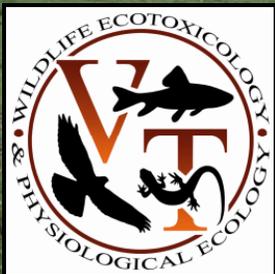
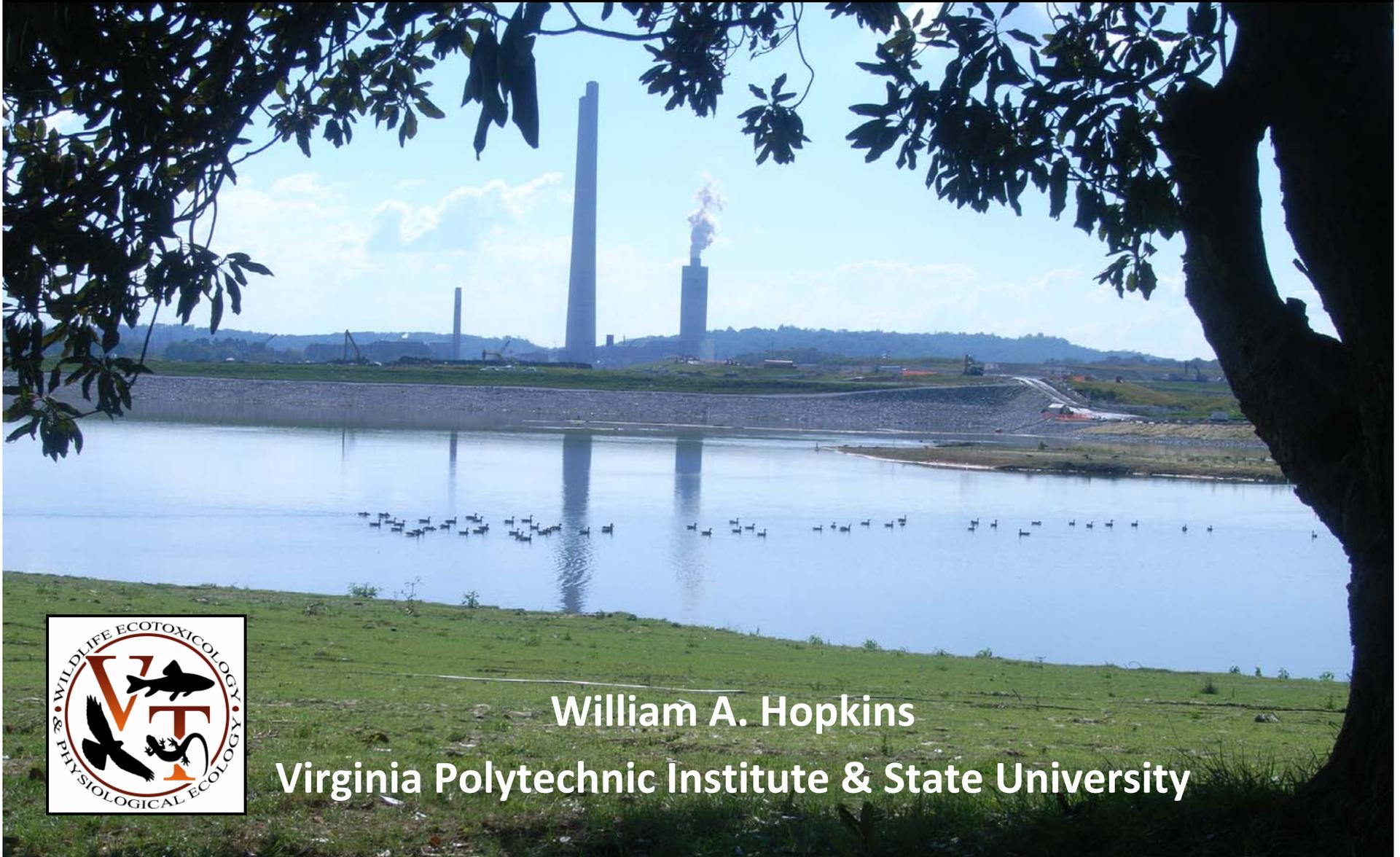


