

A photograph of a forest floor covered in vibrant green moss and a small stream. The scene is a dense forest with many thin, vertical tree trunks. The ground is covered in a thick layer of bright green moss, with some areas showing brown and yellowish patches. A small, shallow stream flows through the center of the forest, its water reflecting the surrounding greenery. The lighting is soft, suggesting an overcast day or a shaded forest interior.

SCIENCE OFFICE RESEARCH

February 11, 2022

Pinelands Commission Meeting

SCIENCE OFFICE PERSONNEL

Staff Member

Years of Service

John Bunnell

32

Kim Laidig

29

Patrick Burritt

14

Marilyn Sobel

6

Jeff Dragon

3

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

1994 - 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



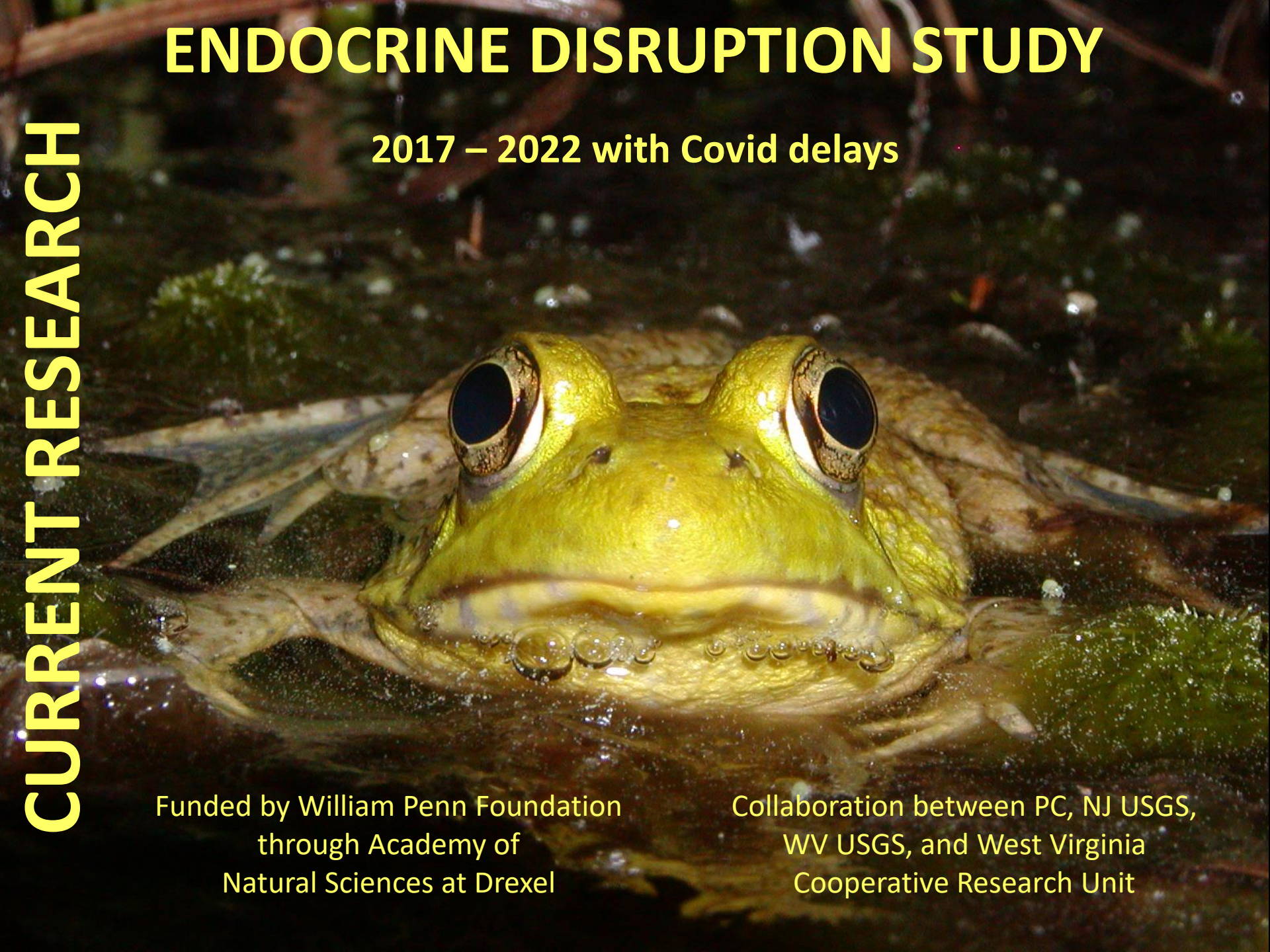
ENDOCRINE DISRUPTION STUDY

2017 – 2022 with Covid delays

CURRENT RESEARCH

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

Collaboration between PC, NJ USGS,
WV USGS, and West Virginia
Cooperative Research Unit

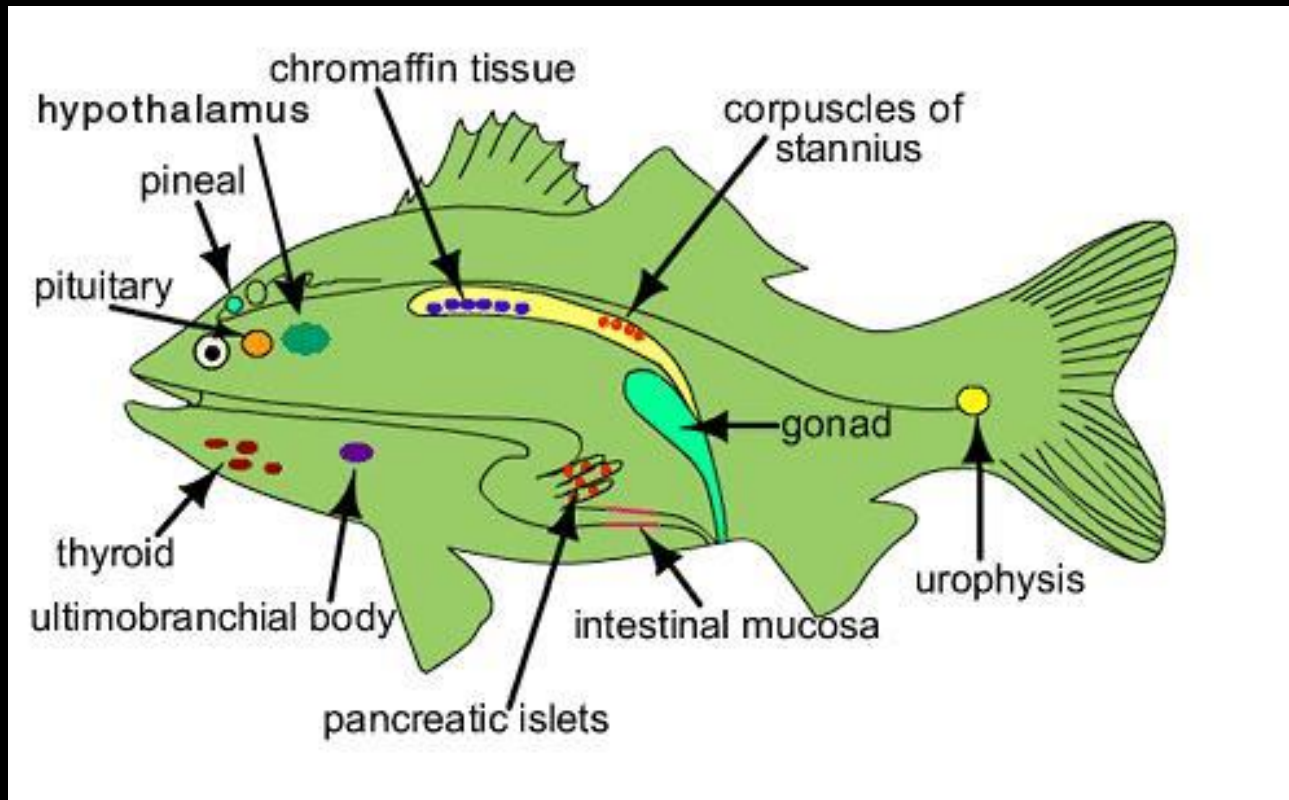


ENDOCRINE DISRUPTION STUDY

Endocrine System

a collection of tissues in animals that produce hormones to regulate essential life processes

e.g., reproduction, development, etc.



