The Pros and Cons of Long-Term Ecological Research Based on Lessons from Five Decades

2005 State of the Colorado River in Grand Canyon Science Symposium

Sponsored by:

U.S. Geological Survey
Grand Canyon Monitoring and Research Center

October 25, 2005

Whit Gibbons
University of Georgia
Savannah River Ecology Lab

HOW DOES LONG-TERM ECOLOGICAL RESEARCH

APPLY TO ADAPTIVE MANAGEMENT OF THE

COLORADO RIVER, GRAND CANYON, AND GLEN CANYON?

ADAPTIVE MANAGEMENT

Science-based decision making

"The need for credible scientific information that can serve as a feedback loop between management actions . . . the effects of those actions is of critical importance in adaptive management."

ADAPTIVE MANAGEMENT

Debris Fans
Humpback Chub
Trophic Structure
Recreational Use
Sandbar Stability
Streamflow
Sandbar Responses
Stream Food Chains
Carbon Cycling
Sandbar Restoration
Rainbow Trout
Suspended-Sediment Concentration
Cultural Resources
Stability of Recirculation Eddy Bars
Downstream Sand Resources
Birds
Spatial Data Accuracy
Nonnative Fishes
Water-Surface Elevations
Sand Storage
Fishes
Terrestrial Riparian Resources
Aeolian Sand-Transport Rates
Sediment Transport
Drifting Invertebrates
Brown Trout
Organic Matter and Invertebrates
Water Quality
Two-Way Telemetry
Oblique Photogrammetry Assessment
Electrical Power Economic Costs
Climatic Fluctuations
Terrestrial Vegetation Inputs
Riparian Vegetation
Sand Mass Balance
Hydrographic Elevations
Recreational Values
Effects of Drought

ADAPTIVE MANAGEMENT

Abraham E. Springer
Barbara E. Ralston
Christopher S. Magirl
Brian P. Kennedy
F. Mark Gonzales
Matt Kaplinski
Robert Hall
Amy E. Draut
Dennis Fenn
Emily Thompson
Glenn E. Bennett
Gary K. Meffe
Helen C. Fairley
Robert H. Webb
Courtney Giauque
David J. Topping
Jack C. Schmidt
John Loomis
David Otis
John L. Sabo
Mark K. Sogge
R. Scott Rogers
S. Clayton Palmer
Scott A. Wright
Michael D. Yard
Michael E. Douglas
Michael J. Breedlove
Michael Kearsley
Stephen Wiele
Jeffrey E. Lovich
Joseph E. Hazel
Kristin Brown
Josh Korman
Lewis G. Coggins
Marlis R Douglas
Mark Schmeeckle
Michael L. Dennis
Peter G. Griffiths
Nancy Hornewer
Susan Hueftle
Steven P. Gloss
Theodore A. Kennedy
William Pine
William S. Vernieu
Yael A. Bernstein

GOALS

1. NATIVE FISH
2. AQUATIC FOODBASE
3. RESTORE EXTIRPATED SPECIES
4. RAINBOW TROUT
5. KANAB AMBERSNAIL
6. BIOTIC RIPARIAN AND SPRING COMMUNITIES
7. TEMPERATURE, QUALITY, AND FLOW DYNAMICS
8. SEDIMENT STORAGE
9. RECREATION
10. POWER PRODUCTION
11. CULTURAL RESOURCES
12. HIGH QUALITY MONITORING AND RESEARCH

ENVIRONMENT

PEOPLE

ECOLOGY

Glen Canyon Dam Adaptive Management Program

PRINCIPLES

Much remains unknown about the Colorado River ecosystem below Glen Canyon Dam

Management efforts will prevent any further human-induced extirpation or extinction of native species

Achieve Adaptive Management Program goals, through experimentation and monitoring

Attempt to return ecosystem patterns and processes to their range of natural variability

Recognizing the diverse perspectives and spiritual values of the stakeholders, the unique aesthetic value of the Grand Canyon will be respected and enhanced.

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Recognizing the diverse perspectives and spiritual values of the stakeholders, the unique aesthetic value of the Grand Canyon will be respected and enhanced.

Knowing that the same native species are present

as when our ancestors arrived

offers a spiritual comfort that many people aspire to,

one that offers solace that precedes our modern needs for

technological advancements and artificial backdrops.

WHY HERPETOFAUNA?

THE SOUTHEASTERN COIN OF THE REALM

WHAT IS SREL AND WHY?

PARADOX AND PERCEPTION

LONG-TERM STUDIES

INSIGHTS AND REVELATIONS

WHY HERPETOFAUNA?

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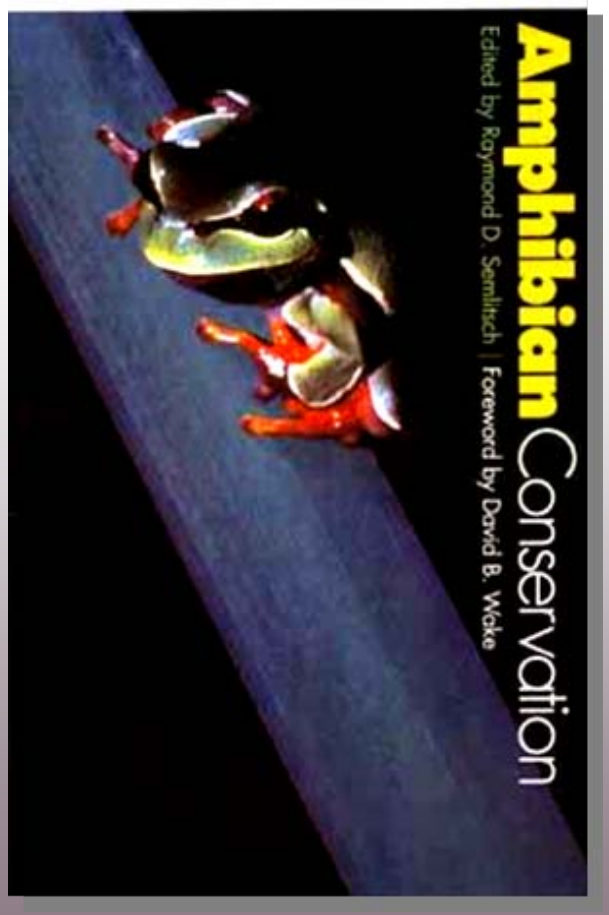
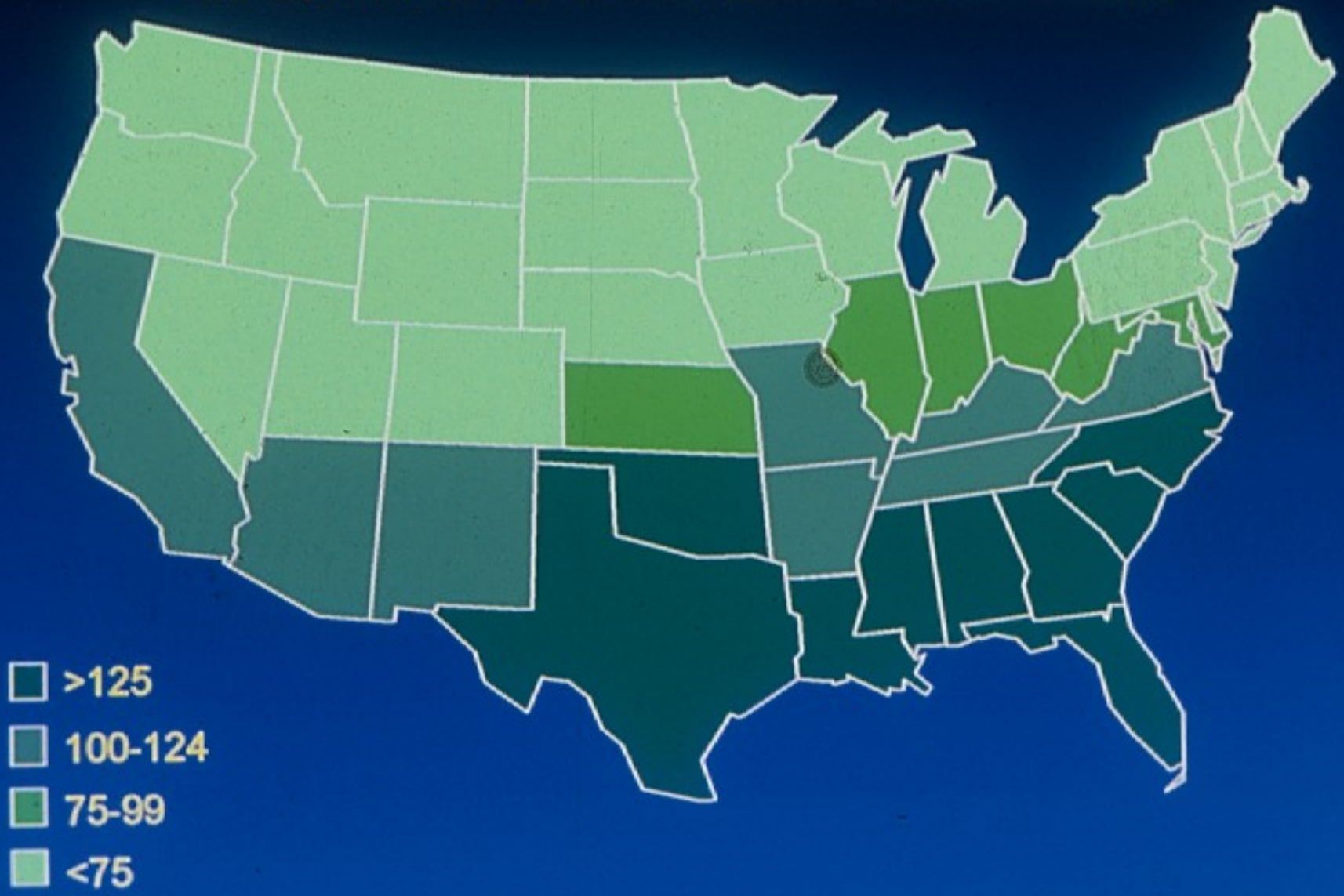
“Herpetofauna (reptiles and amphibians) are unquestionably under siege on local, regional, and global scales, with many species and populations declining.”



PARTNERS IN AMPHIBIAN AND REPTILE CONSERVATION
PARC

Amphibian and Reptile Biodiversity



Why amphibians?

Salamander Diversity

HIDDEN BIODIVERSITY

Cryptic Species

HIDDEN BIODIVERSITY

Rare?

Rainbow snake
Farancia erytrogramma

Nocturnal

Spotted salamander
Ambystoma maculatum

HIDDEN BIODIVERSITY

Two-toed amphiuma
Amphiuma means

Secretive

Habitat restricted

Spotted turtle
Clemmys guttata

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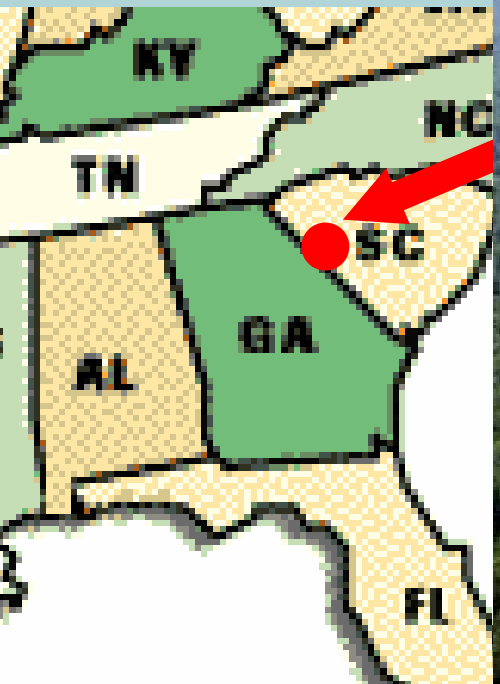
THE SAVANNAH RIVER ECOLOGY LABORATORY

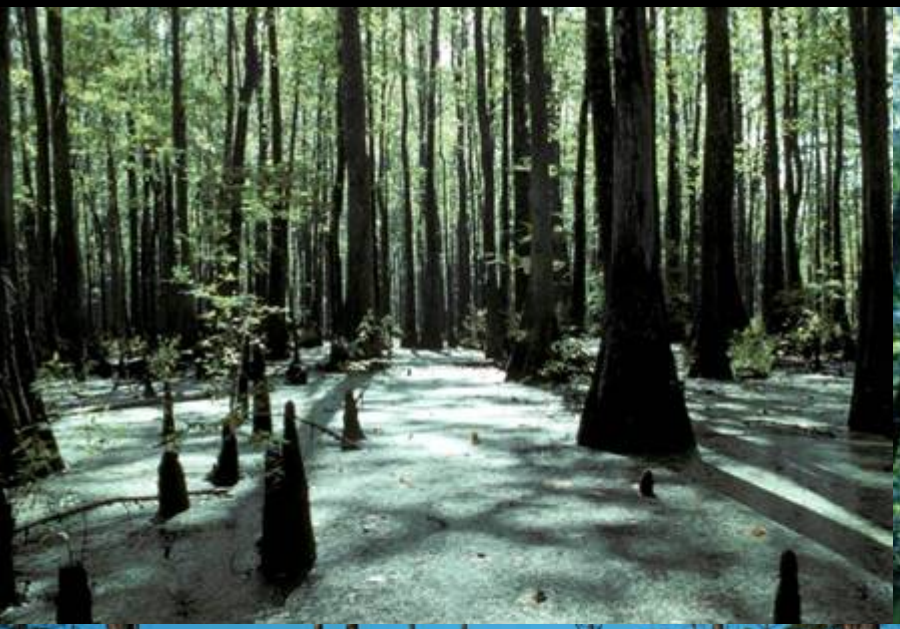
WHO, WHAT, WHY, WHERE, WHEN?

The University of Georgia
Savannah River Ecology Laboratory



SAVANNAH RIVER SITE

NATURAL HABITATS OF THE UPPER COASTAL PLAIN



MORE SPECIES OF
AMPHIBIANS AND REPTILES
DOCUMENTED FROM
THE SAVANNAH RIVER SITE
THAN FROM ANY OTHER
PUBLIC LAND AREA
IN NORTH AMERICA

WHY HERPETOFAUNA?

THE SOUTHEASTERN COIN OF THE REALM

WHAT IS SREL AND WHY?

PARADOX AND PERCEPTION

LONG-TERM STUDIES

INSIGHTS AND REVELATIONS

Perceptions of Species Abundance, Distribution, and Diversity: Lessons from Four Decades of Sampling on a Government-Managed Reserve

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ABSTRACT / We examined data relative to species abundance, distribution, and diversity patterns of reptiles and amphibians to determine how perceptions change over time and with level of sampling effort. Location data were compiled on more than one million individual captures or observations of 98 species during a 44-year study period on the US Department of Energy's (DOE) Savannah River Site National Environmental Research Park (SRS-NERP) in South Carolina. We suggest that perceptions of herpetofaunal species diversity are strongly dependent on level of effort and that land management decisions based on short-term data bases for some faunal groups could result in serious errors in environmental management. We provide evidence that acquiring information on biodiversity distribution patterns is compatible with multiyear spatially extensive research programs and also provide a perspective of what might be achieved if long-term, coordinated research efforts were instituted nationwide.

To conduct biotic surveys on government-managed lands, we recommend revisions in the methods used by government agencies to acquire and report biodiversity data. We suggest that government and industry employees engaged in biodiversity survey efforts develop proficiency in field identification for one or more major taxonomic groups and be encouraged to measure the status of populations quantitatively with consistent and reliable methodologies. We also suggest that widespread academic cooperation in the dissemination of information on regional patterns of biodiversity could result by establishment of a peer-reviewed, scientifically rigorous journal concerned with status and trends of the biota of the United States.

KEY WORDS: Abundance; Amphibian; Biodiversity; Distribution; Land management; Reptile

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During the past 44 years, the US Department of Energy's (DOE) Savannah River Site National Environmental Research Park (SRS-NERP) has been the focus of extensive biotic inventory and research efforts (Cohn 1994, Gibbons 1994). The 803-km^2 SRS-NERP was established in west-central South Carolina during 1951 to support five nuclear production reactors and associated cooling canals, roads, office buildings, and industrial facilities. Approximately 95% of the site consists of planted pine forests, second-growth hardwood habitats, and a variety of natural terrestrial and aquatic habitats. Since 1951, biotic surveys and ecological studies have been conducted on the SRS-NERP to quantitatively sample resident biota and assess the environmental effects of site development (Golley 1965, Gibbons 1994). Thus, the SRS-NERP ranks among the largest tracts of land in North America for which species abundance, distribution, and diversity have been measured on a long-term basis.

The herpetofauna have been a primary focus of extensive and intensive research on the SRS-NERP since 1951, resulting in the capture and processing of more than one million individuals of 98 species of reptiles

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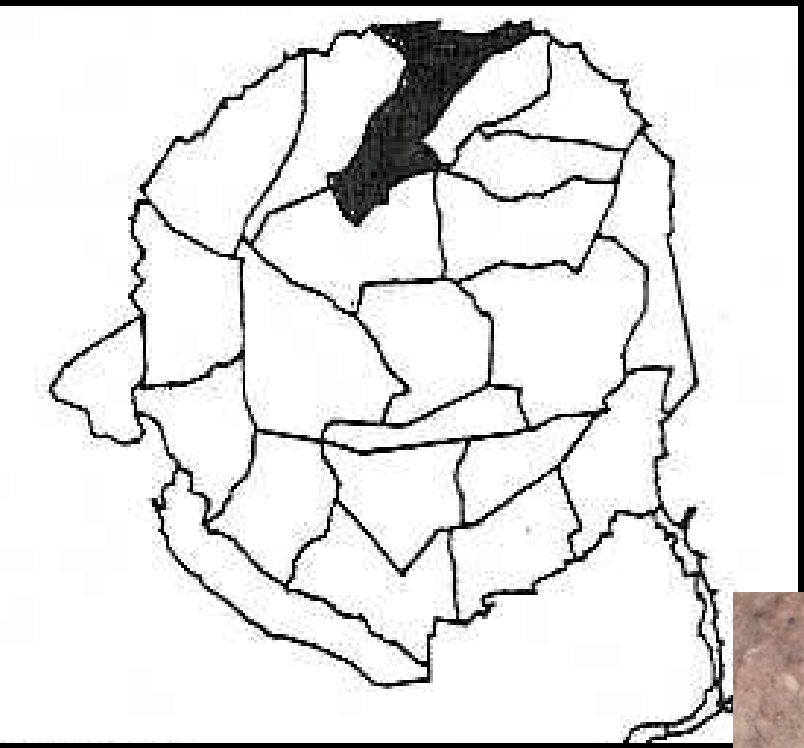
SAVANNAH RIVER SITE
300 square miles