# Bioaccumulation, Maternal Transfer, and Effects of the TVA Kingston Ash Spill



William A. Hopkins  
Virginia Polytechnic Institute & State University

# The people who did all of the work...



Suzy Young, ARCADIS



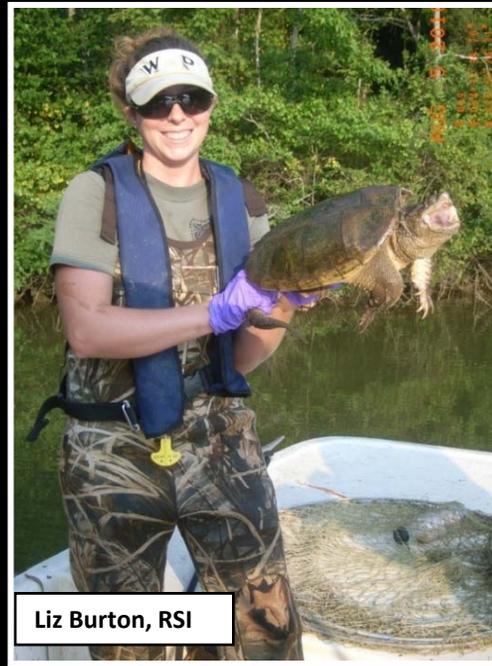
Hill Henry, TVA



Marcy Souza, Univ. Tennessee



Jesse Morris, RSI



Liz Burton, RSI



Ken Weisz, TVA

# Kingston, TN Ash Spill

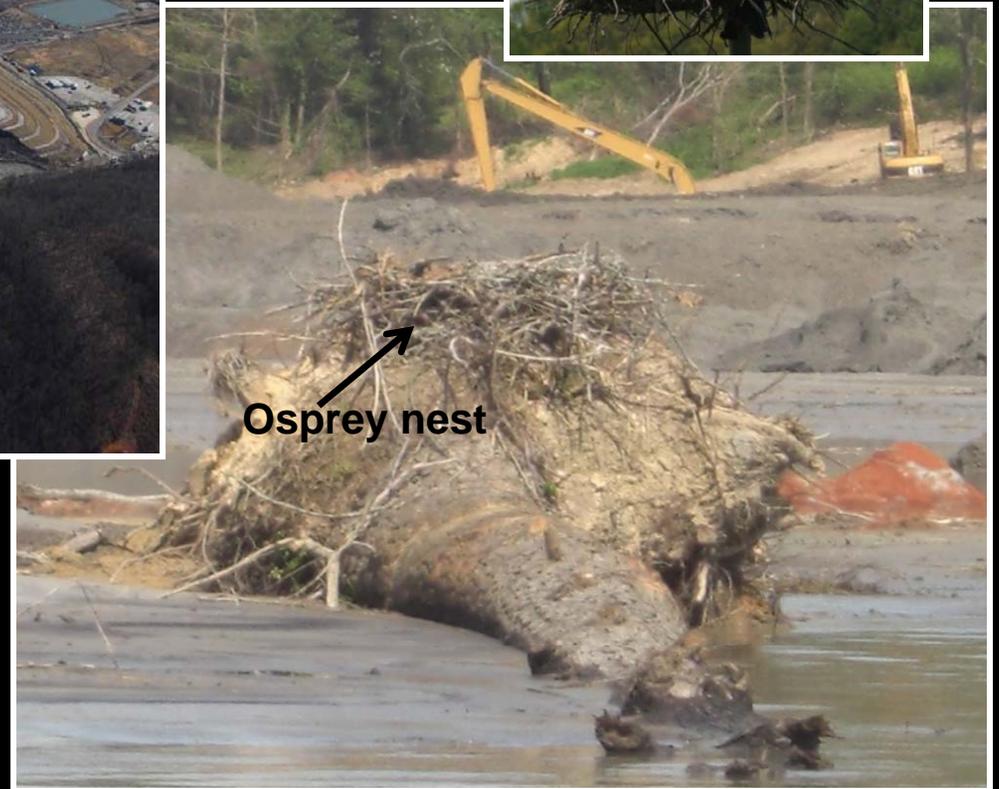


Image taken June 2007



Image taken August 14, 2009

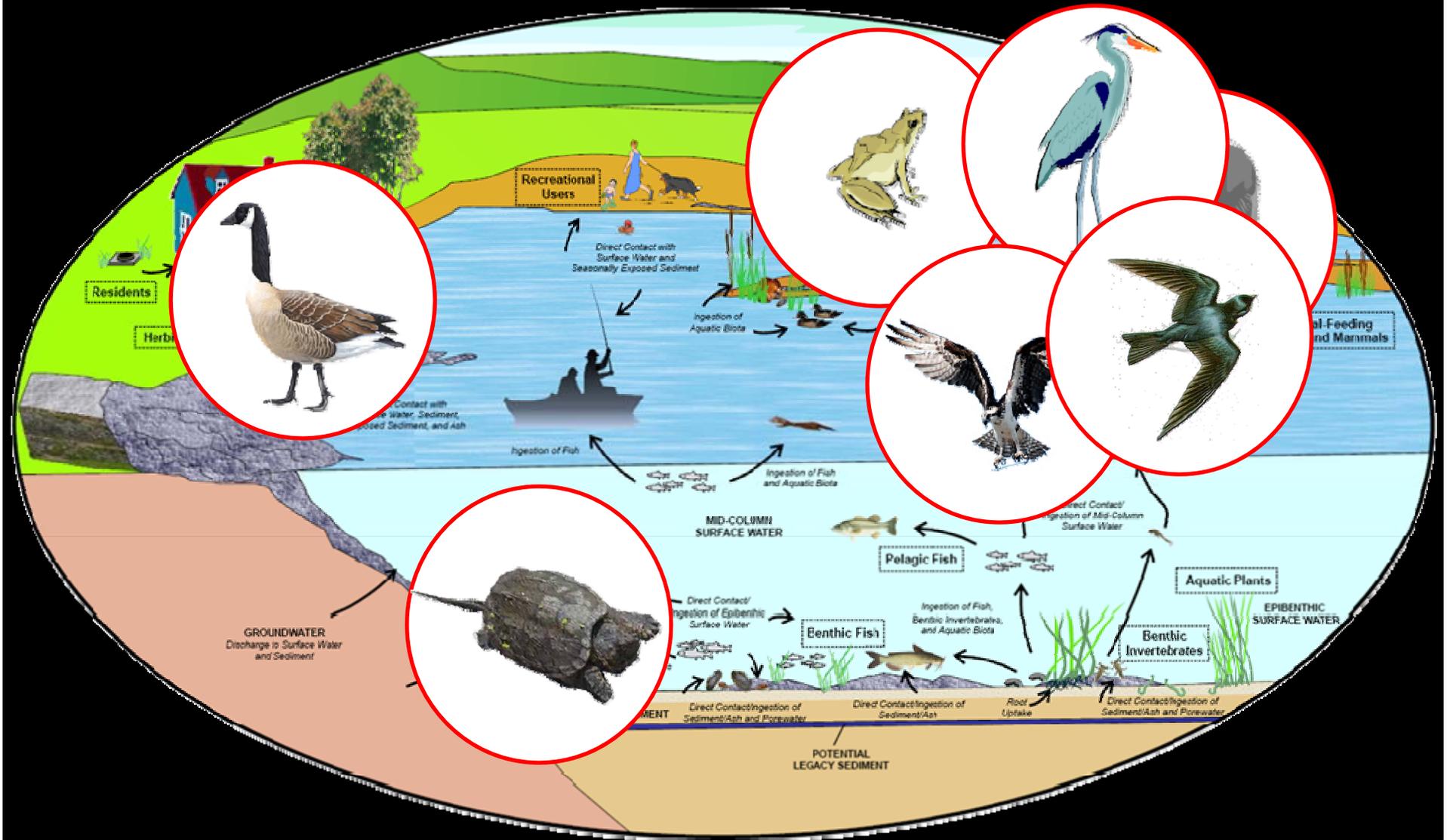
# TVA's Response to Wildlife



**Ash Settling Basins, SC, USA**



# Conceptual Exposure Model



# Study Objectives

- **Determine whether trace elements are bioavailable to wildlife occupying different trophic levels/feeding ecologies**
- **Determine whether wildlife are maternally transferring trace elements to young**
- **Determine whether bioaccumulation and maternal transfer result in adverse effects**