ENDOCRINE DISRUPTION STUDY

The background of the slide features a collection of laboratory glassware, including beakers and Erlenmeyer flasks, arranged on a reflective surface. The glassware contains liquids of various colors: purple, blue, red, green, and yellow. The lighting is soft, creating subtle reflections on the surface below the glassware.

Water Chemistry

3 measures of hormone activity
7 natural phytoestrogens and mycotoxins
35 hormones and hormone conjugates

22 trace metals

69 other compounds that include:
(surfactants, fragrances, antioxidants, disinfectants,
food additives, plastic components, industrial solvents,
polycyclic aromatic hydrocarbons, fecal and plant sterols,
phosphate flame retardants, and high-use domestic pesticides)

ENDOCRINE DISRUPTION STUDY

Fish and Frogs

Hormones

vitellogenin (in bass)

Sex

skewed sex ratio can indicate endocrine disruption

Occurrence of testicular oocytes

simultaneous presence of male and female gonadal tissue or intersex

Parasites

an indicator of a suppressed immune system which may be linked to EDCs

ENDOCRINE DISRUPTION STUDY

PC role was collection of animals and managing the study

USGS role was chemical and histological analysis

USGS is currently analyzing data and drafting manuscript for publication

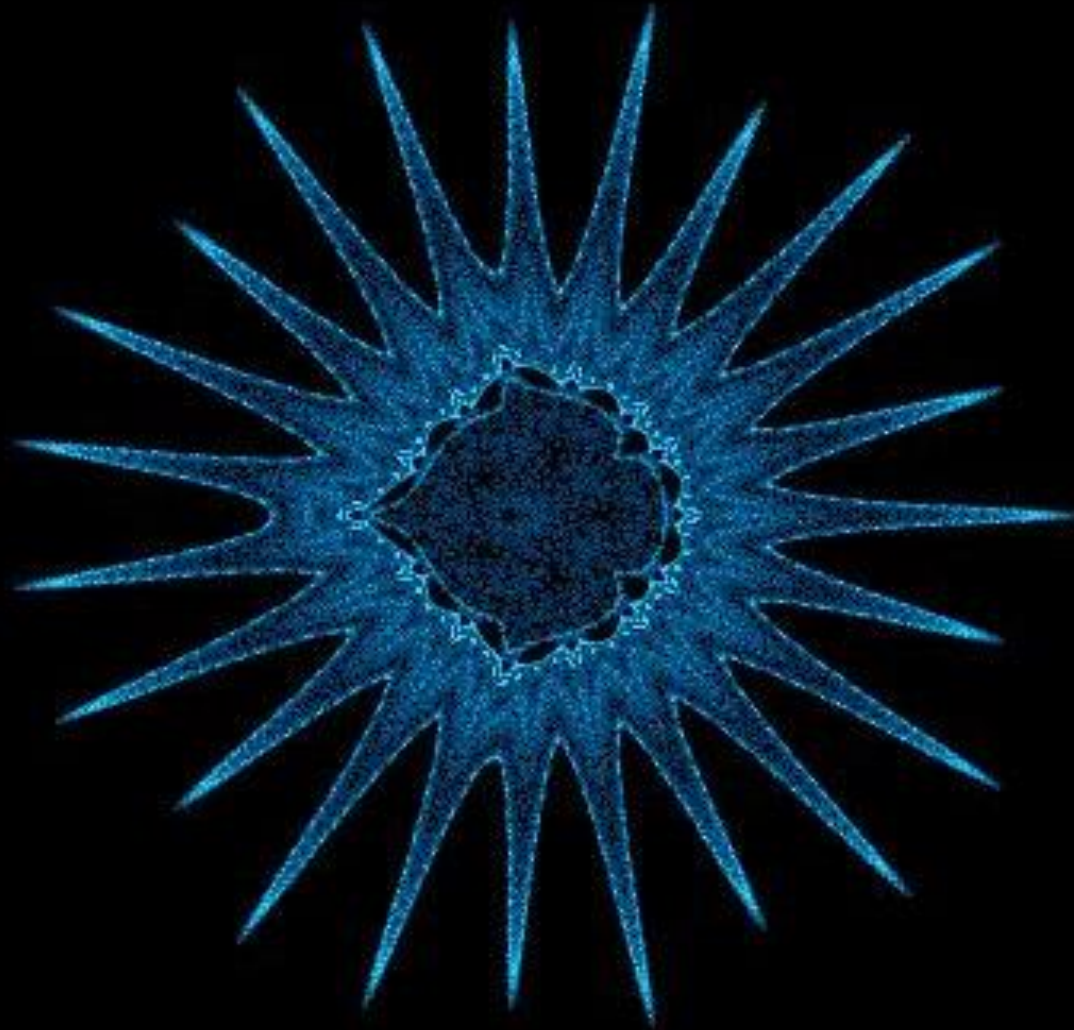
NJDEP DF&W replaced bass in one lake where bass were harvested



MICROORGANISM STUDY

2019 – 2022

EPA funded collaboration between PC, USGS, and NJDEP



MICROORGANISM STUDY

Wetland Mapping

Mapped stormwater basins throughout the Pinelands using 2007 aerial photography in previous study of natural ponds, excavated ponds, and stormwater basins

