Project Update: October 2018

As per the project schedule, we successfully conducted fieldwork between July–September 2018. We sampled seven areas, four habitats by area (some unavailable in some areas), and captured 295 caimans. We recorded size, sex, and geo-position of animals, and collected tissues for stable isotope analysis as proposed in the project.

Moreover, I participated of 25th Working Meeting of the Crocodile Specialist Group (CSG/SSC/IUCN) in Santa Fé, Argentina, with an oral presentation as an initial result of the first collections. Abstract and presentation below.

25th Working Meeting of the Crocodile Specialist Group, Santa Fe, Argentina May 7th to 10th 2018

Intraspecific Variation and Spatial-Temporal Differences in the Isotopic Niche of *Caiman crocodilus* (Spectacled Caiman) in an Agricultural Landscape

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Carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope ratios of different body tissues can provide information about variation or similarity in the trophic niche at different spatial-temporal scales. We assessed the effects of sex, ontogeny, and habitat use on the trophic niche of *Caiman crocodilus* using $\delta^{13}C$ and $\delta^{15}N$ from five tissues with different turnover rates (plasma, muscle, red blood cell, nail, and scute). We sampled 42 *C. crocodilus* (22 females and 20 males) in an agricultural landscape in the Araguaia floodplain, Lagoa da Confusão, Tocantins, Brazil. We used Bayesian Model Averaging to assess models of isotopic composition and estimated niche width and overlap with Bayesian standard ellipses. $\delta^{13}C$ increased according to isotopic incorporation time, but there was high overlap among different tissues. $\delta^{13}C$ and $\delta^{15}N$ varied significantly between habitats, with *C. crocodilus* from pond and lake having higher variability and significantly larger niche widths than those in ditch and river. Females had higher variability in $\delta^{13}C$ and $\delta^{15}N$ and larger niche width than males, independently of tissue. Females in the pond and ditch had larger niche width than males, although higher overlap between sexes was evident in river and pond. $\delta^{13}C$ decreased with snout-vent length (SVL) and slopes differed between sexes, whereas $\delta^{15}N$ increased with SVL in males, but decreased with SVL in females. In the Araguaia floodplain, *C. crocodilus* has a diverse and relatively invariable diet over time, as inferred from stable isotope ratios. Yet, between-habitat variation in stable isotope ratios suggests a trophic dynamics resulting from movement patterns across interconnected habitats, or human influences on the ecosystem. Presumably, differences in foraging and habitat use patterns lead to wider niches in females, despite both sexes feeding in similar trophic levels.

Keywords: Araguaia floodplain; diet; sexual niche variation; temporal isotopic specialists.

Intraspecific variation and spatial-temporal differences in the isotopic niche of *Caiman crocodilus* (Spectacled caiman) in an agricultural landscape

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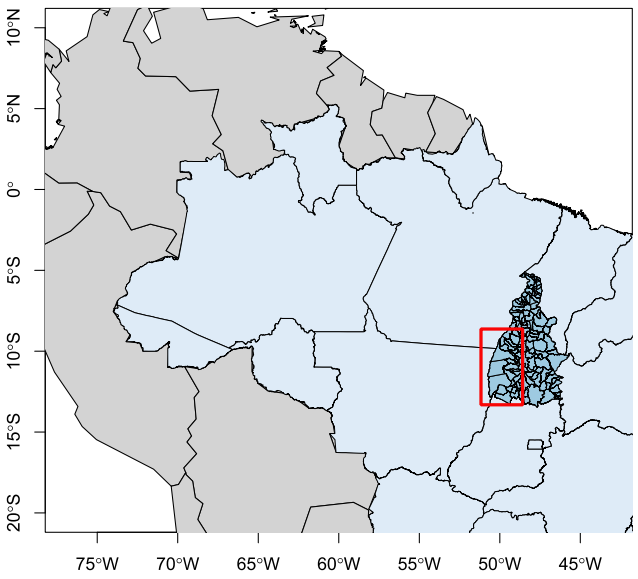
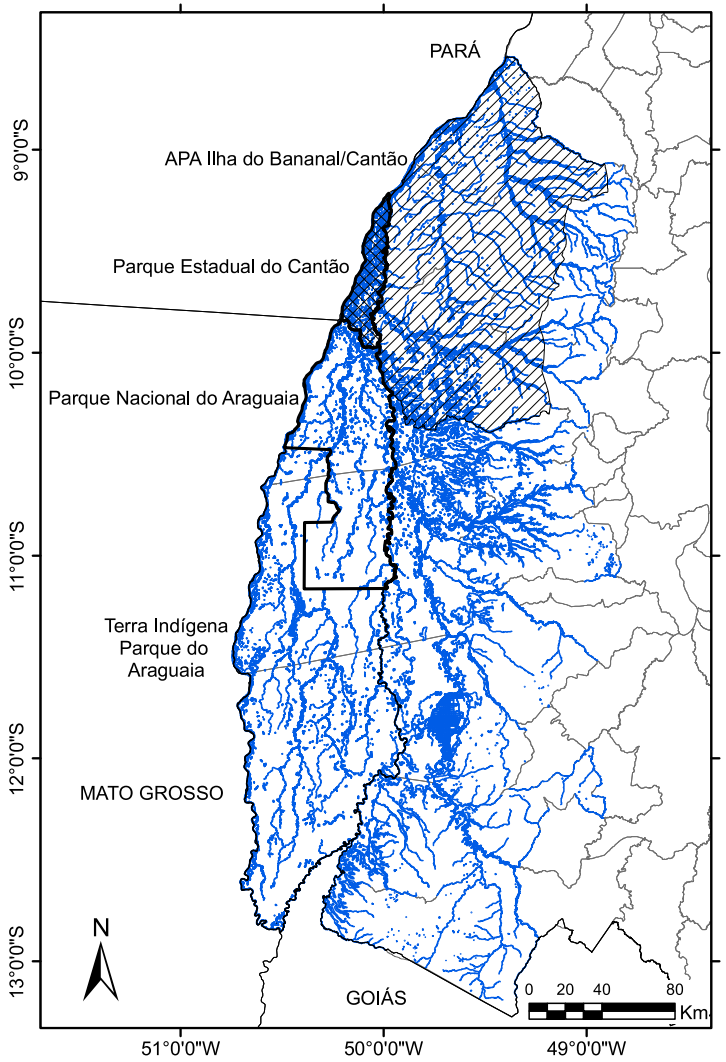
Araguaia floodplain