SAVANNAH RIVER SITE
300 square miles

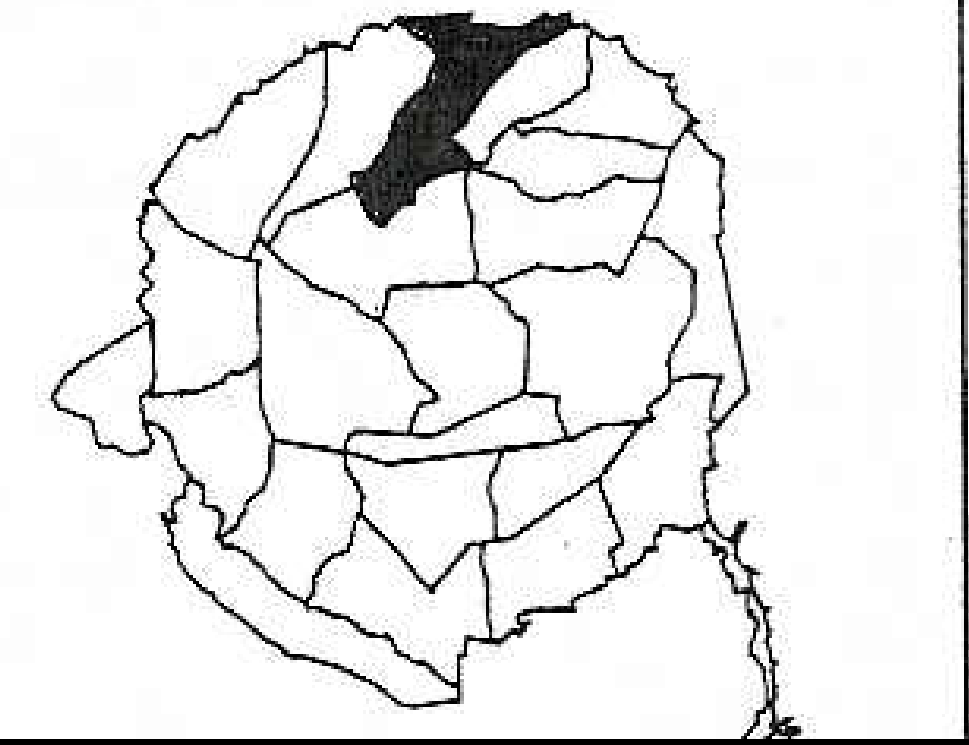
24 USFS compartments

SAVANNAH RIVER SITE
300 square miles

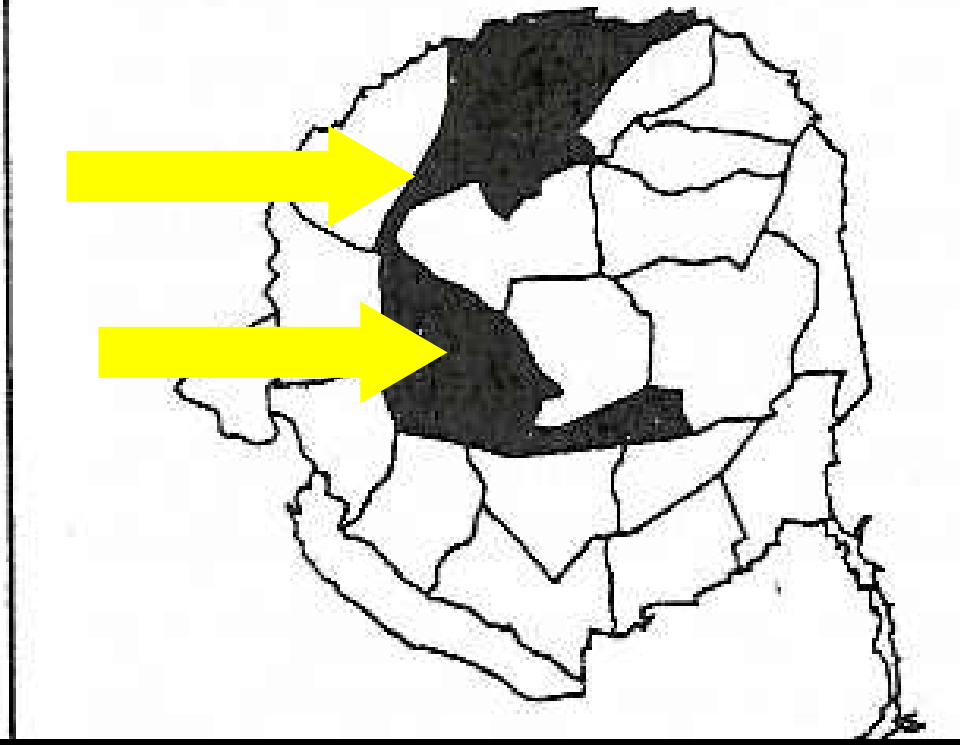


Southeastern Crowned Snake
Tantilla coronata

1951 – 1959

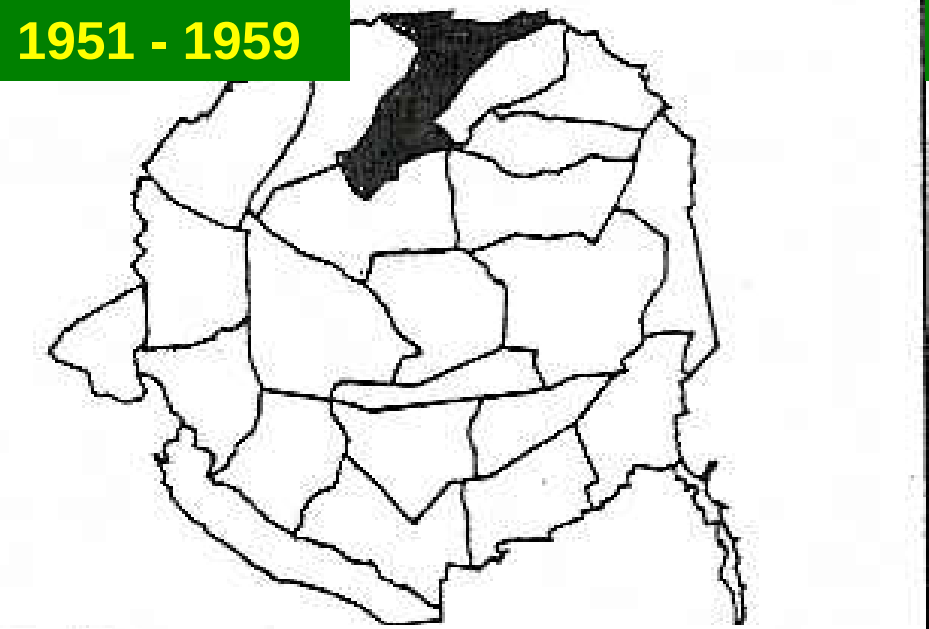


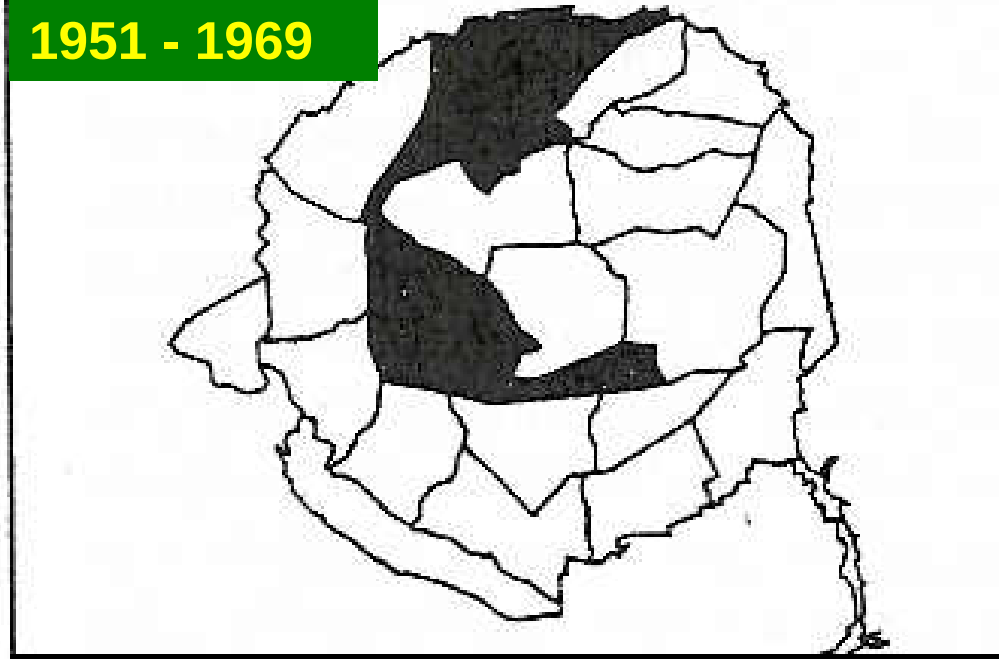
1951 - 1959

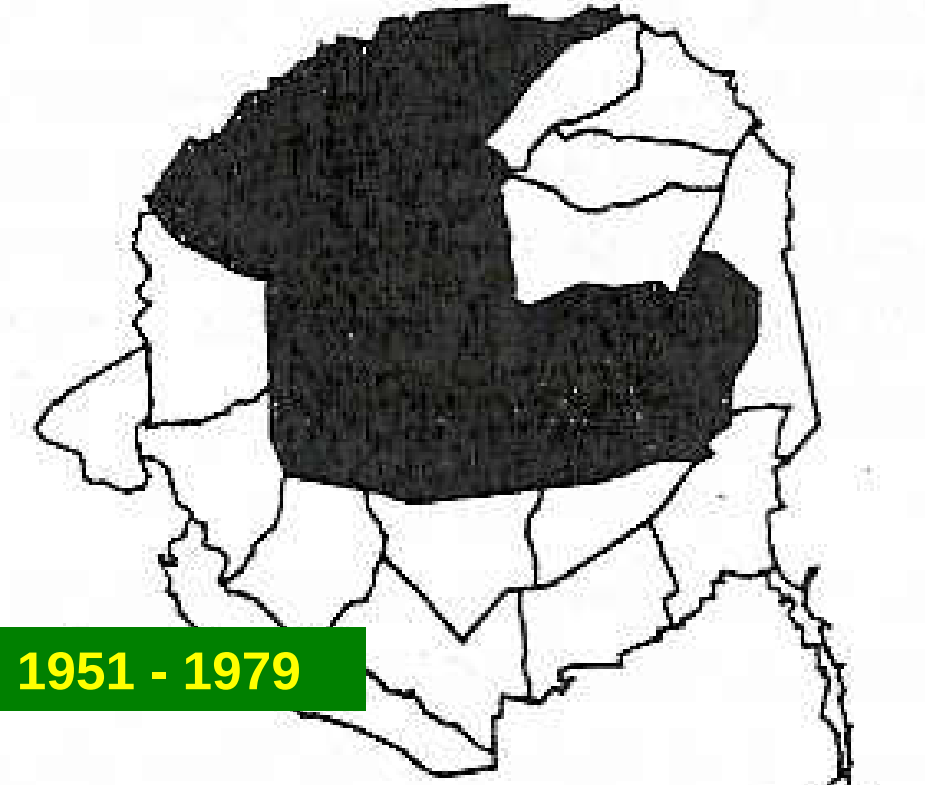


1951 - 1969

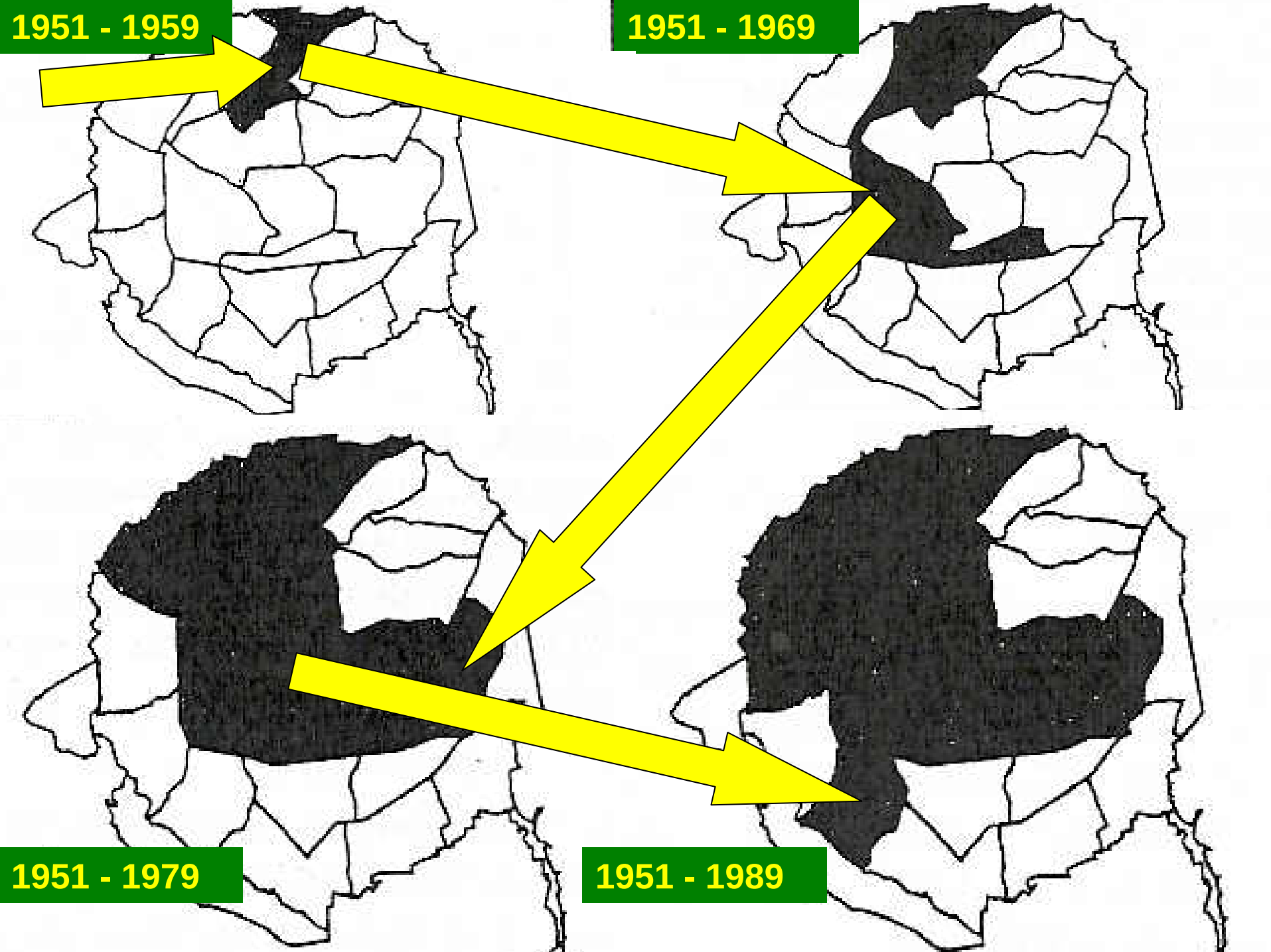
Southeastern Crowned Snake
Tantilla coronata