# Bioaccumulation/ Maternal Transfer of Se

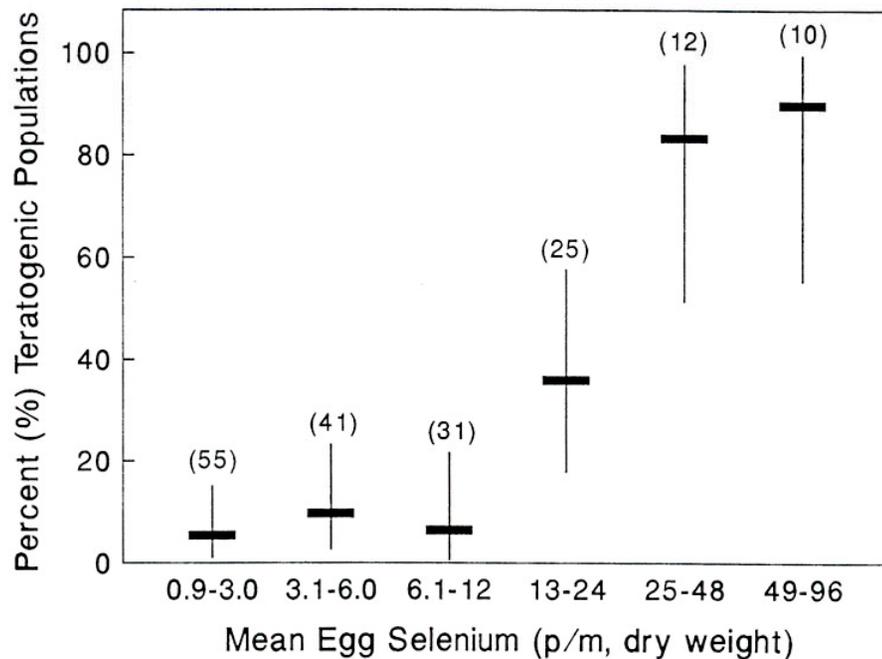
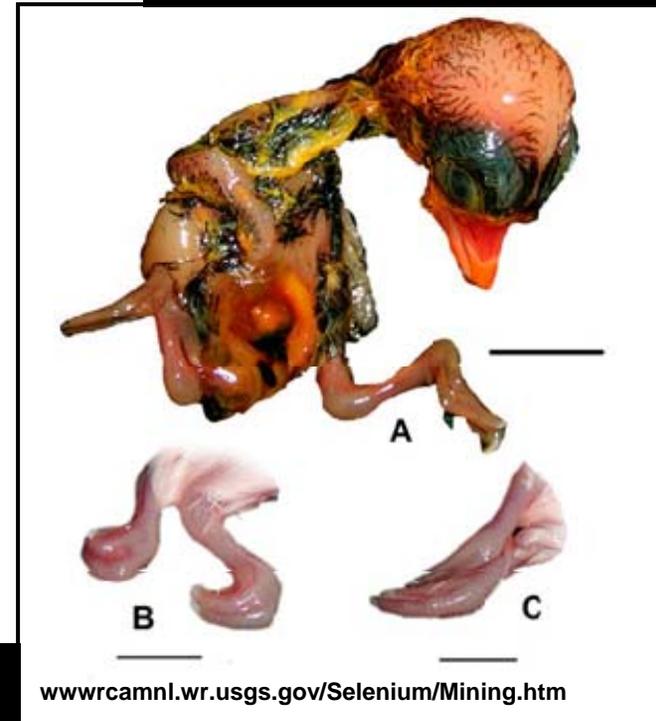
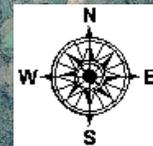


Figure 1. Dose-response relationship between mean egg selenium and teratogenic classification of aquatic bird populations.



From: Skorupa & Ohlendorf, 1991. Contaminants in drainage water and avian risk thresholds. Pp 345-386 In: The economics and management of water and drainage in agriculture (Dinar & Ziberman, eds).