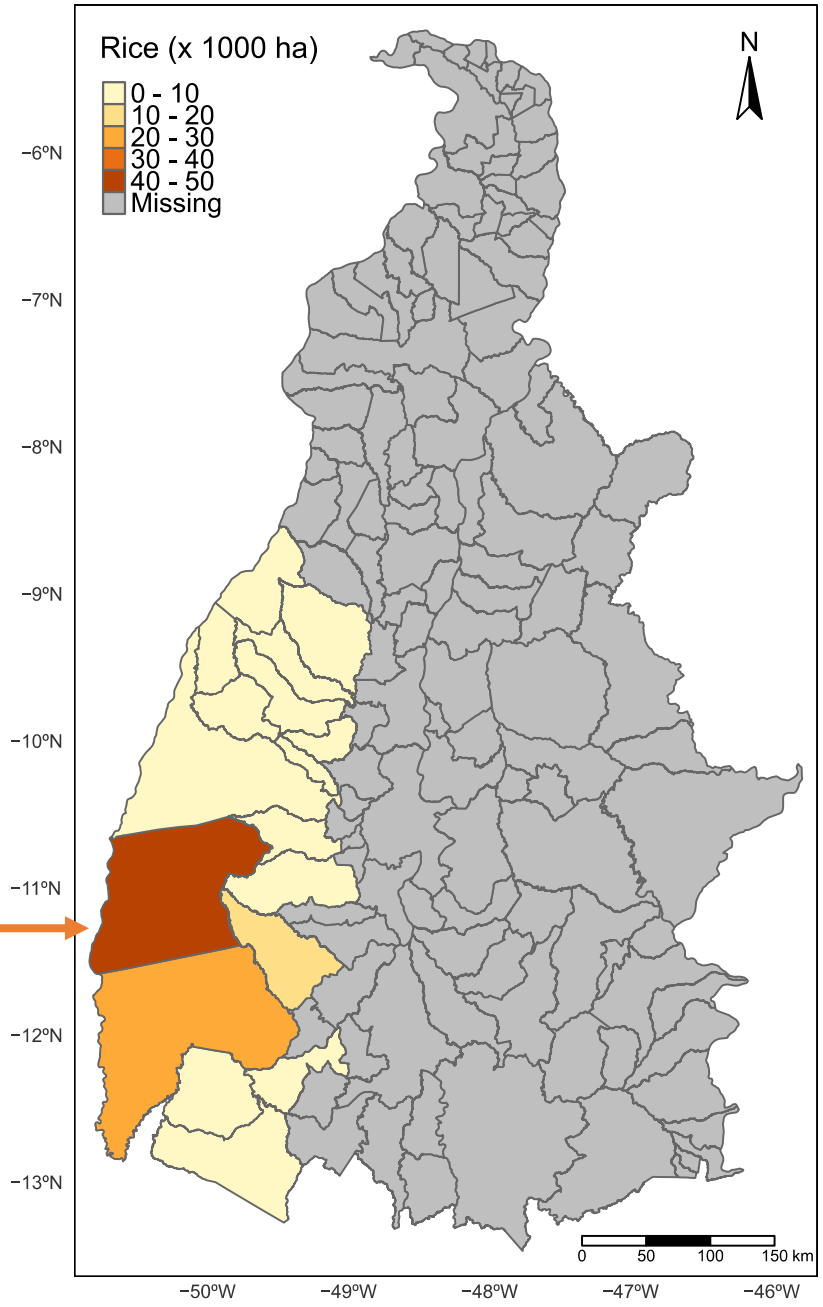


Irrigated rice

State	Area (ha)
Rio Grande do Sul	1 127 916
Maranhão	239 004
Mato Grosso	187 817
Santa Catarina	148 706
Tocantins	119 826
Piauí	91 183
Pará	66 255
Rondônia	43 574

Source: IBGE (2016)