Update basin mapping using 2017 aerial photography

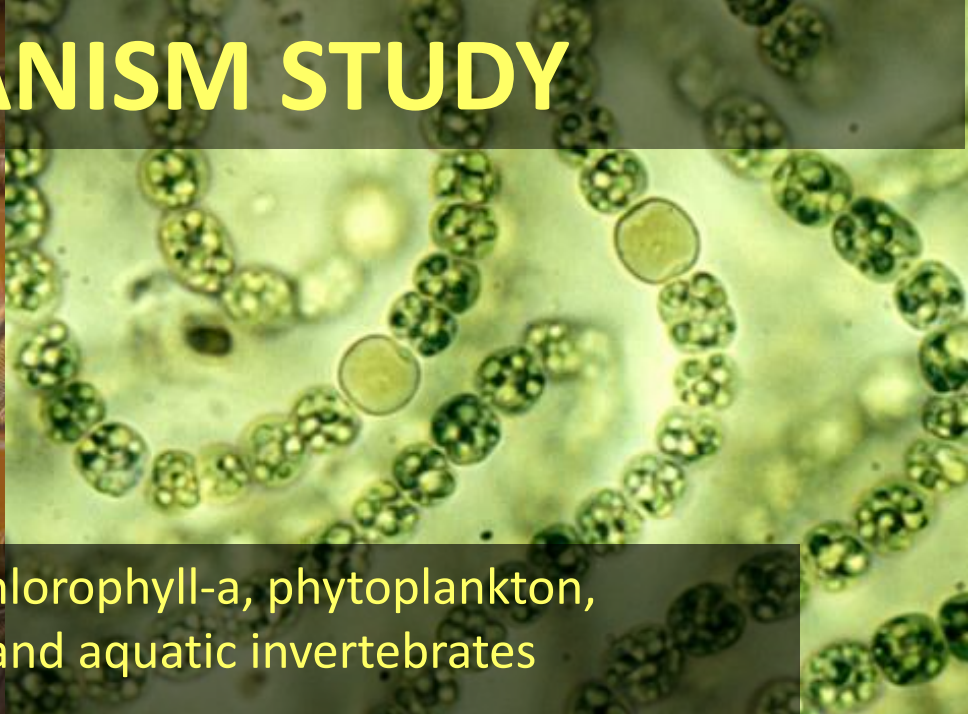
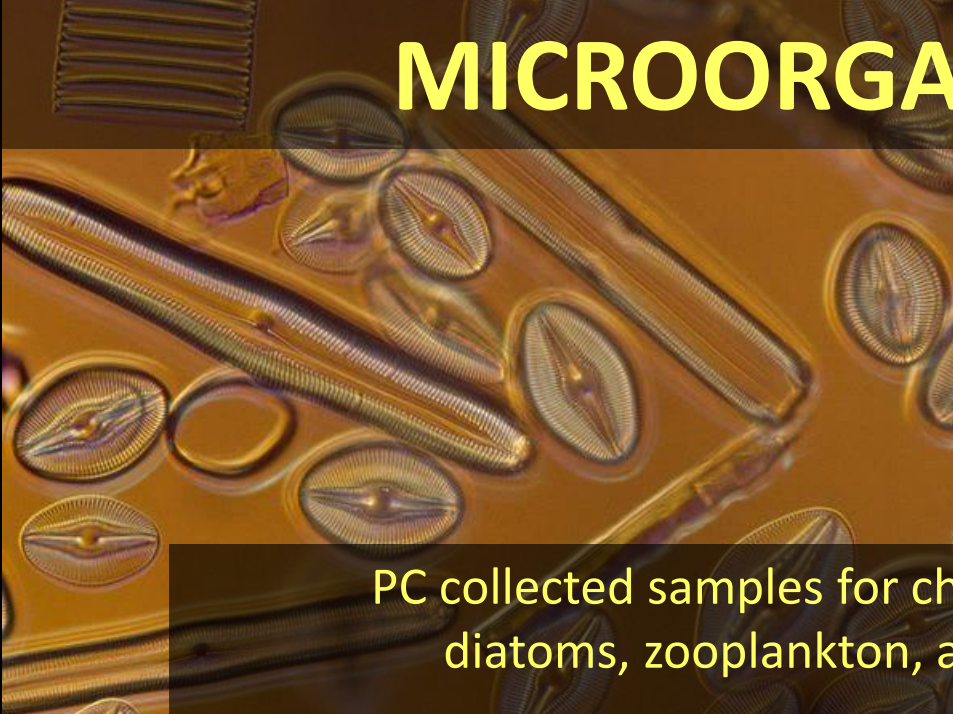
MICROORGANISM STUDY

Use the existing pool of 197 sites to select subset

Selected 20 natural ponds,
20 excavated ponds, and 20 stormwater basins

USGS sampled water for pH, SC, Cl, NO₂+NO₃, NH₃,
PO₄, trace metals, and pesticides

MICROORGANISM STUDY



PC collected samples for chlorophyll-a, phytoplankton, diatoms, zooplankton, and aquatic invertebrates



NJDEP chlorophyll-a, diatoms, aquatic invertebrates
EcoAnalysts, Inc. consultants identified phytoplankton and zooplankton



MICROORGANISM STUDY

A landscape photograph of a wetland area. The foreground is dominated by tall, dense grasses in shades of green and brown, growing in shallow water. In the background, a thick line of tall, dark green trees stretches across the horizon under a clear blue sky.

Currently writing final report for EPA

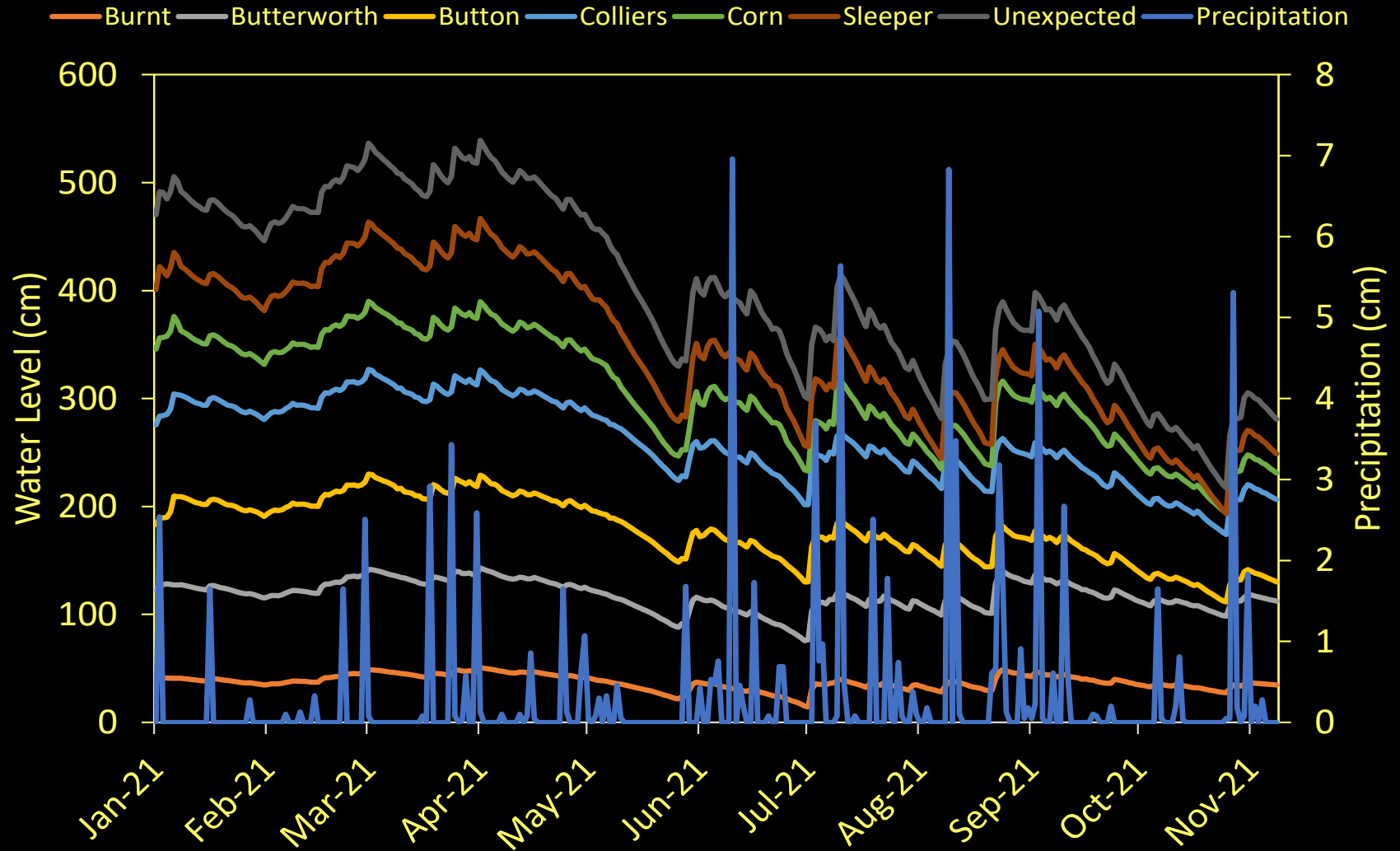
Will present the results to the PC when completed

Intend to combine vegetation, fish, and frog data from previous study with chemistry, diatoms, phytoplankton, zooplankton, and invertebrate data and write a comprehensive manuscript for publication

