Morphological Variation of Lingual Glands in Wild American Alligator (*Alligator mississippiensis*) Populations

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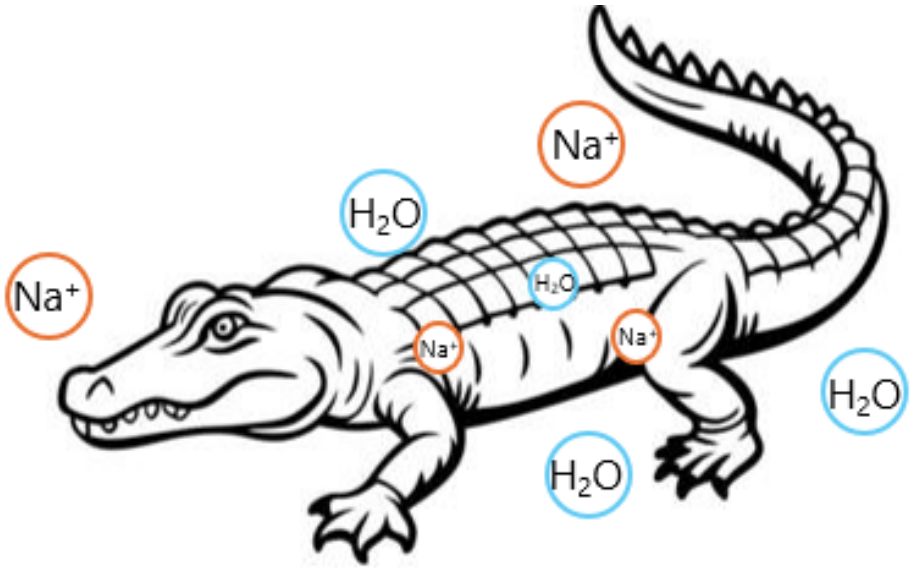
Green Quantitative Ecology

https://www.mirror.co.uk/news/uk-news/wildlife-photographer-snaps-alligator-up-110804

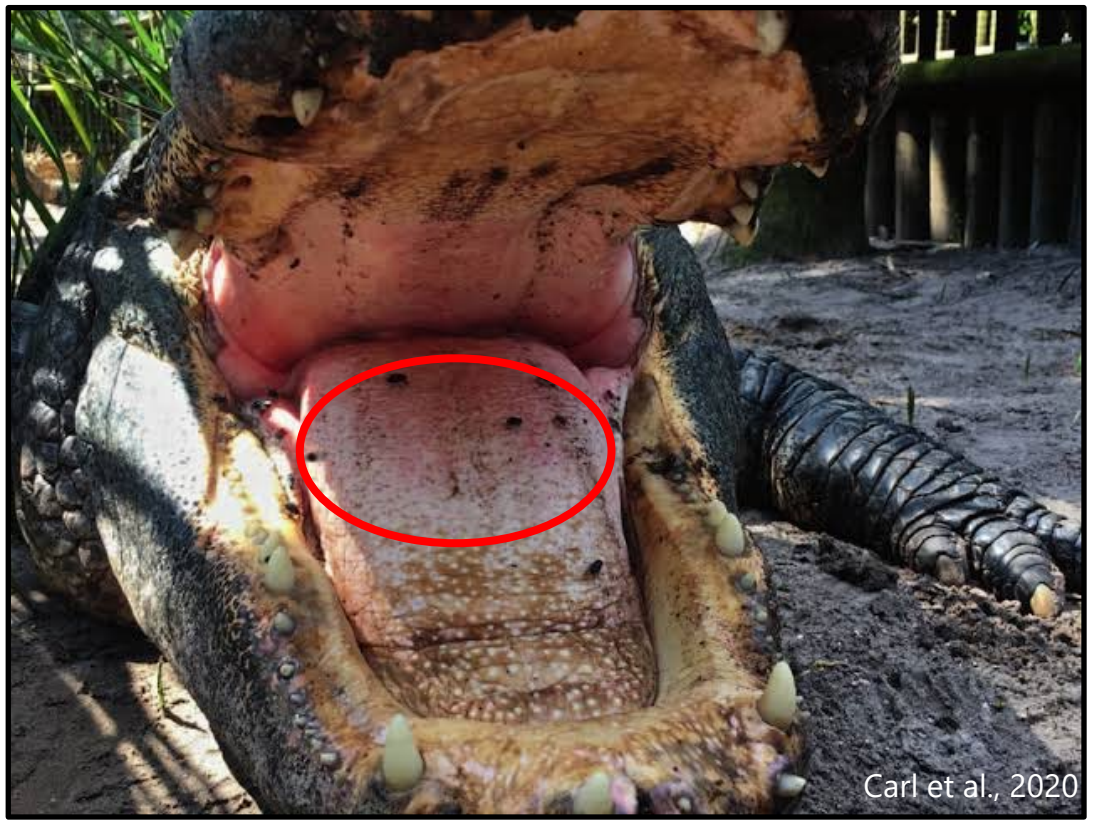
Animal Osmoregulation

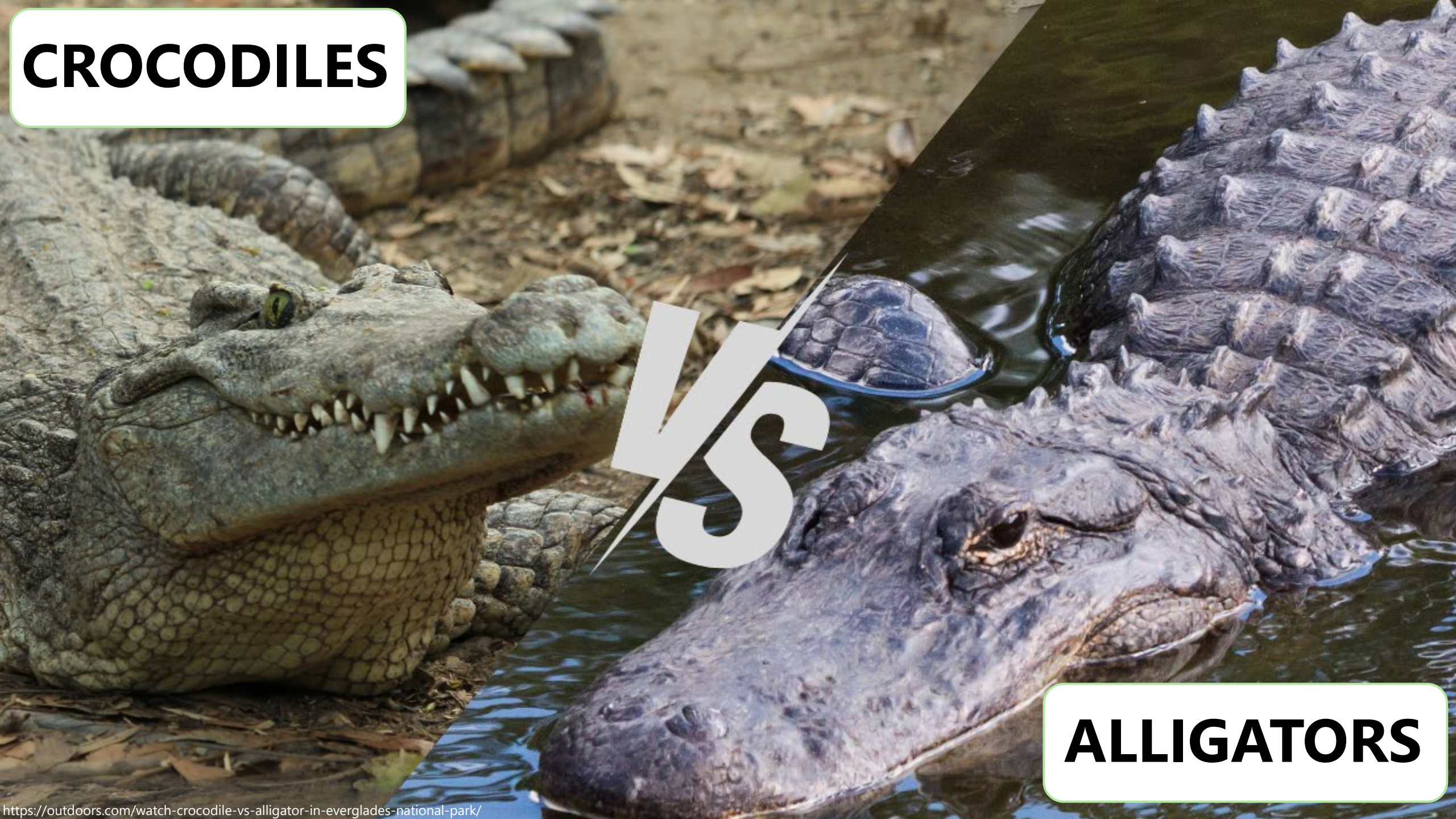
- Most vertebrates must actively maintain bodily water and solute concentrations despite changes in their environment.
- Marine, brackish, and freshwater environments pose very different challenges.
- Two kinds of osmoregulation
  - **Physiological**
  - **Behavioral**