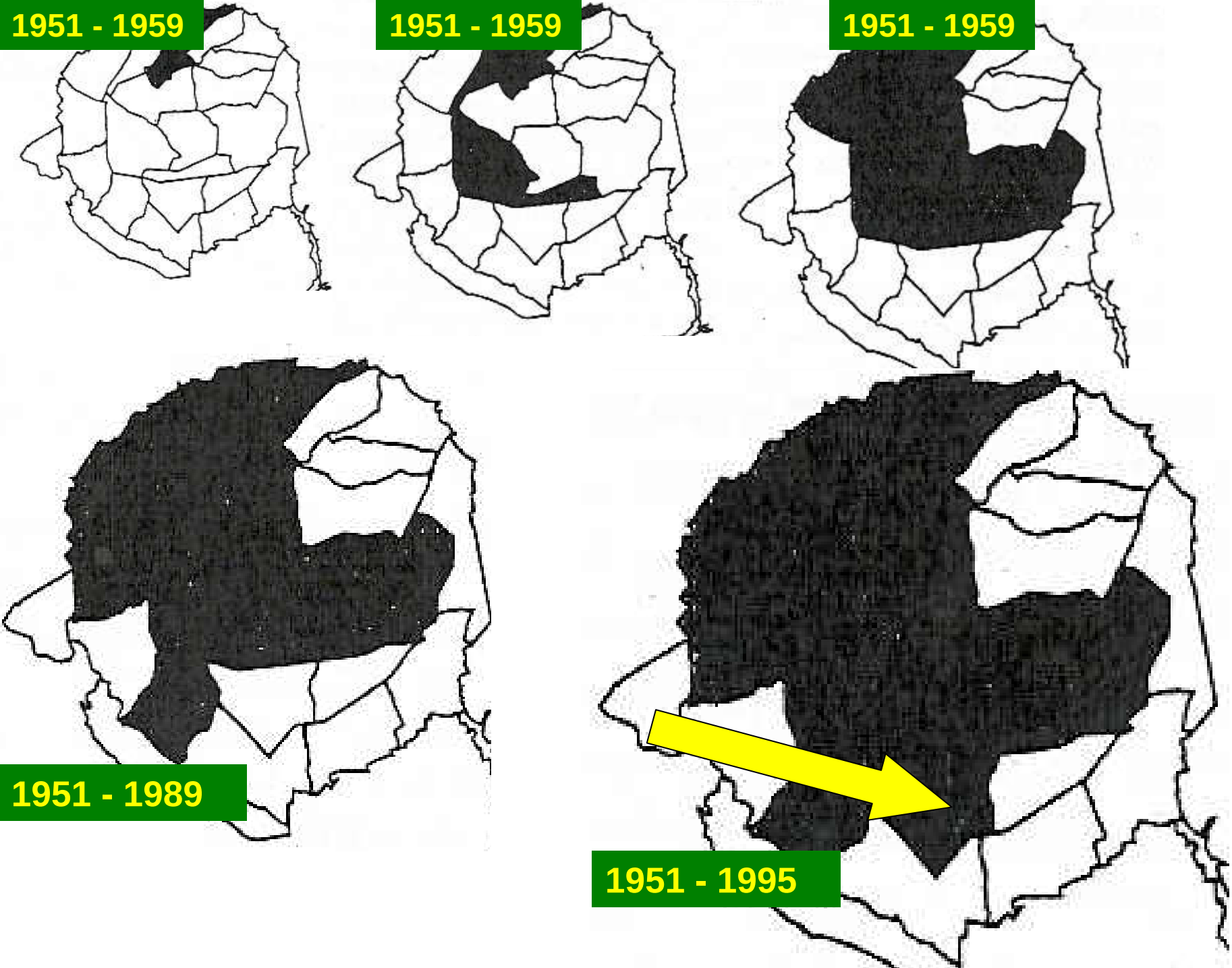




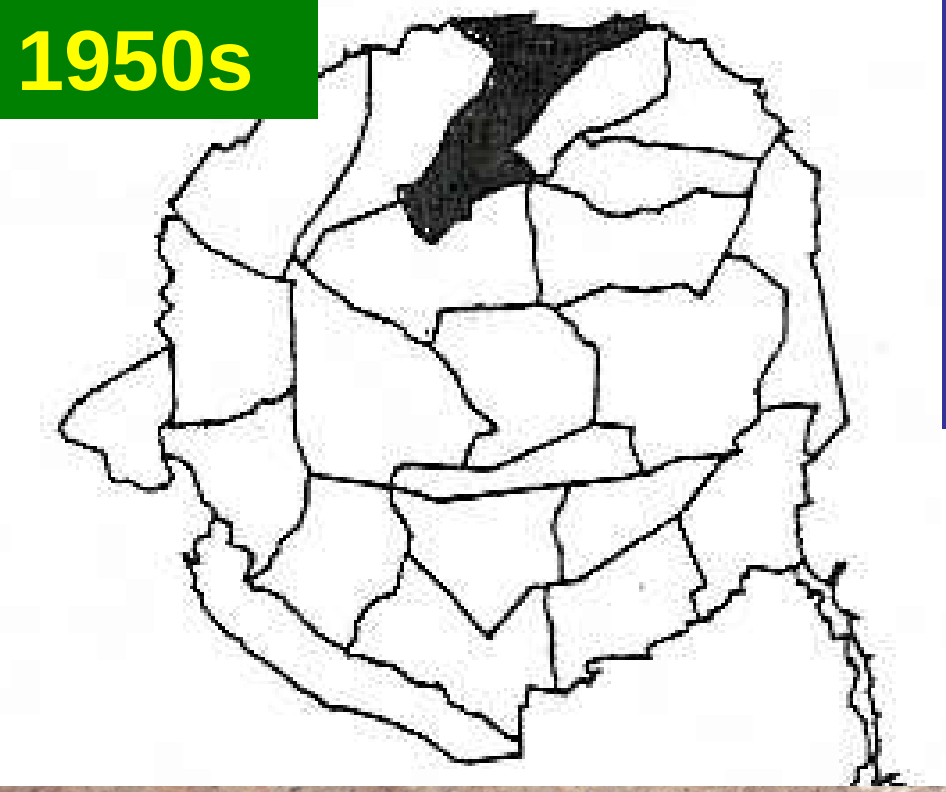


Southeastern Crowned Snake
Tantilla coronata

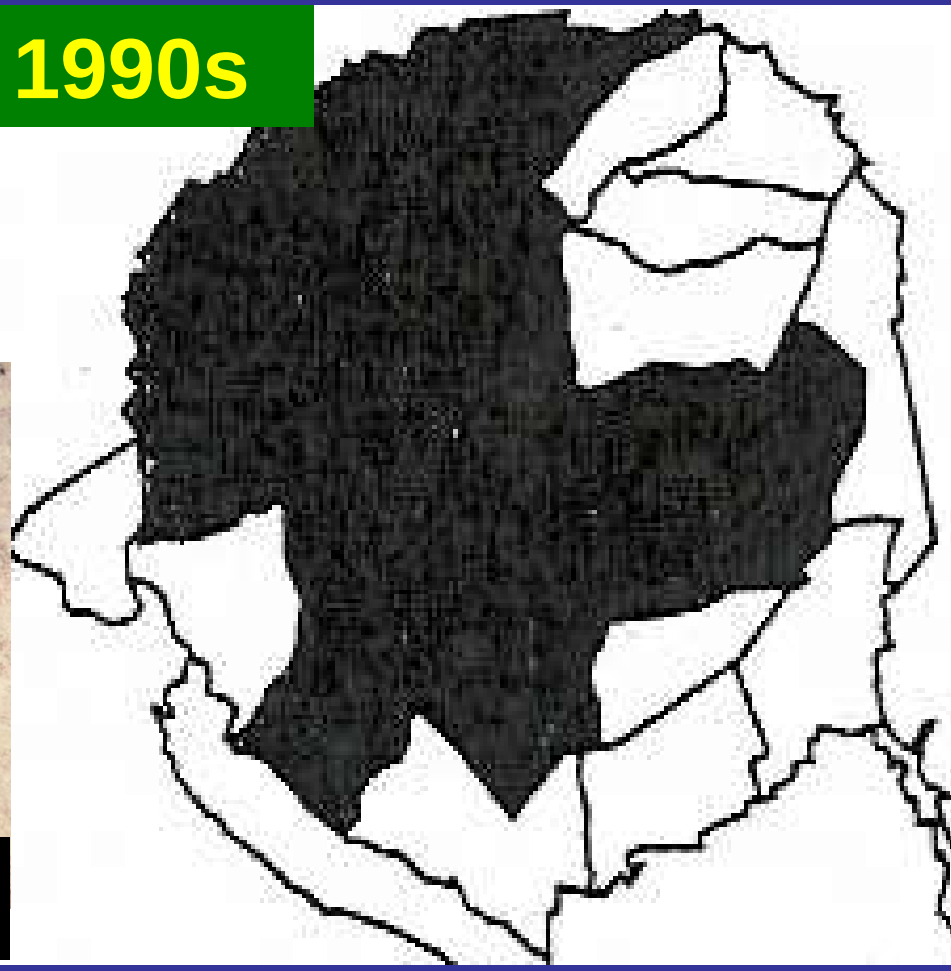

1951 - 1959
1951 - 1969
1951 - 1979
1951 - 1989


1951 - 1959
1951 - 1959
1951 - 1959
1951 - 1989
1951 - 1995

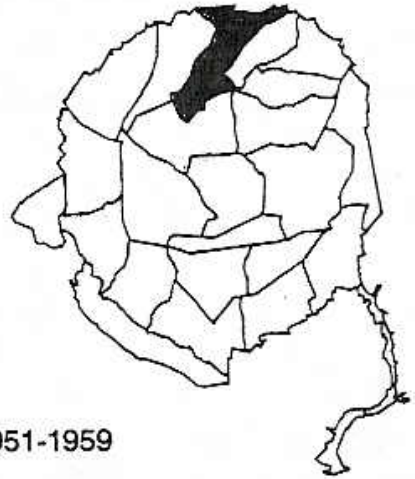
1950s

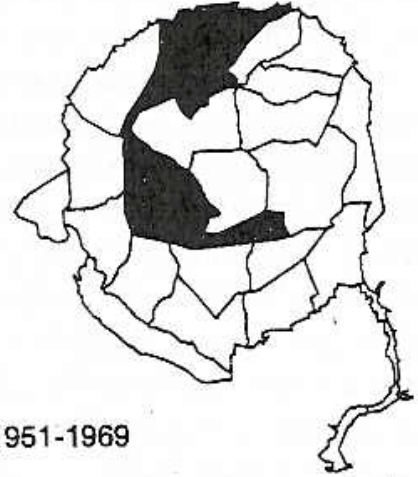


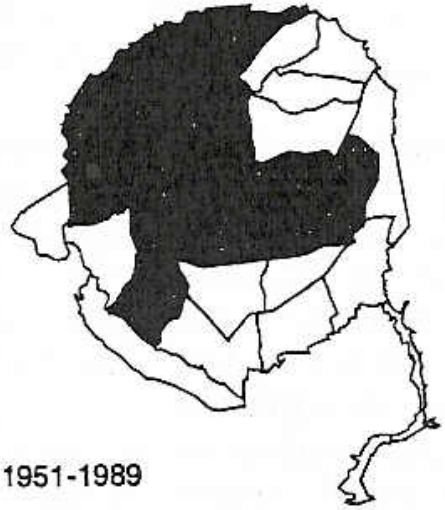
1990s

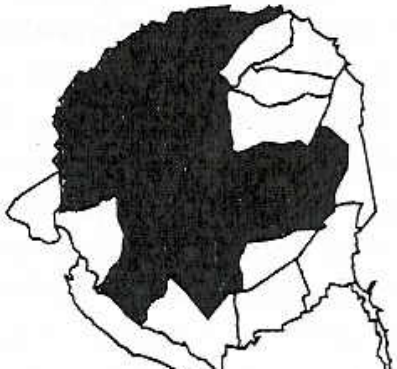


Southeastern Crowned Snake
Tantilla coronata





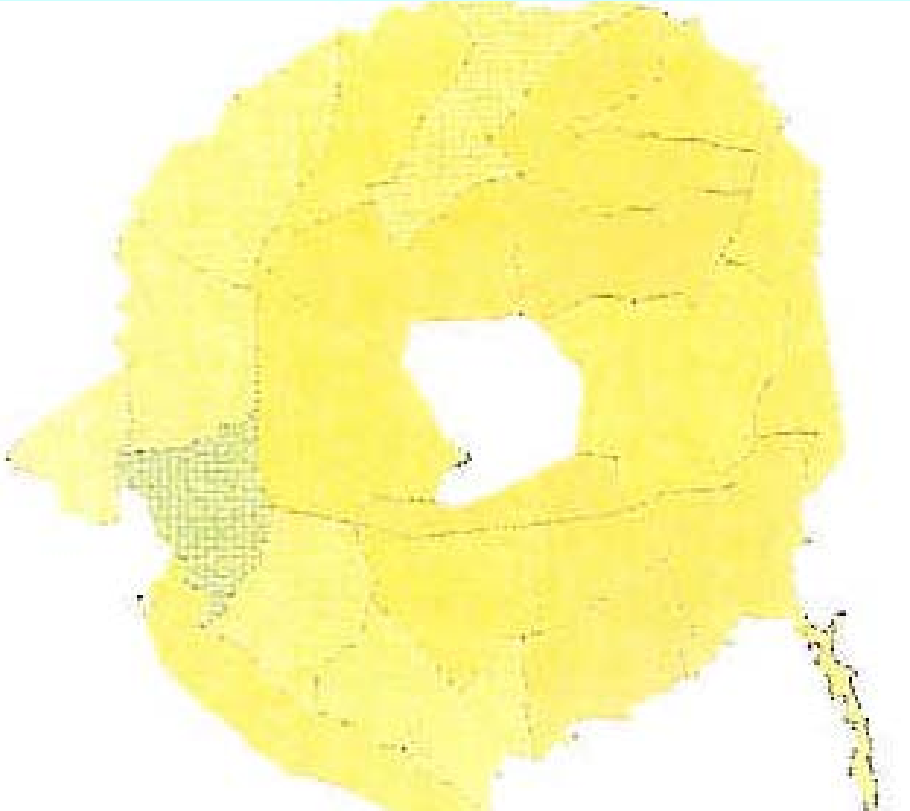


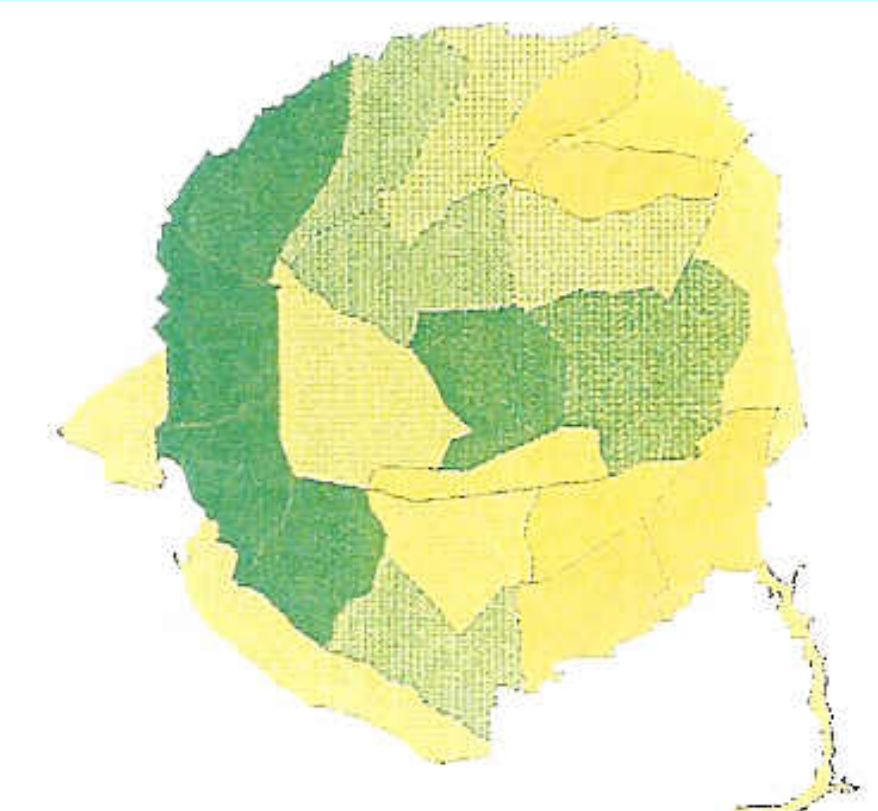


EASTERN CROWNED SNAKE

Tantilla coronata

CUMULATIVE NUMBER OF SPECIES PER COMPARTMENT





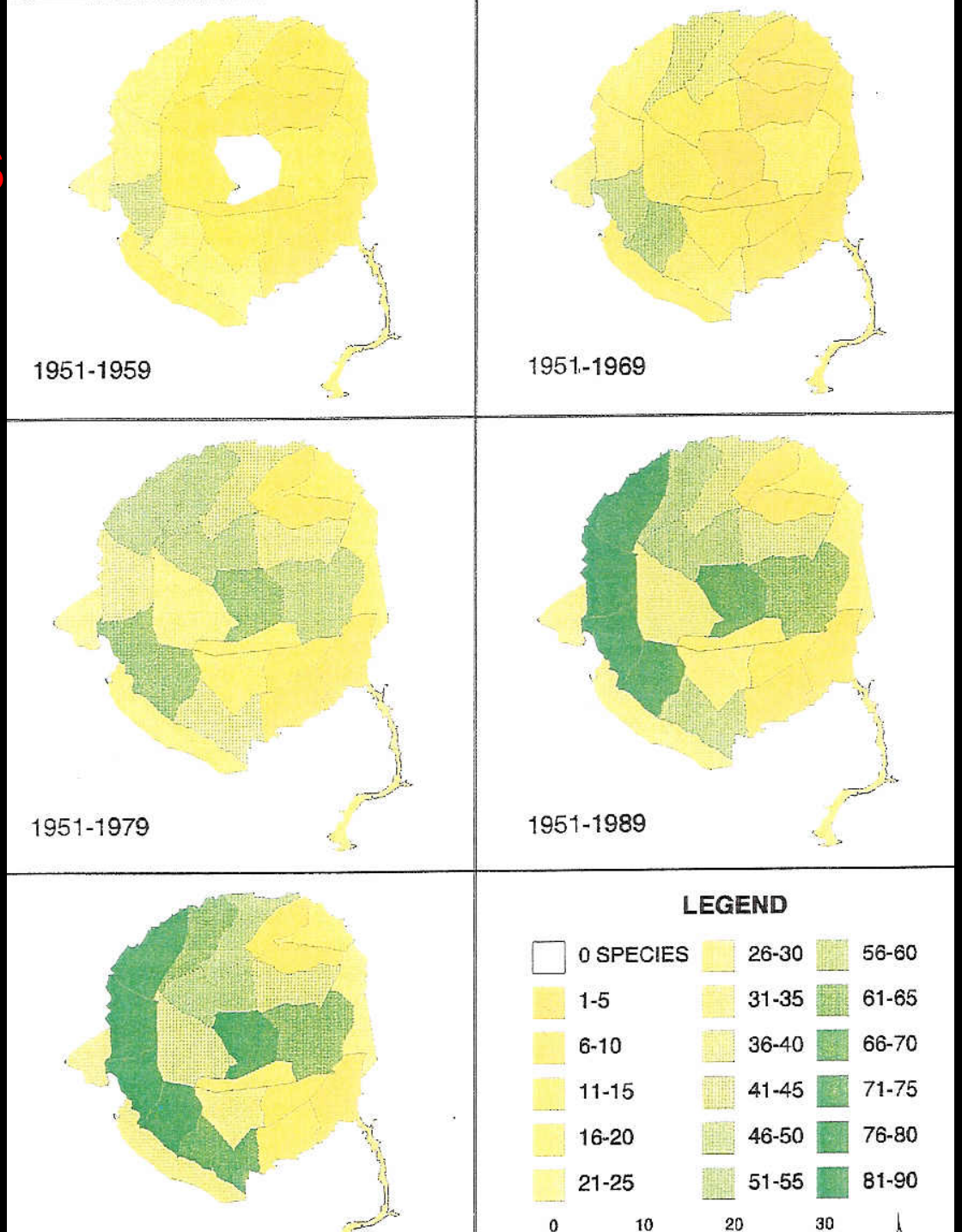
1950s

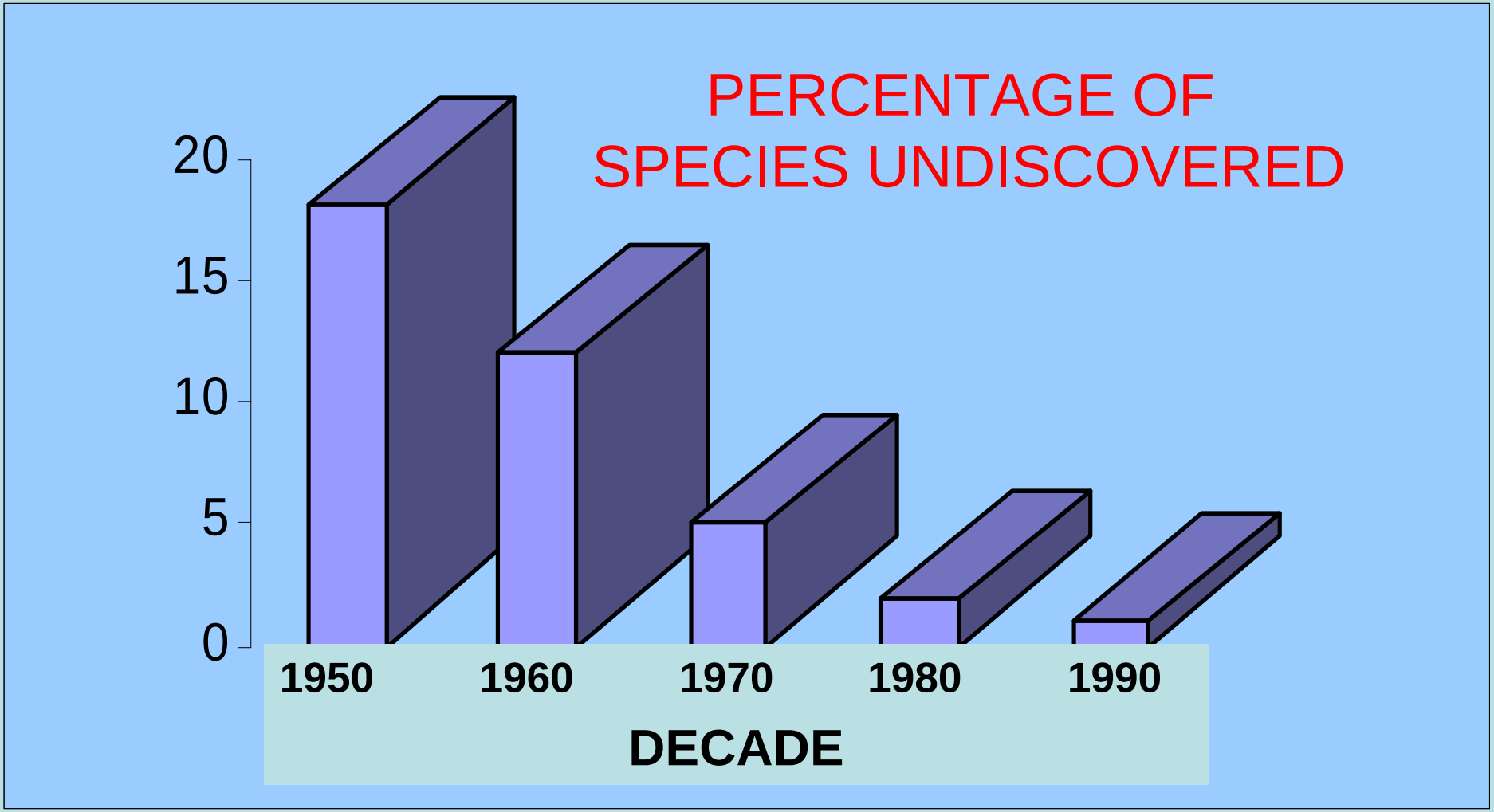
1960s

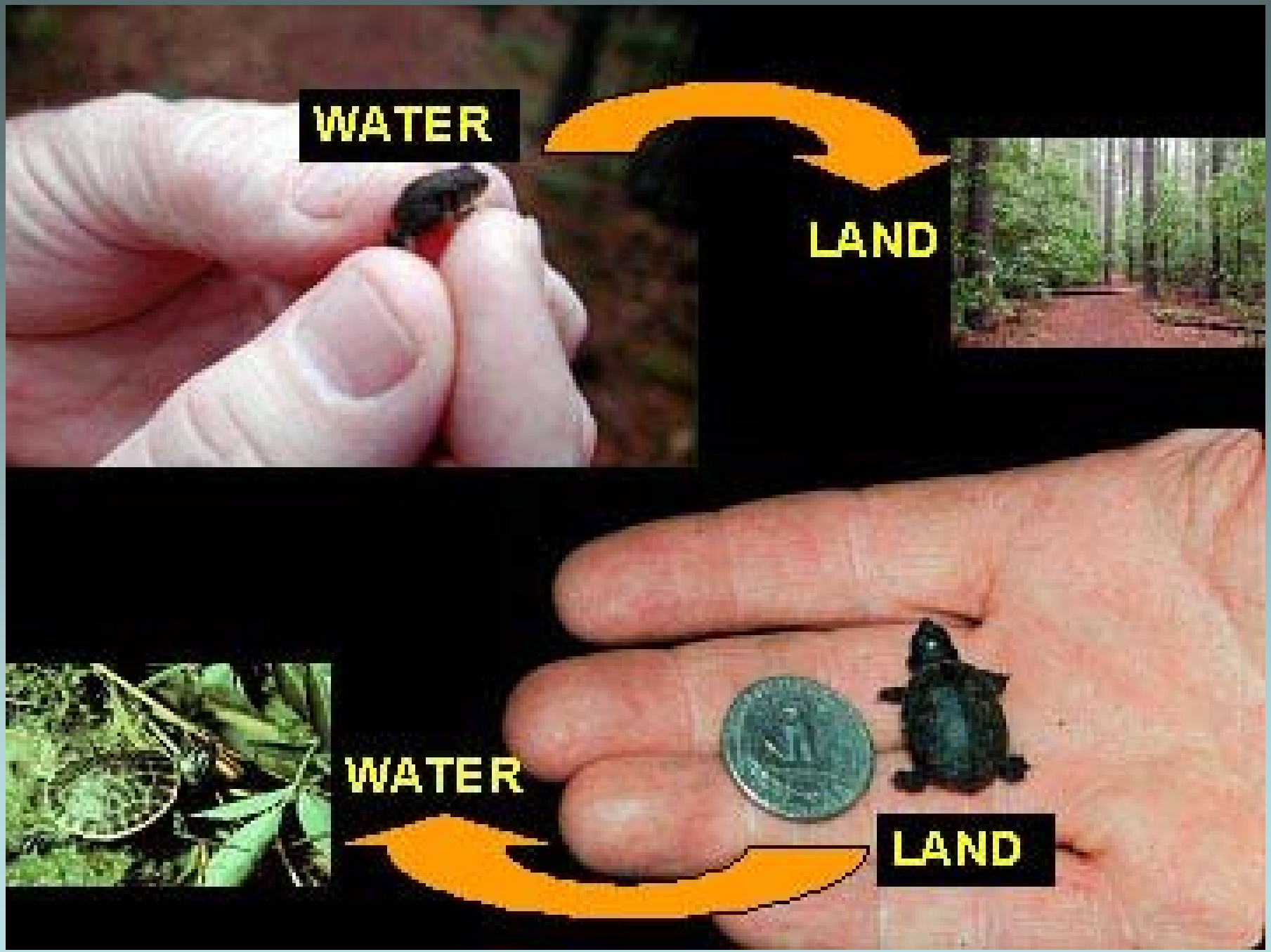
1970s

1980s

1990s



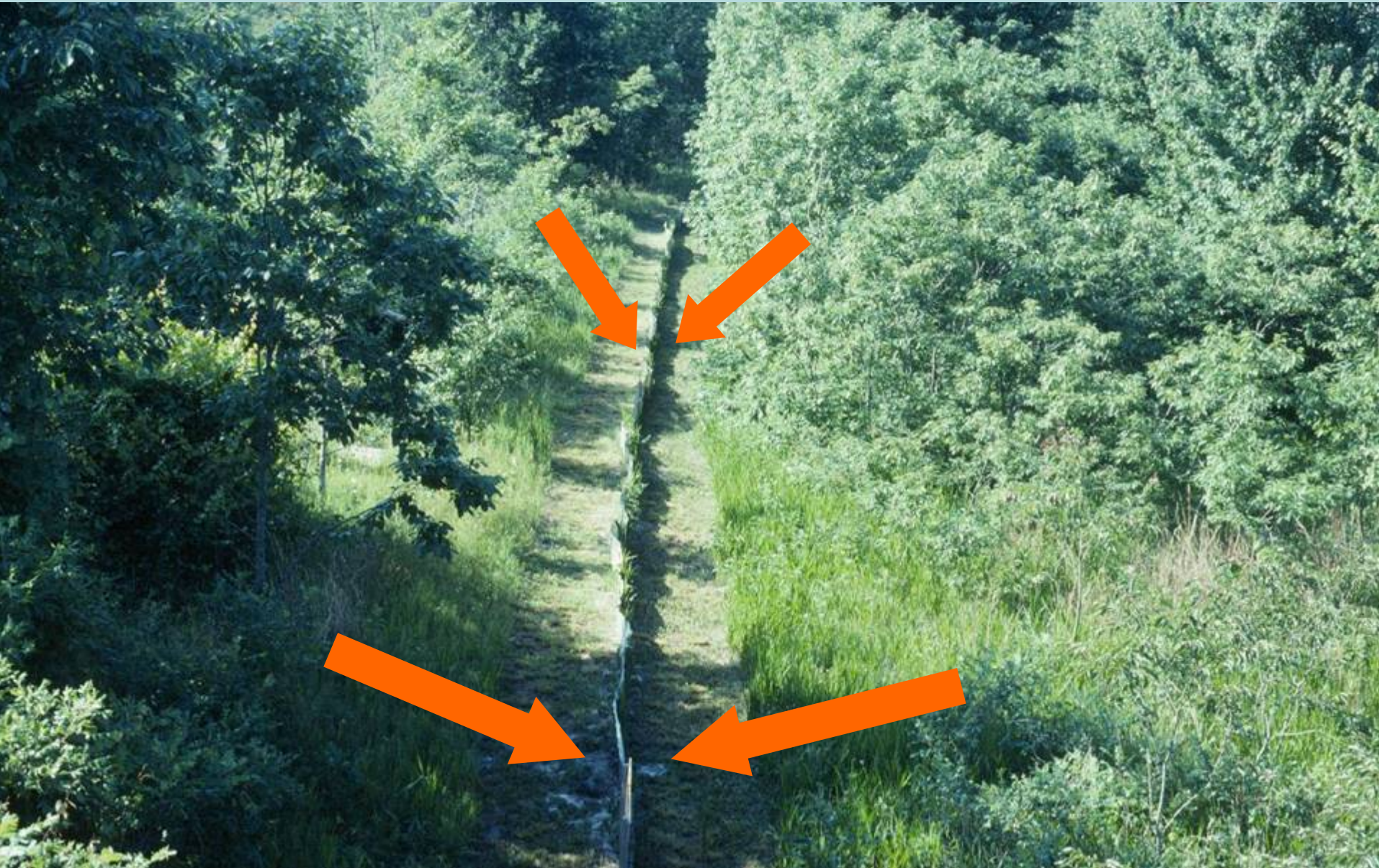

PERCENTAGE OF
SPECIES UNDISCOVERED
20
15
10
5
0
1950
1960
1970
1980
1990
DECADE


WATER
LAND
WATER
LAND

CAROLINA BAY WETLANDS

HABITATS FOR HERPETOFAUNA

TERRESTRIAL DRIFT FENCE



SUPPORTING DATA

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JOE SCHUBAUER
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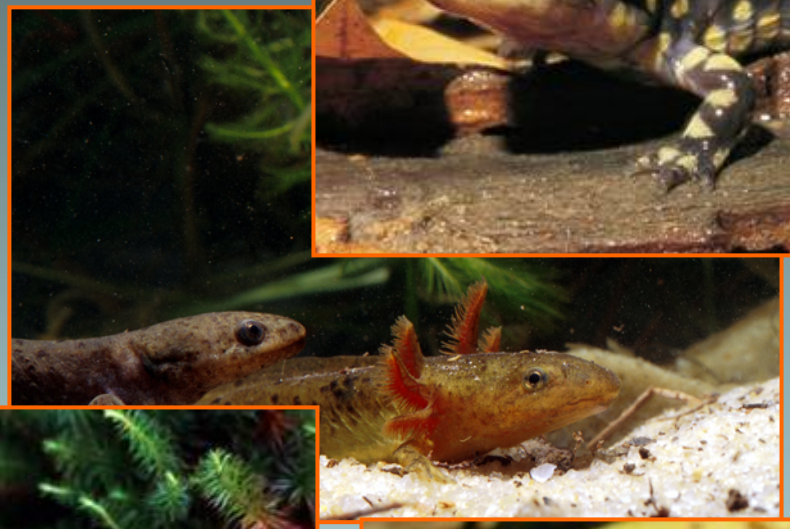
TONY TUCKER
JUDY GREENE
MATT GREENE
STEVE BENNETT
JOE PECHMANN
RAY SEMLITSCH
HENRY WILBUR
KURT BUHLMANN
PERI MASON
RICK SHINE
MARGARET WEAD
MELISSA PILGRIM
JIM KNIGHT
KIMBERLY ANDREWS