Reference Site: Timberlake

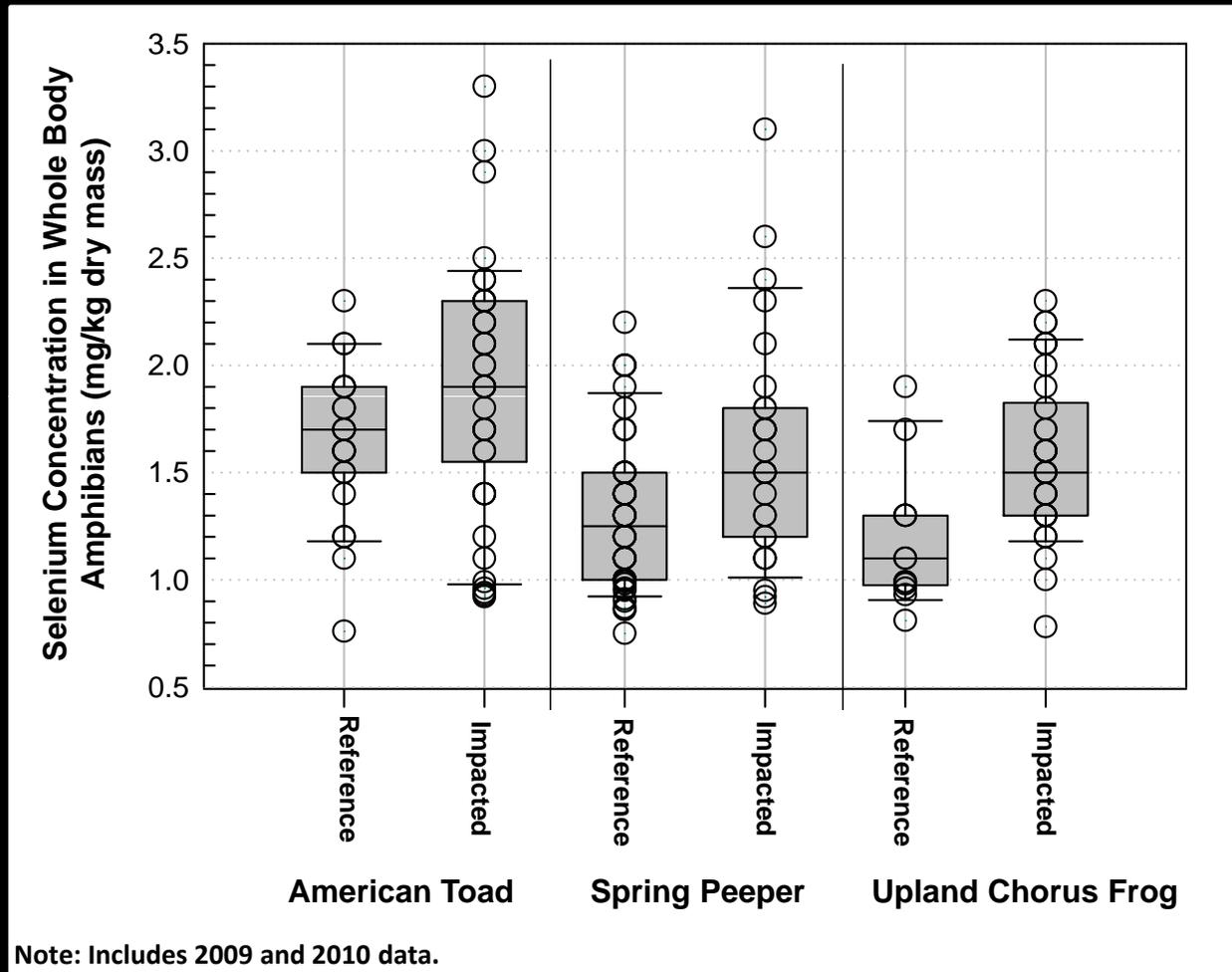


Kingston  
Fossil Plant

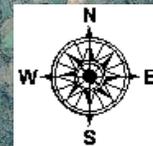
## Amphibians

Sites = 5  
n = 76 (2009)  
n = 121 (2010)

# Amphibians (Whole Body)

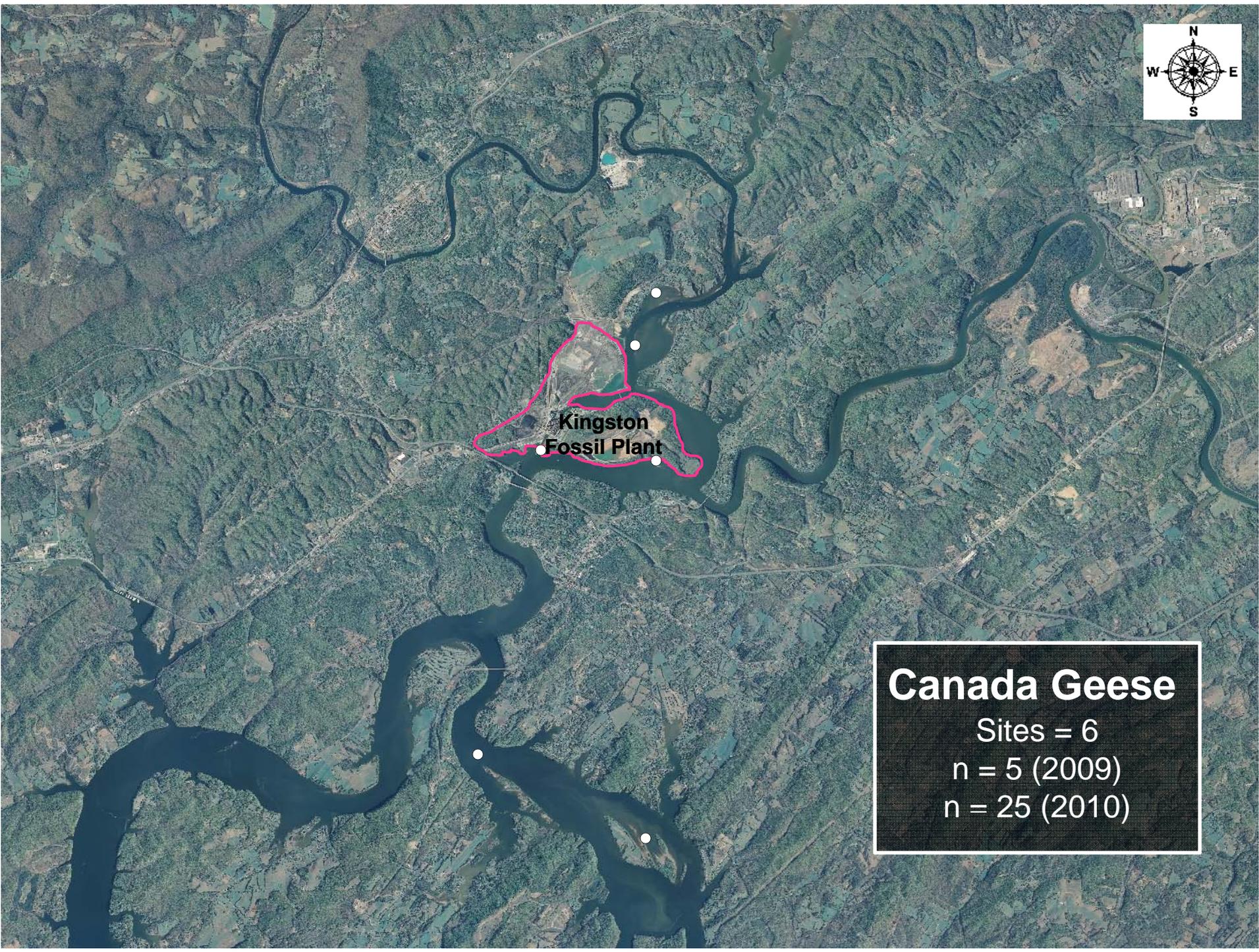


- **2-way ANOVA, Species ( $p=0.009$ ), Location ( $p<0.001$ )**  
**Interaction ( $p=0.672$ )**