Crocodilian Lingual Glands

- All crocodilians possess lingual glands
- Posterior portion of tongue
- Small (<2 mm)
- **Number varies by group**
  - **Crocodiles = 20-40**
  - **Alligators = 50-100+**
- **Function varies by group**





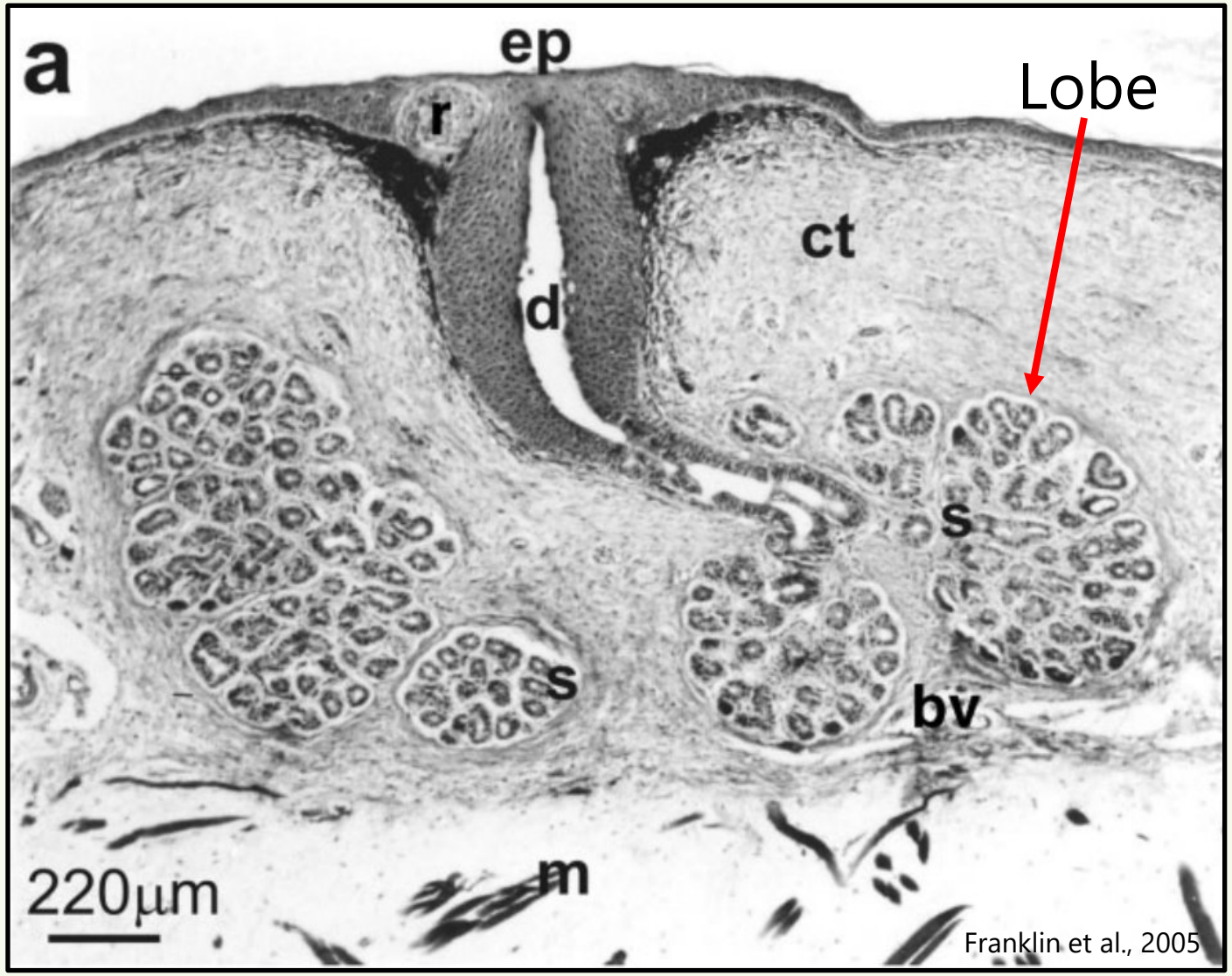
https://outdoors.com/watch-crocodile-vs-alligator-in-everglades-national-park/

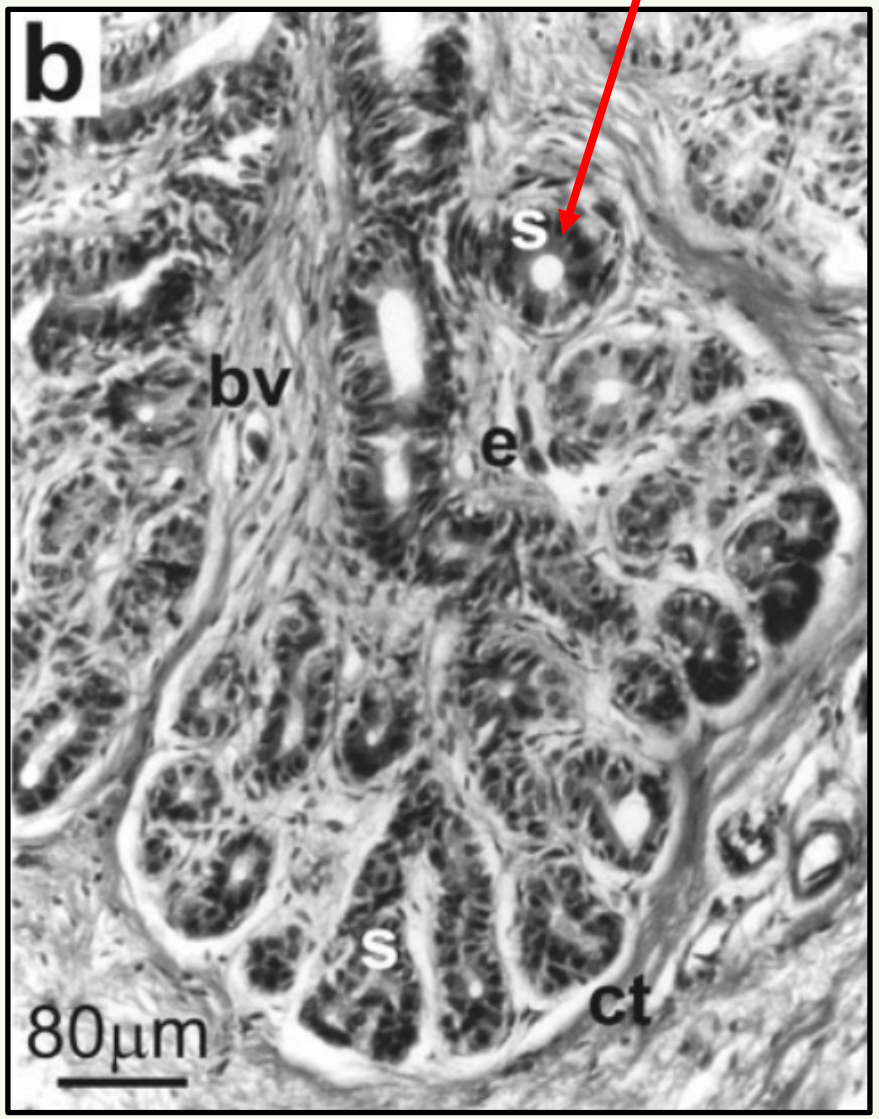
Crocodile Lingual Glands 1.1

Cramp et al., 2007


Grigg and Kirshner, 2015

Crocodile Lingual Glands 1.2



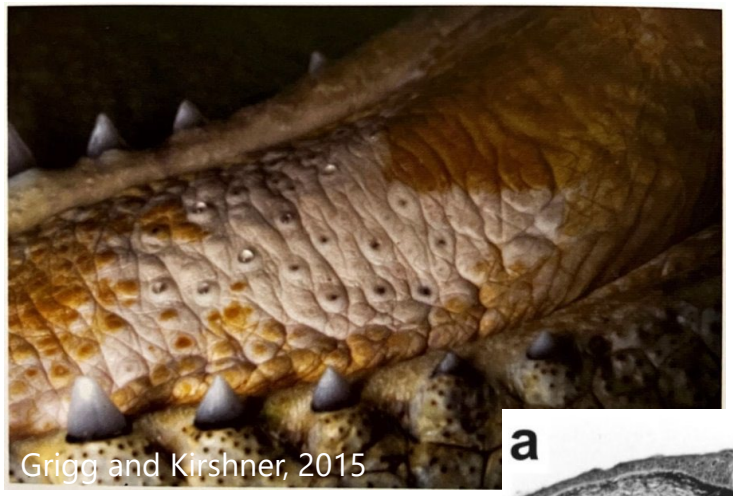


Crocodilian Osmoregulation

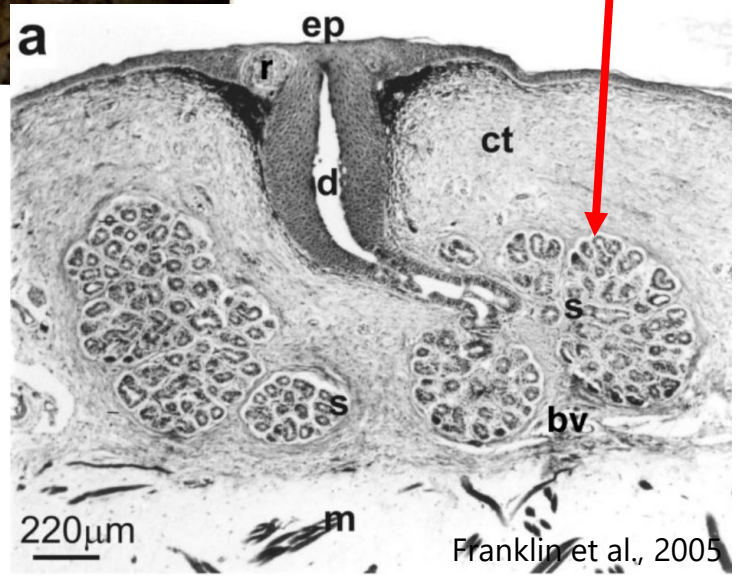
- Rudimentary kidneys
  - Unable to produce hyperosmotic urine
- Crocodiles
  - Kidneys, specialized cloaca, **lingual salt glands**
  - Indiscriminate behavioral osmoregulation
- Alligators and caimans
  - Kidneys, **lingual ~~salt~~ glands**
  - Discriminate behavioral osmoregulation