8th position



Indicator species – *Caiman crocodilus*

Hypothesis

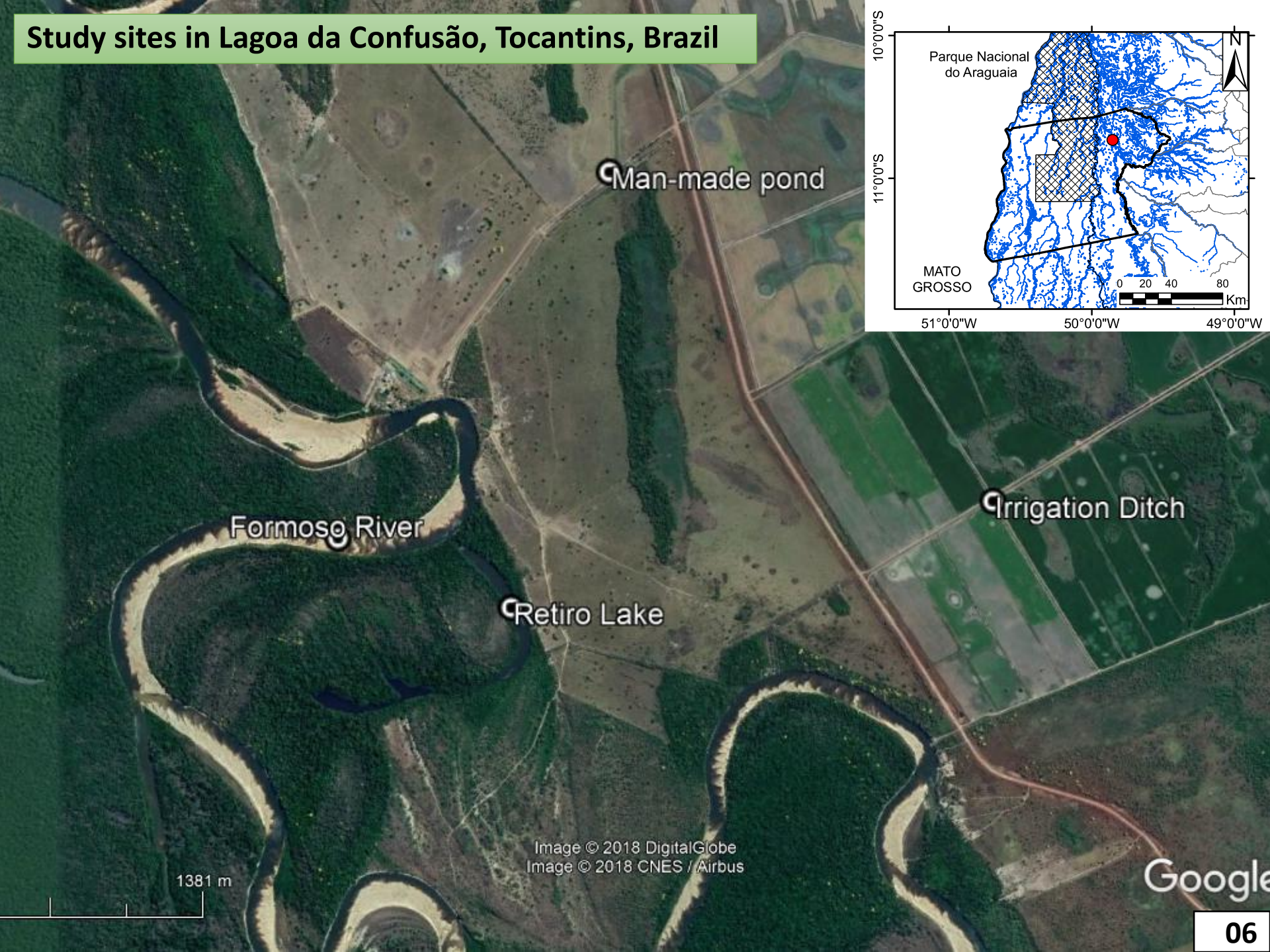
(i) Populations of *Caiman crocodilus* in anthropogenic habitats have larger niche width due impacts of human land uses, including in sexual covariate;

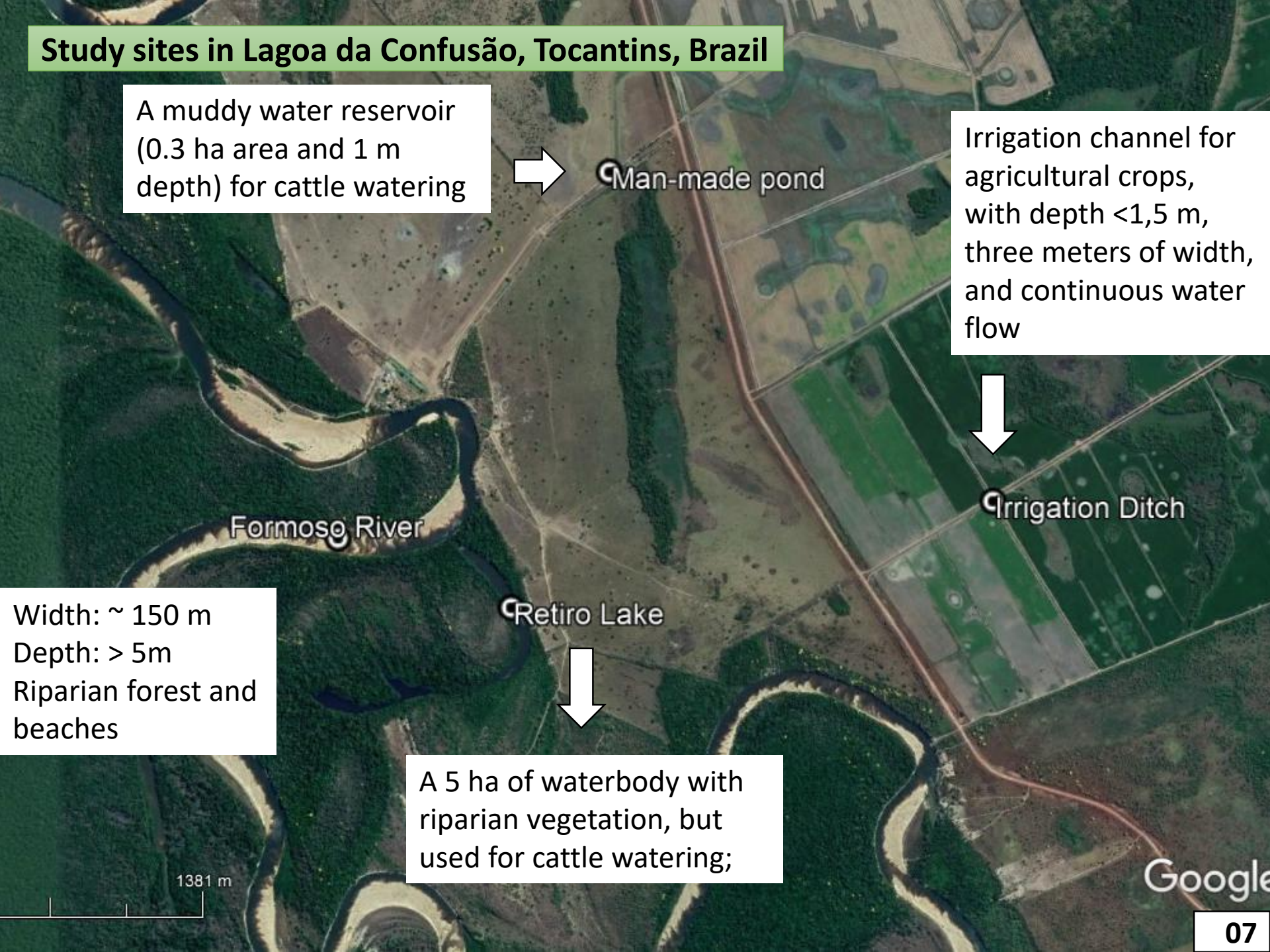
(ii) Populations of *C. crocodilus* in anthropogenic habitats occupy distinct niche position in relation to populations in natural habitats, including in sexual and body size covariates;

