

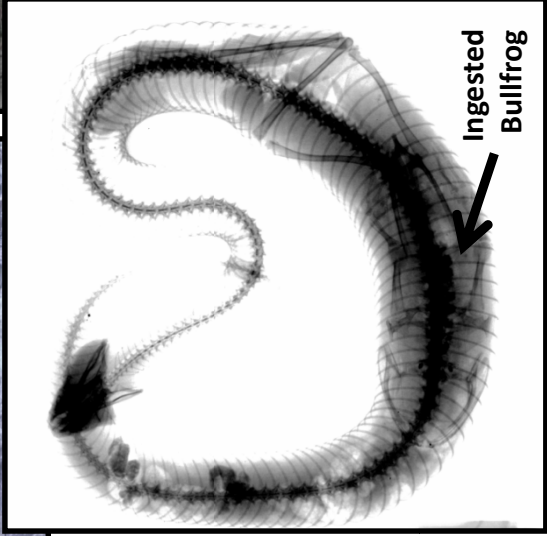
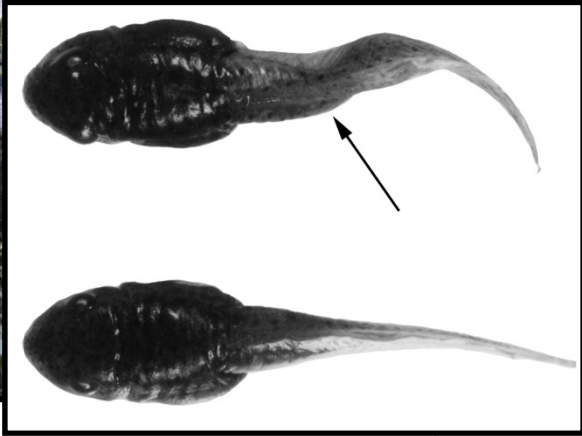
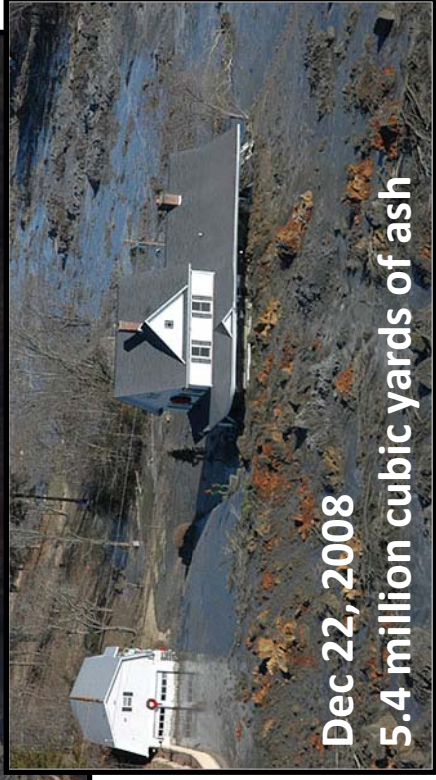
# Reproduction in Aquatic & Terrestrial Wildlife Following Remediation of the TVA Coal Ash Spill in Kingston, TN



**William Hopkins<sup>1</sup> Michelle Beck<sup>1</sup> David Steen<sup>1</sup>  
James Van Dyke<sup>1</sup> Dana Hawley<sup>1</sup> Brian Jackson<sup>2</sup>**

<sup>1</sup>

# Effects of Coal Combustion Byproducts on Wildlife Physiology, Behavior, and Reproduction





# Timeline of events



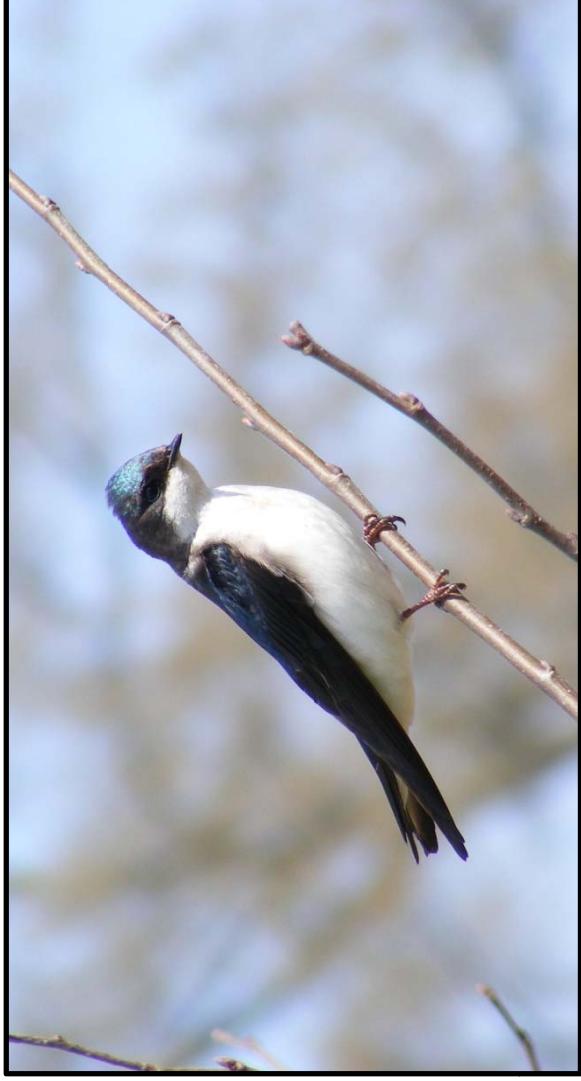
# Overarching Objectives

1. Following remediation, are wildlife exposed to trace elements?
2. Following remediation, do wildlife maternally transfer trace elements to their eggs?
3. Do trace elements affect physiology, behavior, or **\*reproductive success of wildlife post-remediation?**