Lingual Glands in Crocodiles

- 20 – 40
- ~2 mm, lobular, high secretory tubule density
- Salt-secreting
- **Result = high saltwater tolerance**


Grigg and Kirshner, 2015

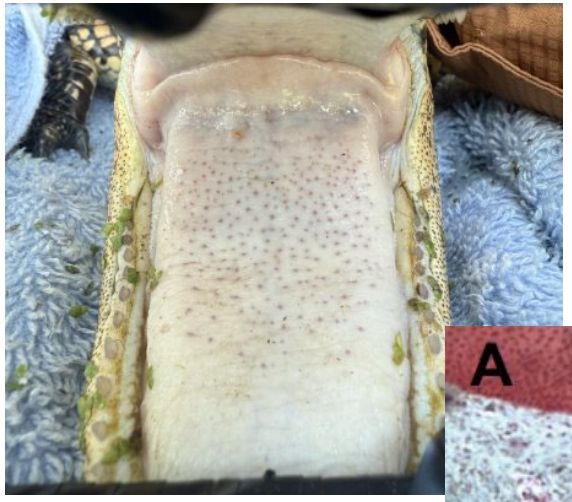
Secretory tubule

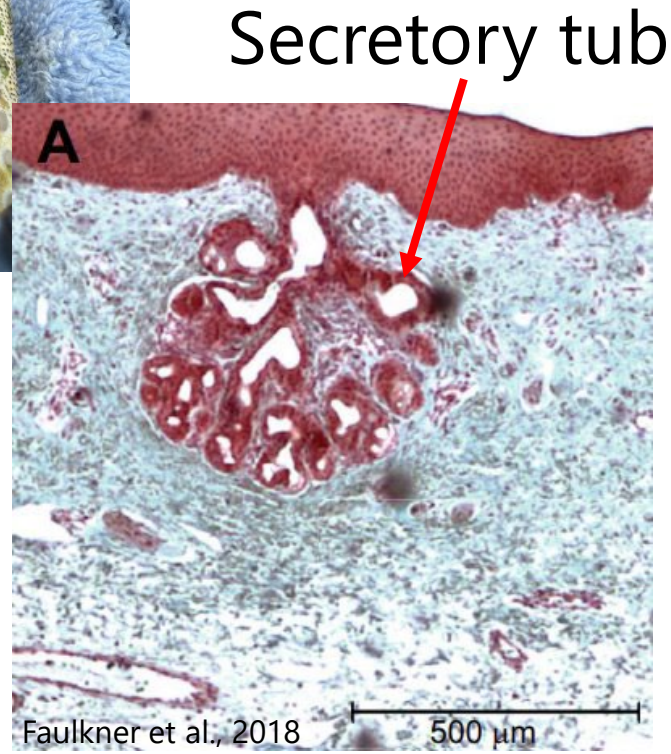


Franklin et al., 2005

Lingual Glands in Alligators

- 50 – 100+
- ~0.5 mm, low secretory tubule density
- “Salivary-only”
- **Result = low saltwater tolerance**





Coastal vs. Inland Alligator Populations

Coastal

- Routine saltwater exposure
  - Food
  - Travel
- Behavioral osmoregulation
- Georgia Barrier Islands

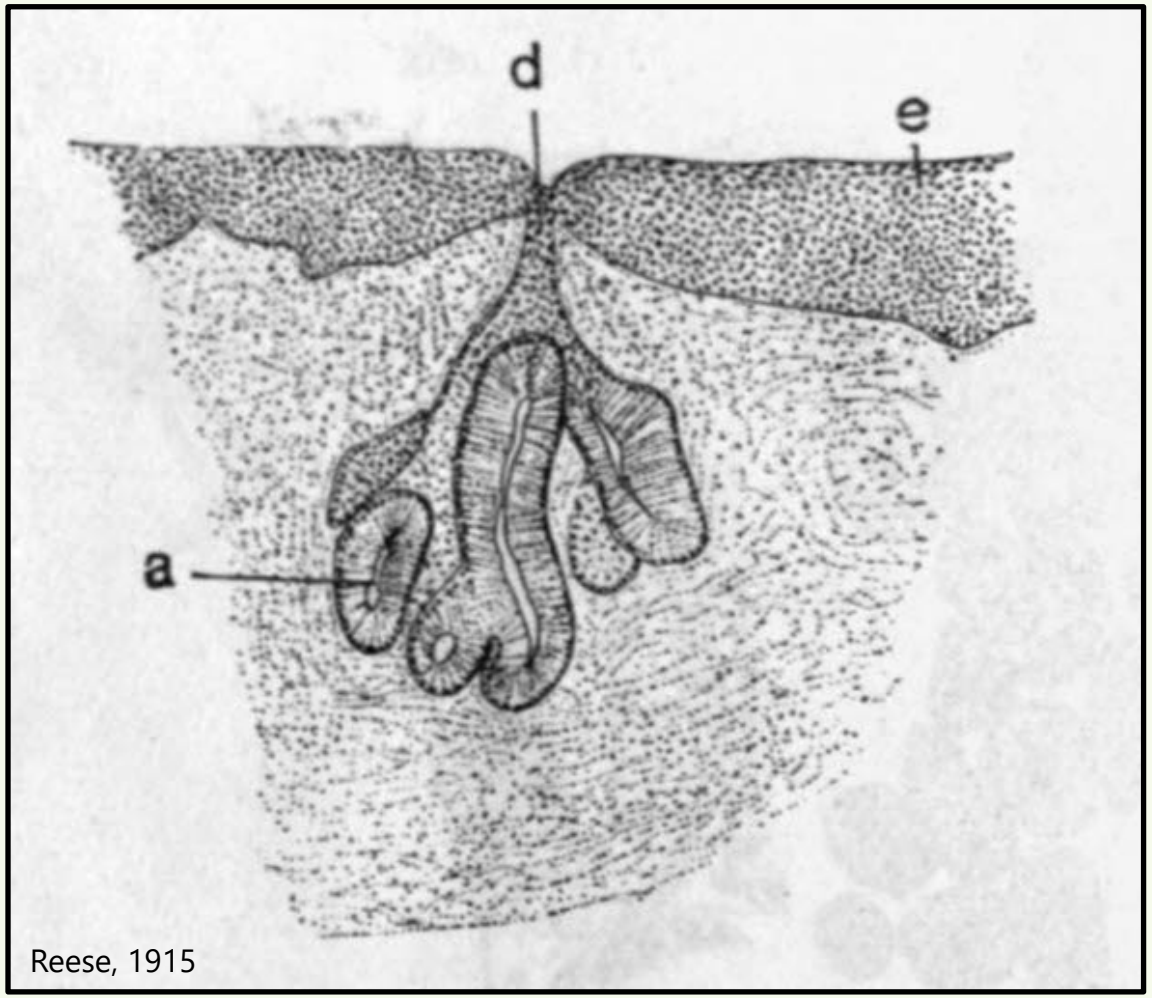

https://www.reddit.com/r/natureismetal/comments/r2amir/a_7foot_alligator_swimming_in_the_surf_on_pawleys/

Inland

- No saltwater exposure
- Freshwater invertebrates, frogs, lizards, rodents
- No behavioral osmoregulation
- Okefenokee Swamp