Rainbow Bay (amphibians)



Long-term census data

Long-term environmental data

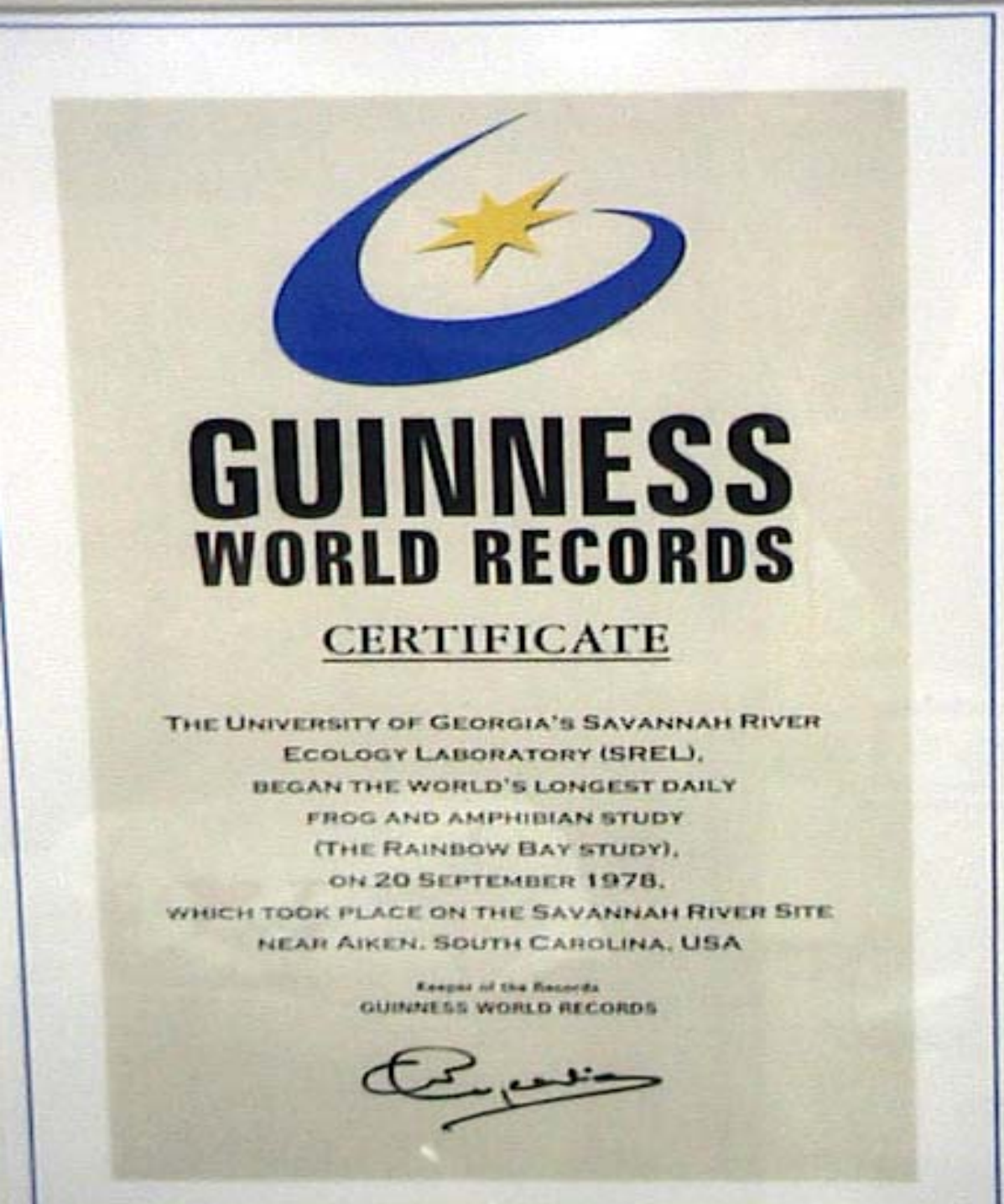
RAINBOW BAY

Traps checked daily since September 1978

Number of amphibian species = 26

Number of individuals captured = >600,000

Some amphibian recaptures after > 10 years



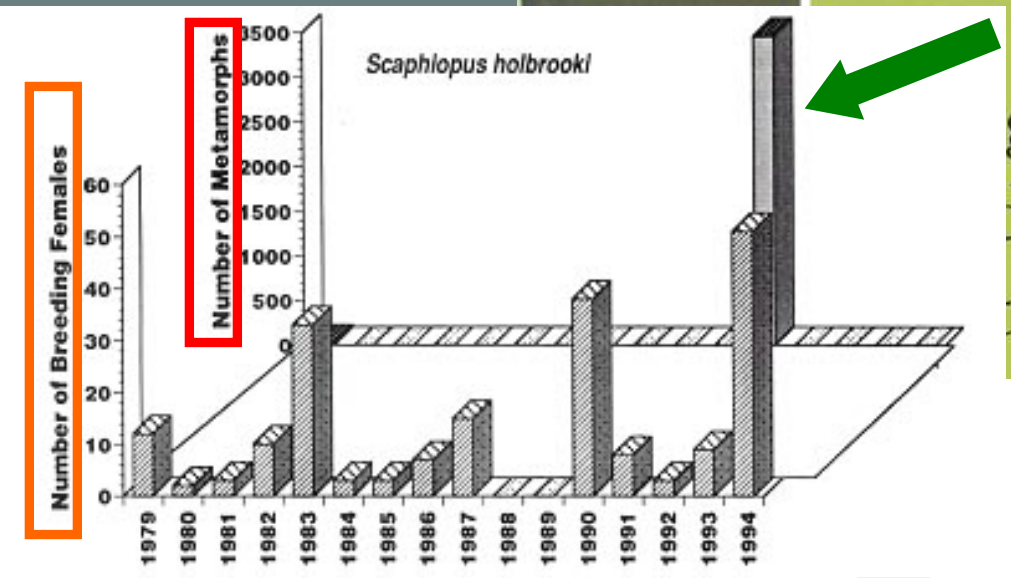
GUINNESS
WORLD RECORDS

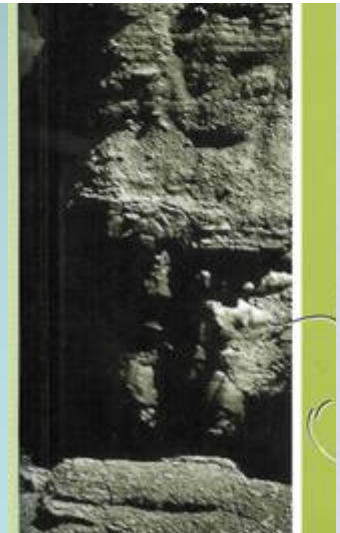
CERTIFICATE

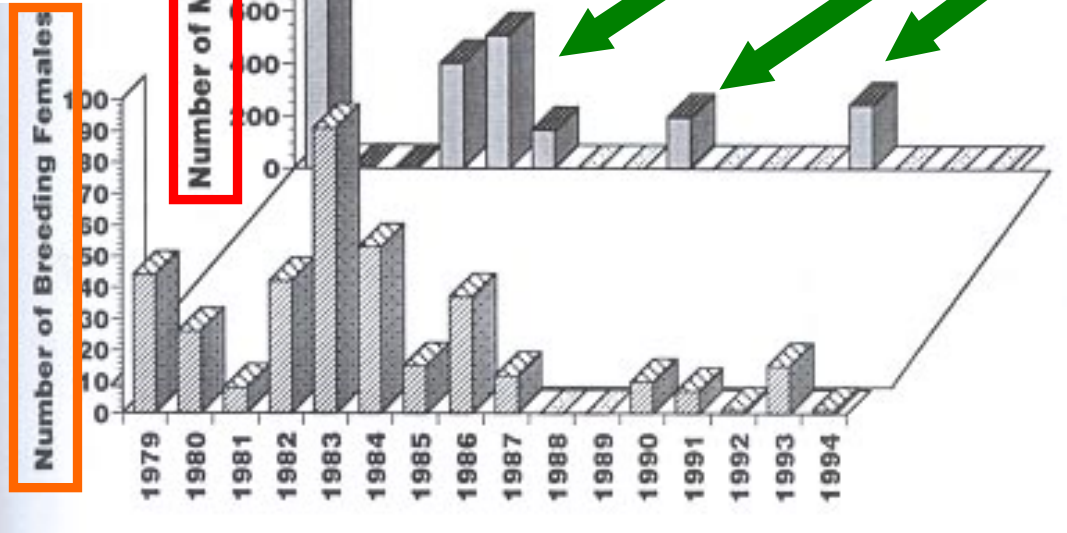
THE UNIVERSITY OF GEORGIA'S SAVANNAH RIVER
ECOLOGY LABORATORY (SREL),
BEGAN THE WORLD'S LONGEST DAILY
FROG AND AMPHIBIAN STUDY
(THE RAINBOW BAY STUDY),
ON 20 SEPTEMBER 1978,
WHICH TOOK PLACE ON THE SAVANNAH RIVER SITE
NEAR AIKEN, SOUTH CAROLINA, USA

