
Snakes are active earlier and later than initially thought
Dens can be shared: corn snakes, pine snakes, black racers, hognose

JOINT CORN SNAKE STUDY

2. Head started vs cold released hatchlings

CURRENT RESEARCH



JOINT CORN SNAKE STUDY

2. Head started vs cold released hatchlings

CURRENT RESEARCH