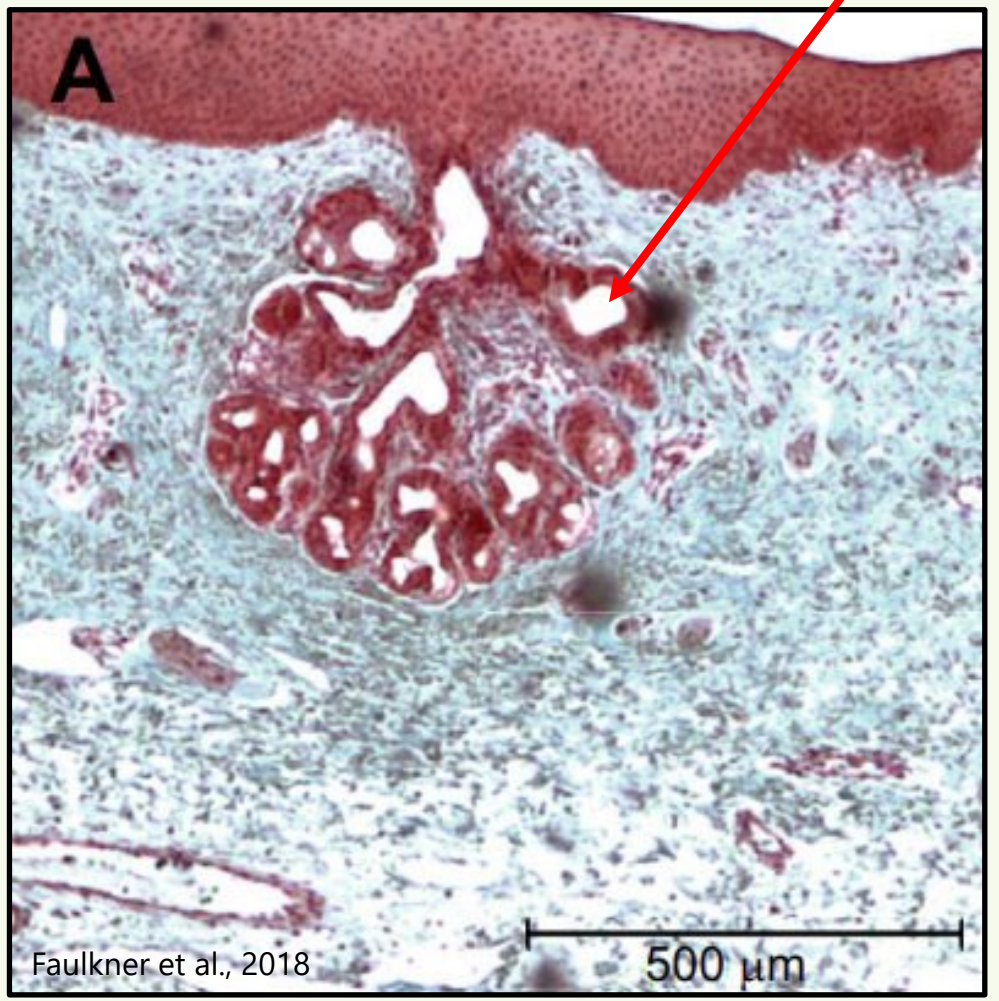

https://lovedwellshere.com/okefenokee-national-wildlife-refuge-a-visit-to-the-swamp/

Alligator Lingual Glands 1.1



Reese, 1915

Secretory tubule



Faulkner et al., 2018

Alligator Populations

- **Coastal**
- Routine saltwater exposure
  - Food
  - Travel
- Georgia Barrier Islands

- **Inland**
- No saltwater exposure
- Okefenokee Swamp

https://lovedwellshere.com/okefenokee-national-wildlife-refuge-a-visit-to-the-swamp/

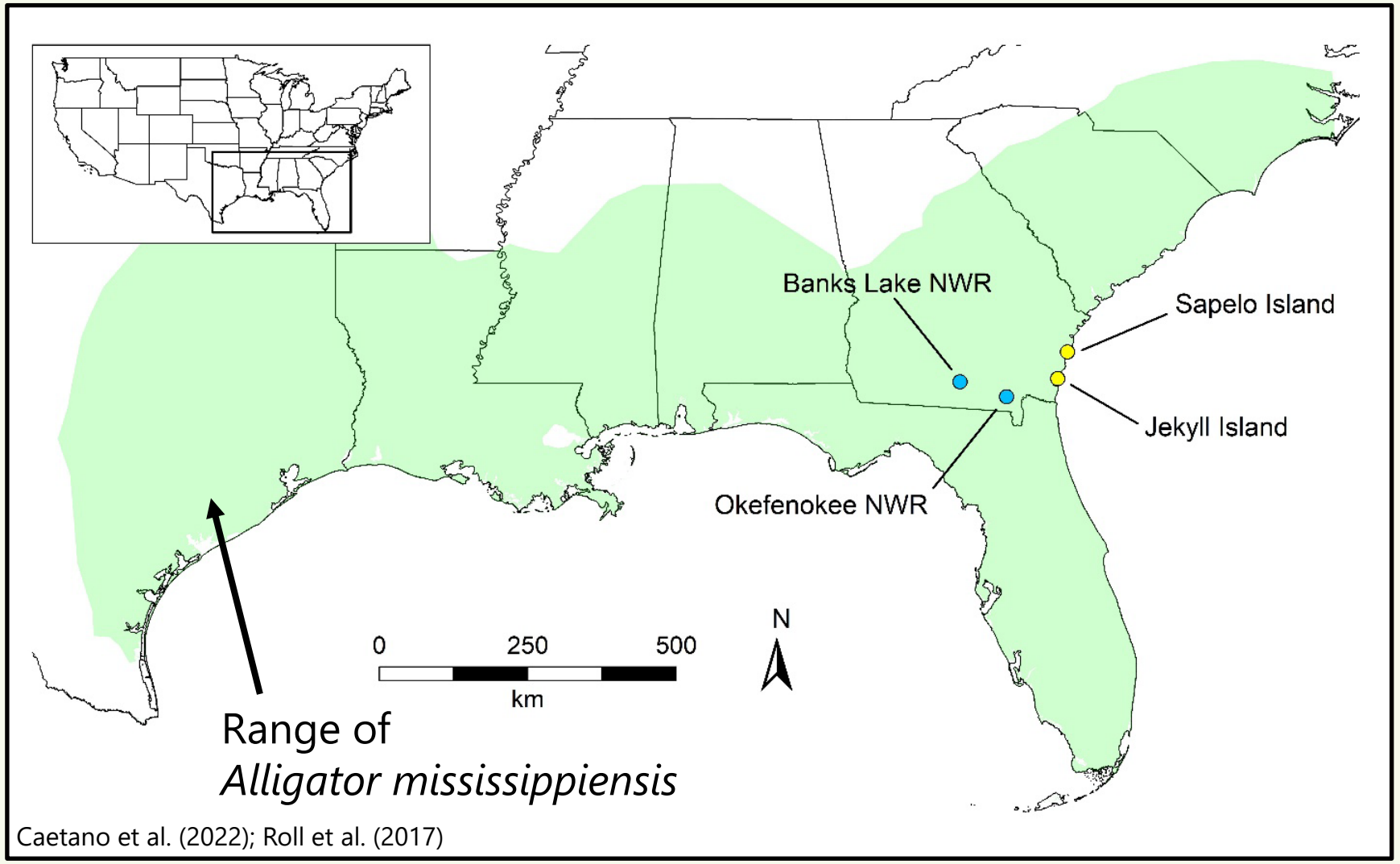
Questions

1. Are there morphological differences in the lingual glands between inland and coastal alligator populations?

2. Are coastal populations of alligators more osmotically stressed than their inland counterparts?

Methods: Site Selection

- 4 sites
  - 2 coastal
  - 2 inland
- One week per site
- Captured 6 to 15 alligators per site



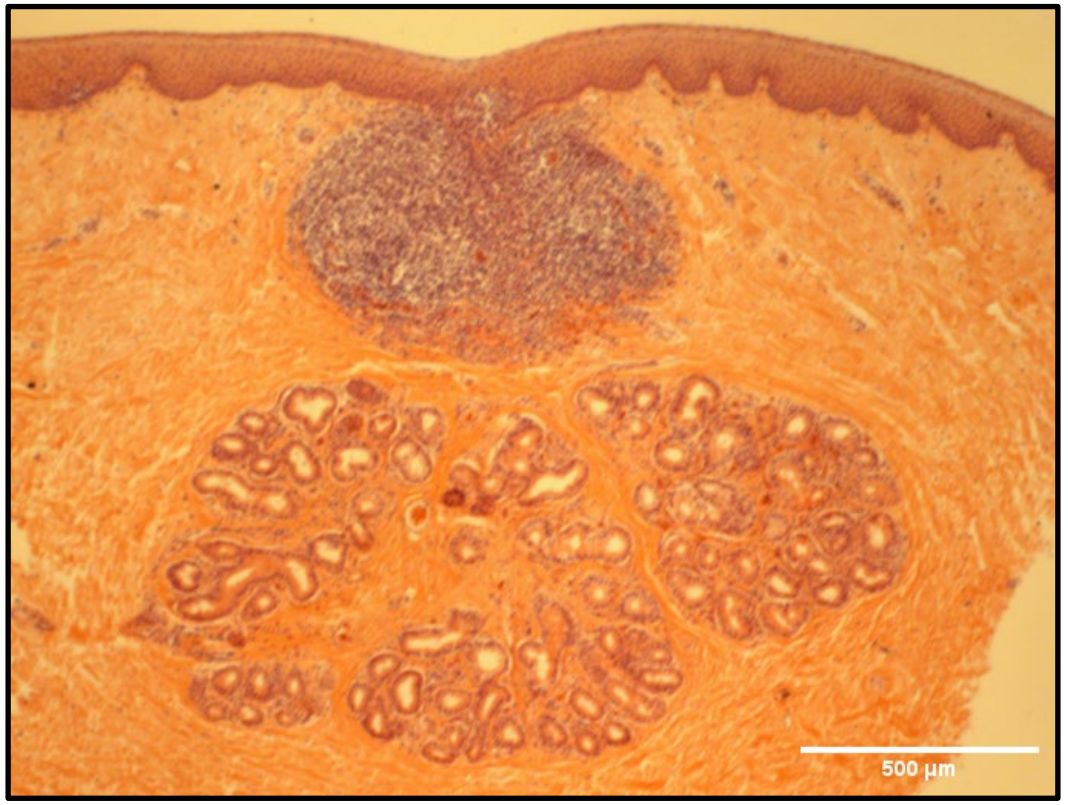
Caetano et al. (2022); Roll et al. (2017)