WATER LEVEL MONITORING

NPS funded ongoing environmental monitoring

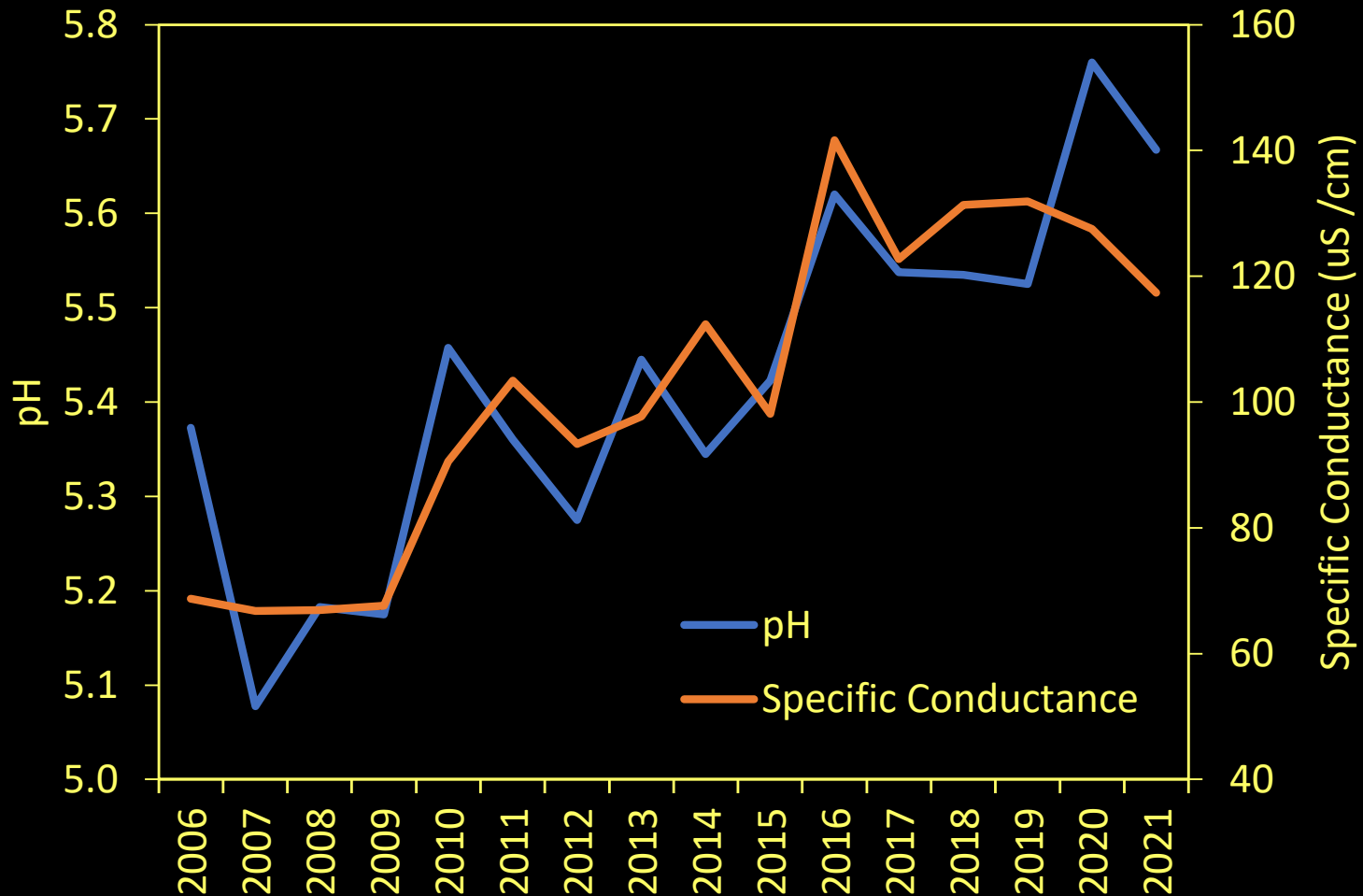
33 forest plots + 1 plot with data logger and 30 ponds + 7 ponds with data loggers



PINELANDS WIDE WQ MONITORING

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

Four Mile Branch at Lighthouse Road



SNAKE RESEARCH



- I. Snake Genetics (PCF)
- II. Snake Fungal Disease (NPS)
- III. King Snake Study (EPA)
- IV. Joint Corn Snake Study (PCF)
- V. Long-term Snake Monitoring (NPS)

I. CORN SNAKE & KING SNAKE GENETICS

A close-up photograph of a corn snake with a patterned body of brown, black, and white. A cluster of small, white, translucent eggs is attached to its back. The snake is surrounded by tall, thin grasses with green and yellowish heads. The background is a soft, out-of-focus blue and purple.

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

Sampling snakes from our
studies and other snakes

Genetic diversity,
population
substructure,
isolation

Wharton corn snakes
are well mixed

Berkeley population
isolated by distance

Need more outlier
corn snake samples

Need better genetic
markers for kings

II. SNAKE FUNGAL DISEASE



Emerging fungal
disease in snakes

Caused by
Ophidiomyces ophiodiicola (Oo)