Keeper of the Records
GUINNESS WORLD RECORDS

FLUCTUATIONS IN AMPHIBIAN REPRODCUTION AT RAINBOW BAY OVER YEARS







SPADEFOOT TOADS

Scaphiopus holbrooki

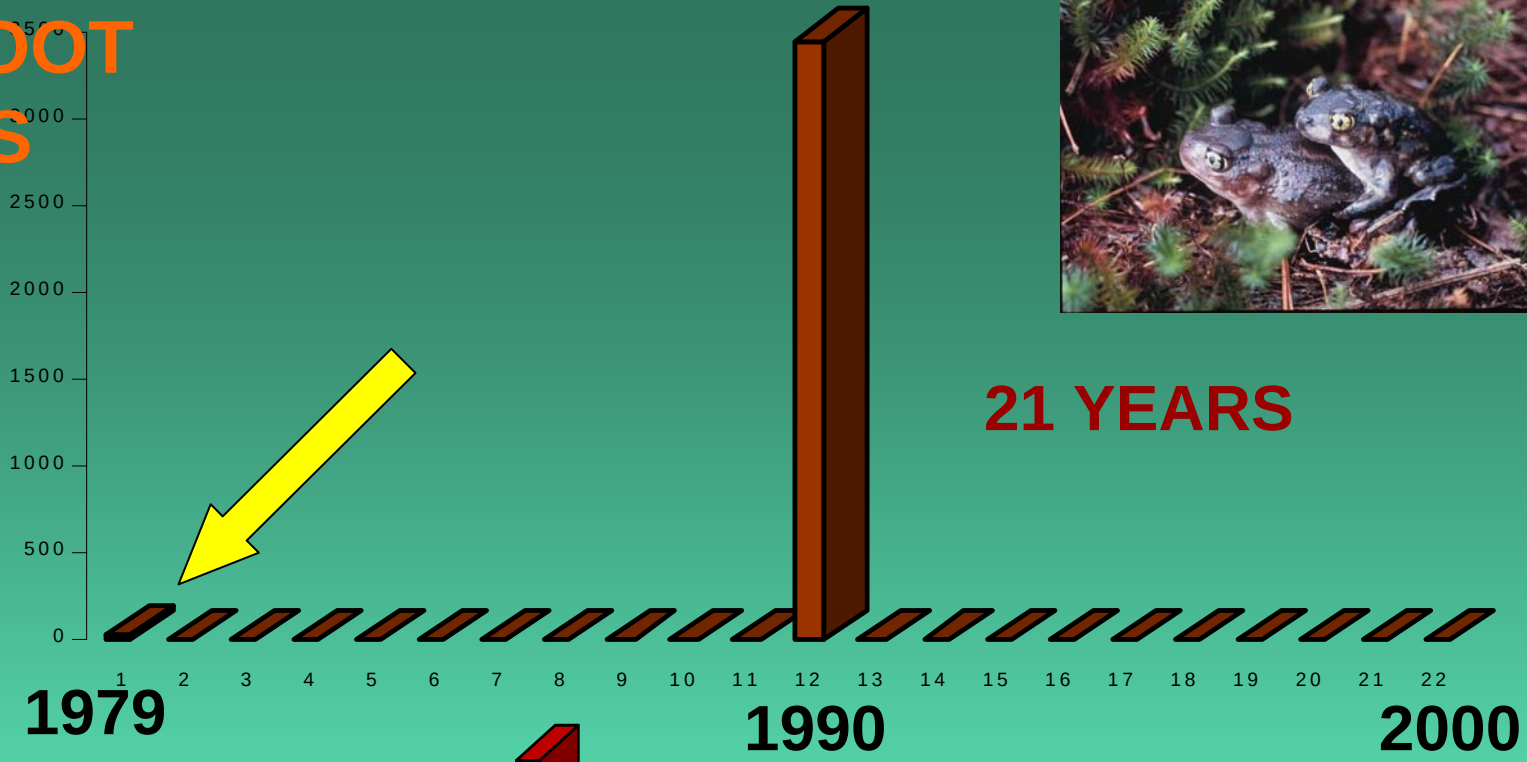
5 YEARS

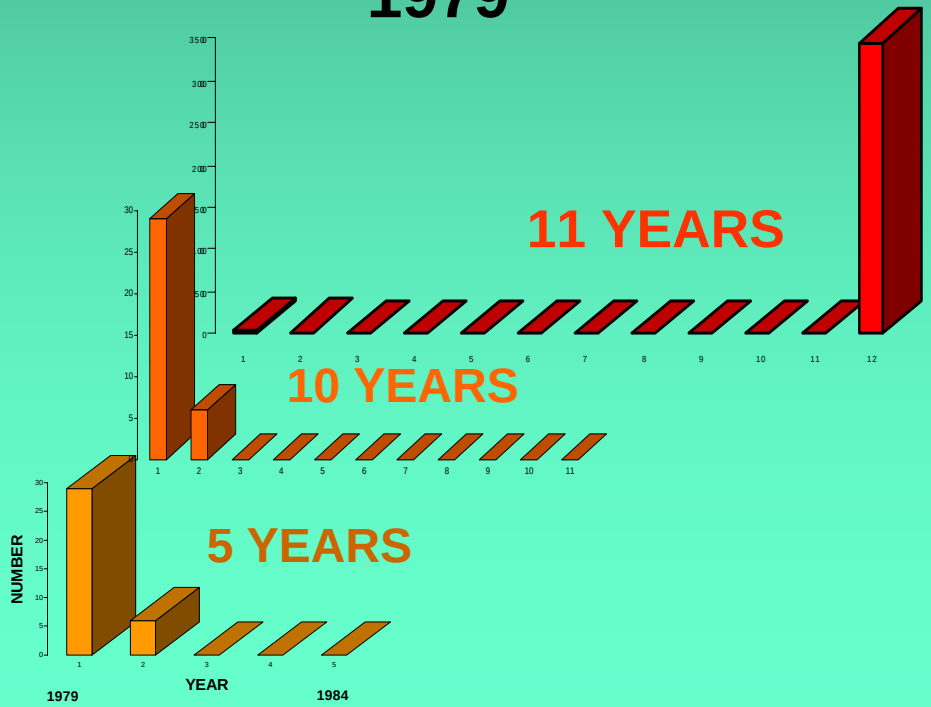
JUVENILE SPADEFOOT TOADS

SPADEFOOT TOADS

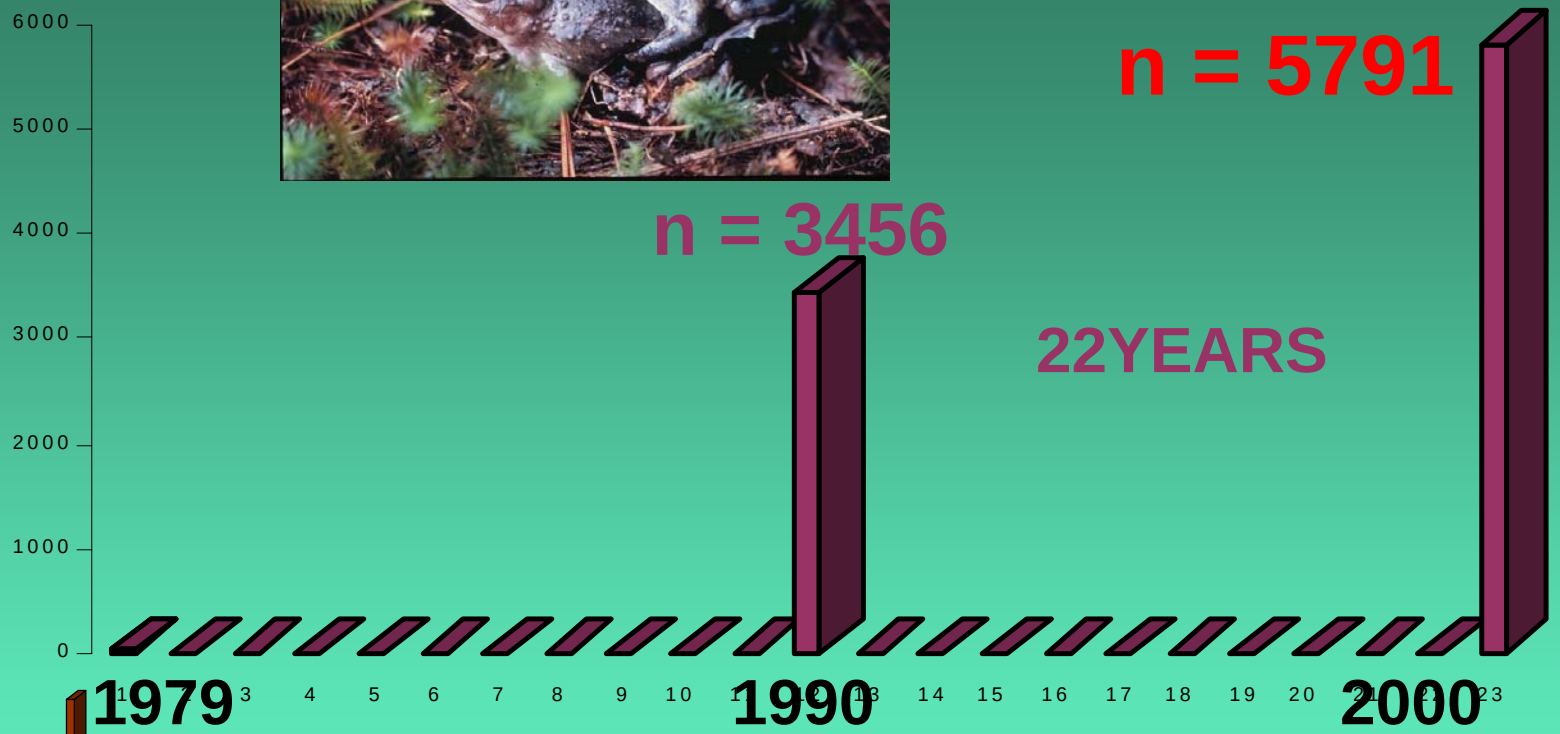
n= 3456

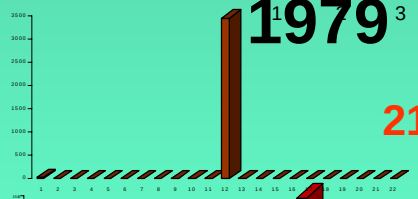
SPADEFOOT TOADS



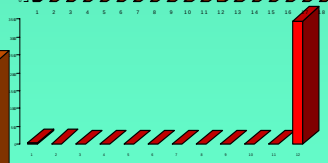


SPADEFOOT TOADS

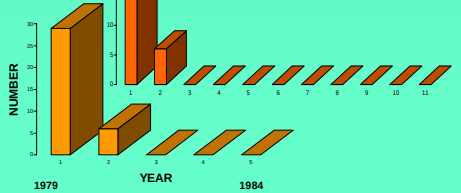




21 YEARS



11 YEARS



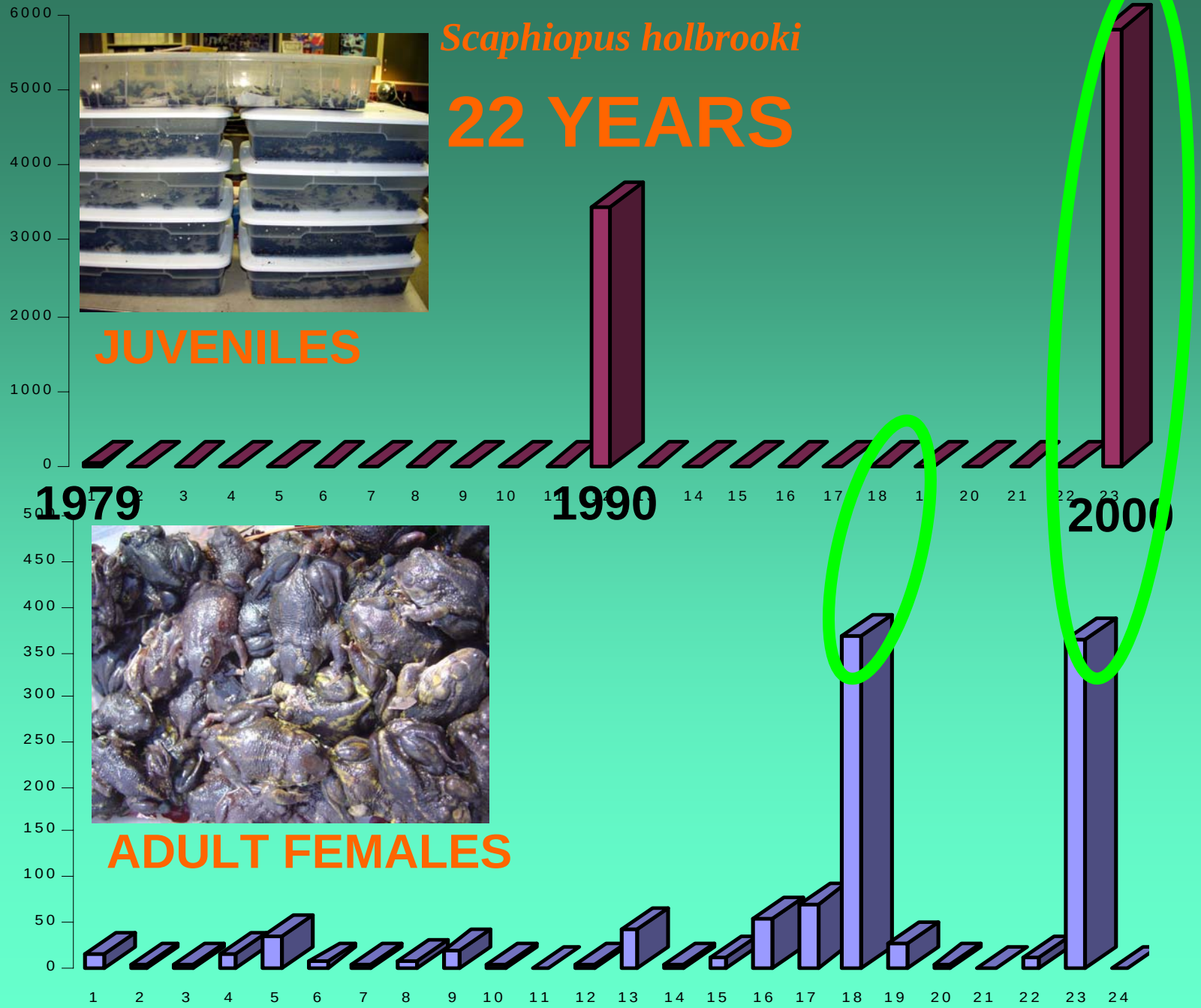
10 YEARS

5 YEARS

SPADEFOOT TOADS

Scaphiopus holbrooki

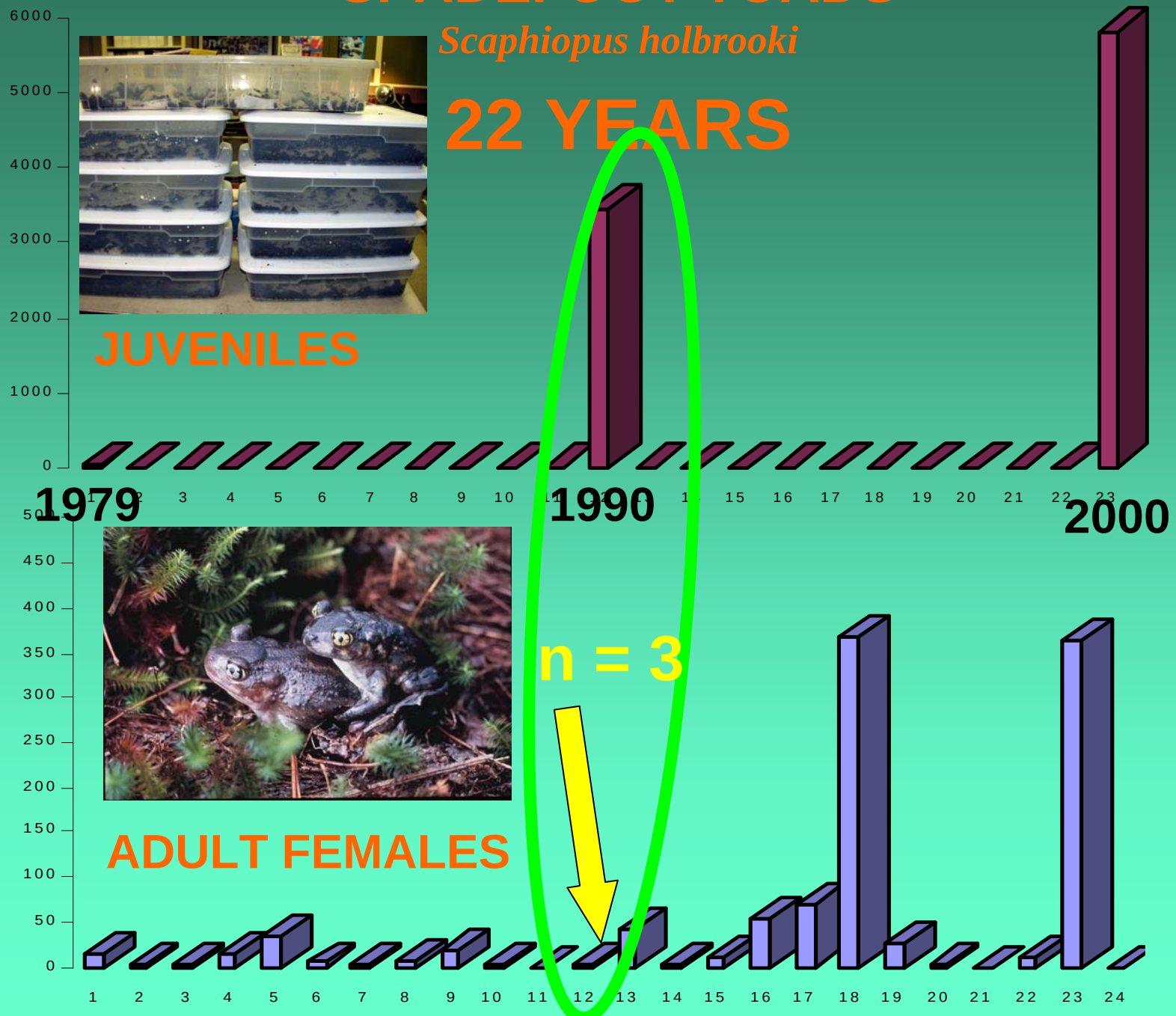
22 YEARS



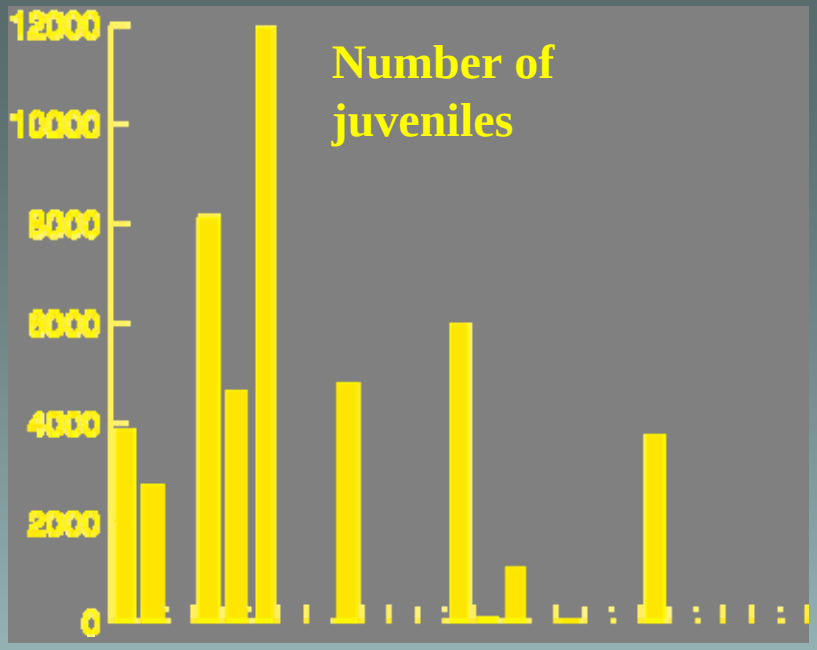
SPADEFOOT TOADS

Scaphiopus holbrooki

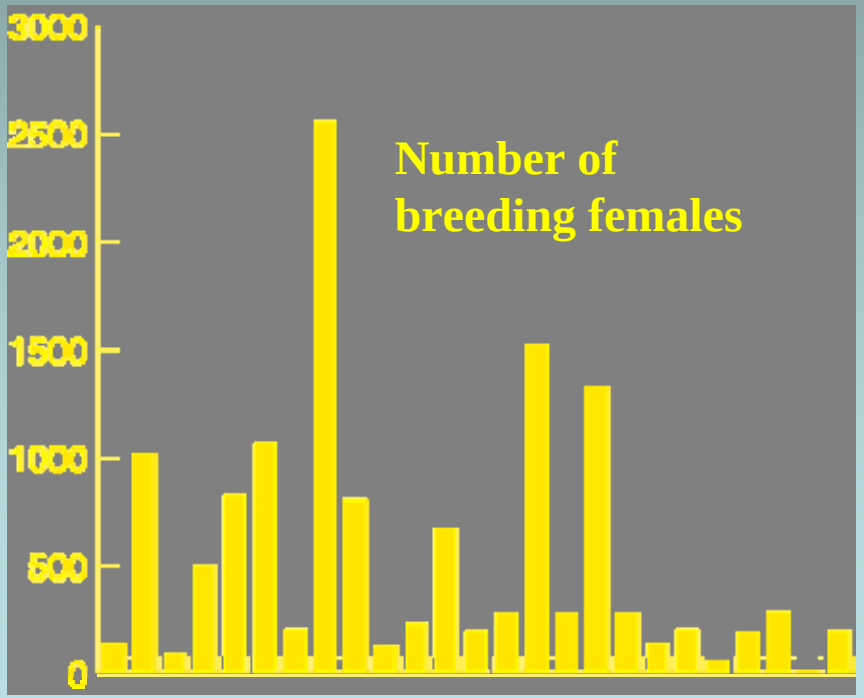
22 YEARS



Mole Salamanders

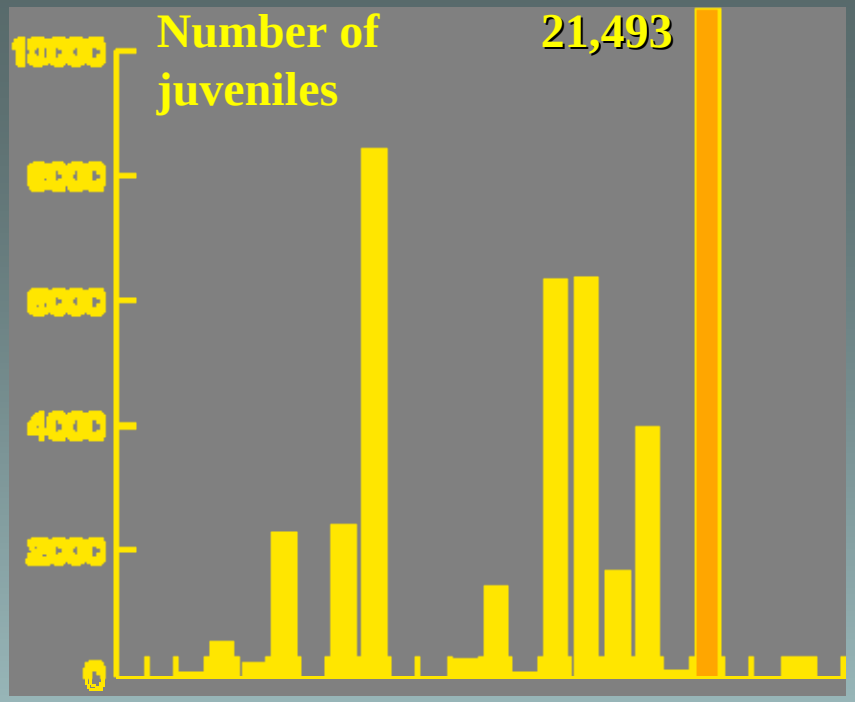


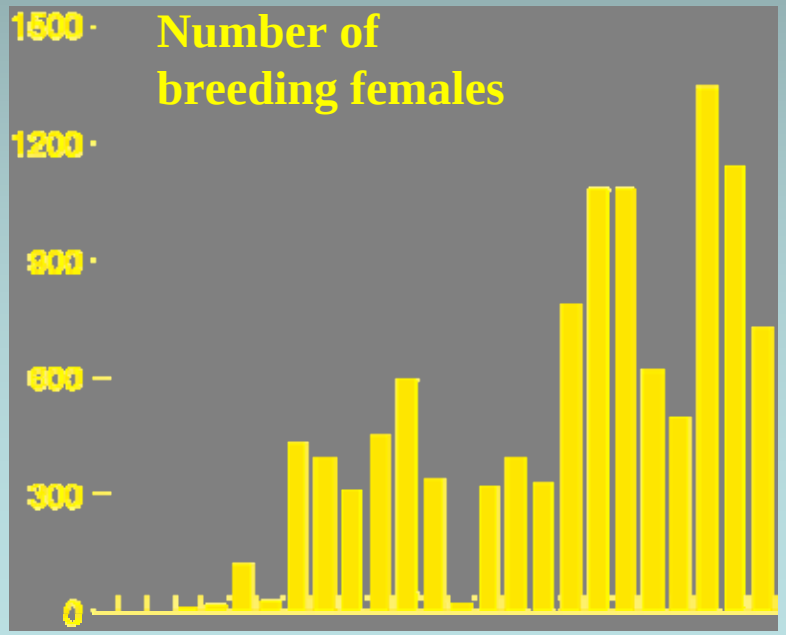
1979 2003



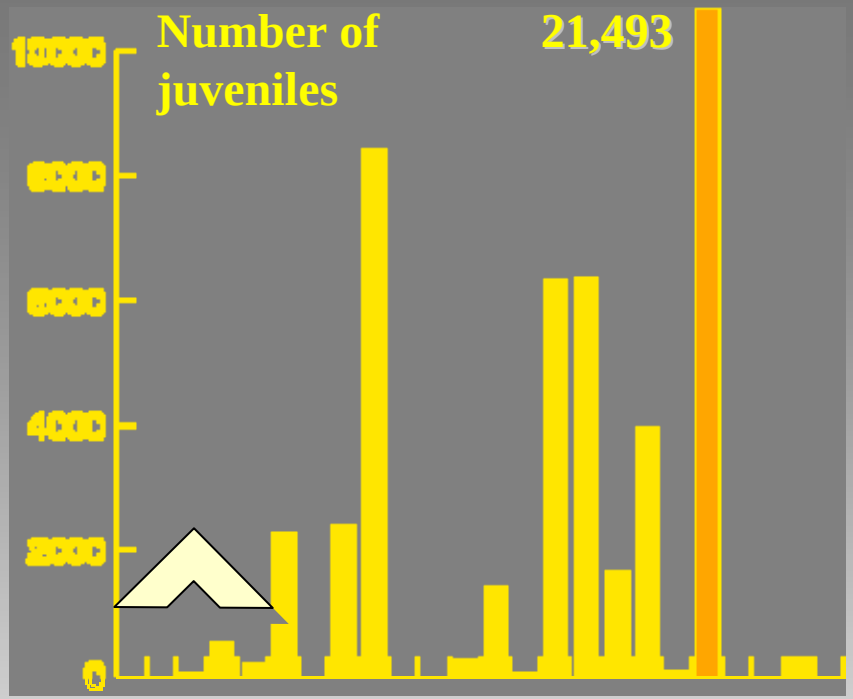
1979 2003

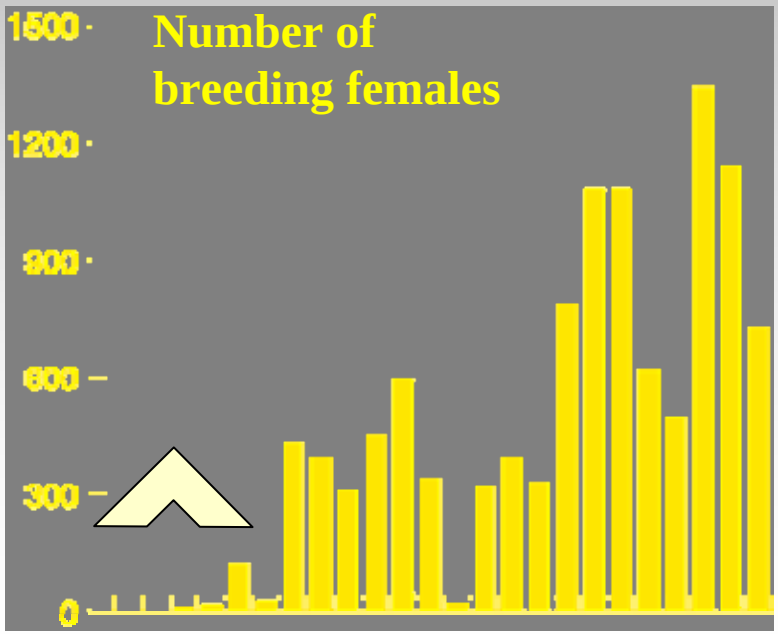
Marbled Salamanders





Marbled Salamanders

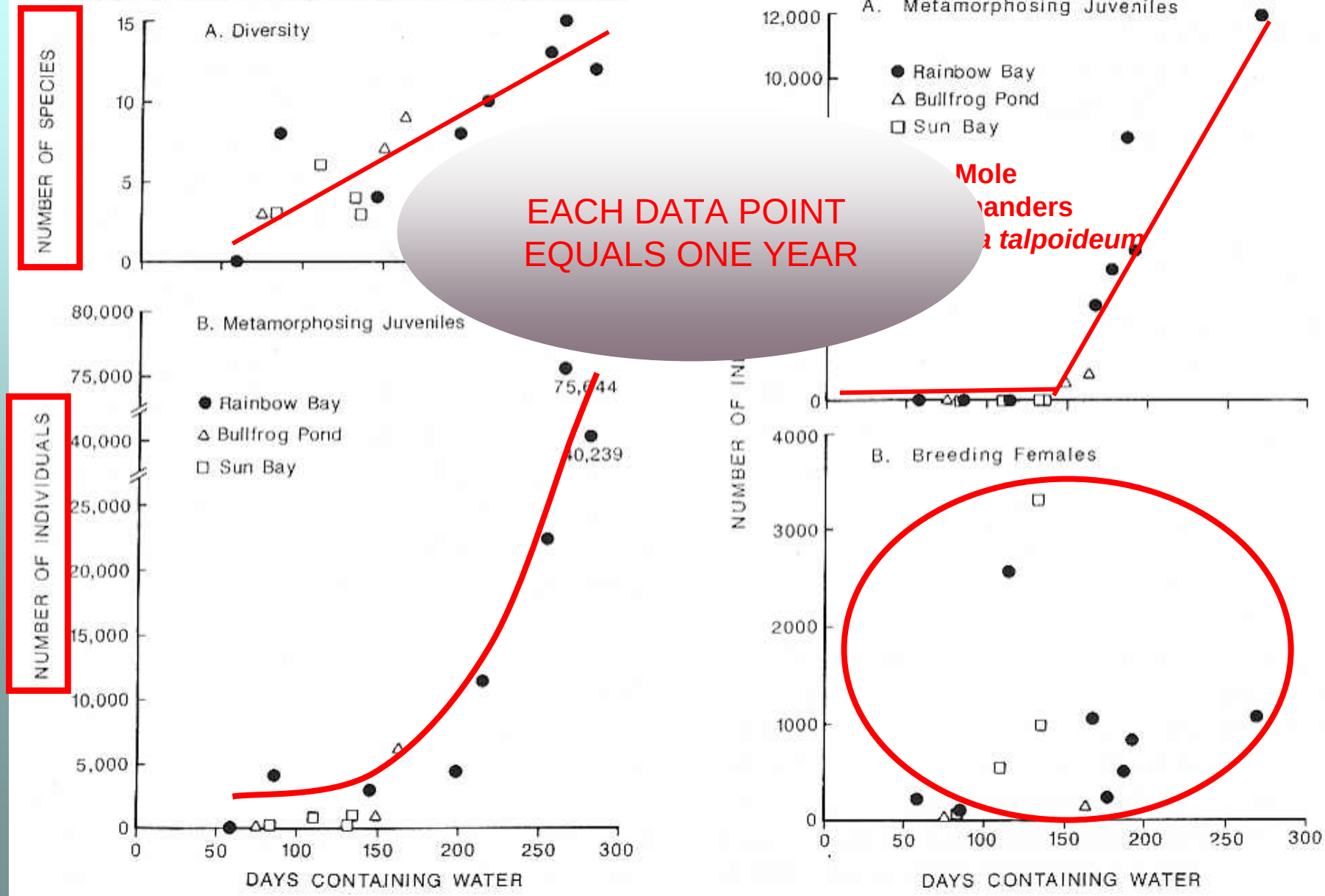




001301
Wetlands Ecology and Management, Vol. 1 no. 1 pp. 3-11 (1989)
SPB Academic Publishing, The Hague

Influence of wetland hydroperiod on diversity and abundance of metamorphosing juvenile amphibians

Joseph H.K. Pechmann, David E. Scott, J. Whitfield Gibbons and Raymond D. Semlitsch*
University of Georgia's Savannah River Ecology Laboratory, P.O. Drawer E, Aiken, SC 29802 U.S.A.