Field Data Collection

- Captured with rod and reel and secured to board.
- Collected:
  - Morphometrics
  - Lingual gland count
  - Water salinity
  - Blood sample
  - Lingual gland biopsy – custom jaw prop

Lab Data Collection

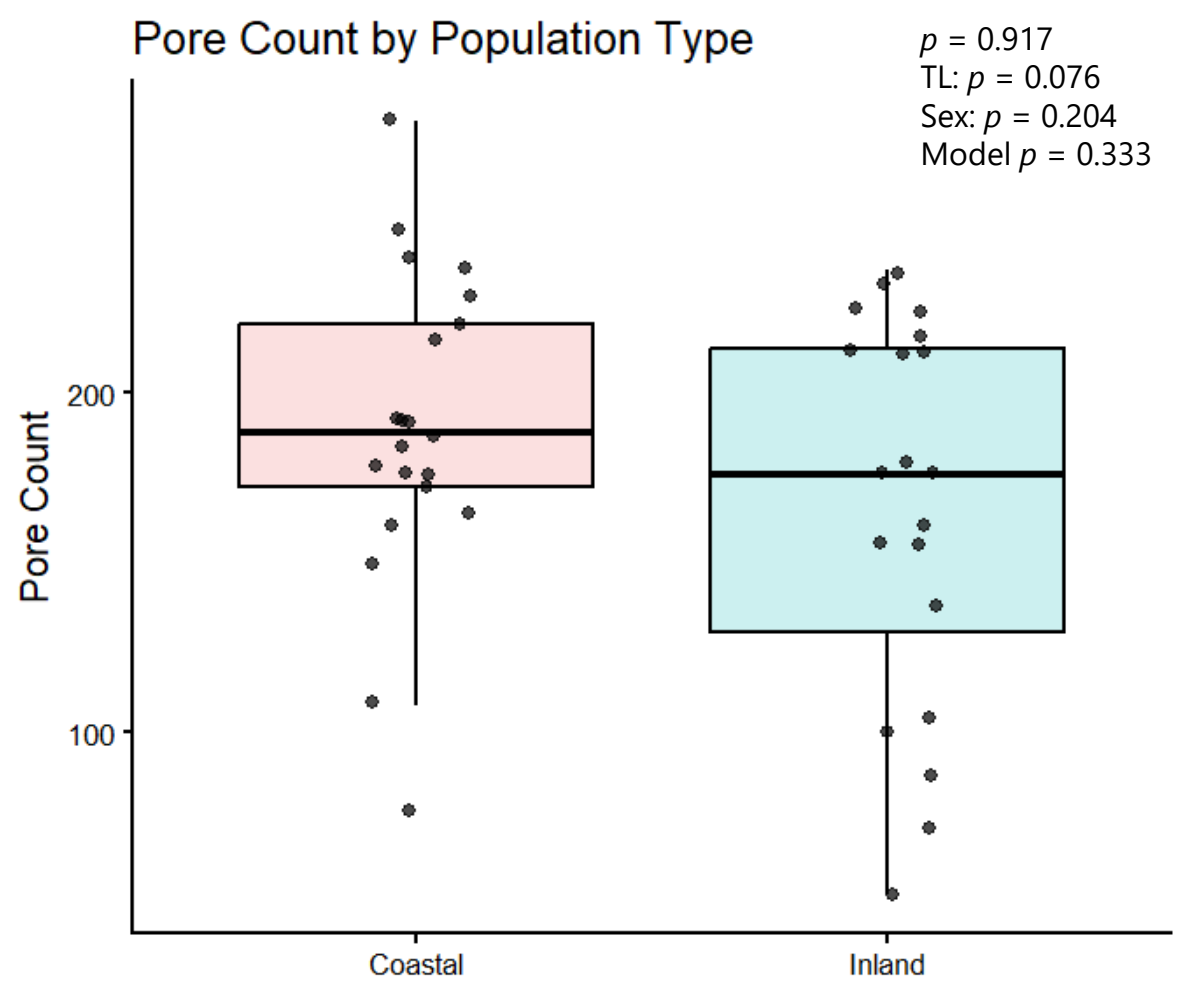
- Blood samples → University of Miami Avian and Wildlife Lab
- Lingual gland biopsies → paraffin histology, H&E staining
- ImageJ
  - Secretory tubule count
  - Secretory tubule density
  - Secretory tubule lumen area
  - Gland area