Rutgers and HA has been
excavating dens for 35+ years

Collaboration between Rutgers,
HA, USGS, and PC

Opportunity to sample
for Oo inside dens

Pilot sampling in 2018 and
all snakes in 2019-2021

Oo only in den soils and not
in soil with other microbes

One journal publication,
more to come

III. KING SNAKE STUDY

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

2019 - 2023 EPA funded
collaboration with PC,
HA, and TCNJ

Transmitters in 39 kingsnakes
20 females and 19 males

20 snakes are in winter dens

Activity range and habitat use

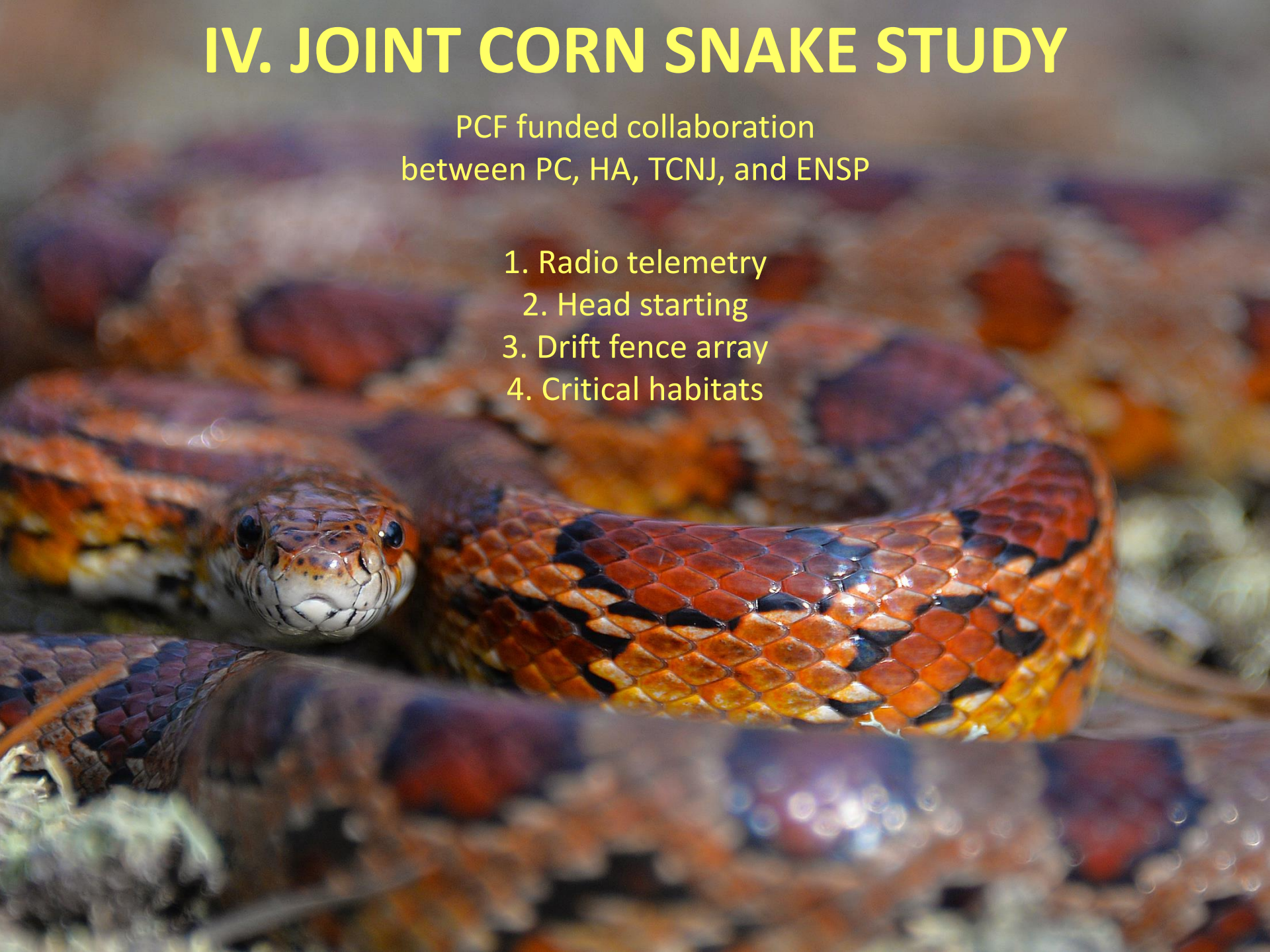
Timing of denning
and nesting



IV. JOINT CORN SNAKE STUDY

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

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



IV. JOINT CORN SNAKE STUDY

1. Radio telemetry

Capture snakes
Surgically implant
radio transmitters



IV. JOINT CORN SNAKE STUDY

1. Radio telemetry



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

Began to analyze data

IV. JOINT CORN SNAKE STUDY

2. Head started vs cold released hatchlings



Collected 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

IV. JOINT CORN SNAKE STUDY

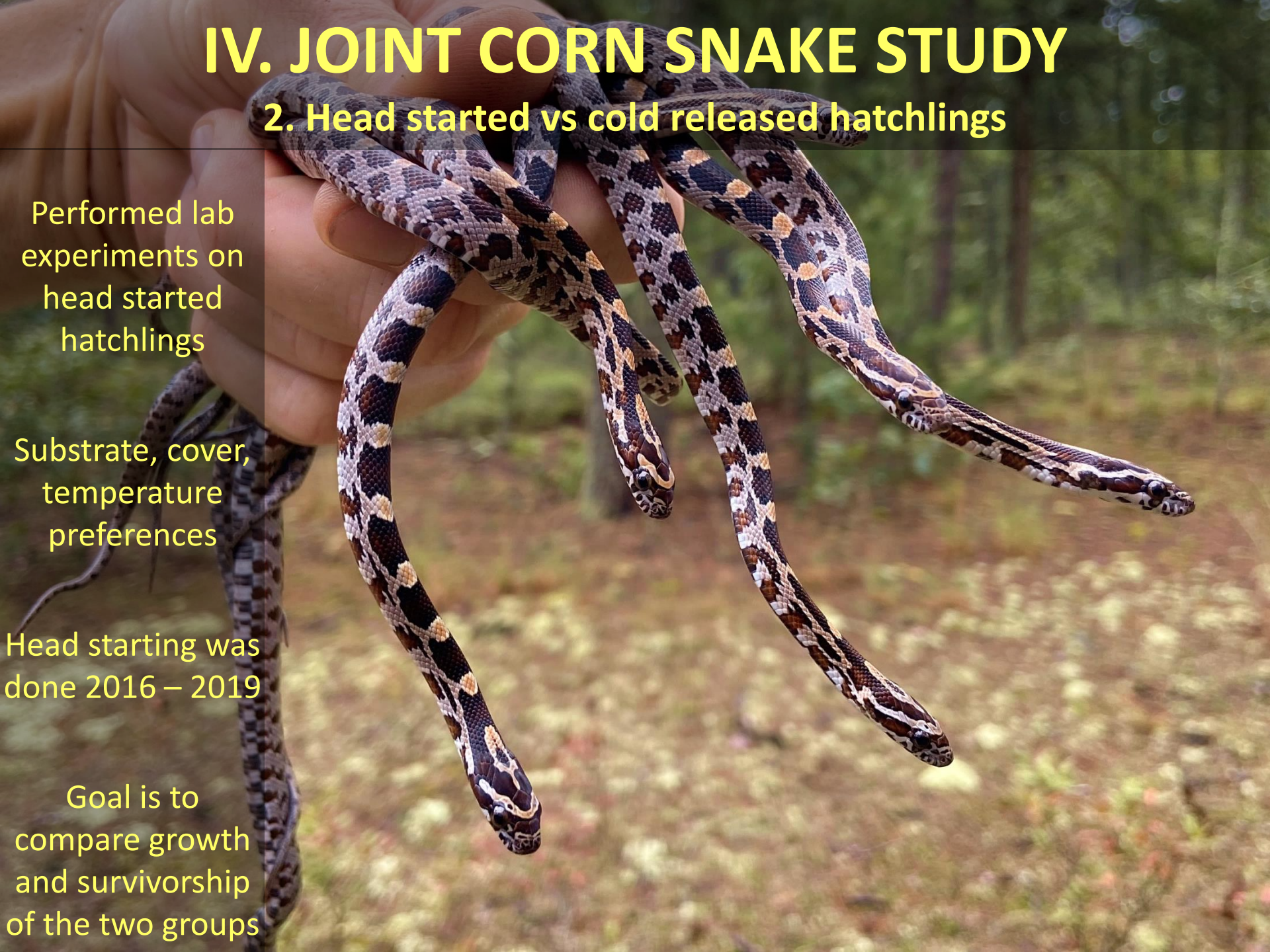
2. Head started vs cold released hatchlings