(iii) Impacts of different land uses cause invariability in the niche width and position along time;

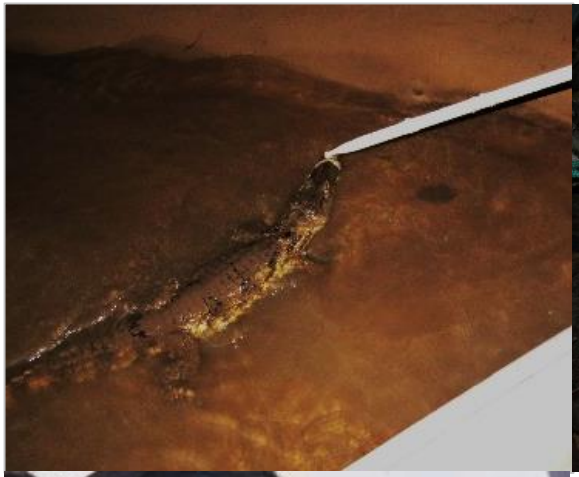


Study sites in Lagoa da Confusão, Tocantins, Brazil




Study sites in Lagoa da Confusão, Tocantins, Brazil
A muddy water reservoir (0.3 ha area and 1 m depth) for cattle watering
Man-made pond
Irrigation channel for agricultural crops, with depth <1,5 m, three meters of width, and continuous water flow
Irrigation Ditch
Formoso River
Retiro Lake
Width: ~ 150 m
Depth: > 5m
Riparian forest and beaches
A 5 ha of waterbody with riparian vegetation, but used for cattle watering;
1381 m
Google

Captures, biometry, and tissue collection



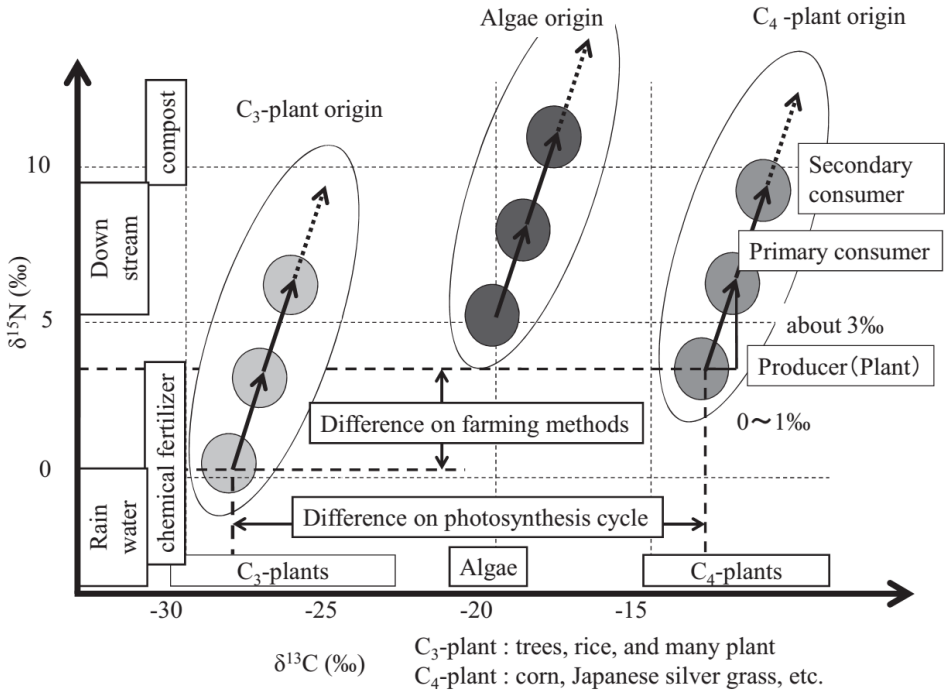
- Captured: 42 animals
  - Females: 22 ind.
  - Males: 20 ind.