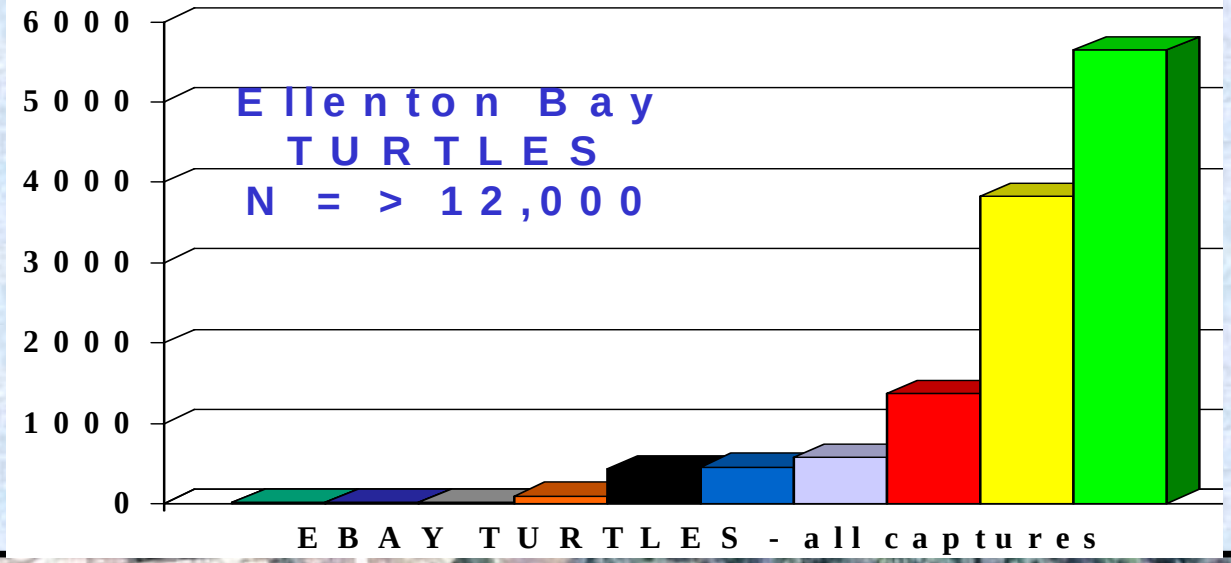


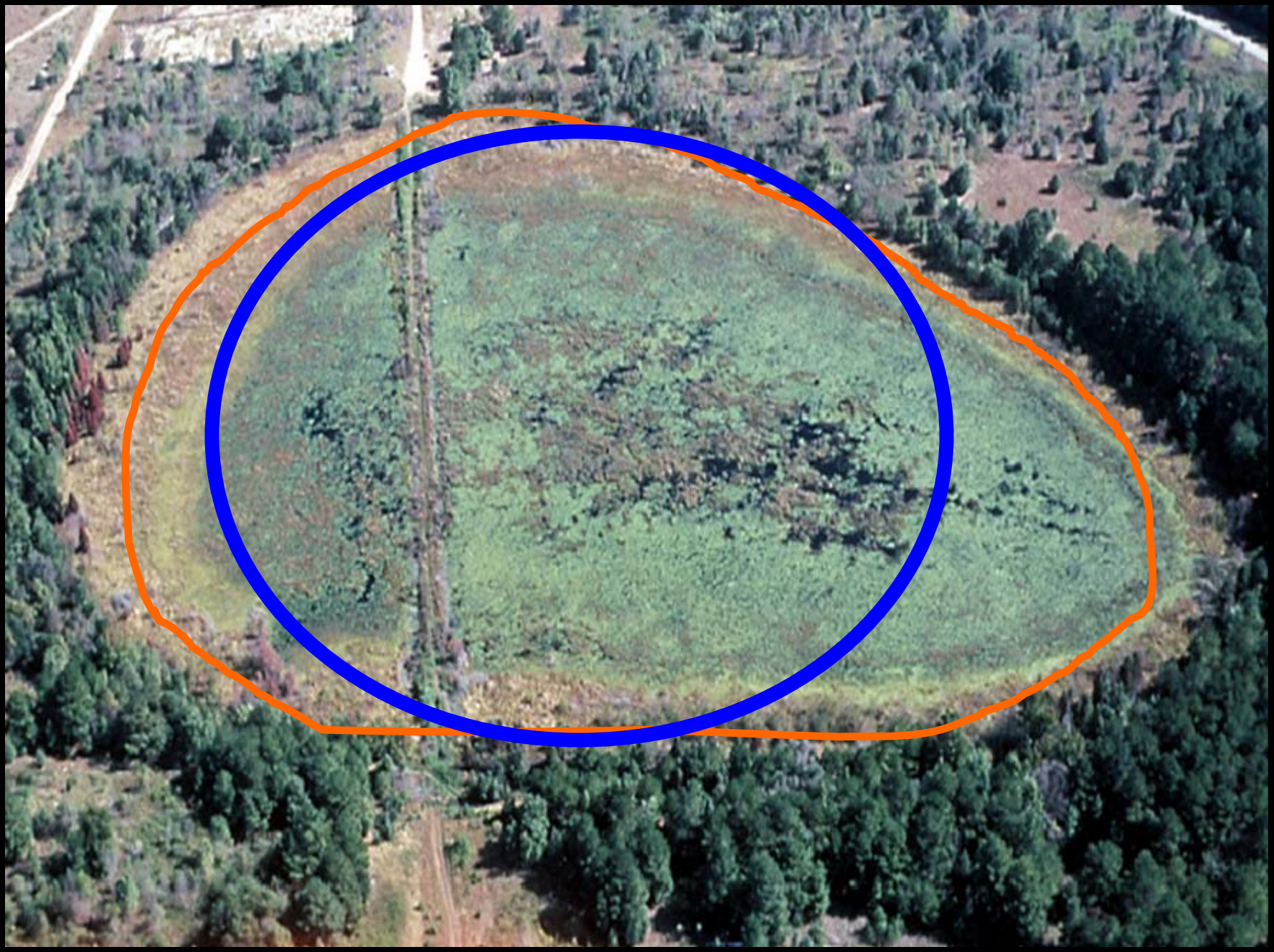
EACH DATA POINT
EQUALS ONE YEAR

Mole
anders
a talpoideum

Ellenton Bay, a Carolina bay on the Savannah River Site (SRS) in South Carolina, is an isolated wetland for which herpetofaunal records have been kept for 38 years.

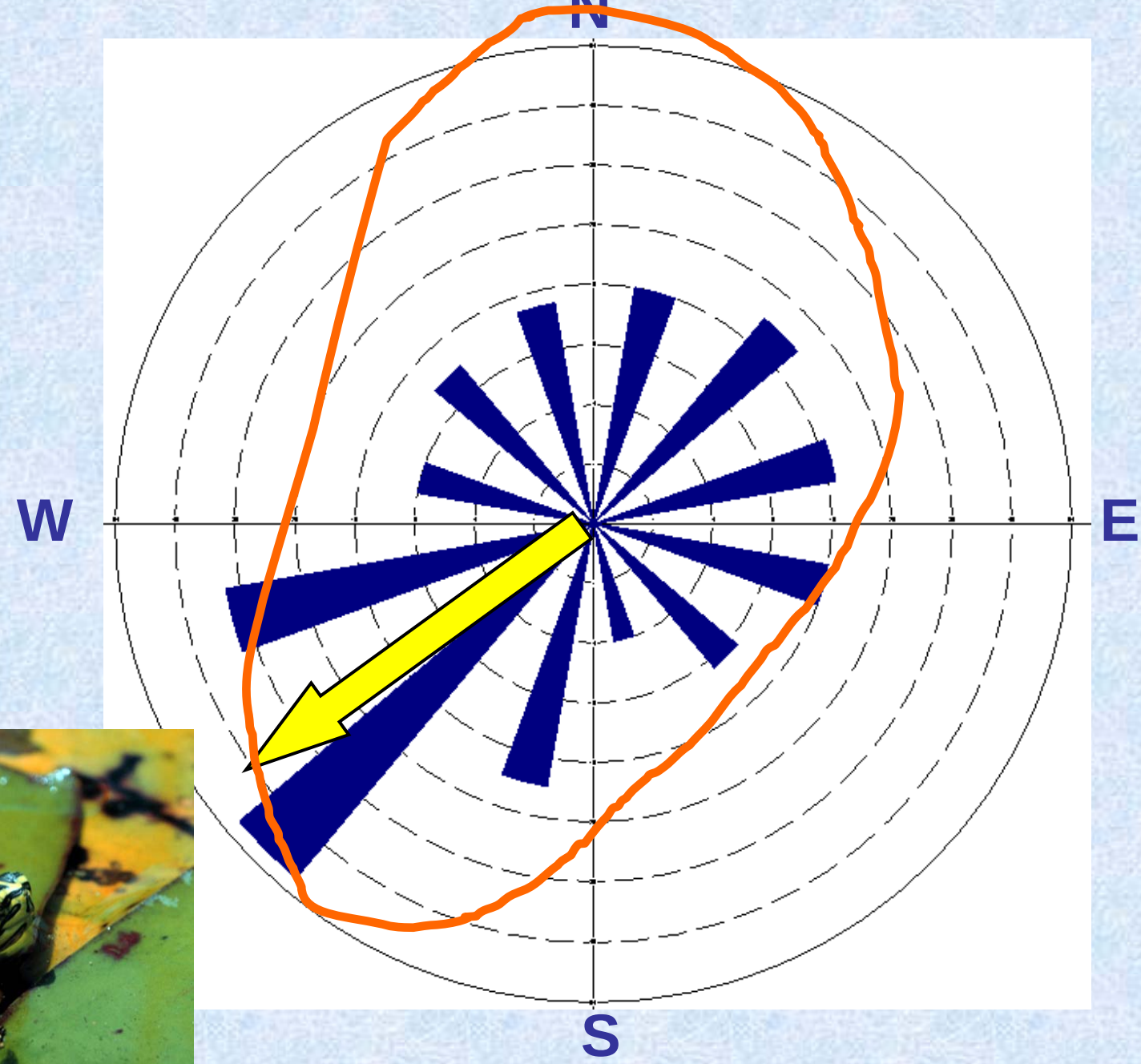
FRESHWATER TURTLE HABITATS


6000
5000
4000
3000
2000
1000
0
Ellenton Bay
TURTLES
N = > 12,000
EBAY TURTLES - all captures