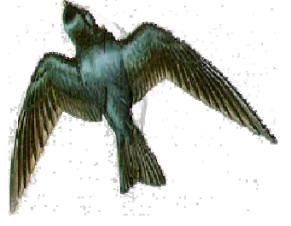
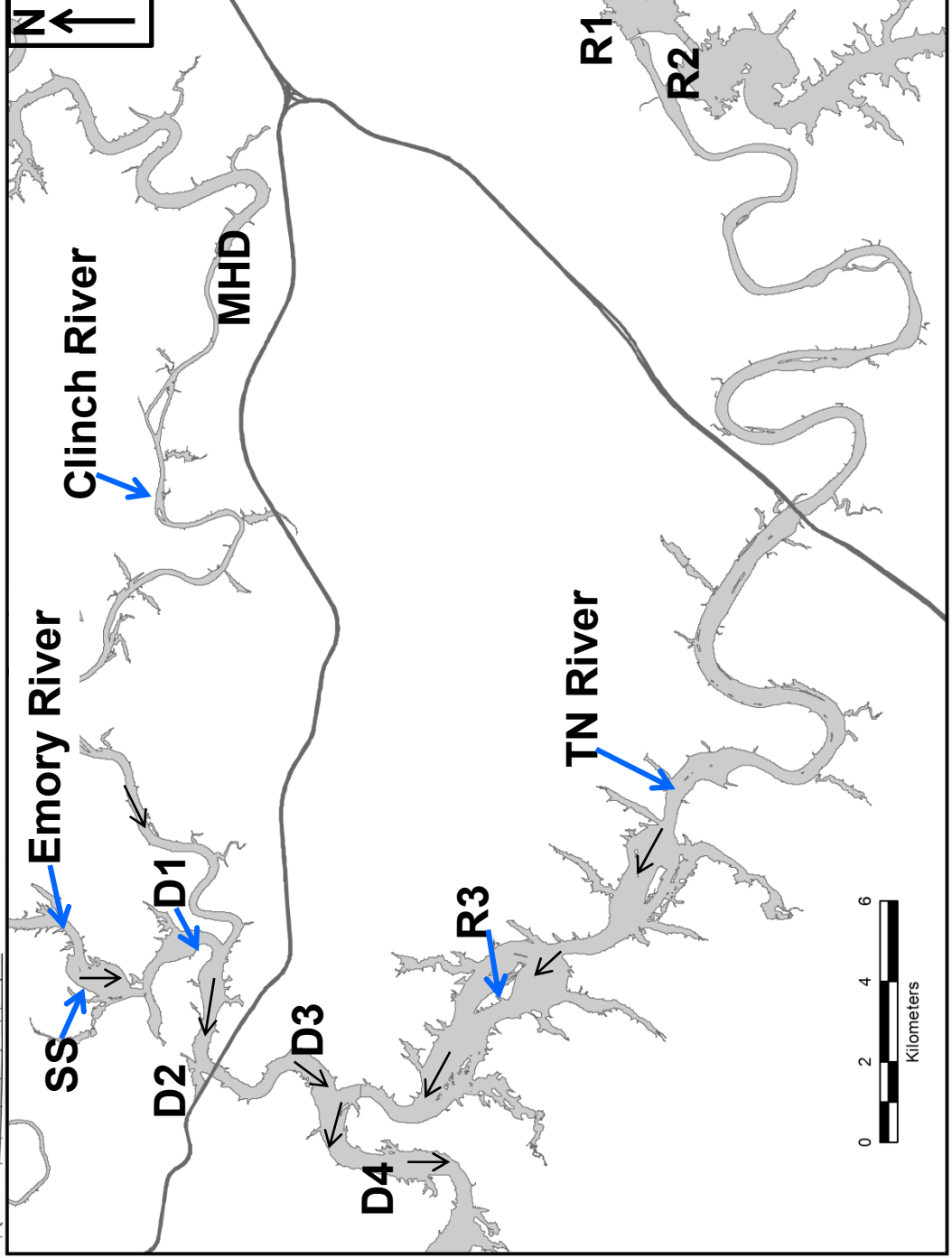


# Why tree swallows?

1. Well studied in the wild
2. Large sample sizes are possible
3. Link between aquatic and terrestrial ecosystems
  - Feed heavily on emerging aquatic insects
4. Used in other ecotoxicological studies



# Tree swallow study area





# Methods for 2011 & 2012

- Monitored  $\approx$  500 nest boxes daily
- Mist-net adults or trap in nest box
- Basic reproductive parameters-clutch size, hatching & fledging success
- Measured, banded and bled adults & nestlings
- Collected 1 fresh egg from each clutch, blood and diet samples-quantified concentrations of 20 elements
- Focus today on As, Hg, Se, & Sr



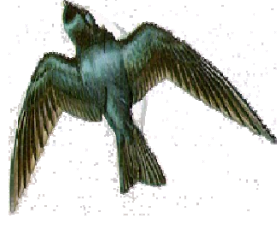
# Tree swallows sampling effort 2011 & 2012

**Monitored 1121 nests**

**Banded 3699 tree swallows**

**Collected 473 food samples**

**Collected 881 fresh eggs**





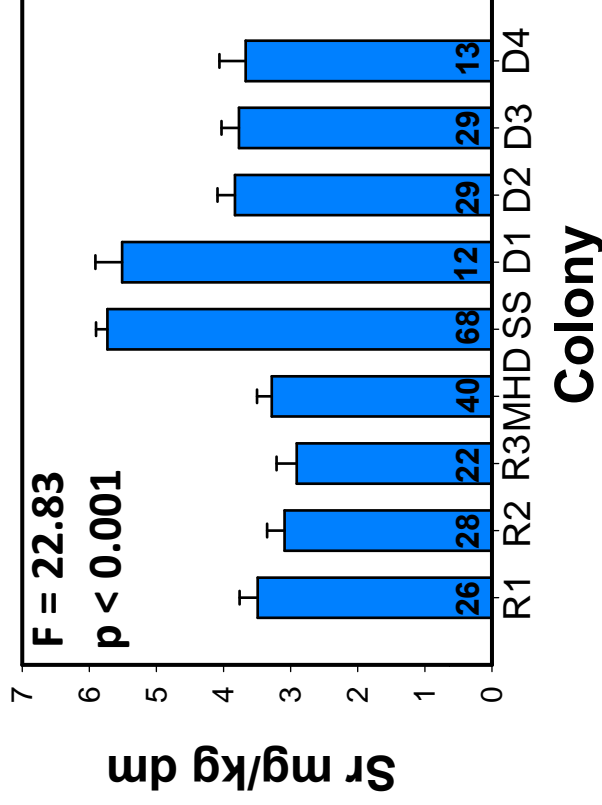
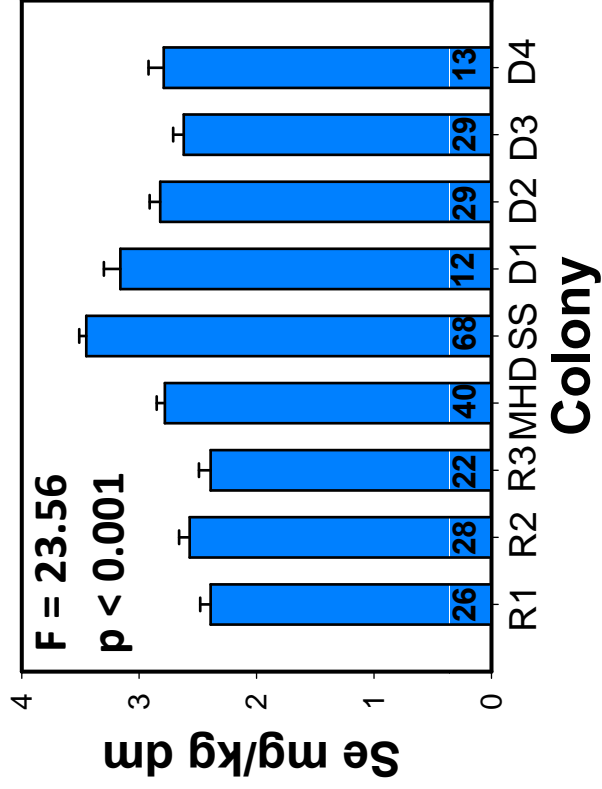
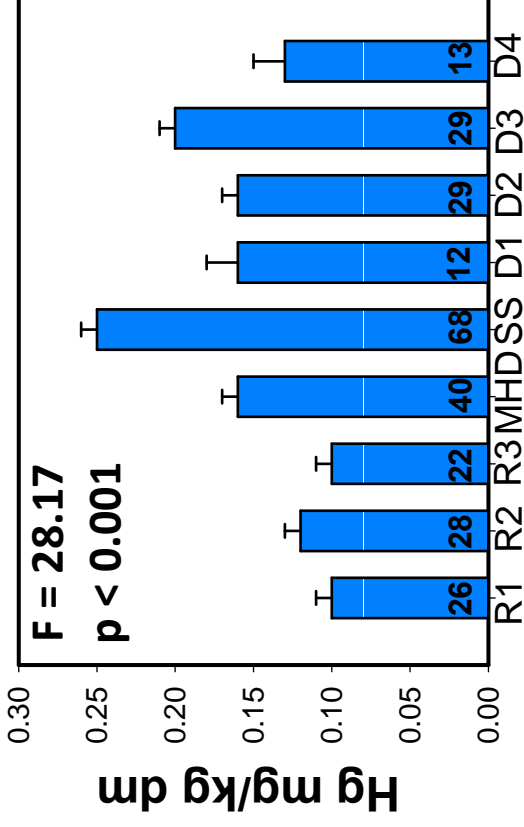
# Questions