- Size: Snout-vent length (SVL)
- Sex

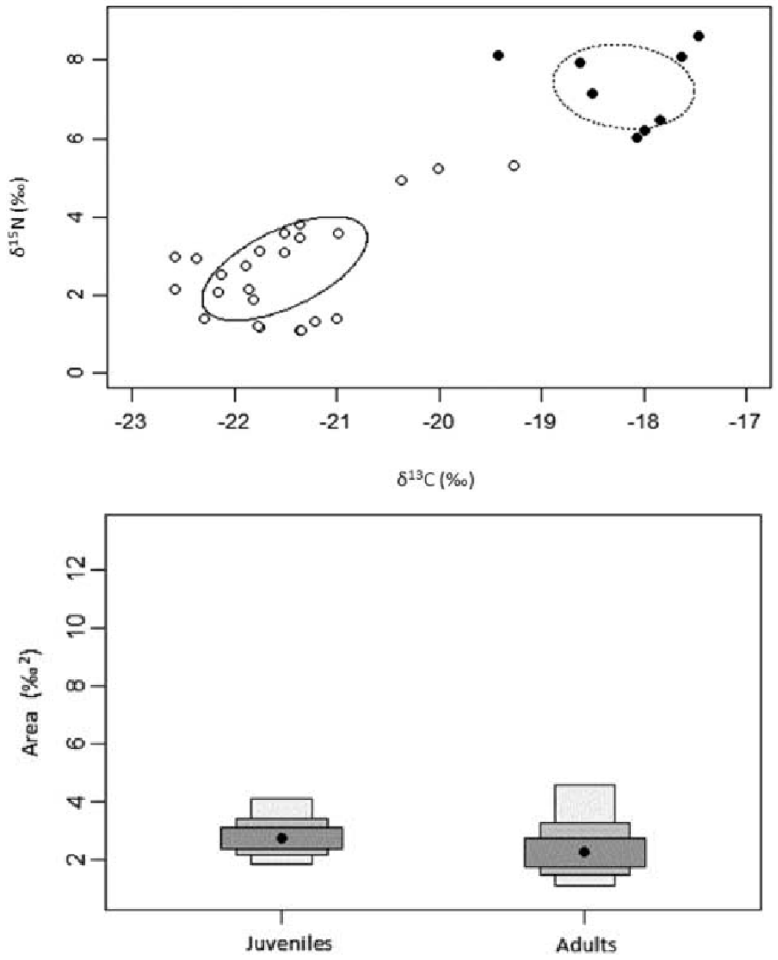
- Tissue collection:
  - Plasma
  - Red blood cells (RBC)
  - Tail muscle
  - Claw
  - Tail scute

Methods

- Trophic niche of *C. crocodilus* by stable isotopes
  - Niche width measure: Bayesian standard ellipse area (SEA_B)
  - Niche overlap between groups



Source: Mori et al. (2015)



Source: Marques et al. (2013)

Methods

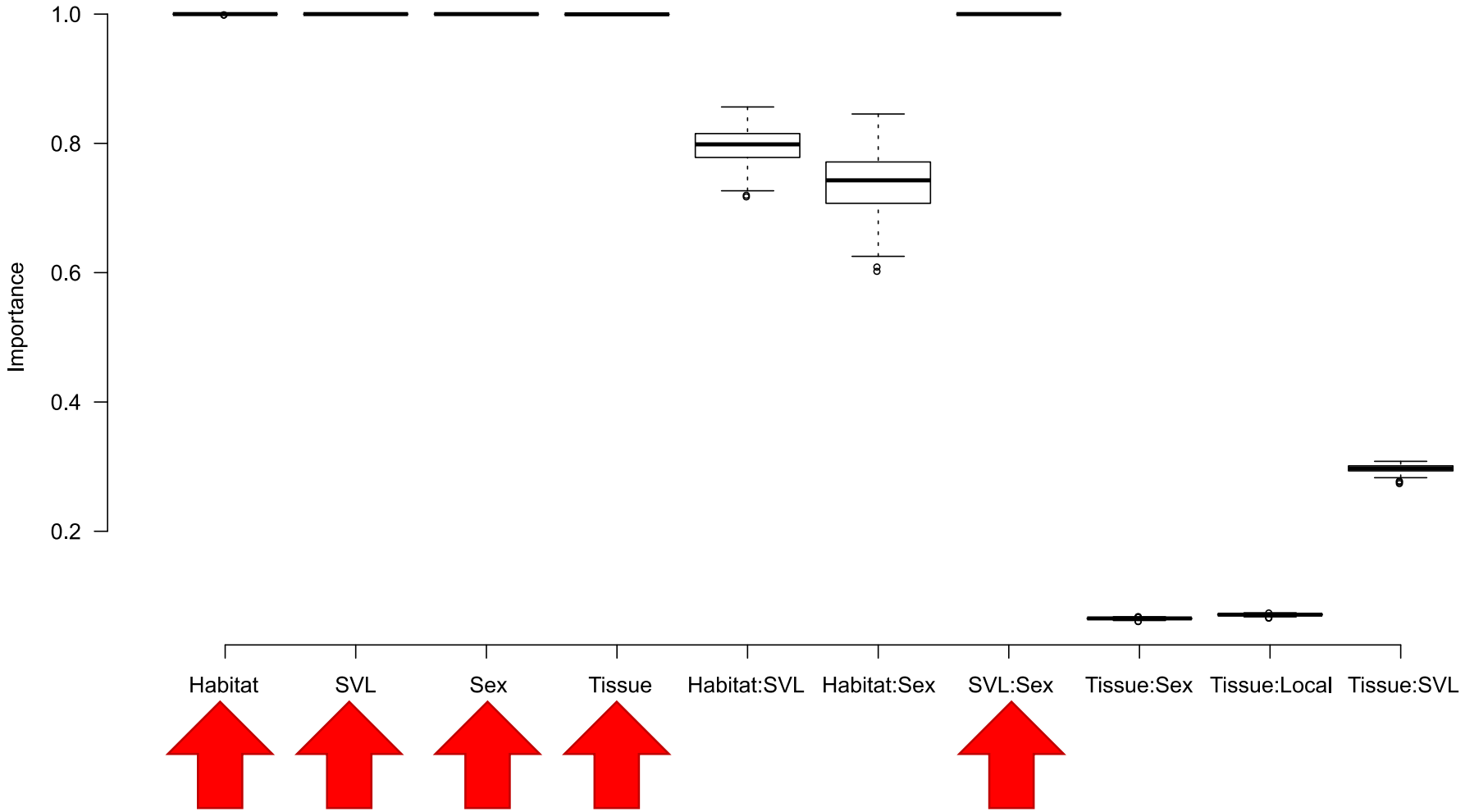
- Isotopic analysis
  - Laboratório de Ecologia Isotópica/Centro de Energia Nuclear na Agricultura (CENA/USP)