NON-DROUGHT 5 years DISPERSE (no return) n = 231 46/yr

TURTLES LEAVING ELLENTON BAY

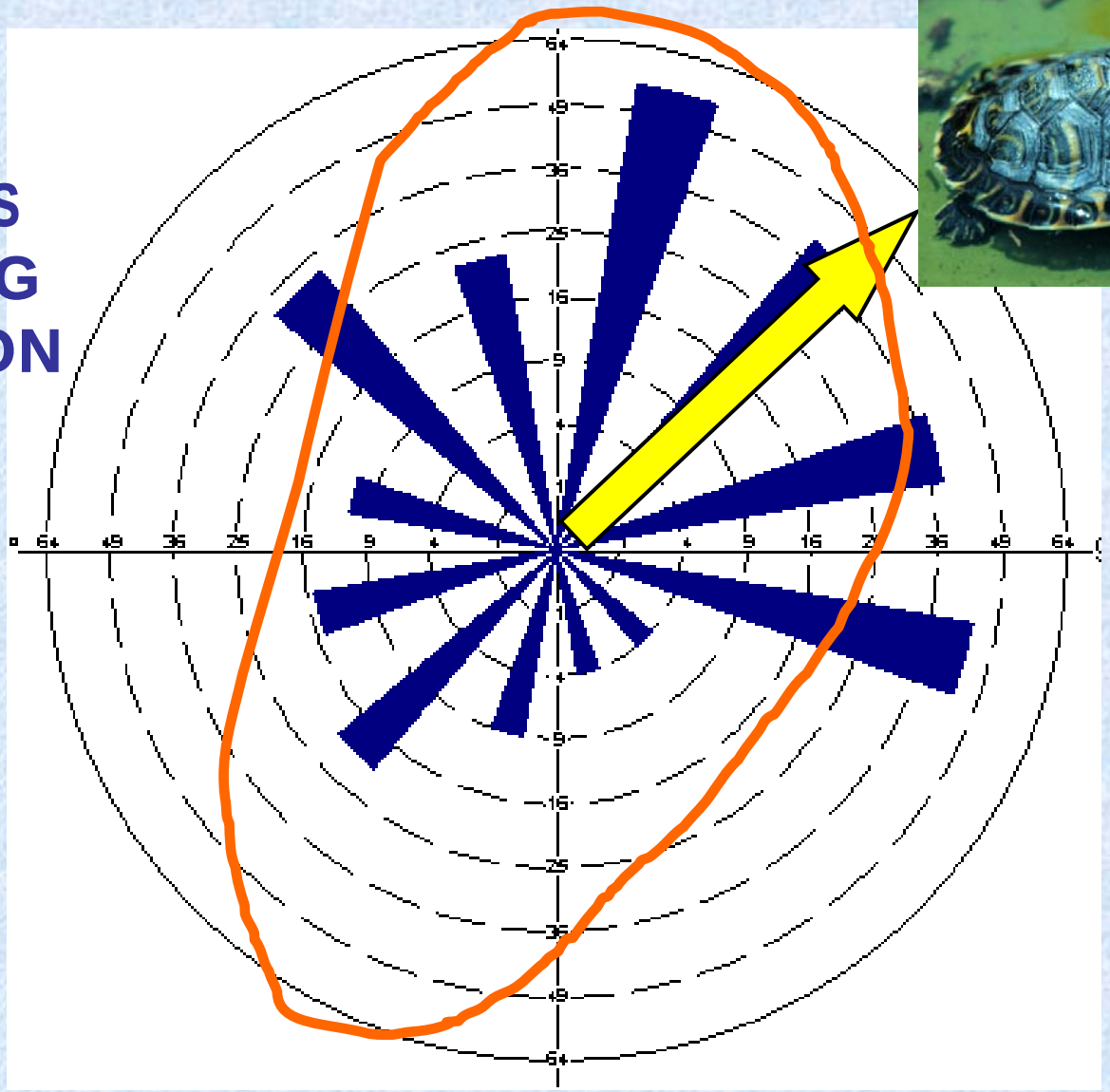


DROUGHT 1 year DISPERSE (no return) n = 293 293/yr

N

TURTLES LEAVING ELLENTON BAY

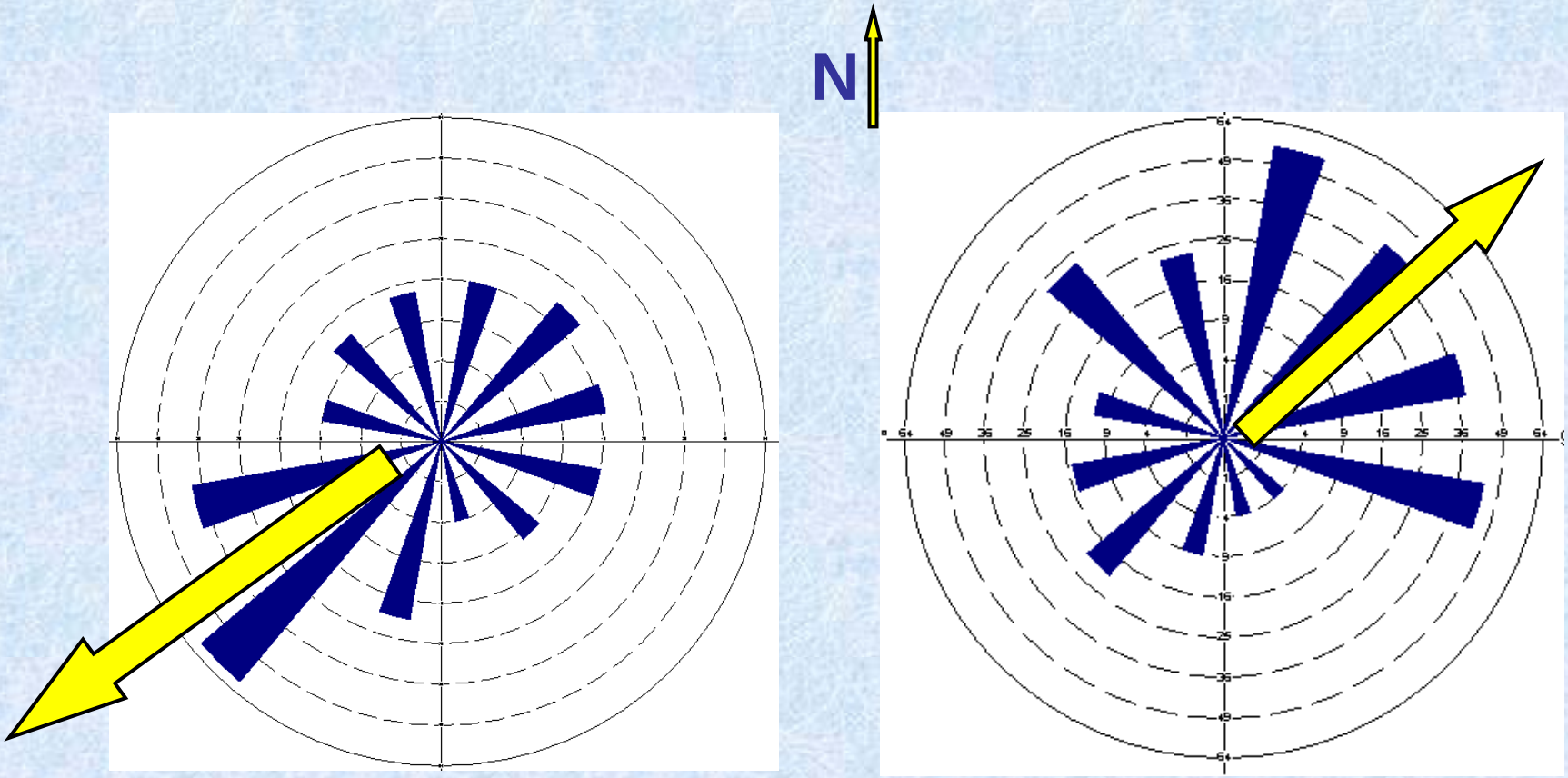
W



E

S

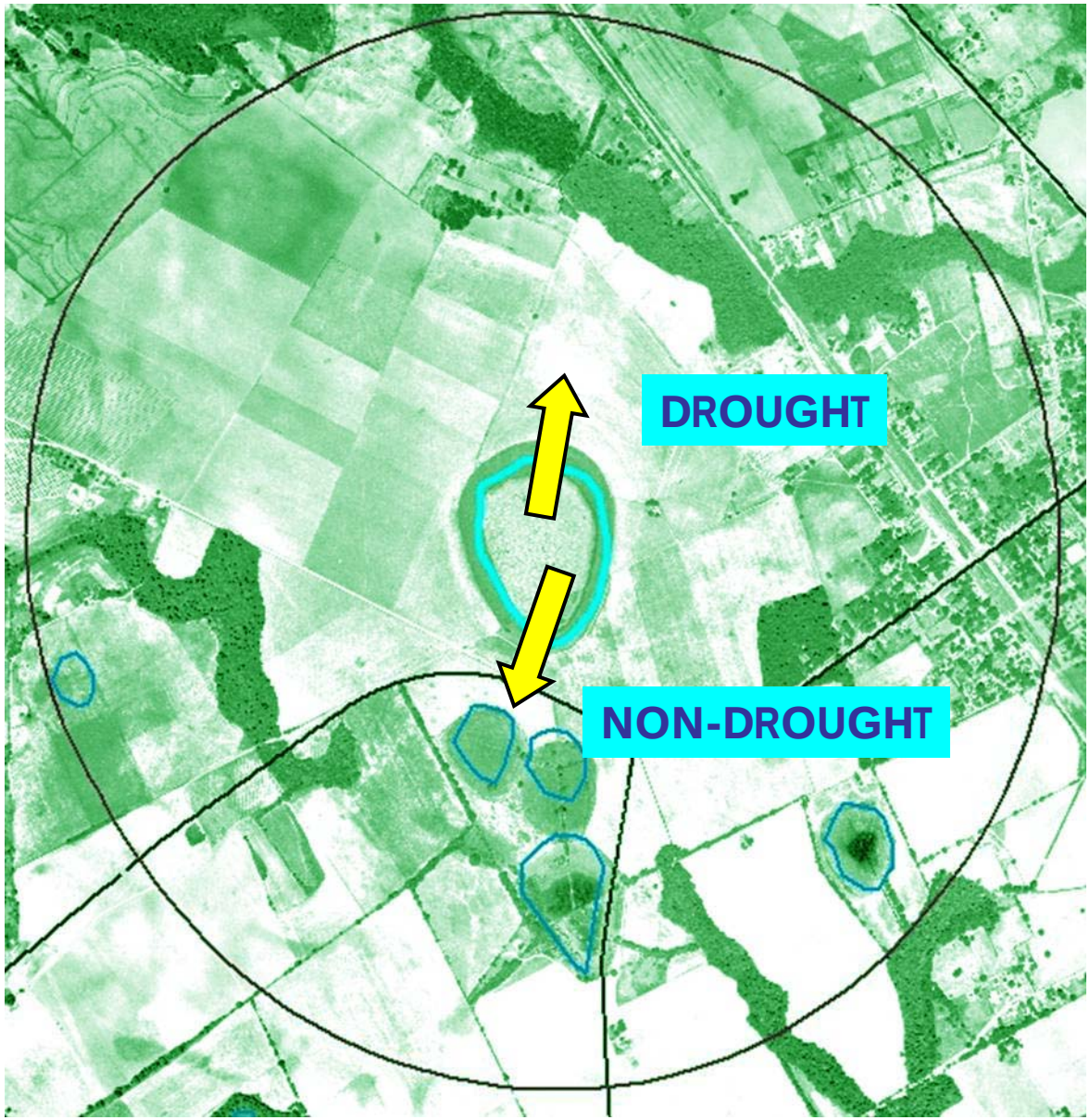
TERRESTRIAL DISPERSAL BY ELLENTON BAY TURTLES



231 in 5 years

293 in 1 year

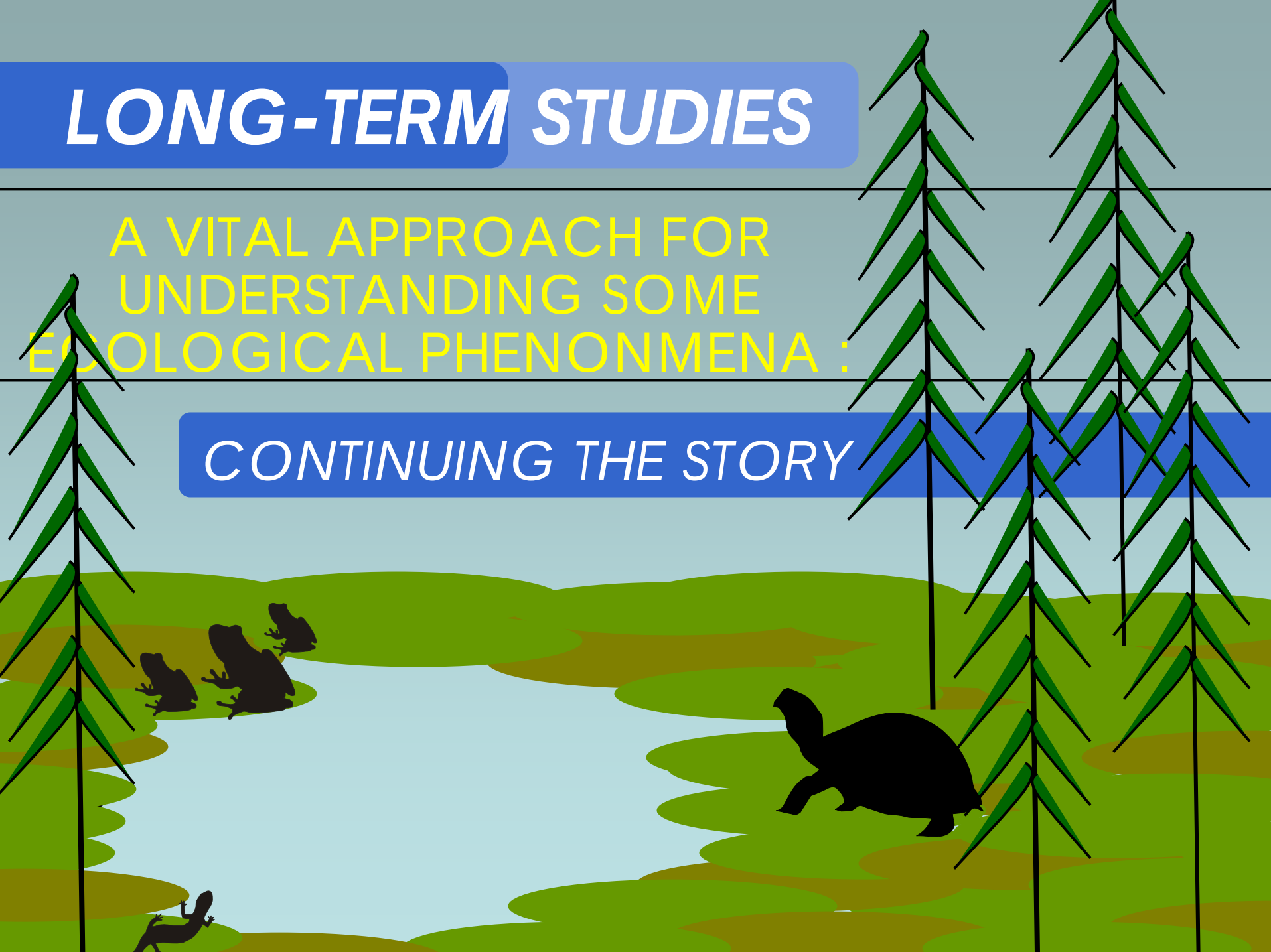
ELLENTON BAY METAPOPULATION



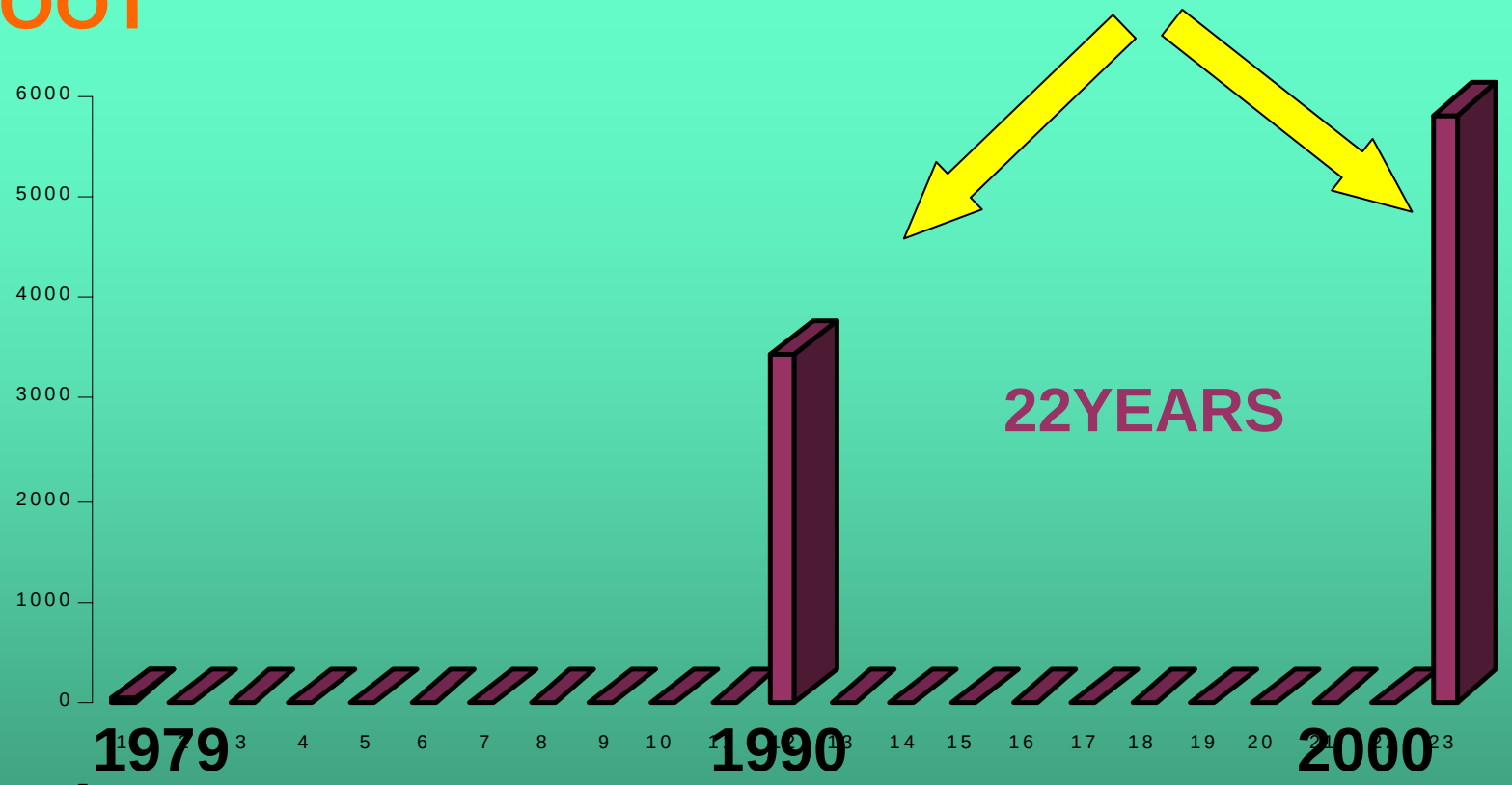
LONG-TERM STUDIES

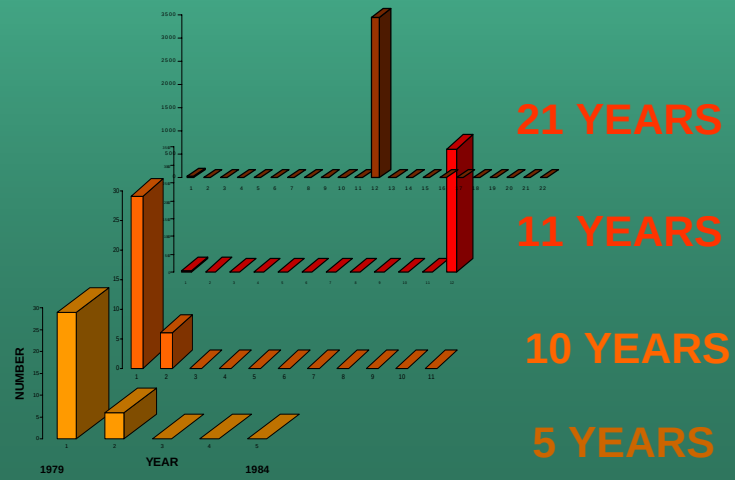
A VITAL APPROACH FOR UNDERSTANDING SOME ECOLOGICAL PHENONMENA :

CONTINUING THE STORY

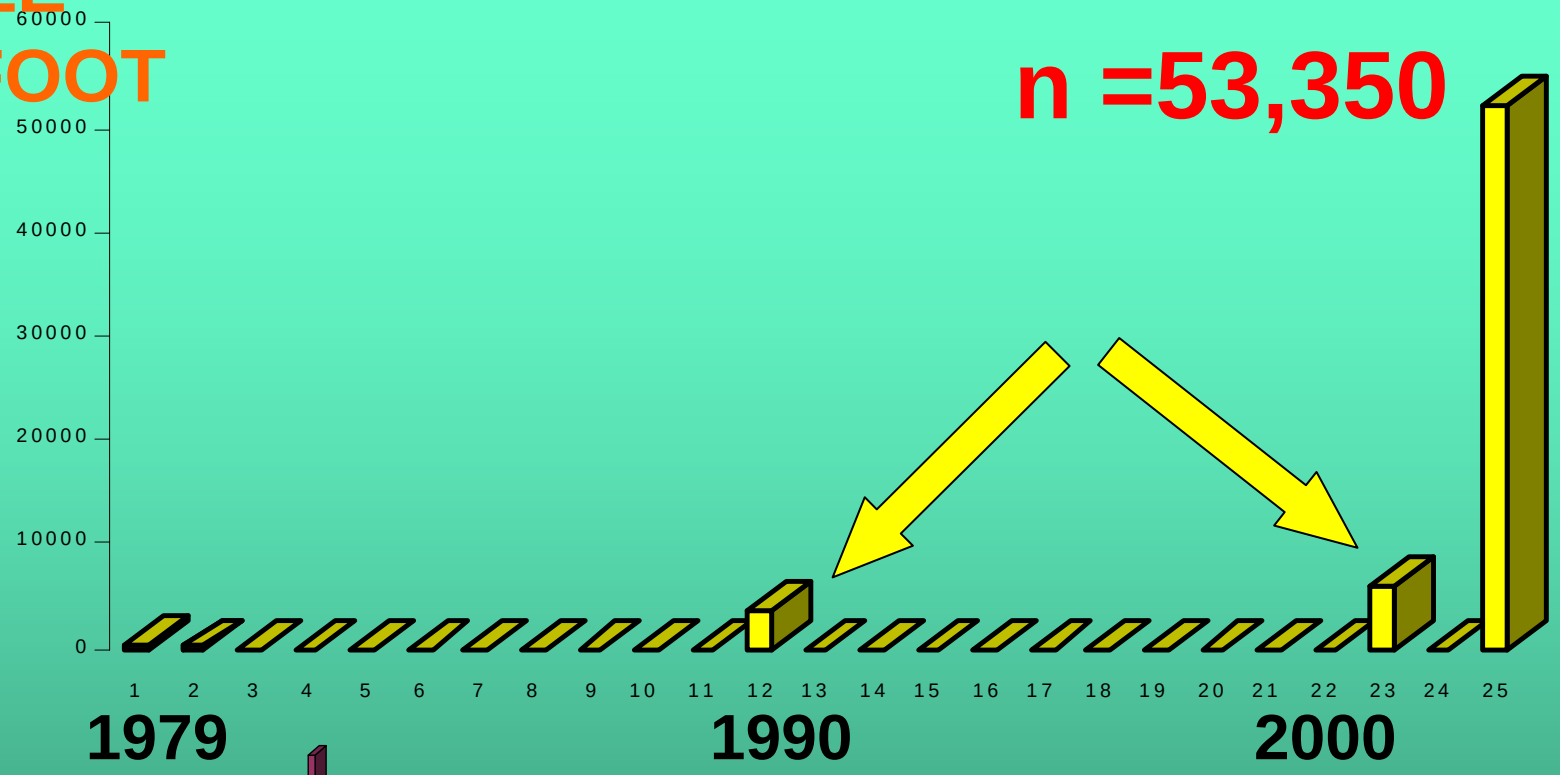


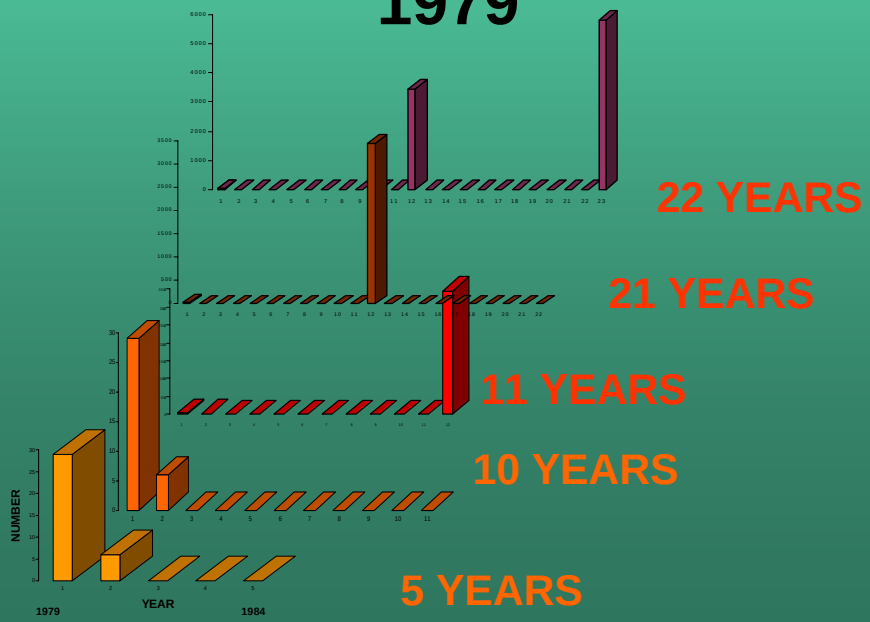
JUVENILE SPADEFOOT TOADS





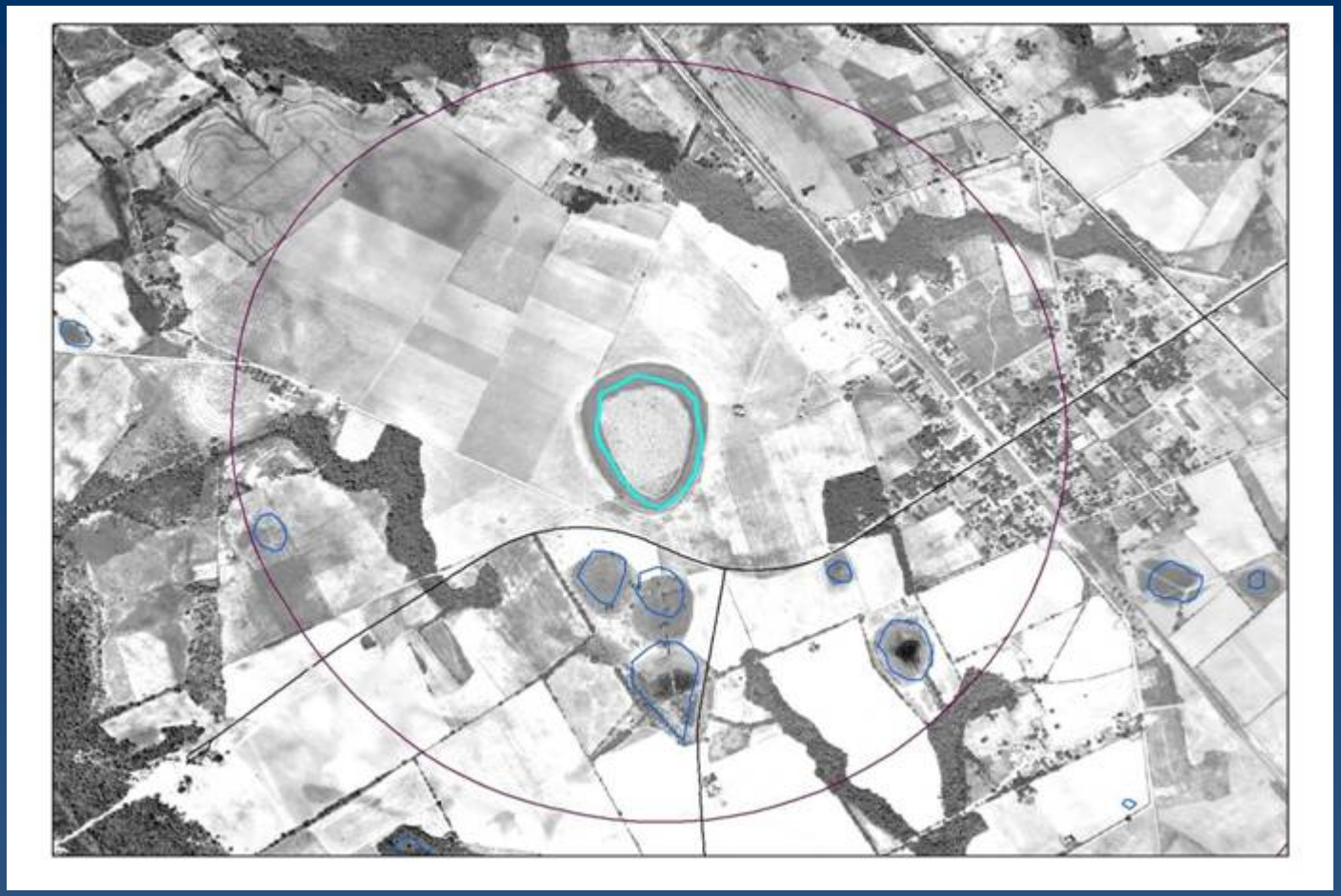
JUVENILE SPADEFOOT TOADS



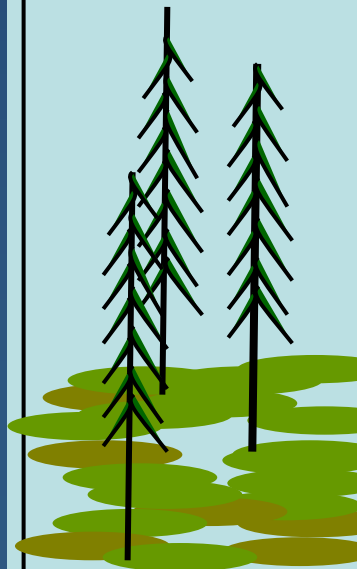


HOW PRODUCTIVE CAN A WETLAND BE ?

HOW PRODUCTIVE CAN A WETLAND BE ?



Fifty years ago the wetland would have been assessed as degraded because of its location in the center of several hundred acres of cotton and corn fields.



However, with the establishment of the SRS, the wetland is now protected and has since been reforested around the margins.