Performed lab experiments on head started hatchlings

Substrate, cover, temperature preferences

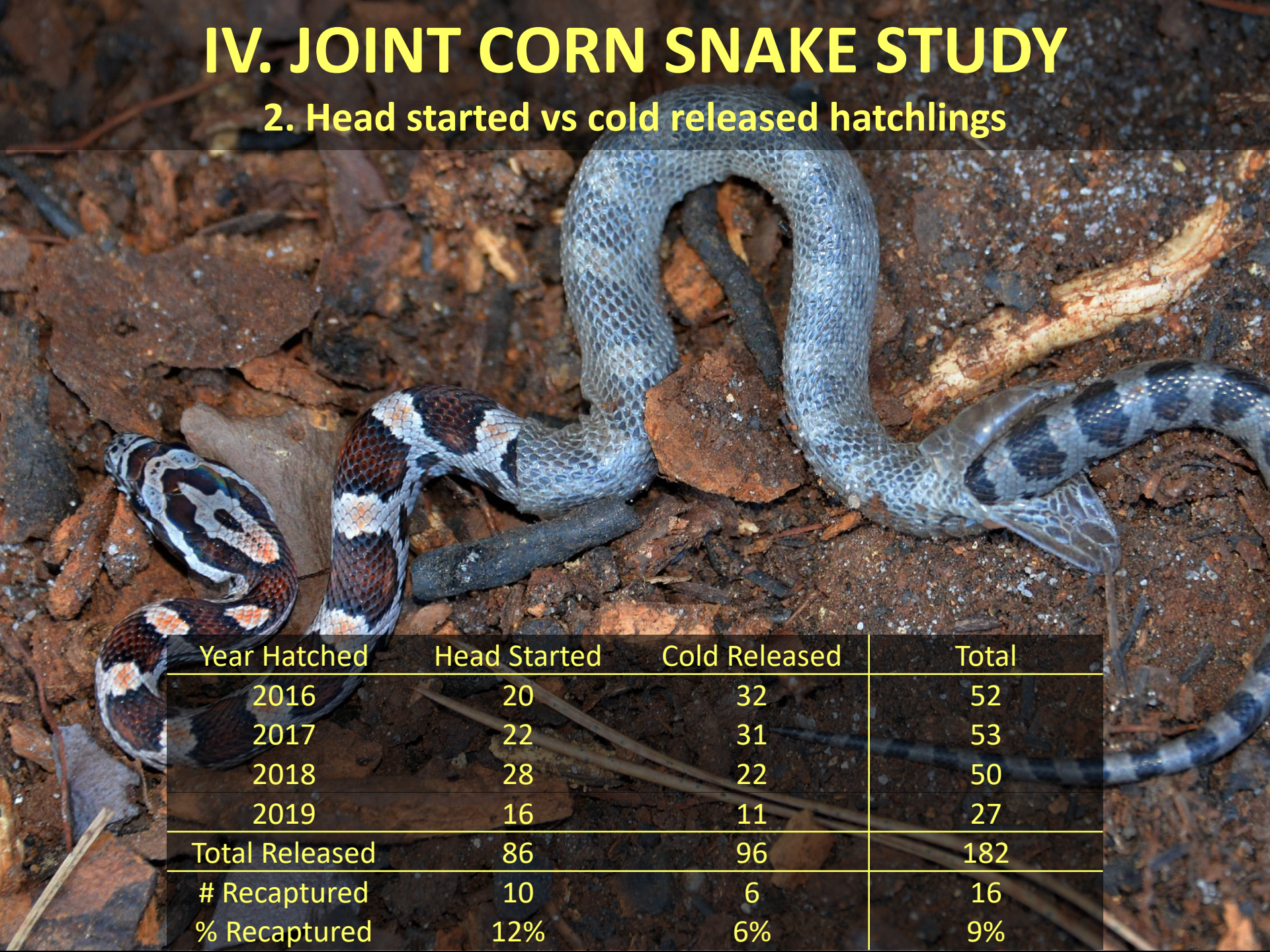
Head starting was done 2016 – 2019

Goal is to compare growth and survivorship of the two groups



IV. JOINT CORN SNAKE STUDY

2. Head started vs cold released hatchlings



Year Hatched	Head Started	Cold Released	Total
2016	20	32	52
2017	22	31	53
2018	28	22	50
2019	16	11	27
Total Released	86	96	182
# Recaptured	10	6	16
% Recaptured	12%	6%	9%