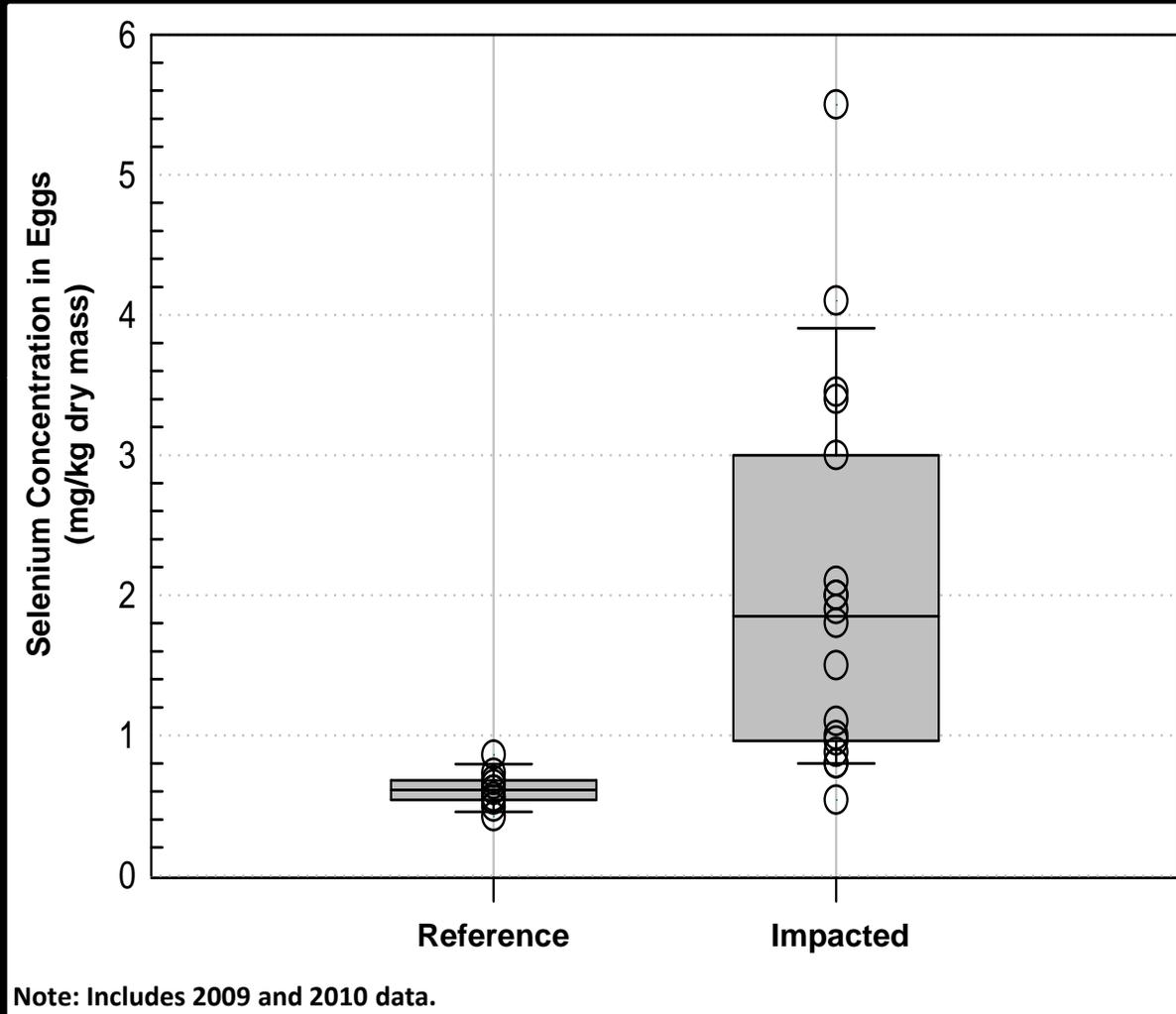


**Kingston  
Fossil Plant**

**Canada Geese**  
Sites = 6  
n = 5 (2009)  
n = 25 (2010)



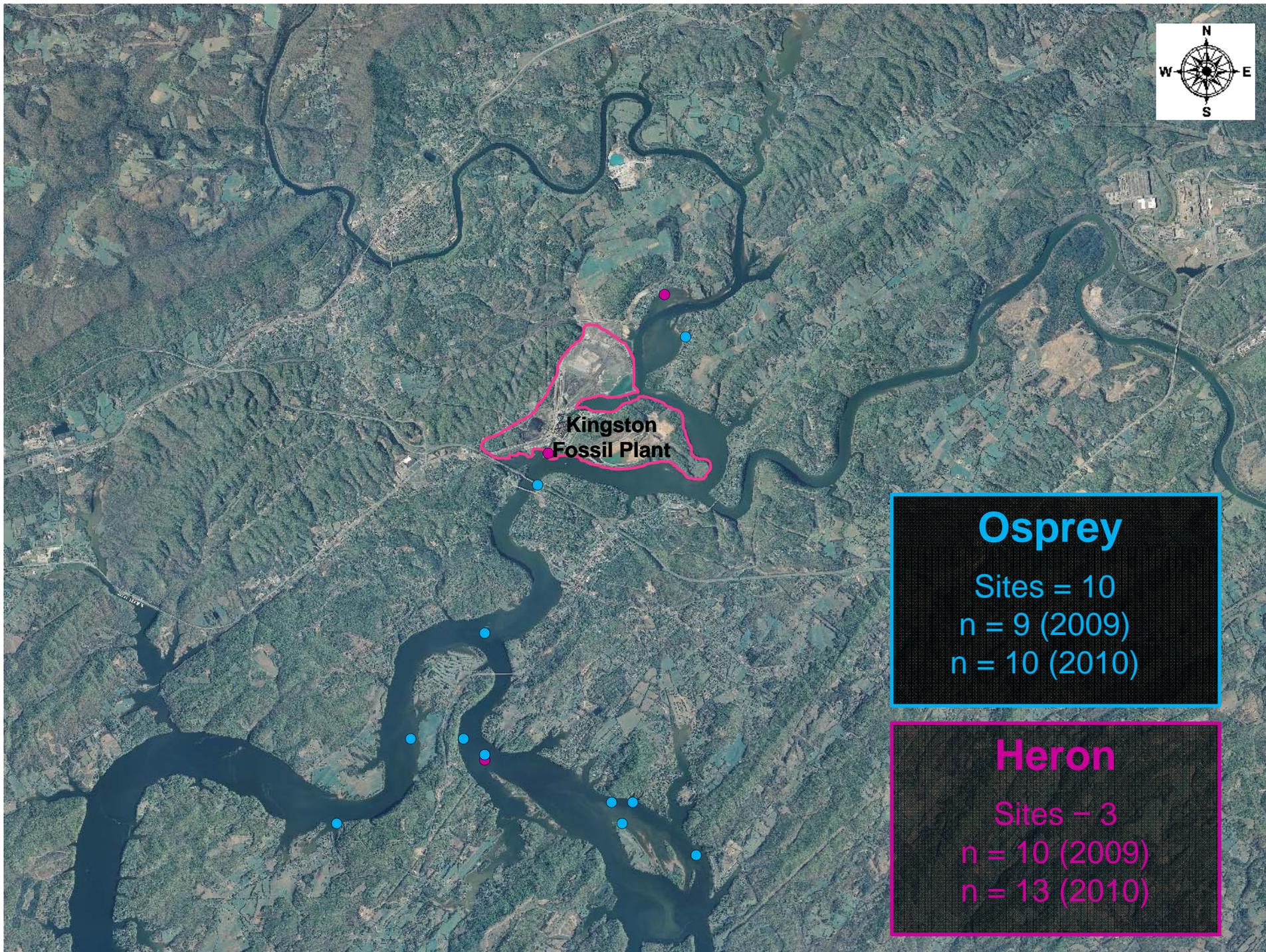
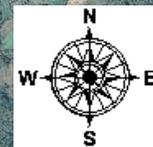
# Canada Goose Eggs