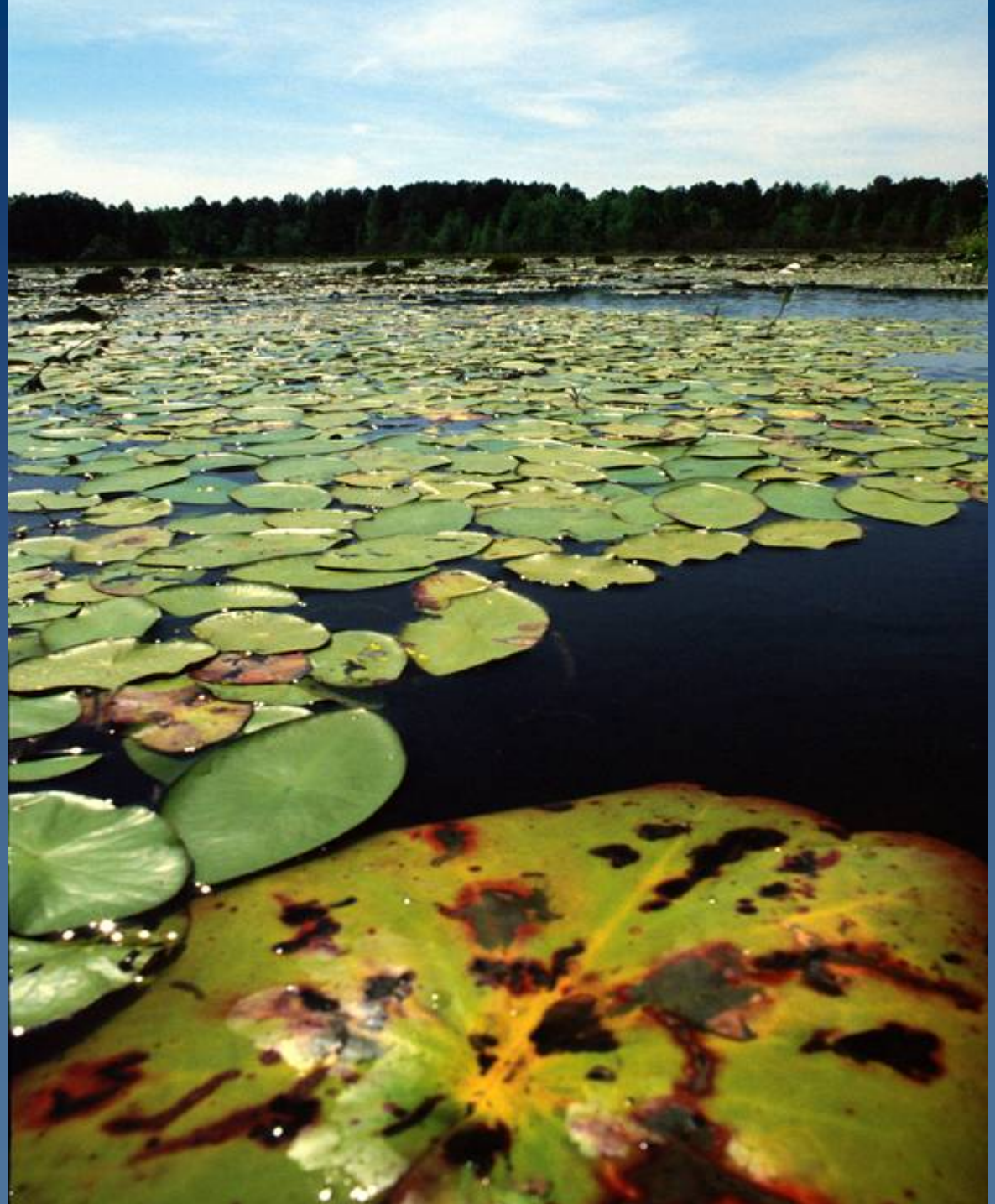
Questions

How productive can a formerly degraded wetland be?

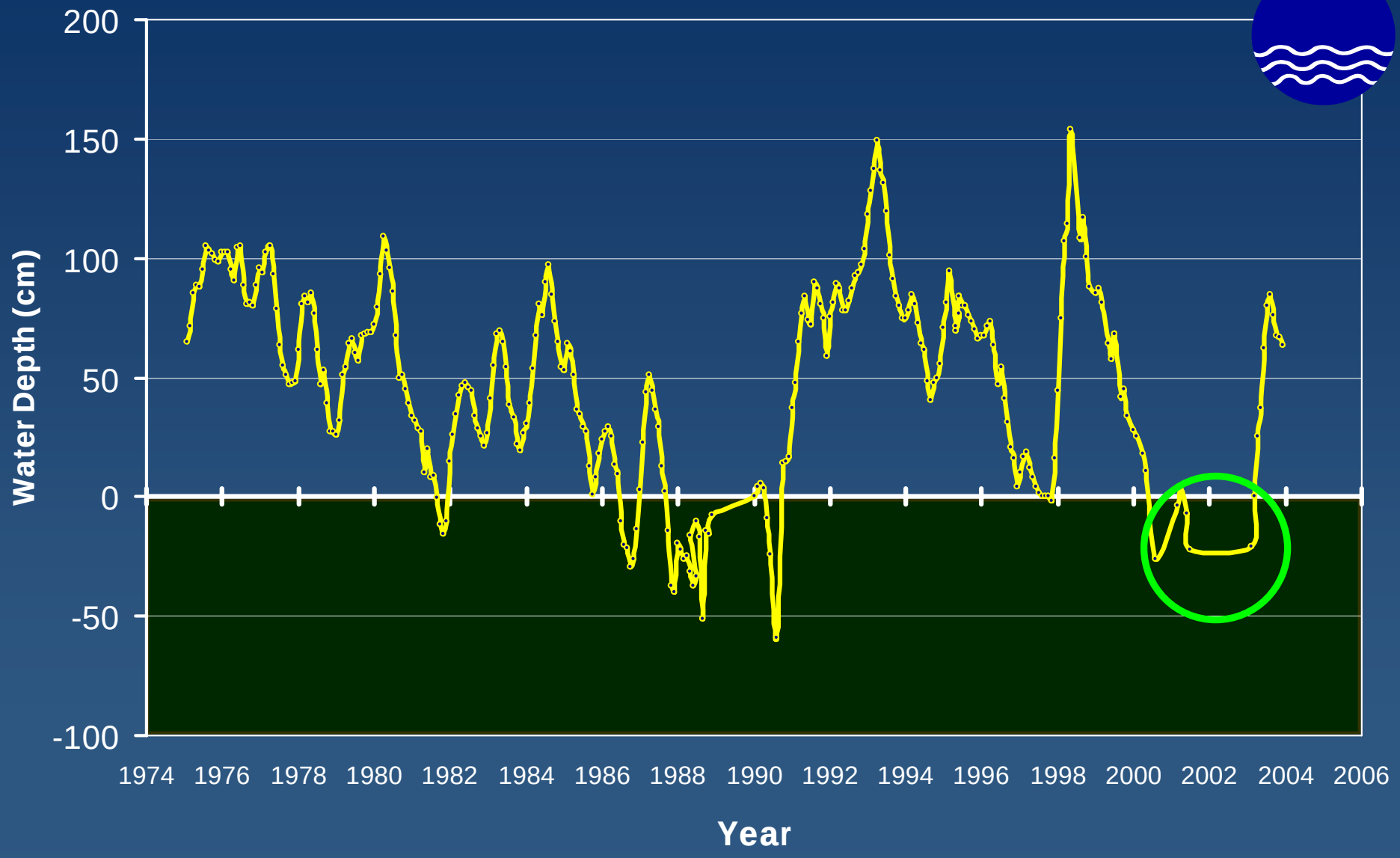
What conclusions can be made about such a recovery?

What factors contribute to these types of recoveries?

How critical are metapopulation processes to a wetland community's success?



Ellenton Bay Water Level

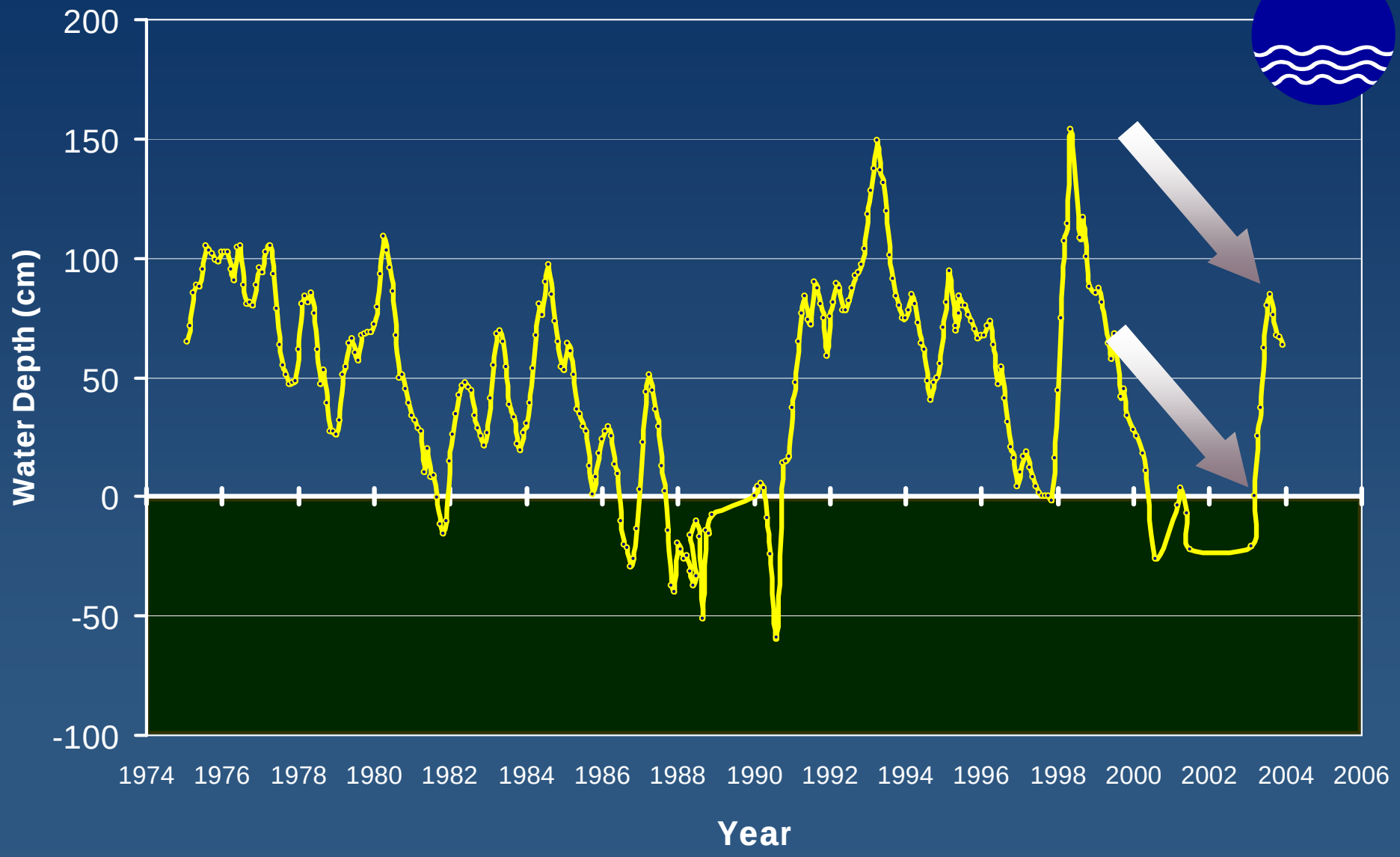


REINSTALLATION OF ELLENTON BAY

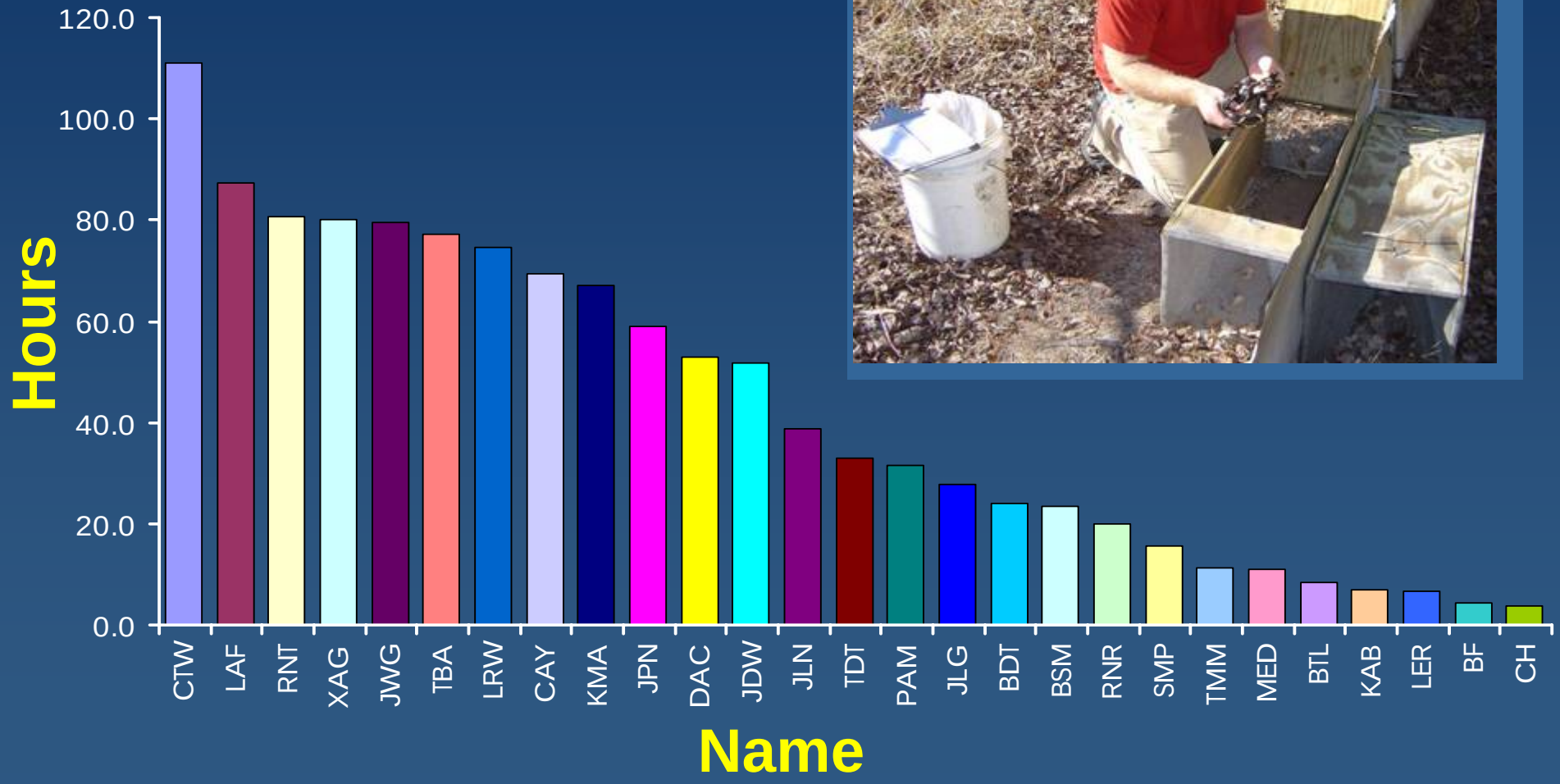
MORE THAN A THIRD OF A CENTURY

In 2003, Ellenton Bay was encircled by a drift fence with pitfall and funnel traps that were checked at least twice daily for a full year

Ellenton Bay Water Level



Hours and Hours at Ellenton Bay



ELLENTON **BAY**

Traps checked at least daily from 1 February 2003 to 31 January 2004

Number of amphibian species = 24
Number of reptile species = 35

Total Captures

Reptiles = 1100

Amphibians = 407,943

Common Species

Southern toad
Bufo terrestris
115,056 produced

Southern Leopard Frog
Rana sphenocephala
232,069 produced

Common Species

Black Swamp Snake
Seminatrix pygaea
138 individuals

Mole Salamander
Ambystoma talpoideum
8463 produced

Common Species

Ornate chorus frog
Pseudacris ornata
3126 produced

Cottonmouth
Agkistrodon piscivorus
115 captures

And Rarer Species

Gopher Frog
Rana capito
3 individuals

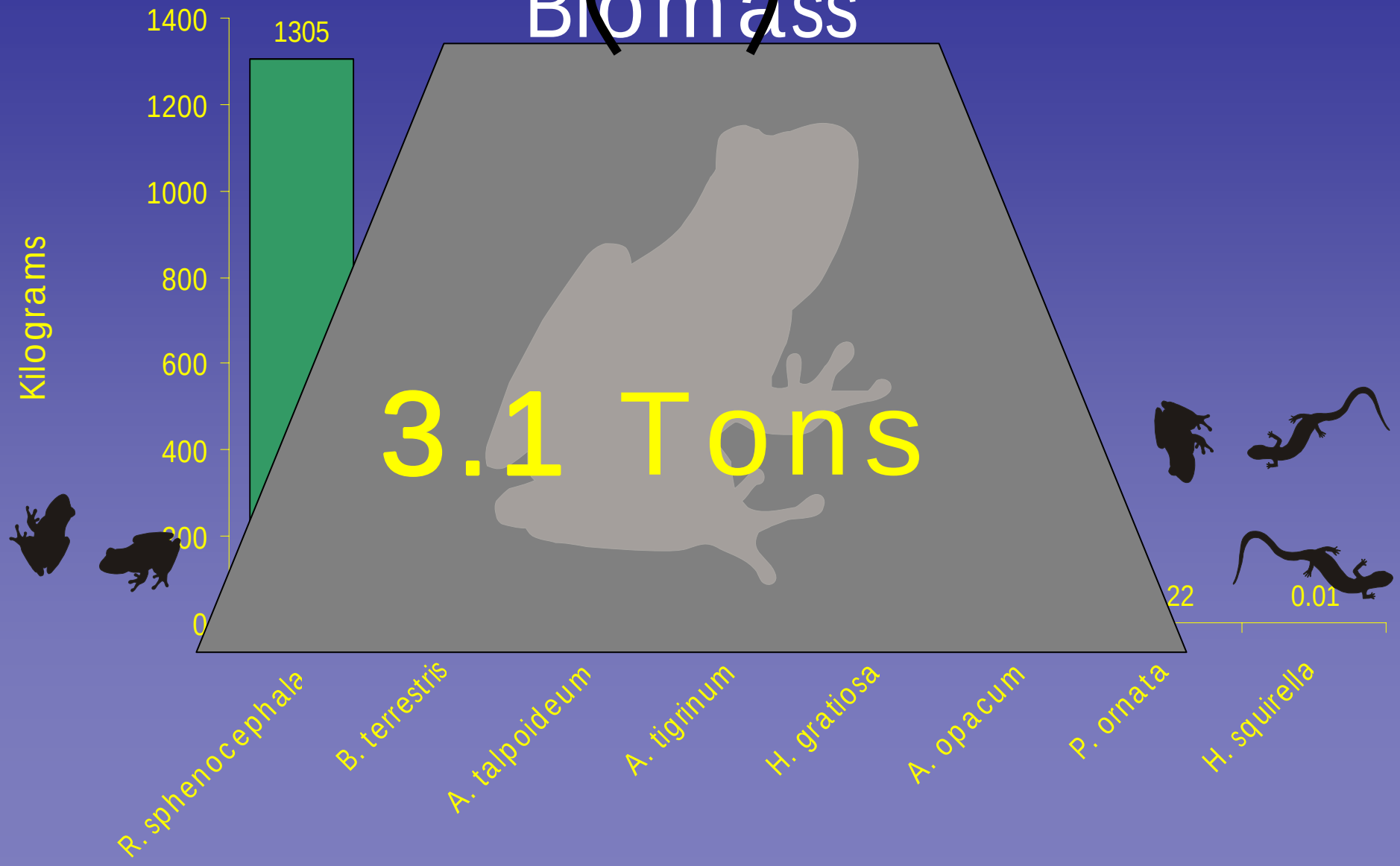
Chicken Turtle
Deirochelys reticularia
16 individuals

And Rarer Species

Rainbow snake
Farancia erytrogramma
7 individuals

Dwarf salamander
Eurycea quadridigitata
18 captures

2003 EBAY Amphibian Biomass



The Pros and Cons of Long-Term Ecological Research

THE CONS

COMMITMENT

PATIENCE

UNEXPECTED REVELATIONS

The Pros and Cons of Long-Term Ecological Research

THE PROS

UNDERSTANDING OF ECOSYSTEM

SCIENCE-BASED DECISION MAKING

KNOWLEDGE OF THE NATURAL WORLD

Special Acknowledgments

SREL Graduate Students

Kimberly Andrews
Gabrielle Graeter
Tracey Tuberville
Lucas Wilkinson
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Ria Tsaliagos
Tom Luhring
Brian Metts
Brian Todd
Chris Winne

J. D. Willson
David E. Scott
Jeff Harris

The State of the Colorado River Ecosystem in Grand Canyon

Define adaptive management

Define goal of the Glen Canyon effort

Compare SRS and Glen Canyon – geographically, hydrologically (meteorologically), geologically, --

so what do they have in common? -- science-based decision making?

So what can long-term studies by SREL contribute to a better

"...benefits to society including ....habitat for unique organisms such as native fishes..."

"The need for credible scientific information that can serve as a feedback loop between management actions and the effects of those actions is of critical importance in adaptive management."

Our questions

One of the key questions in ecology is what determines the distribution and abundance of organisms.

Why is one species common and another rare?

Why is one species present here and another there?

Only by knowing answers to this basic question about the animal and plant species and communities comprising an ecosystem can we have any idea of what the effect of our activities will have on them.

The native species composition of any area is a vital and fundamental part of the people who inhabit or visit such an area.

Beyond the more basic needs we have for food, water, clothing shelter, many of us have recreational, cultural, and esthetic needs that transcend these basic requirements.

Many of these needs depend on a knowledge that local fauna and flora can persist despite our environmental alterations to achieve other societal goals.

Knowing that the same native species are present as when our ancestors arrived offers a spiritual comfort that many people aspire to, that offers a solace that precedes our modern needs for technological advancements and artificial backdrops.

I realize this is only one of the components of adaptive ecosystem management.

But this is the one I work with and the one my examples of long-term study must come from.

CONCLUSIONS

Wetland communities can recover from agricultural uses

Wetland communities can recover from natural droughts

Terrestrial features are critical for maintaining metapopulation connectivity