- 1. After remediation, are trace elements being transferred to eggs? Does maternal transfer of trace elements affect tree swallow reproductive success?**
- 2. After remediation, are nestling tree swallows being exposed to elevated concentrations of trace elements in their diet?**
- 3. After remediation, does trace element exposure affect nestling growth and fledging success?**

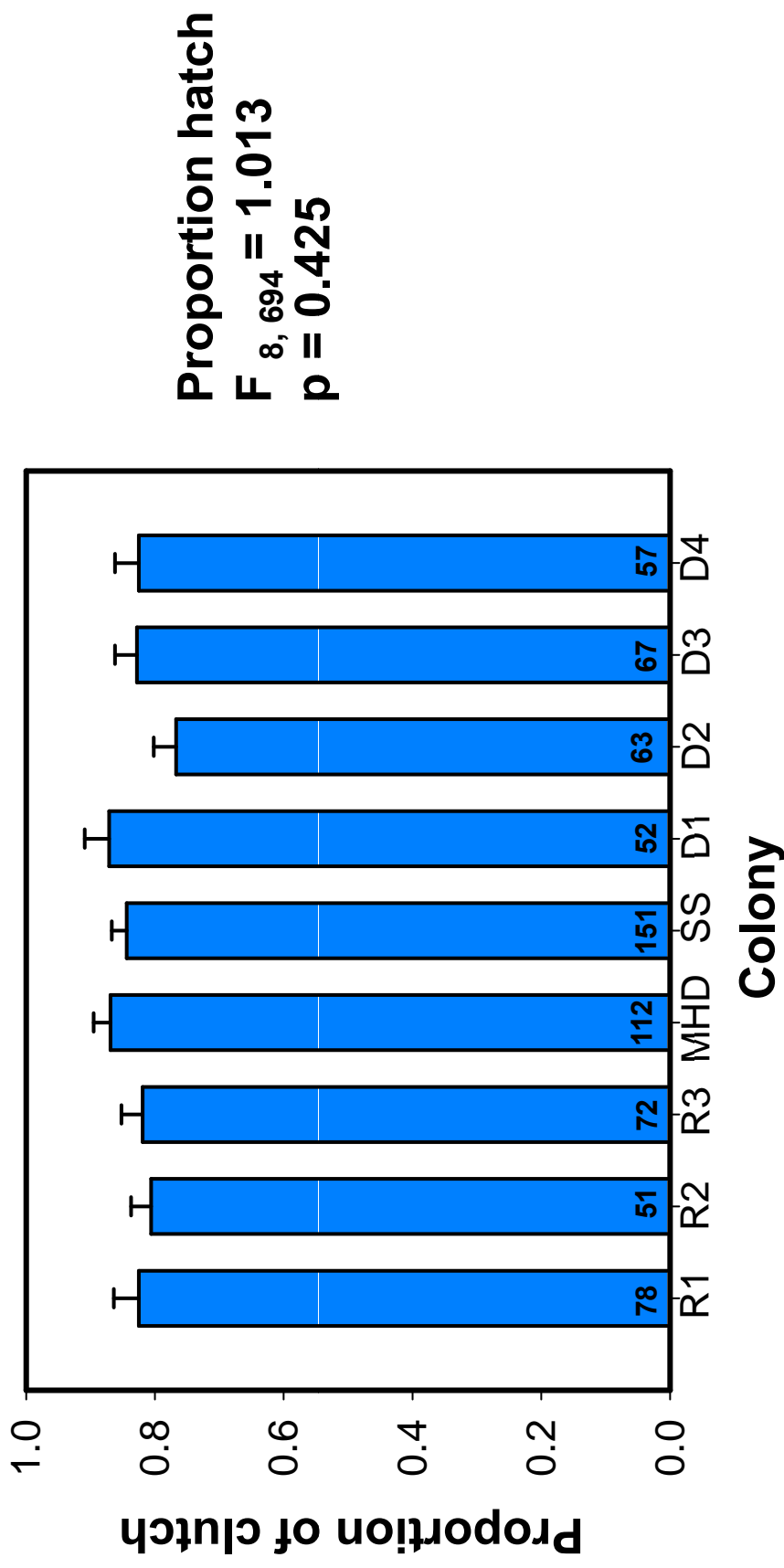


# Post-remediation trace elements in tree swallow egg samples (2011)

As was below  
detection limit



# Post-remediation hatching success among colonies (2011&2012)



Hatching success near the spill area is similar to reference colonies post-remediation