Wilcoxon-Mann Whitney, Site ( $p < 0.001$ )

# Great Blue Heron and Osprey





**Kingston  
Fossil Plant**

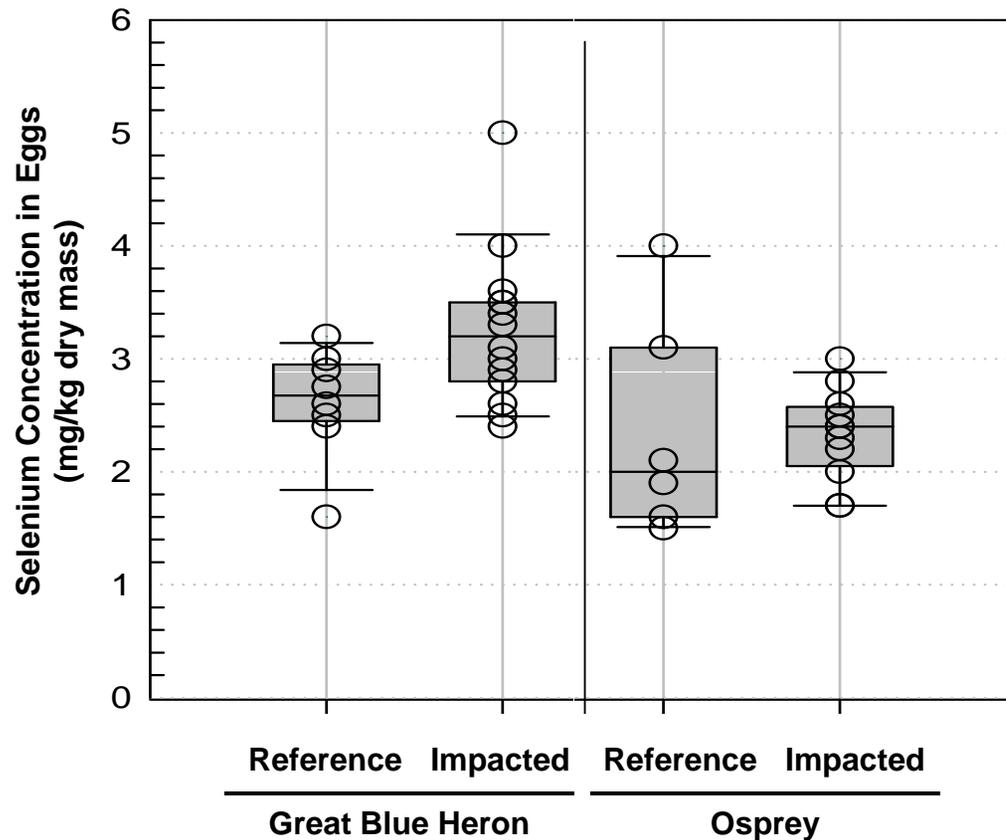
## Osprey

Sites = 10  
n = 9 (2009)  
n = 10 (2010)

## Heron

Sites = 3  
n = 10 (2009)  
n = 13 (2010)

# Great Blue Heron & Osprey Eggs

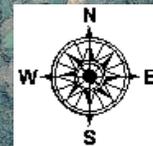


Note: Includes 2009 and 2010 data.



**Heron: t-test, ( $p=0.031$ )**

**Osprey: t-test, ( $p=0.928$ )**



Reference Site 2: Loudoun Dam



Reference Site 3: Tellico Dam



Historically Impacted Site: Melton Hill Dam



Kingston  
Fossil Plant

## Tree Swallows

Total Boxes = 530

Eggs Collected:

n = 63 (2009)

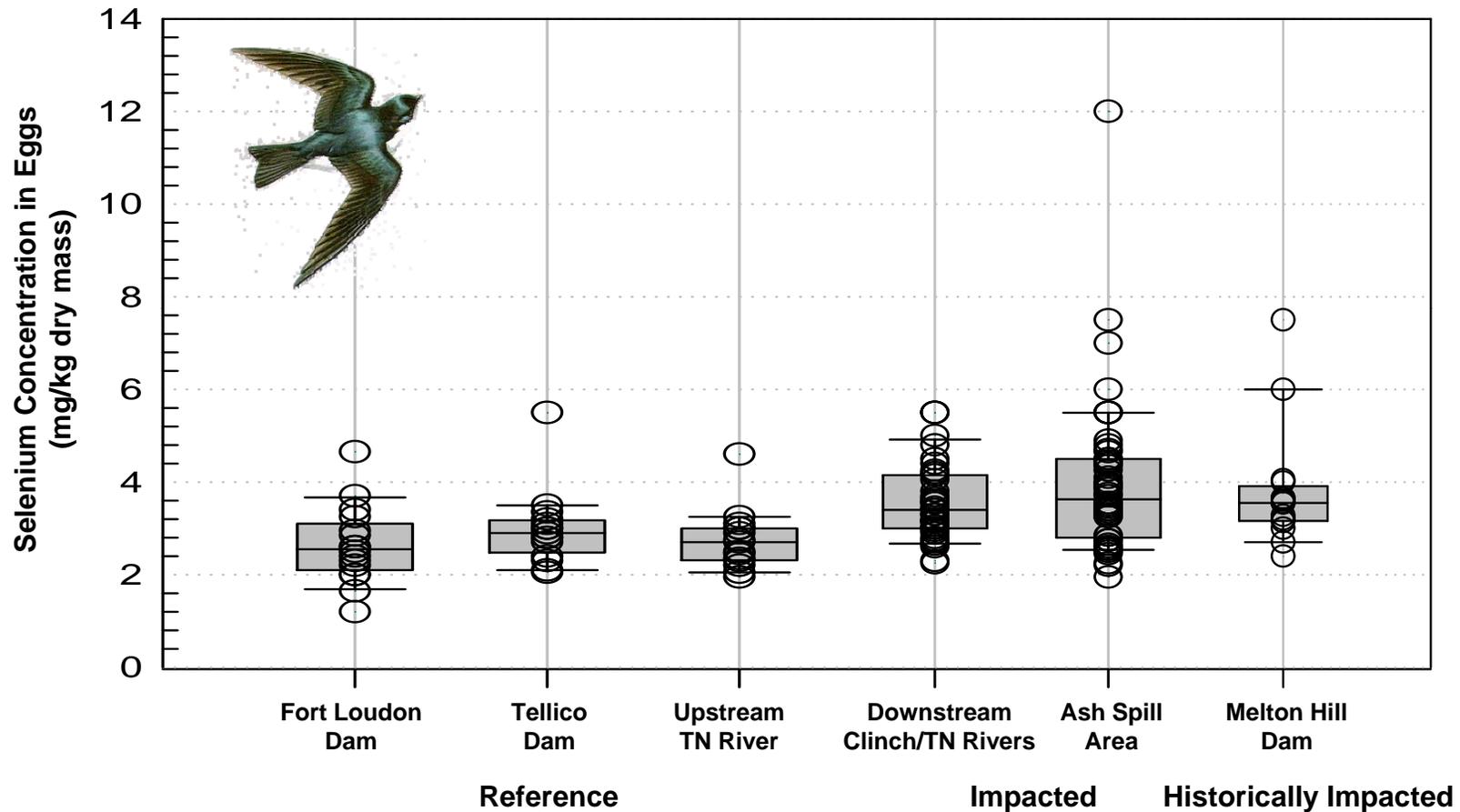
n = 155 (2010)