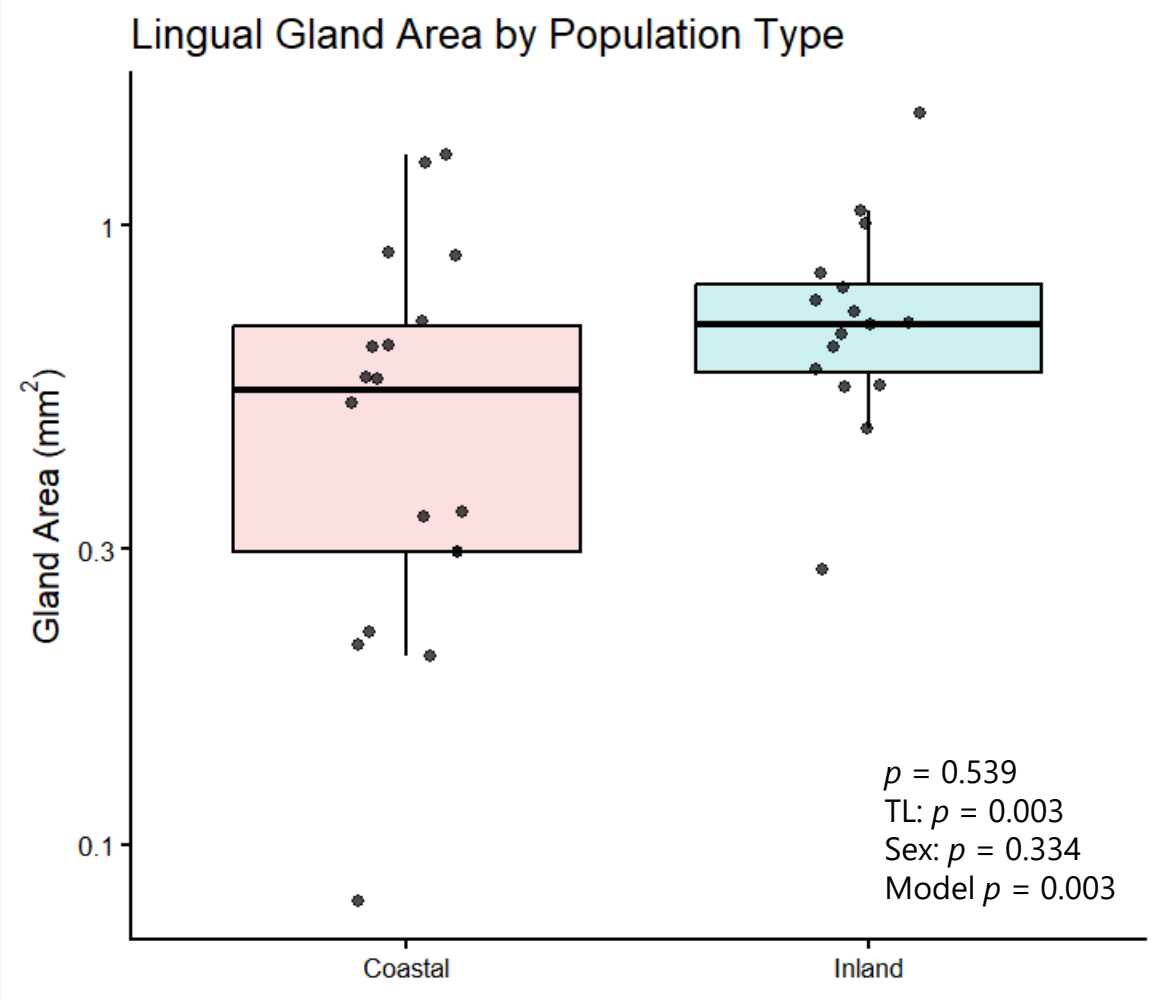


Sample Size

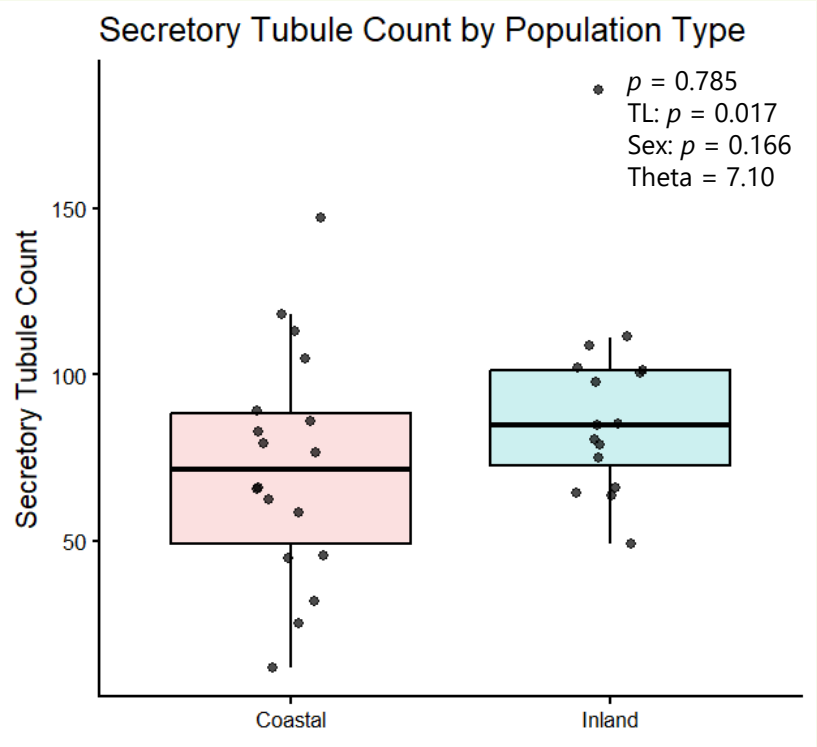
- Total alligators captured: 42
  - 21 from coastal sites
  - 21 from inland sites
- Size range: 90-290 cm
- Limbs lost = 0
- Undergrads eaten = 0
- **All in all, a successful sampling trip!**

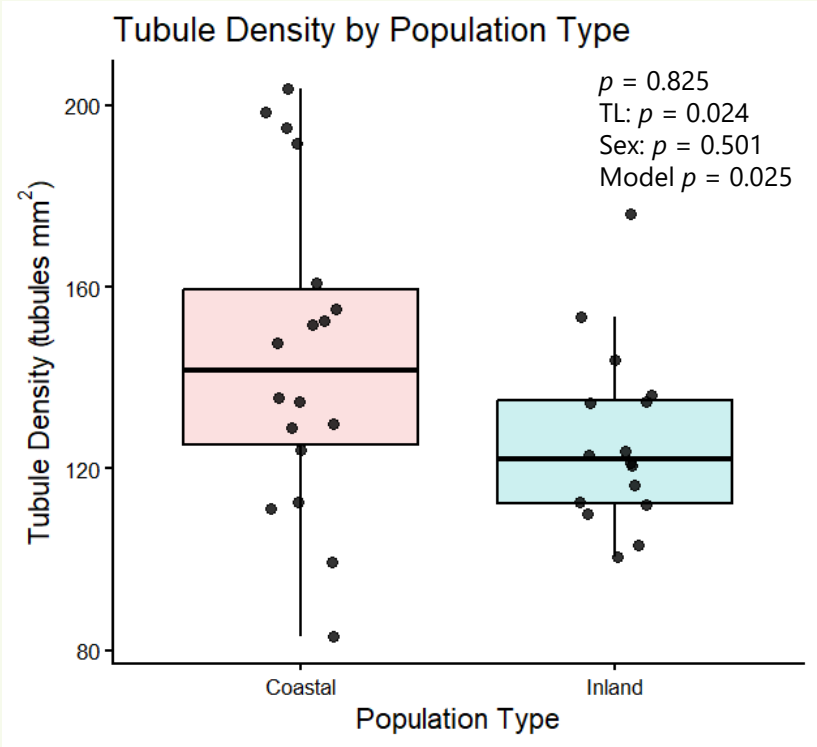
Results: Coastal vs. Inland Gland Morphology