- Bayesian model averaging (BMA)
  - Best predictors:
    - Posterior Inclusion Probabilities (PIPs) - 0.95–1.00%
  - Models evaluation:
    - Posterior Model Probability Correlation (Cor. PMP);
    - Shrinkage coefficient;

Response		Predictors		Interactions of predictors
$\delta^{13}C$ $\delta^{15}N$	~	tissue, SVL, habitat, and sex	+	habitat:SVL, habitat:sex, SVL:sex, tissue:sex, tissue:habitat, and tissue:SVL

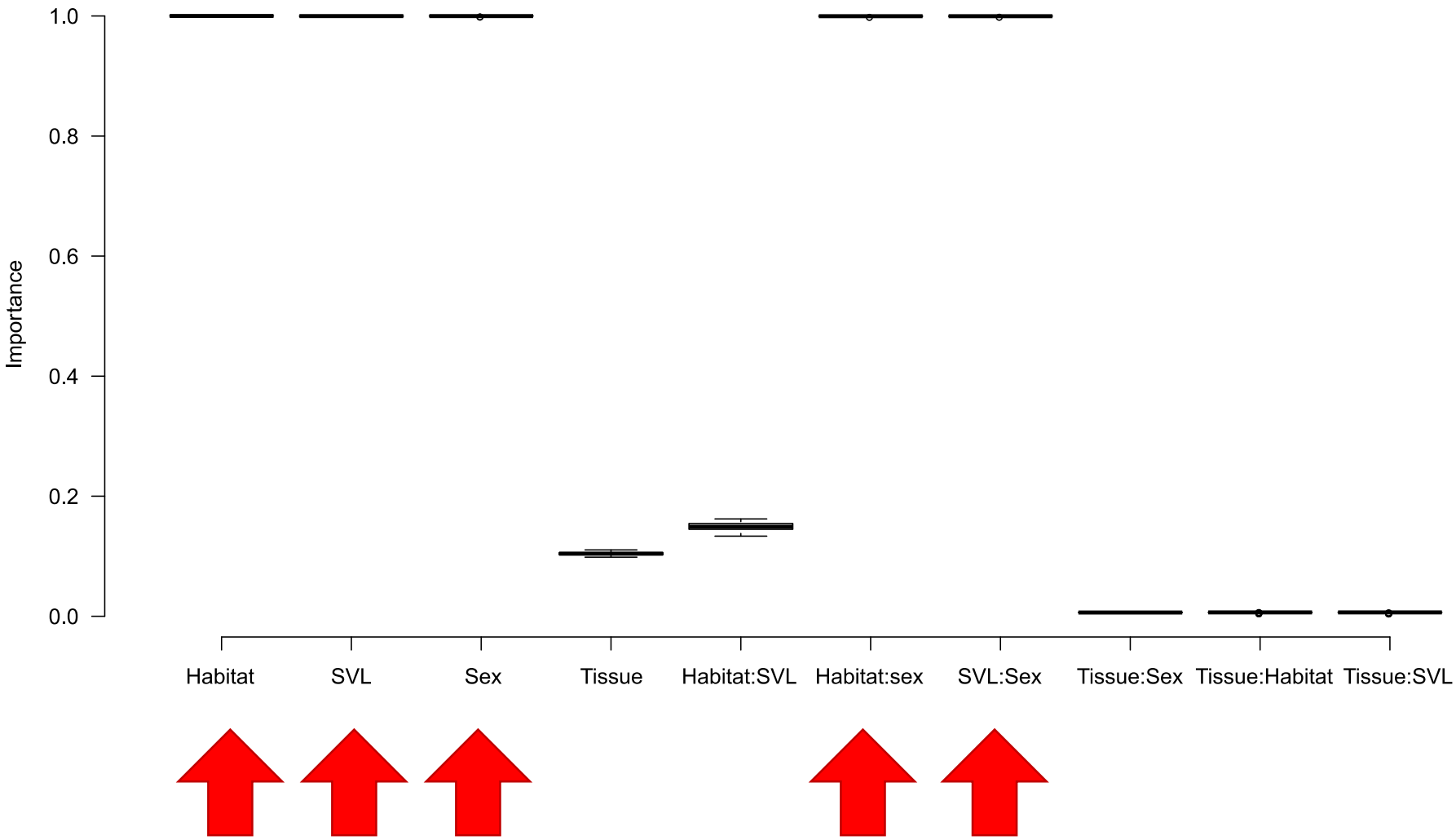
$\delta^{13}C$ BMA Results

Cor. PMP = 1.00, *Shrinkage* = 1.00



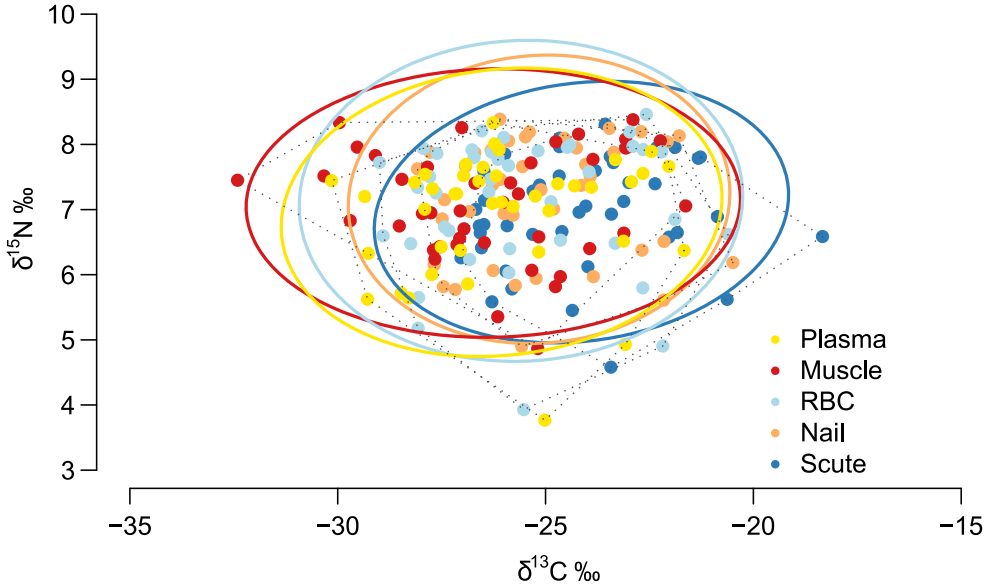
$\delta^{15}N$ BMA Results

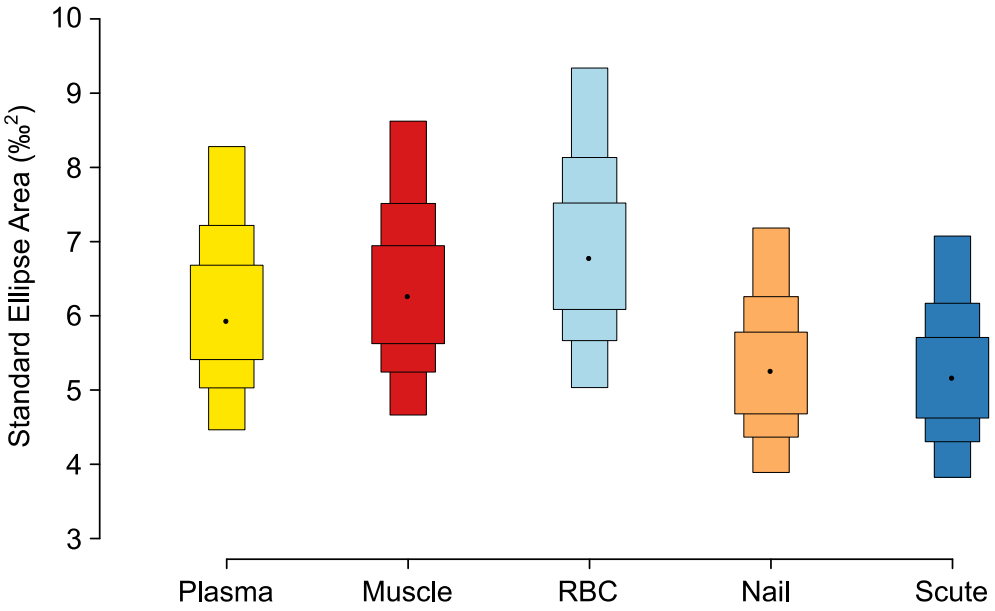
Cor. PMP = 1.00, *Shrinkage* = 1.00



Tissue niches

Invariability of resource use in temporal scale

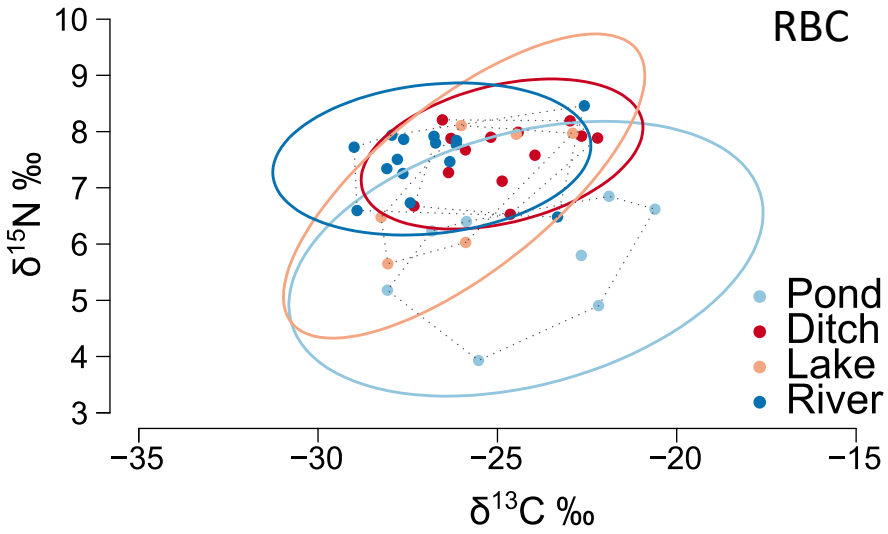


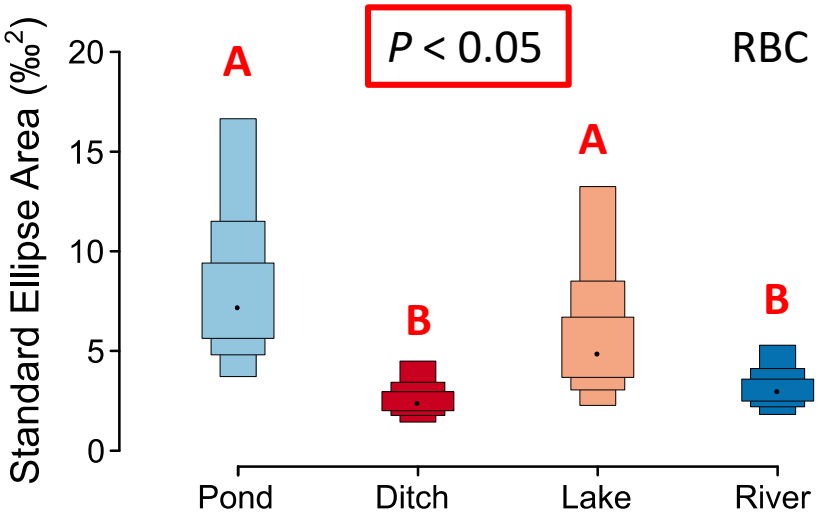


All
$P > 0.05$