Nestlings Collected:

n = 47 (2009)

n = 65 (2010)

# Tree Swallow Eggs



Note: Includes 2010 data, calculated dry weight using 80% moisture.

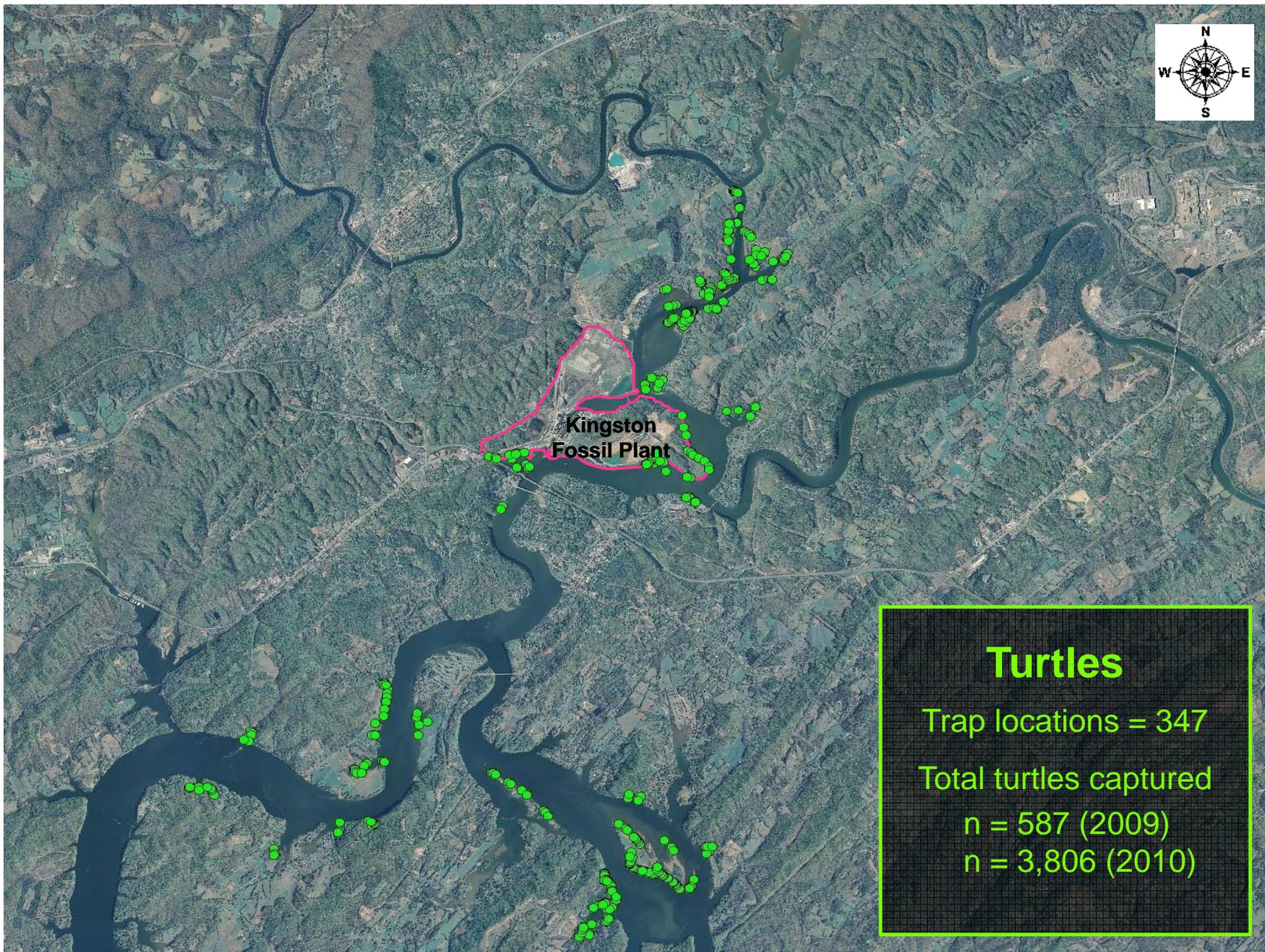
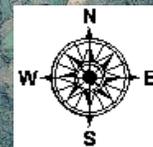
Kruskal-Wallis, site differences ( $p < 0.001$ )