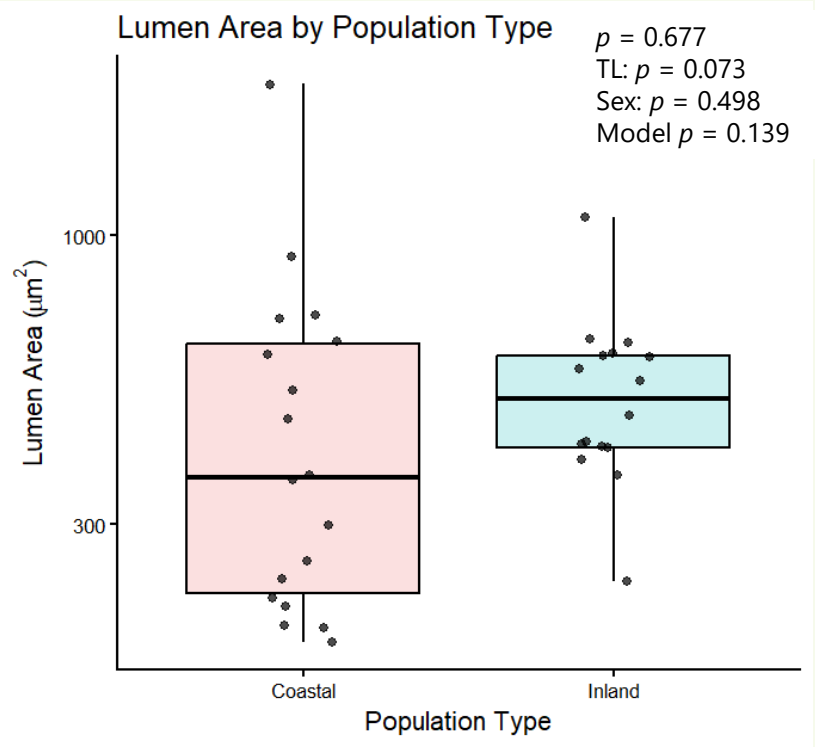


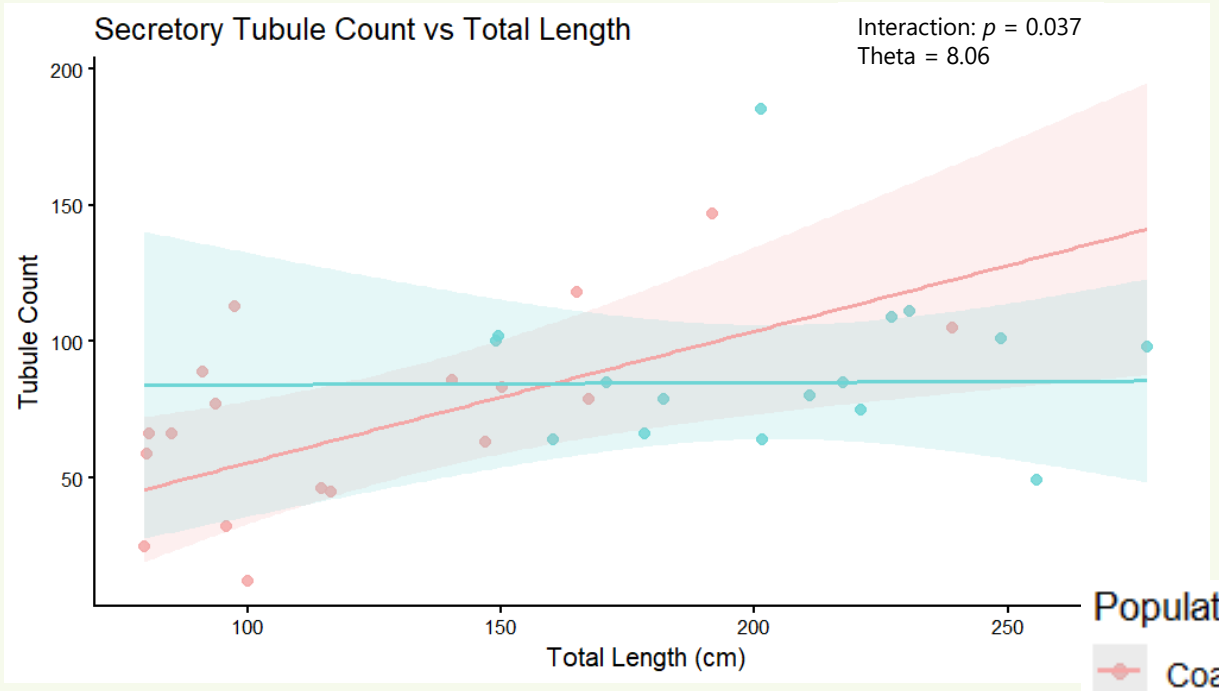


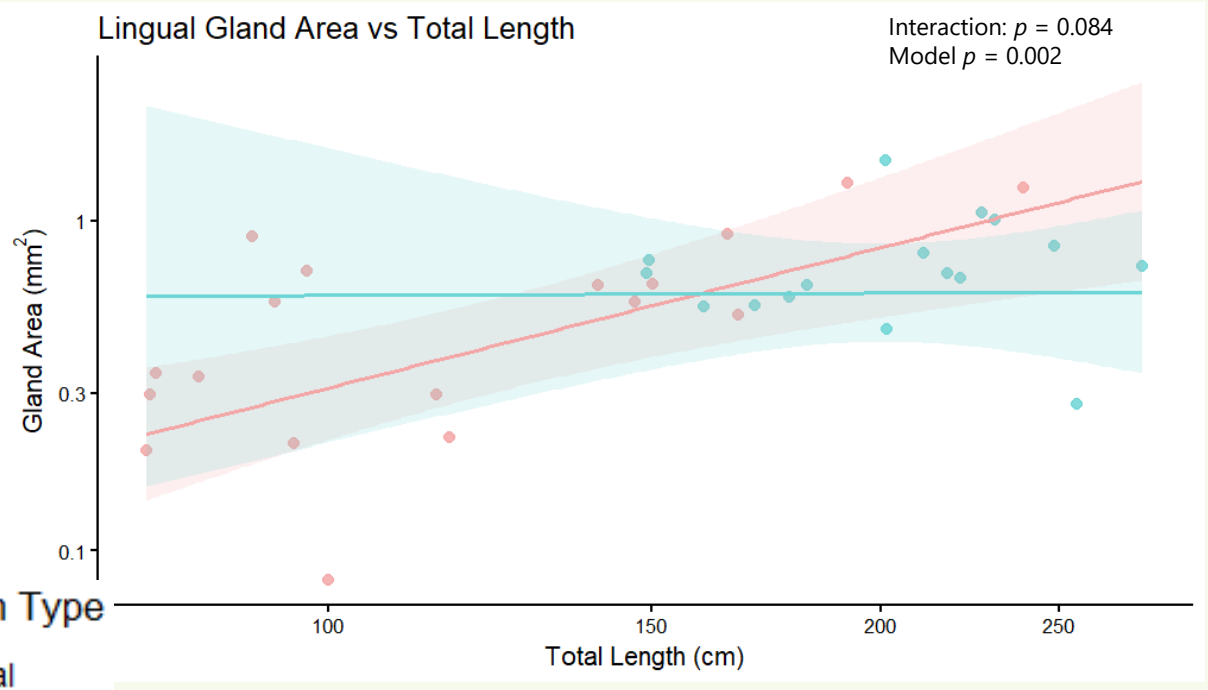
Results: Coastal vs. Inland Tubule Morphology



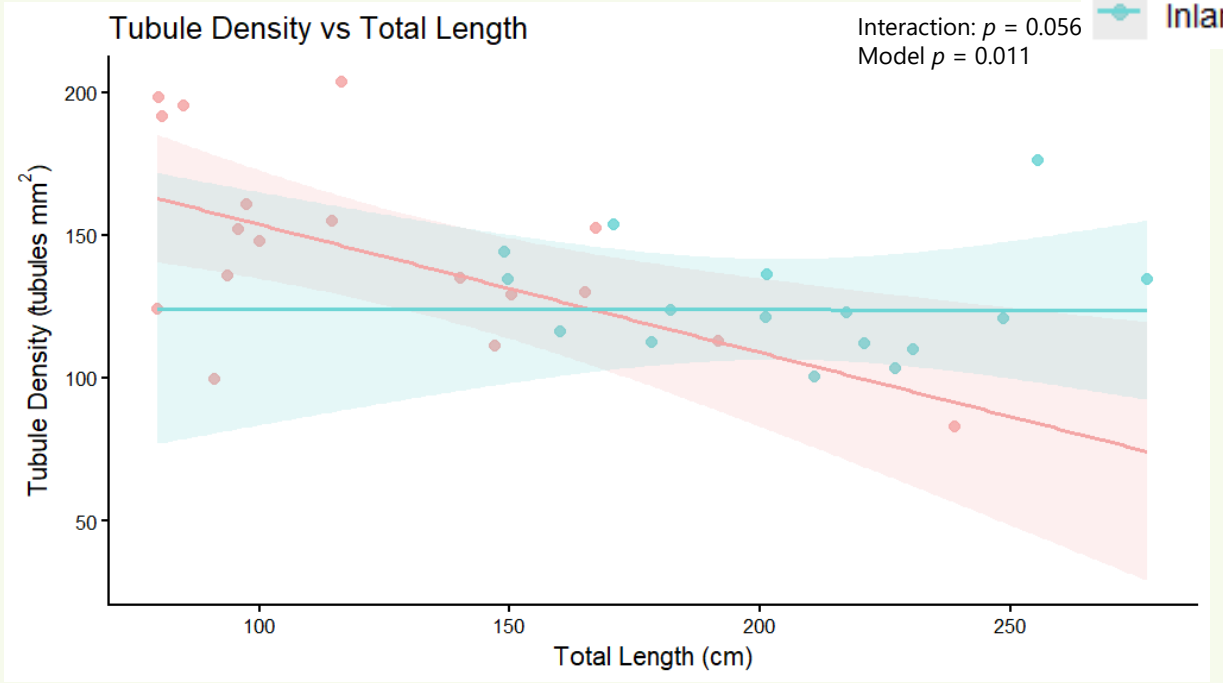


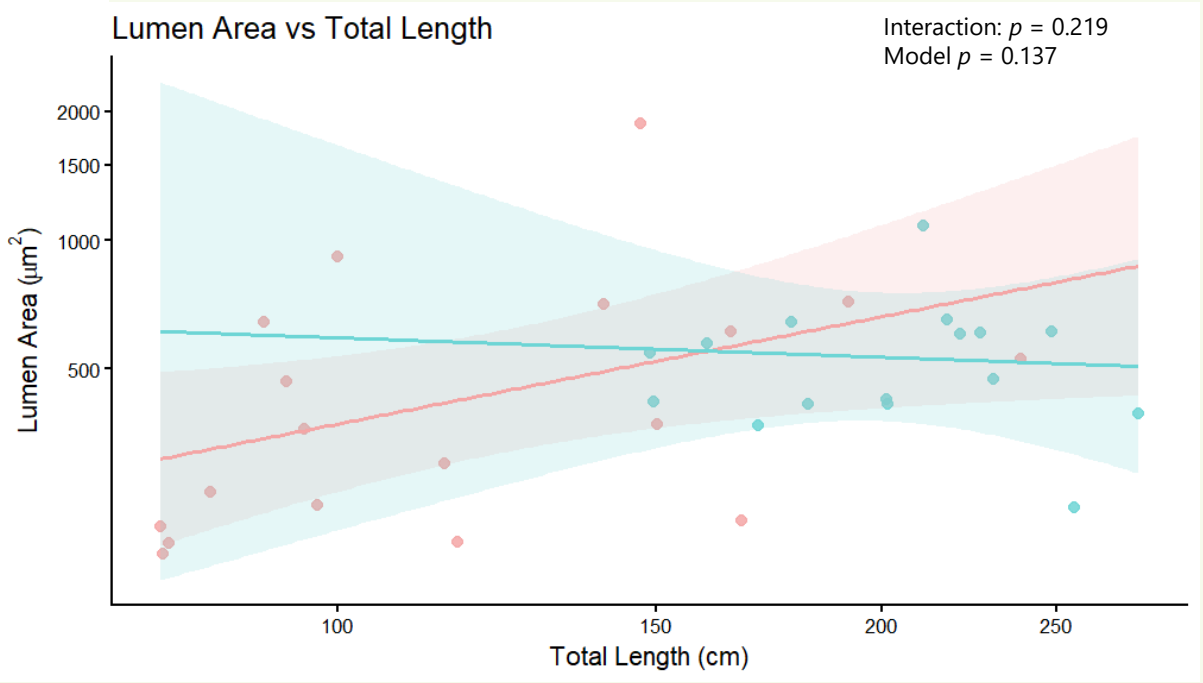



Secretory Tubule Count vs Total Length
Interaction: p = 0.037
Theta = 8.06
Tubule Count
Total Length (cm)