# Questions

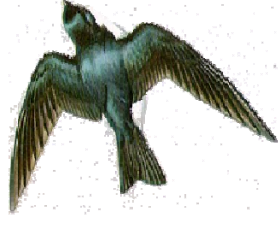
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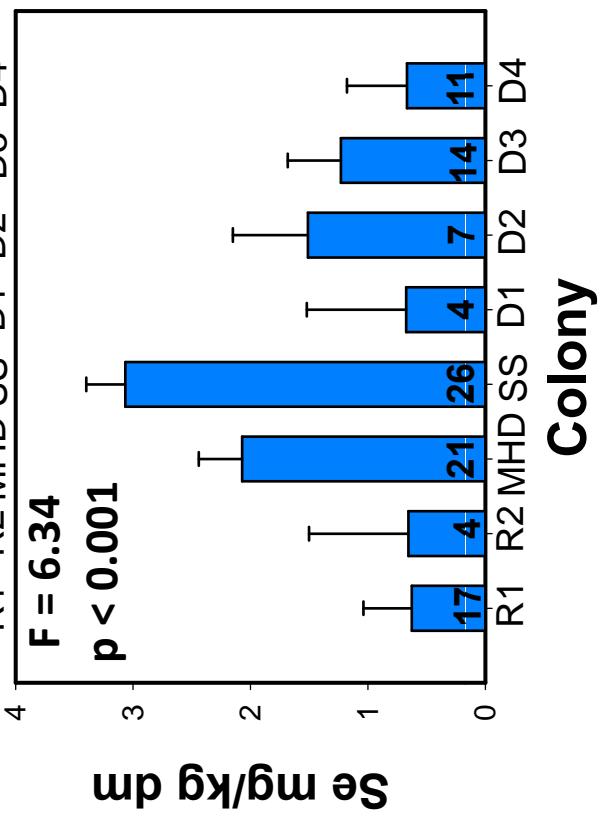
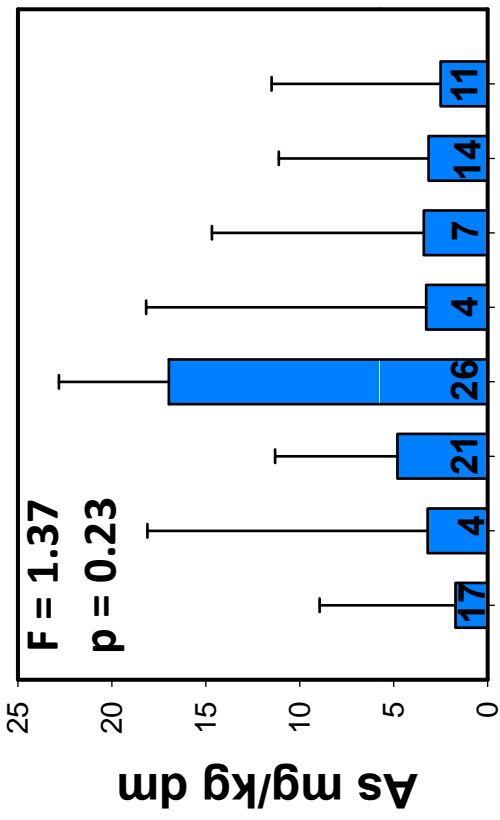
# Tree swallow dietary exposure

-Adults retain food in their bill

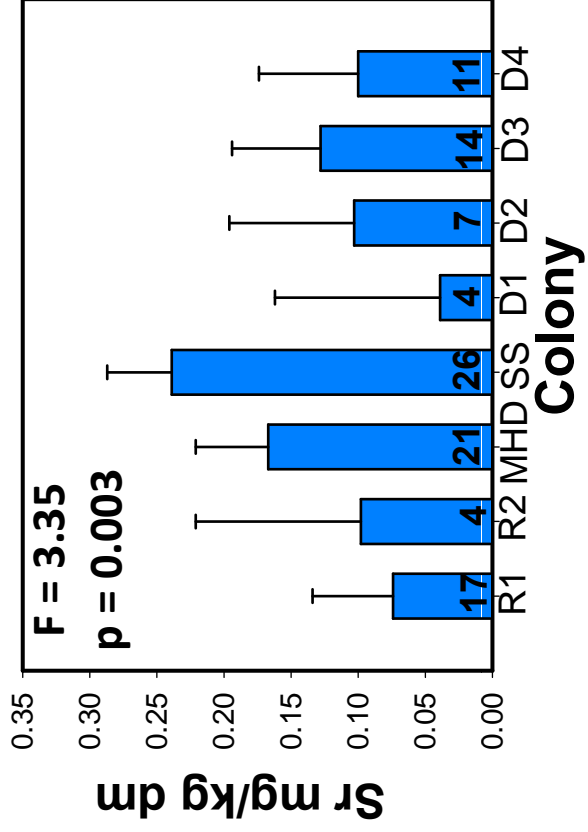
-Many insects can be identified to order or family