Herpnet



Turtlesite.info



## Turtles

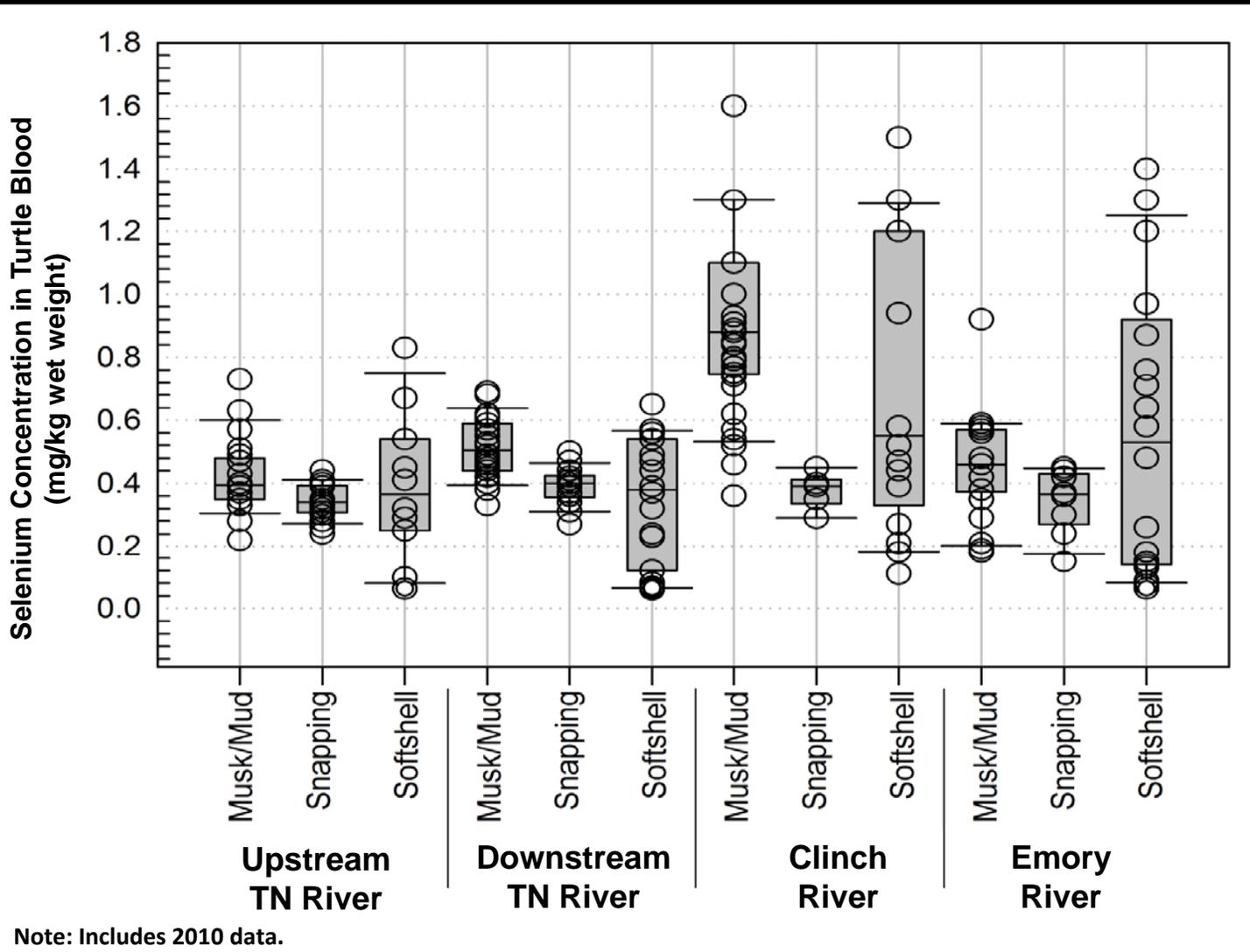
Trap locations = 347

Total turtles captured

n = 587 (2009)

n = 3,806 (2010)

# Turtle Blood



2-way ANOVA, Species ( $p < 0.001$ ); Location ( $p = 0.001$ ); Interaction ( $p = 0.019$ )

# Conclusions

- **Certain trace elements (i.e., Se) are elevated in tissues of most wildlife species evaluated.**
- **Wildlife that have a significant proportion of their diet directly associated with ash appear to be at greatest risk of exposure.**
- **Full scale physiological/reproductive studies will determine whether exposure to trace elements has adverse effects on wildlife currently at greatest risk of exposure.**

# Path Forward: Continued Monitoring



UF



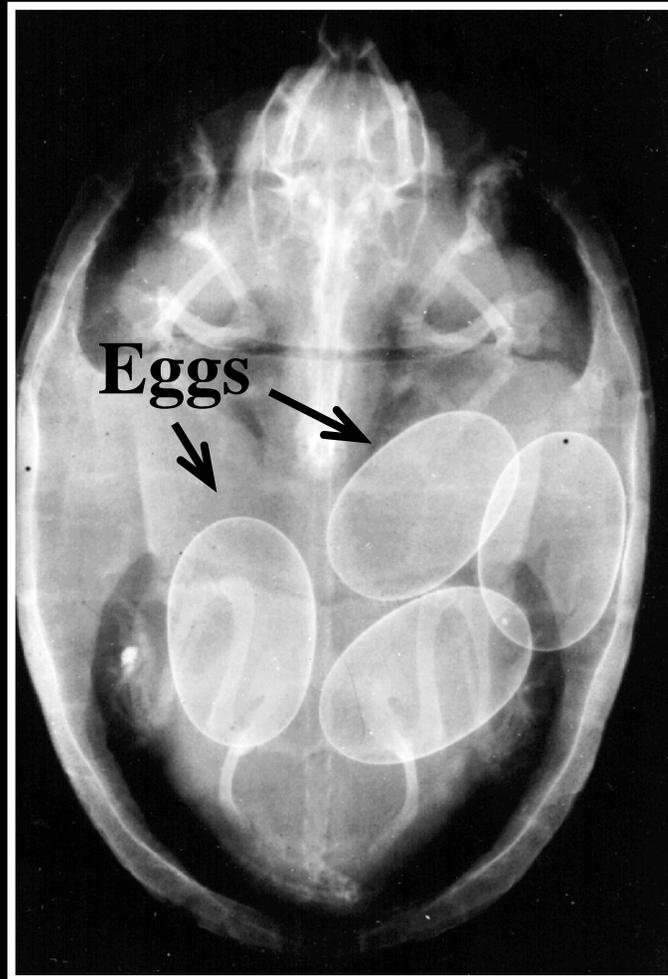


# Path Forward: Effects in Swallows





# Path Forward: Effects in Turtles



# Acknowledgements



**Adam Johnson  
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**Neil Carriker  
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Jason Brown  
David Greenberg**

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**Kingston City Parks and Recreation**

**Mr. and Mrs. Curtis Humphreys  
Mr. and Mrs. McMurray**



**QUESTIONS?**