IV. JOINT CORN SNAKE STUDY

2. Head started vs cold released hatchlings



Two corn hatchlings moved ~1.5 miles from the nest area

IV. JOINT CORN SNAKE STUDY

3. Drift Fence trapping and cover study



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

82 box traps, 82
plywood, 82 metal,
added 14 pitfall traps

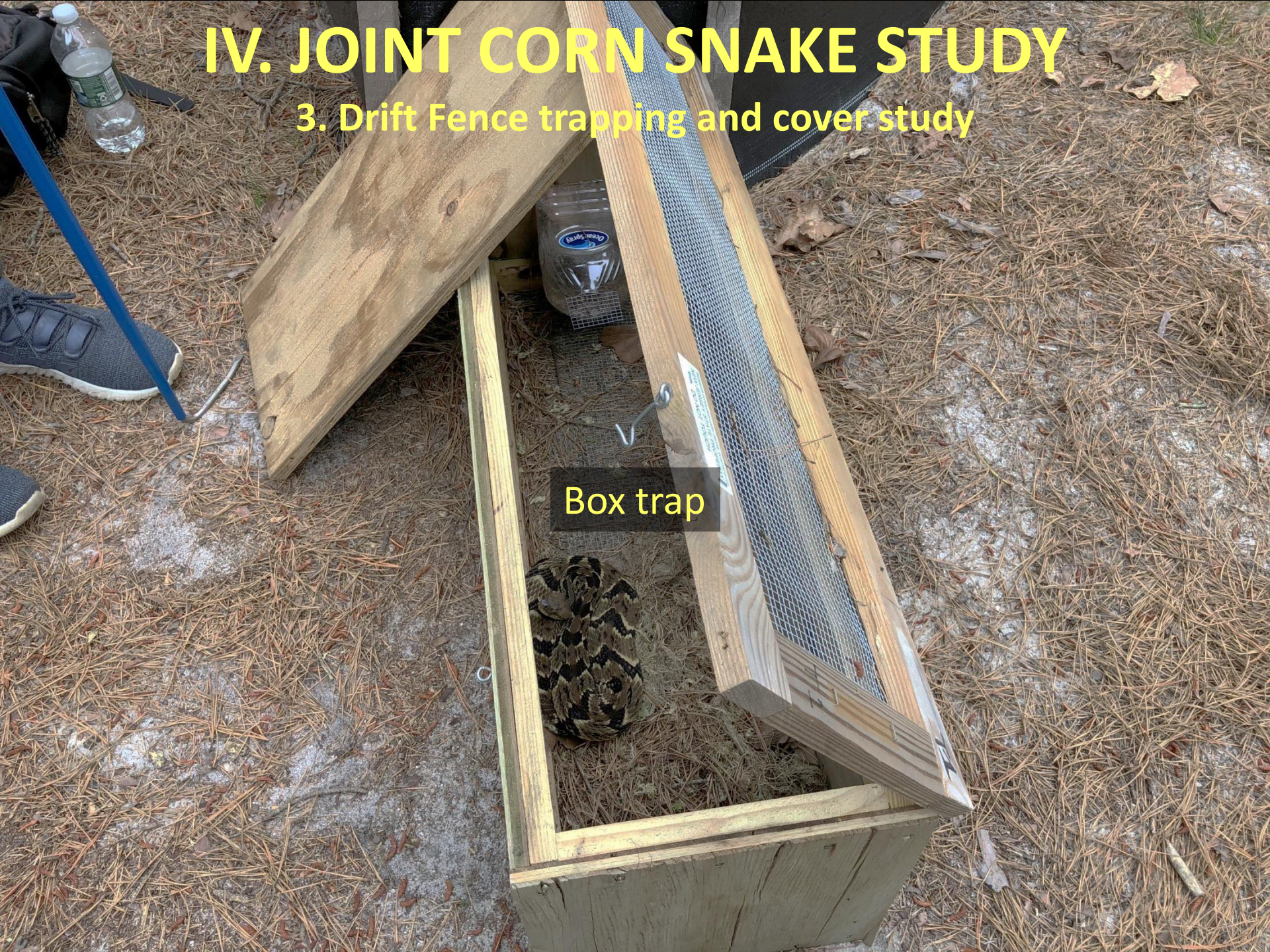
Spring – Fall
2019 – 2022

Goal: capture
hatchlings and assess
survey methods

IV. JOINT CORN SNAKE STUDY

3. Drift Fence trapping and cover study

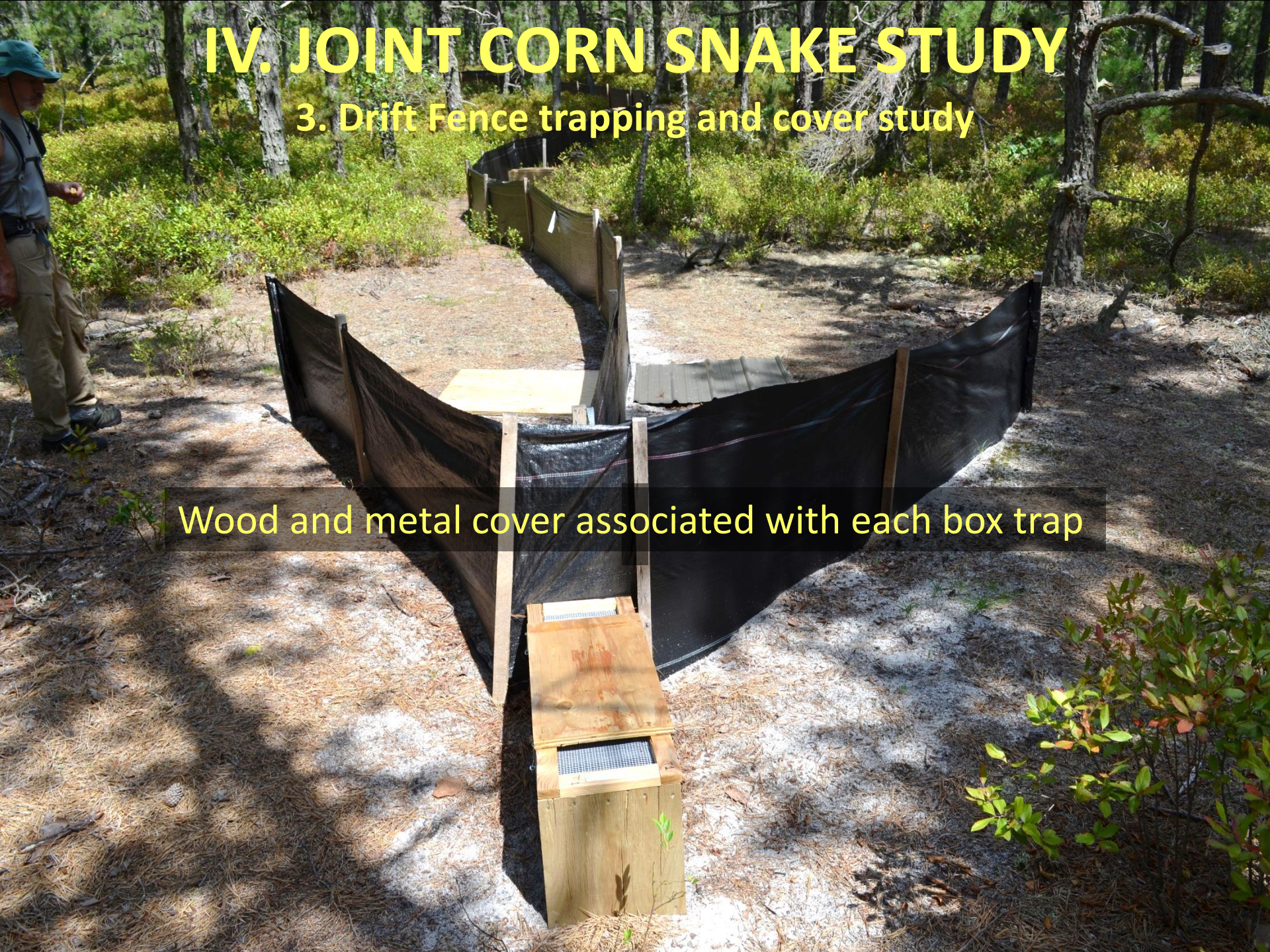
Box trap



IV. JOINT CORN SNAKE STUDY

3. Drift Fence trapping and cover study

Wood and metal cover associated with each box trap



IV. JOINT CORN SNAKE STUDY

3. Drift Fence trapping and cover study



Added 14 pitfall traps in 2021

IV. JOINT CORN SNAKE STUDY

3. Drift Fence trapping and cover study



Total of 6,186
animals

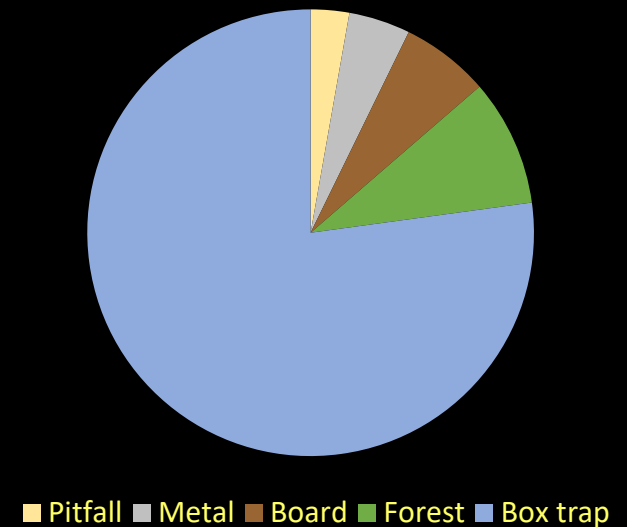
37 different
animal species

15 species of
snakes

IV. JOINT CORN SNAKE STUDY

3. Drift Fence trapping and cover study

Species	Pitfall	Metal	Board	Forest	Box trap	Total
Eastern kingsnake	-	-	-	-	1	1
Eastern worm snake	-	1	-	-	-	1
Northern brown snake	-	-	-	-	1	1
Northern scarlet snake	-	-	-	-	1	1
Timber rattlesnake	-	1	-	-	1	2
Northern pine snake	-	-	1	-	5	6
Eastern hognose snake	-	1	-	1	7	9
Northern water snake	1	-	-	1	12	14
Eastern garter snake	-	1	-	2	13	16
Eastern ribbon snake	1	-	-	2	23	26
Rough green snake	-	-	-	18	18	36
Northern black racer	-	1	7	6	36	50
Corn snake	4	11	14	3	19	51
Southern ringneck snake	3	-	1	-	54	58
Northern redbelly snake	1	-	-	-	86	87
Total	10	16	23	33	277	359