# Post-remediation trace elements in tree swallow bolus samples (2011)

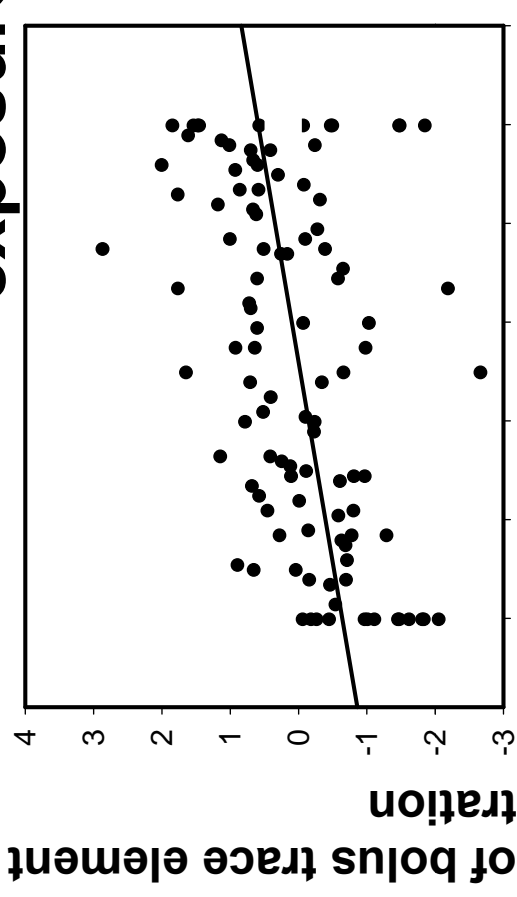


Hg was below detection limit



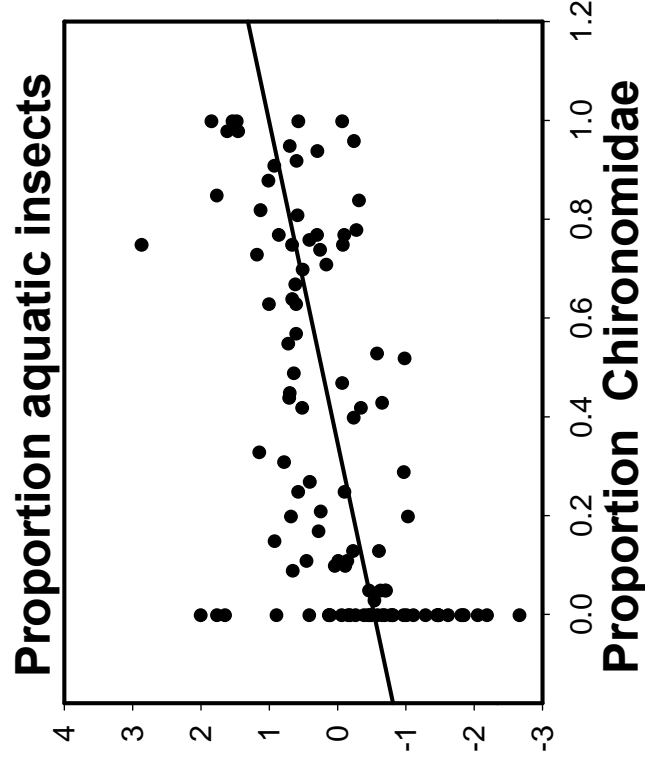


# Diet is related to post-remediation trace element exposure (2011)

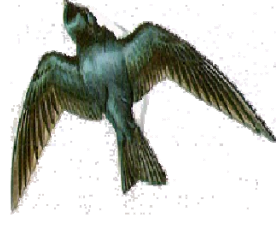


$r^2 = 0.190$ ,  $p < 0.001$

PC1: As, Ba, Cd,  
Cu, Fe, Mn, Se, Sr,  
Zn



$r^2 = 0.338$ ,  $p < 0.001$

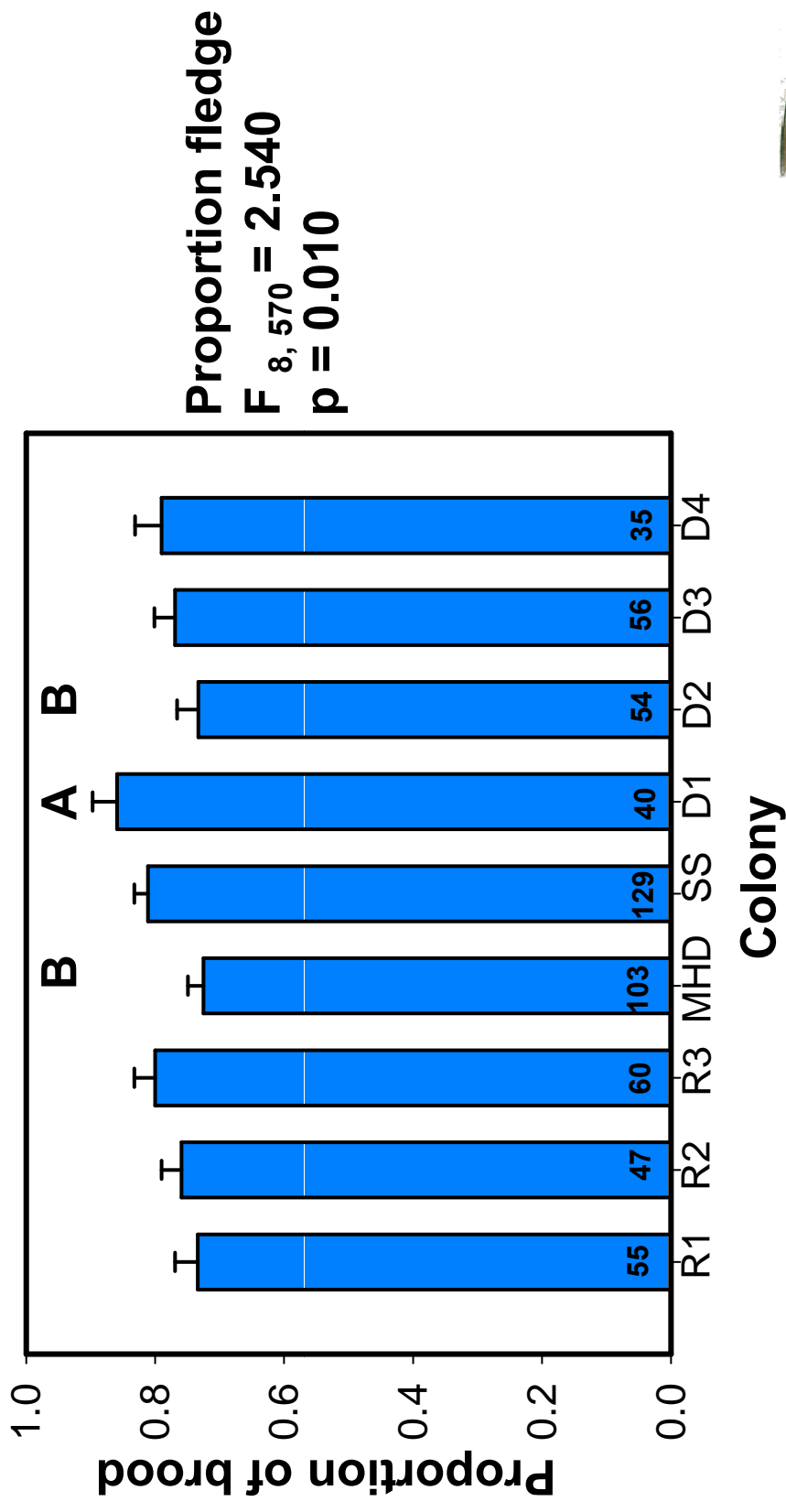


# Questions

1. After remediation, are trace elements being transferred to eggs? Does maternal transfer of trace elements affect tree swallow reproductive success?
2. After remediation, are nestling tree swallows being exposed to elevated concentrations of trace elements in their diet?
3. After remediation, does trace element exposure affect nestling growth and fledging success?



# Post-remediation fledging success among colonies (2011&2012)

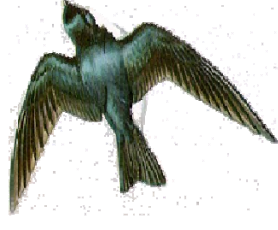


Fledging success near the spill area is similar to reference colonies post-remediation



# Tree swallow summary

- Following remediation, trace element exposure still occurs (eggs, diet, blood) but at relatively low levels
- Detected no significant effects on reproduction post-remediation



# Tree swallow current research directions

- Examine physiological endpoints
  - Stress and immune response
- Effects of multiple stressors
- Relate 2012 trace element data to effects









# Why turtles?



- **Abundant**
- **Site fidelity**
- **Long lived**
- **Diverse feeding strategies**
- **Egg production occurs over several months**
- **Clutches easily incubated/hatchlings easily maintained**