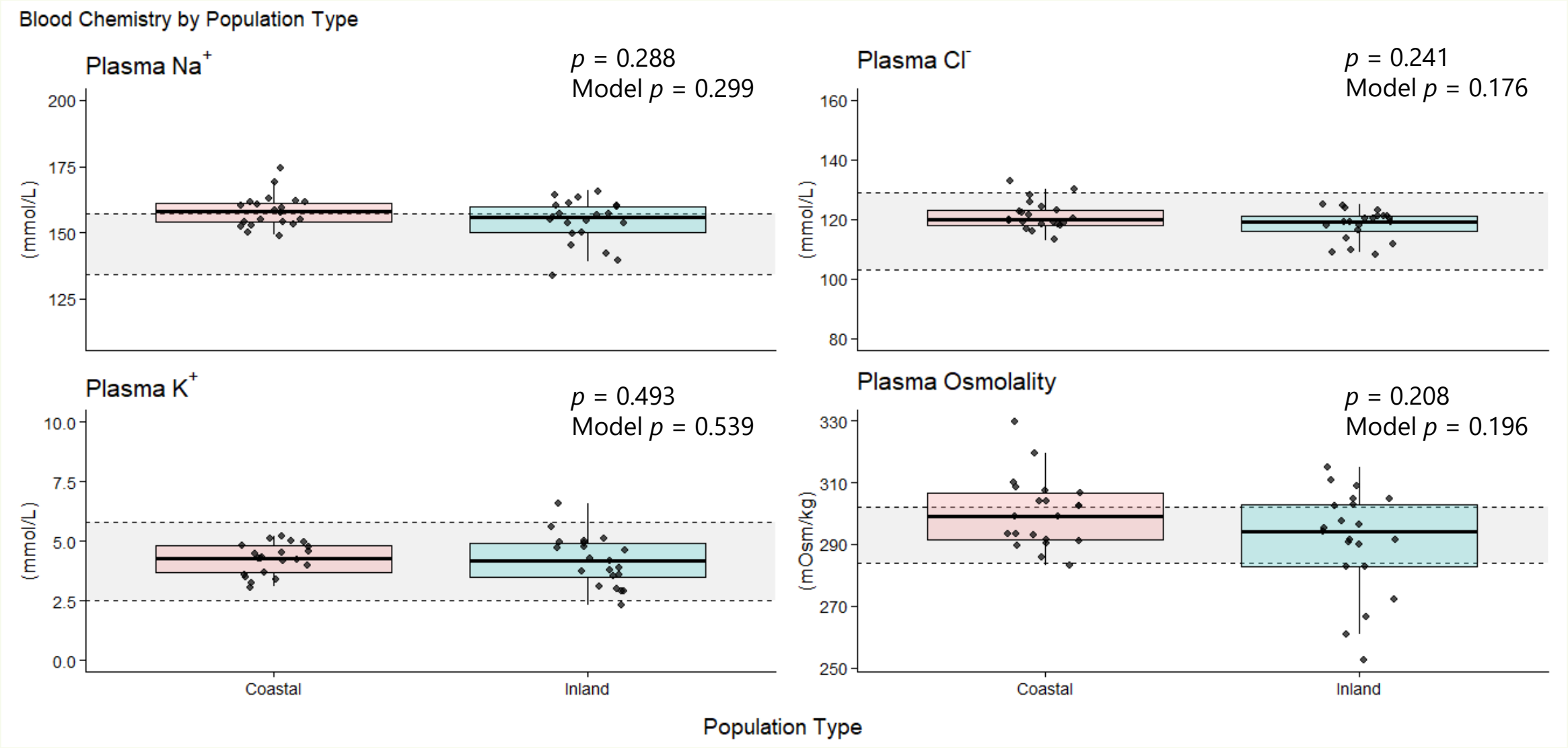

Lingual Gland Area vs Total Length
Interaction: p = 0.084
Model p = 0.002
Gland Area (mm2)
Total Length (cm)


Population Type
Coastal
Inland

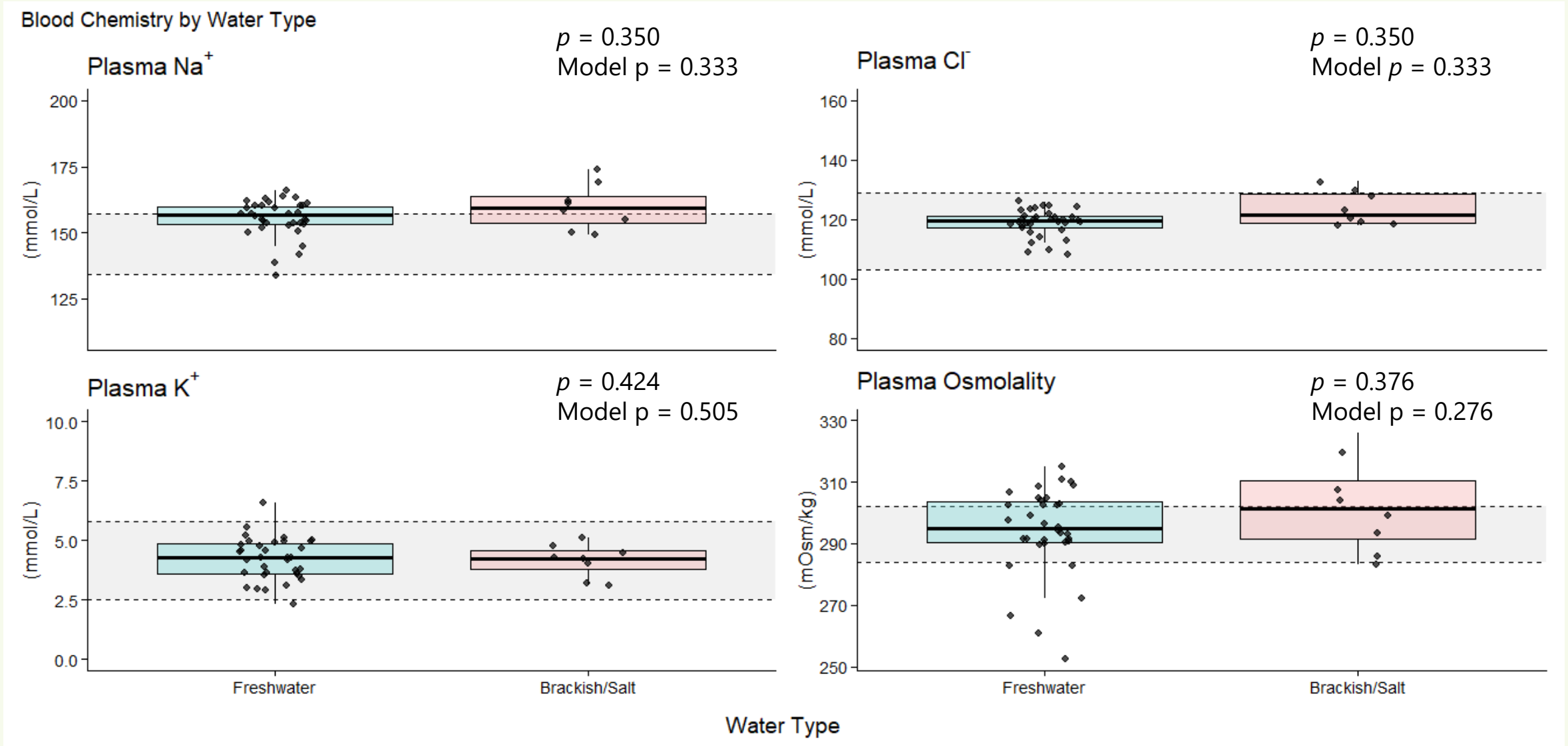

Tubule Density vs Total Length
Interaction: p = 0.056
Model p = 0.011
Tubule Density (tubules mm2)
Total Length (cm)


Lumen Area vs Total Length
Interaction: p = 0.219
Model p = 0.137
Lumen Area (µm2)
Total Length (cm)

Results: Coastal vs. Inland Osmotic Stress



Results: Freshwater vs. Saltwater Osmotic Stress

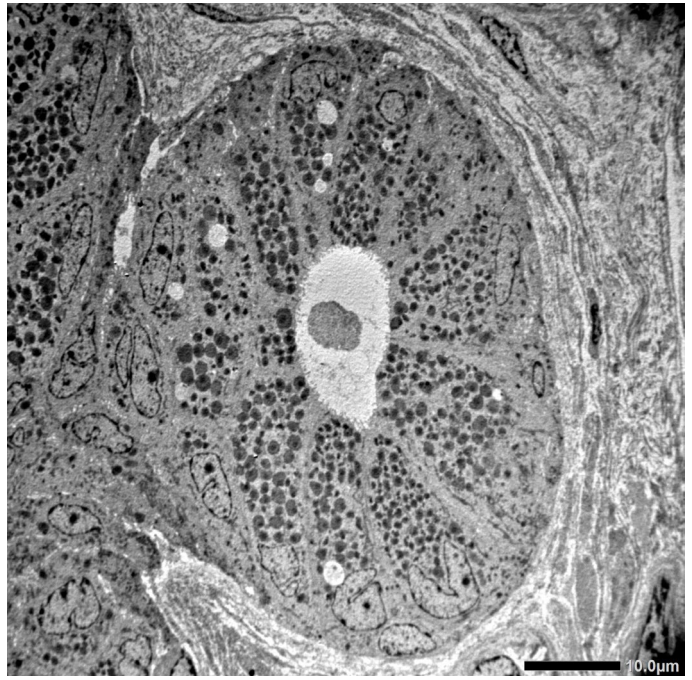


Conclusions

- Alligator lingual gland morphology is not significantly different between coastal and inland populations.
- Scaling of secretory tubule count with body size differs significantly between coastal and inland populations.
- Coastal alligator populations are not more osmotically stressed than inland populations.
- **Key Takeaways**
  - Produced the first description of wild and adult alligator lingual glands.
  - Identified novel lingual gland traits within alligators (multi-lobular structure, larger size, higher tubule density).

Research & Implications

- **Current Work**
  - Quantify lingual gland comparisons between crocodilian species
  - Mitochondrial Abundance via TEM
- **Future Work**
  - Lingual gland secretions
  - Conservation strategies



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- Banks Lake NWR
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