IV. JOINT CORN SNAKE STUDY

3. Drift Fence trapping and cover study



Tracked four corn snakes
around the fence

The tracked corn snakes
climbed over the fence

Moved them back and
climbed over the fence again

IV. JOINT CORN SNAKE STUDY

4. Locate critical habitats

Hibernacula

Identify dens and corral them

Snakes maintain fidelity to den or den cluster

Critical habitats are often communal

Camera monitoring network for security

IV. JOINT CORN SNAKE STUDY

4. Locate critical habitats

Hibernacula



Experimental
modified den
corral for near
roads

IV. JOINT CORN SNAKE STUDY

4. Locate critical habitats

Shed logs and shed trees



Found
numerous shed
stations

11 are
communal shed
stations

Built 2 shed
tree corrals

IV. JOINT CORN SNAKE STUDY

4. Locate critical habitats

Nest areas

15 corn
nest areas



IV. JOINT CORN SNAKE STUDY

4. Locate critical habitats

Nest areas

4 nest areas are communal and
used by multiple snakes

V. LONG-TERM SNAKE MONITORING

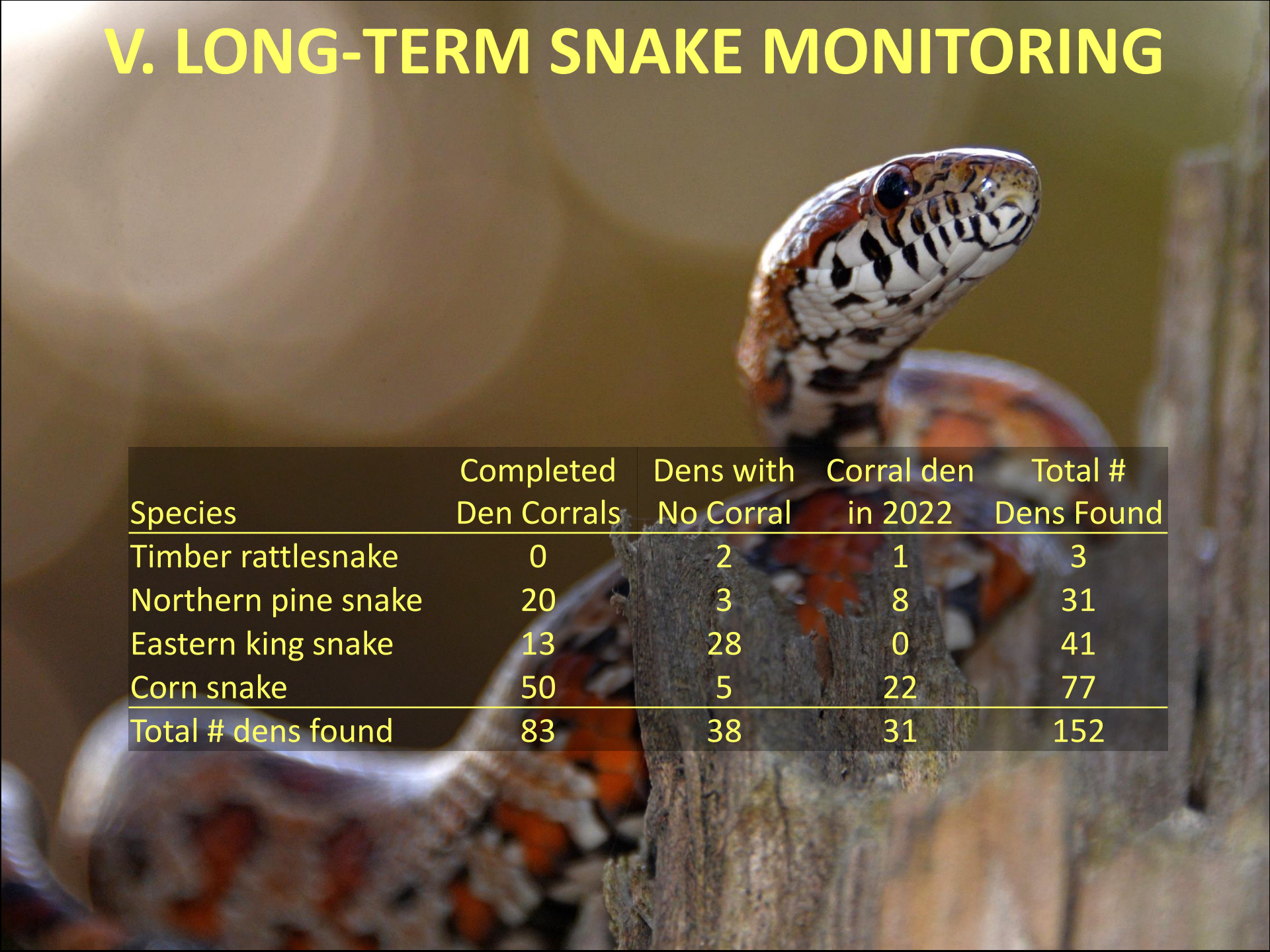


Little data exists on rare snake trends in the Pinelands

Corral is non-invasive method to census snakes

No physical disturbance to dens or hibernating snakes

V. LONG-TERM SNAKE MONITORING



Species	Completed Den Corrals	Dens with No Corral	Corral den in 2022	Total # Dens Found
Timber rattlesnake	0	2	1	3
Northern pine snake	20	3	8	31
Eastern king snake	13	28	0	41
Corn snake	50	5	22	77
Total # dens found	83	38	31	152

V. LONG-TERM SNAKE MONITORING

Snakes Captured and Processed in 2021

Snake	New Snakes	Tagged Snakes	Lab Hatched	Total
Northern scarlet snake	1	-	-	1
Rough green snake	1	-	-	1
Timber rattlesnake	1	-	-	1
Eastern garter snake	6	-	-	6
Eastern hognose	16	-	-	16
Black racer	35	5	-	40
Eastern king snake	22	19	16	57
Northern pine snake	47	28	49	124
Corn snake	63	118	96	277
Total	192	170	161	523

Note: 30 corns, 4 pines, and 2 king were captured more than once in 2021

BOX TURTLE STUDY

DEVELOPING RESEARCH

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

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

Monitor turtles in burned and unburned areas

In 2021, captured and marked 25 turtles and glued transmitters onto 20 turtles

1 killed, 1 missing



GROUND SKINK EDNA STUDY

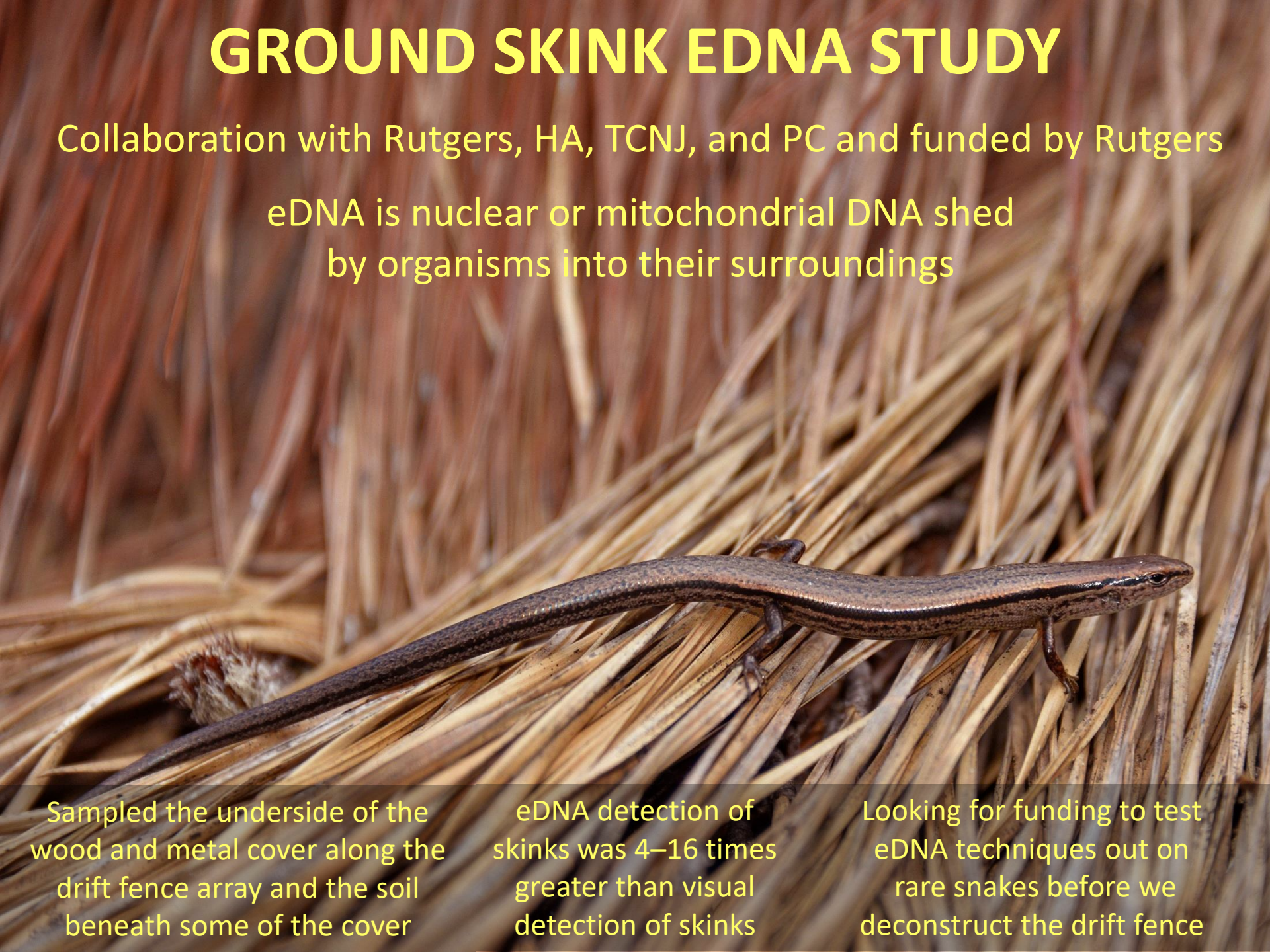
Collaboration with Rutgers, HA, TCNJ, and PC and funded by Rutgers

eDNA is nuclear or mitochondrial DNA shed
by organisms into their surroundings

Sampled the underside of the wood and metal cover along the drift fence array and the soil beneath some of the cover

eDNA detection of skinks was 4–16 times greater than visual detection of skinks

Looking for funding to test eDNA techniques out on rare snakes before we deconstruct the drift fence



QUESTIONS?