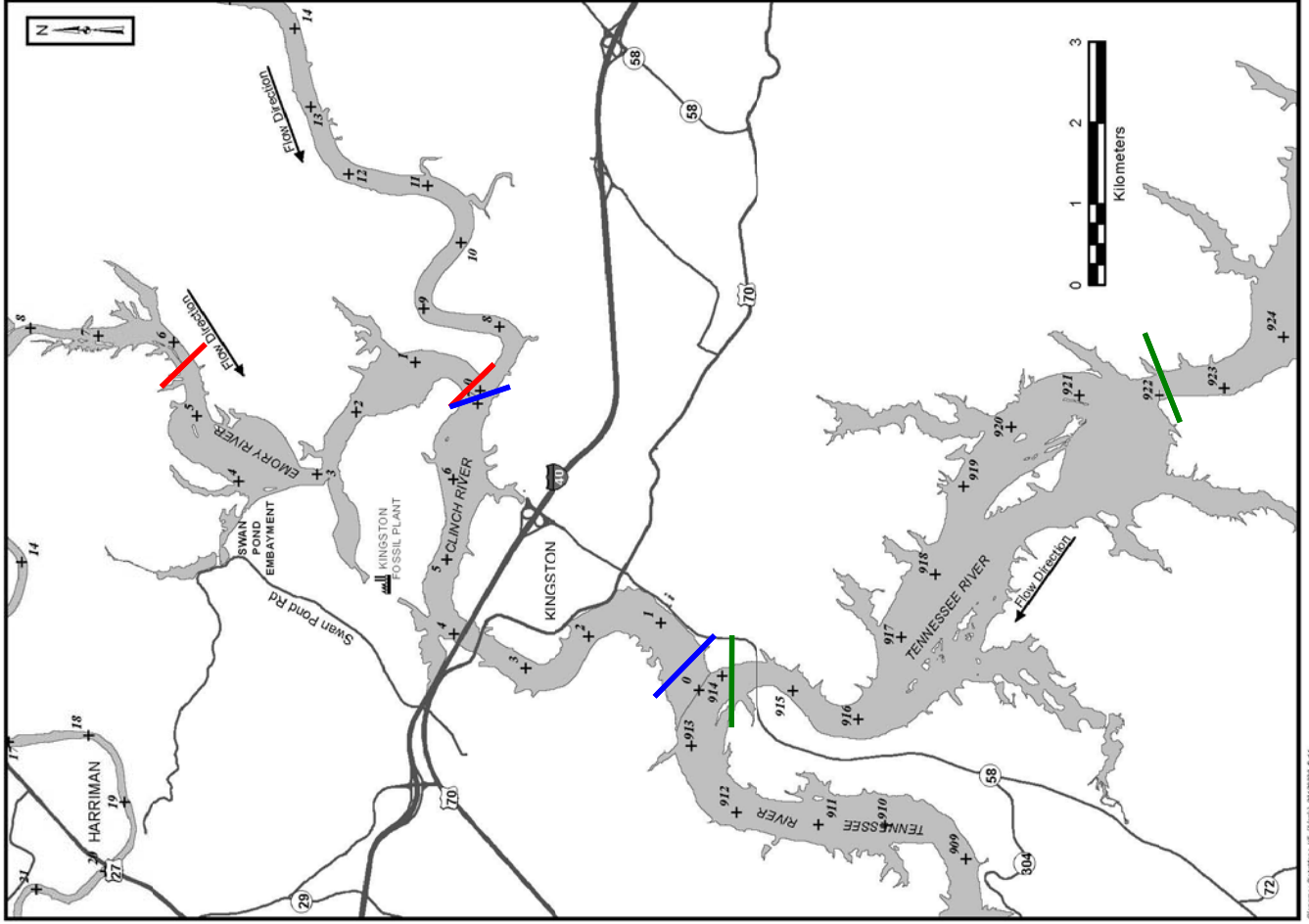


# Trap nights:

**Emory 2,861**  
**Clinch 2,666**  
**Tennessee 2,921**

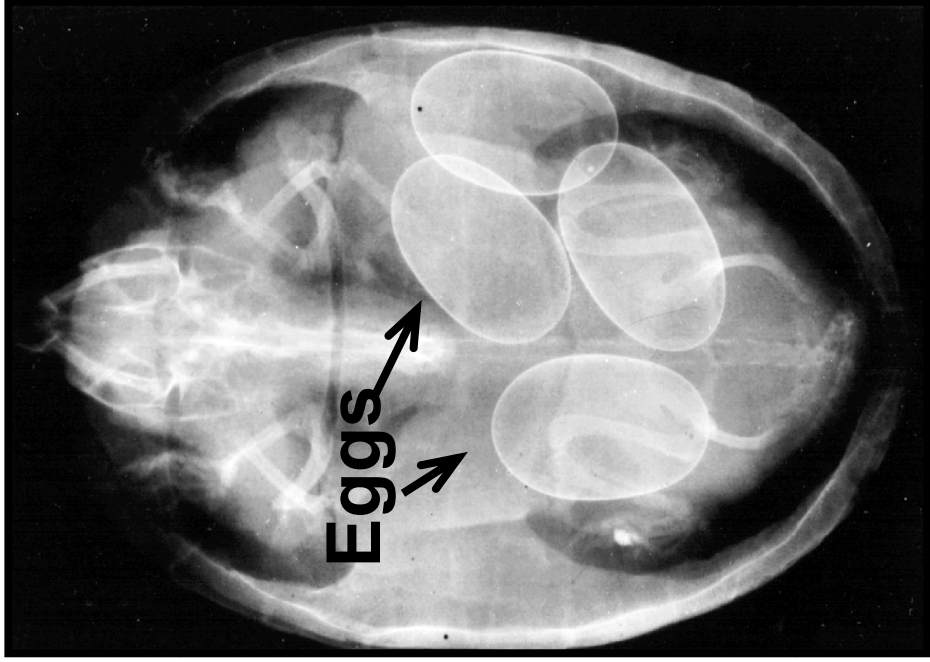
# Turtle captures:

**2011 5,077**  
**2012 4,319**



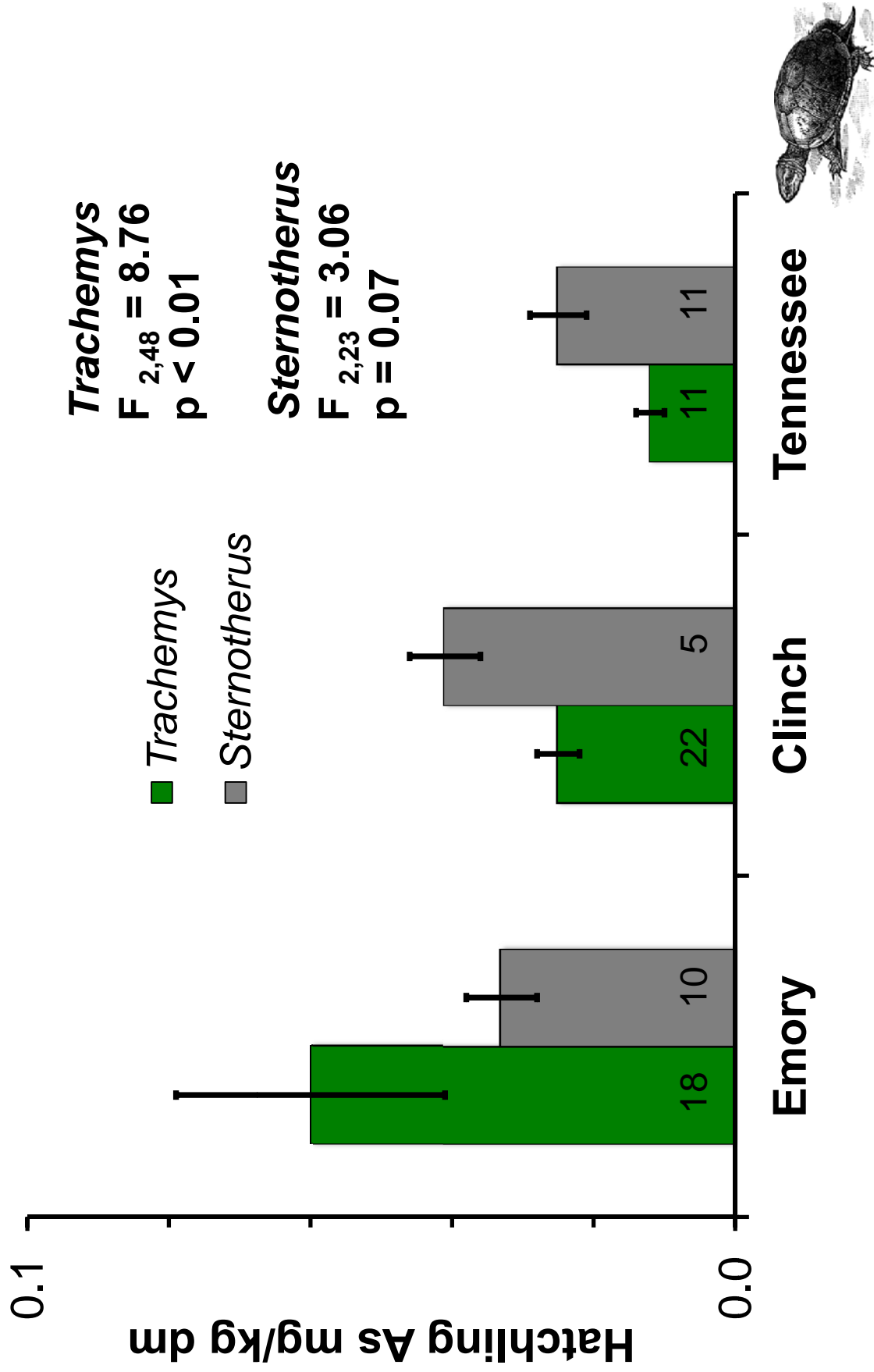
# Egg collection results (2011 & 2012)

- 132 musk (*Sternotherus*) turtle clutches (431 eggs)
- 127 slider (*Trachemys*) clutches (1197 eggs)

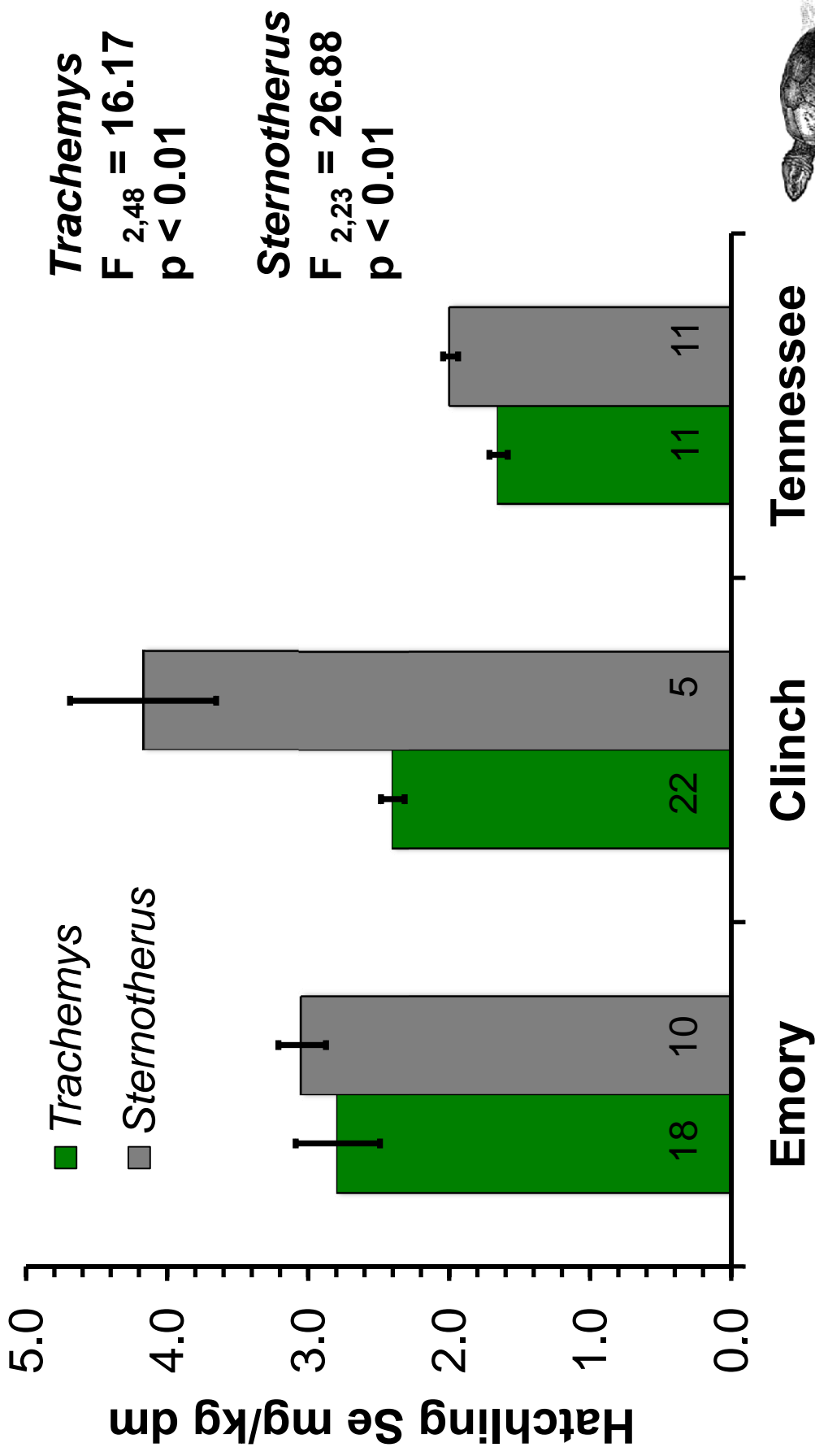




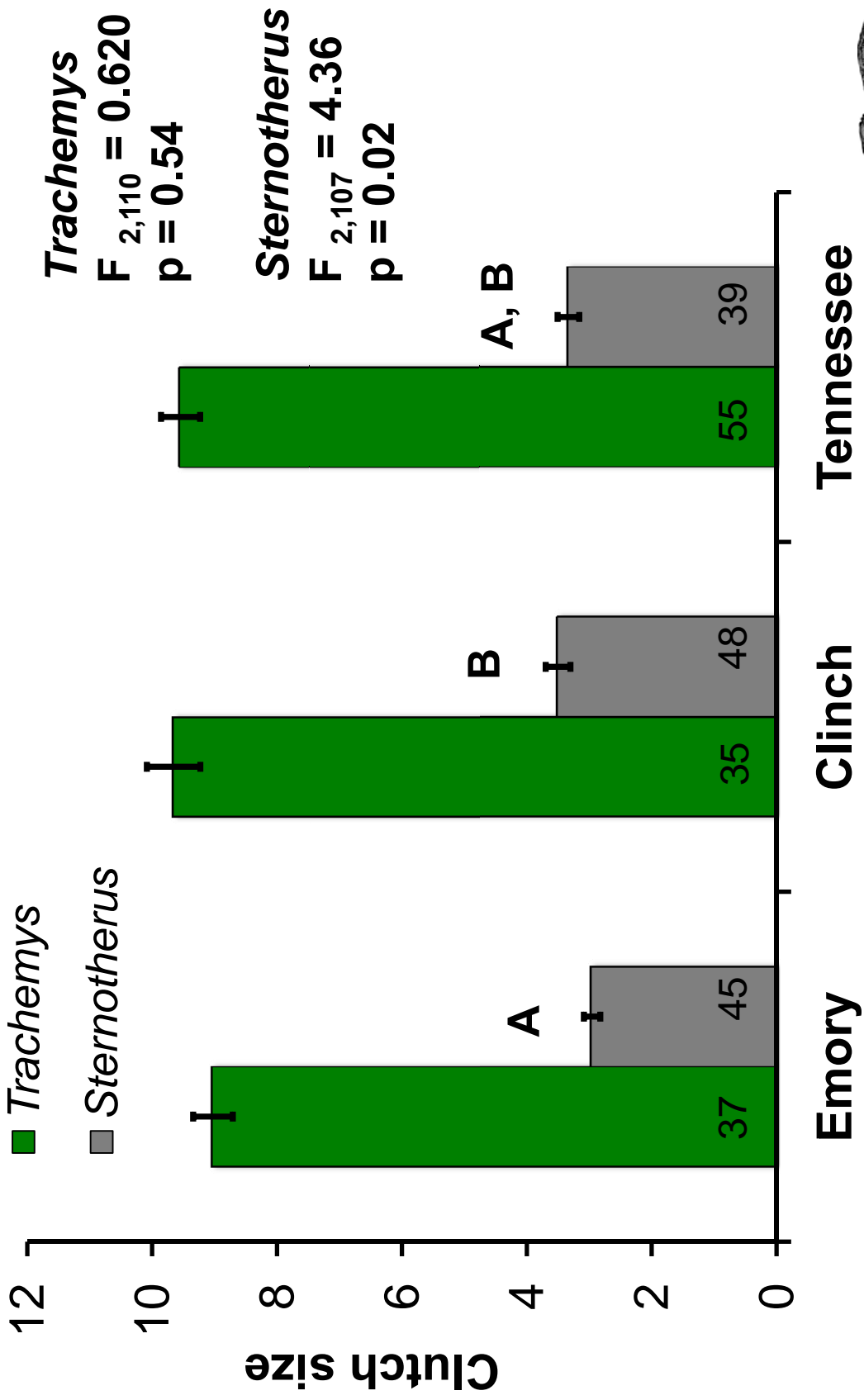
# Post-remediation arsenic concentrations in hatchlings (2011)



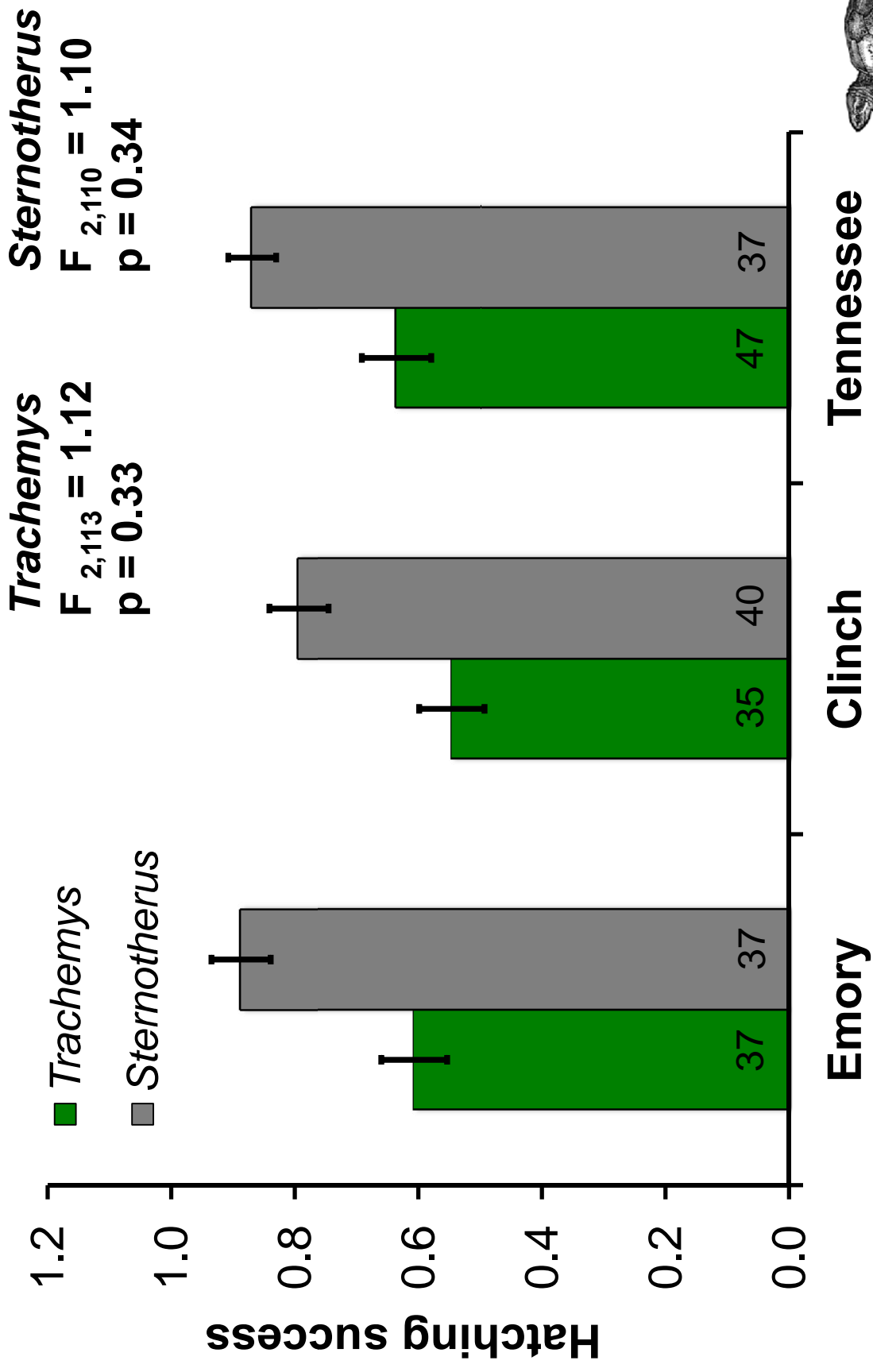
# Post-remediation selenium concentrations in hatchlings (2011)



# Turtle clutch size (2011 & 2012)



# Turtle hatching success (2011 & 2012)





## **Turtles summary**

- **Post-remediation, As and Se concentrations higher in Clinch and Emory Rivers than Tennessee River**
  - **Overall concentrations low**
- **No observed adverse effects on hatching success or clutch size at spill site post-remediation**
- **Ongoing analyses of offspring quality; 2012 data forthcoming and will yield final conclusions**



# Preliminary Take-Home Messages

1. Remediation efforts coupled with the large dilution factor likely limited exposure to trace elements  $\approx$  2.5 years following the spill
  - Elevated concentrations of trace elements (but often below levels of likely concern) in all species post-remediation
2. No signs of reproductive impairment post-remediation



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