Habitat niches along tissues

Tissues showed similar pattern





High niche redundancy

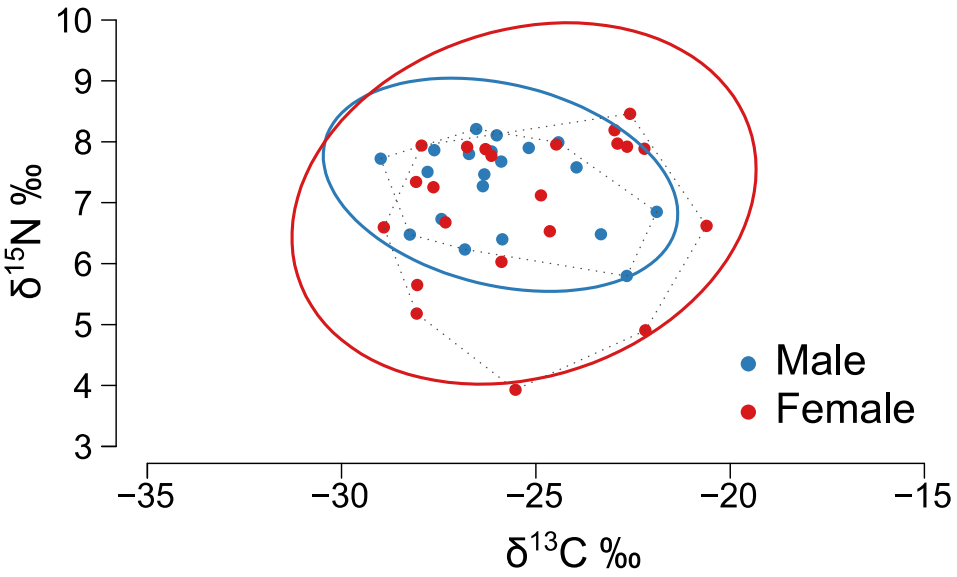
Pond in different position

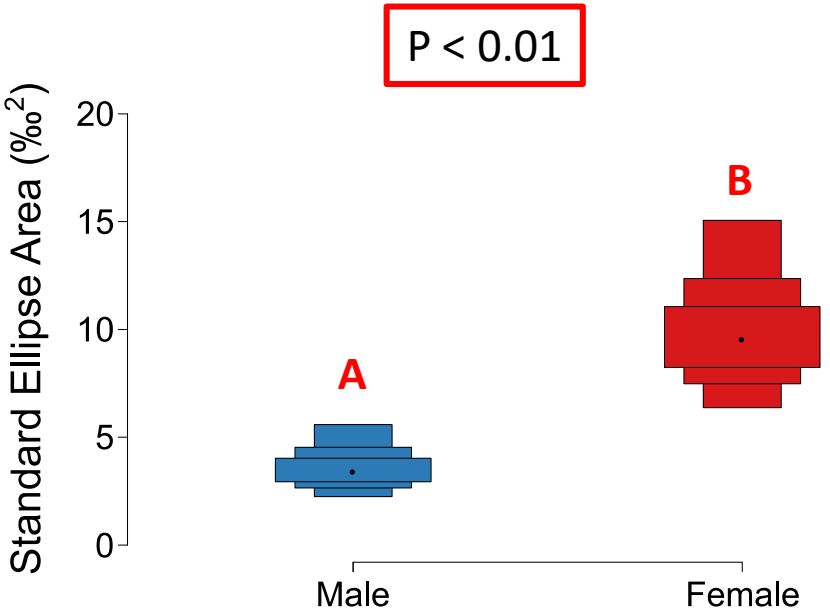
High isotopic range in the Pond

Pond and Lake
Higher niche widths and variability

Ditch and River
Lower niche widths and variability

Sex niche along tissues





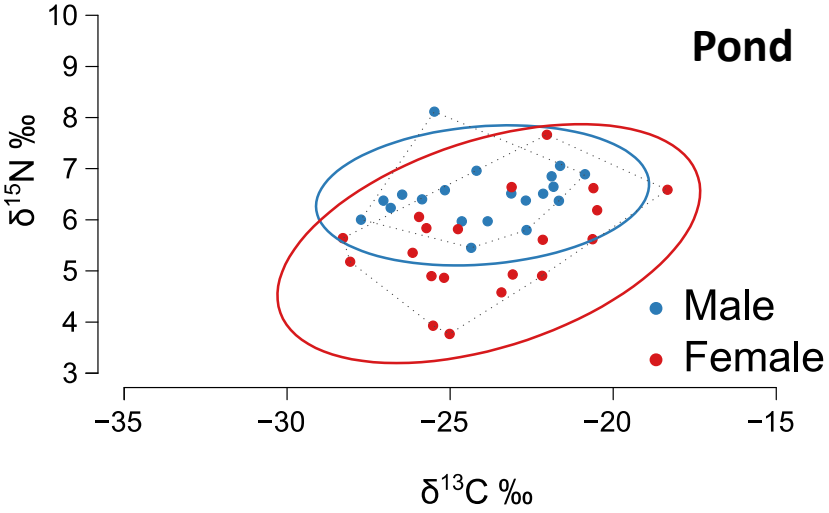
Female niche encompassed male niche

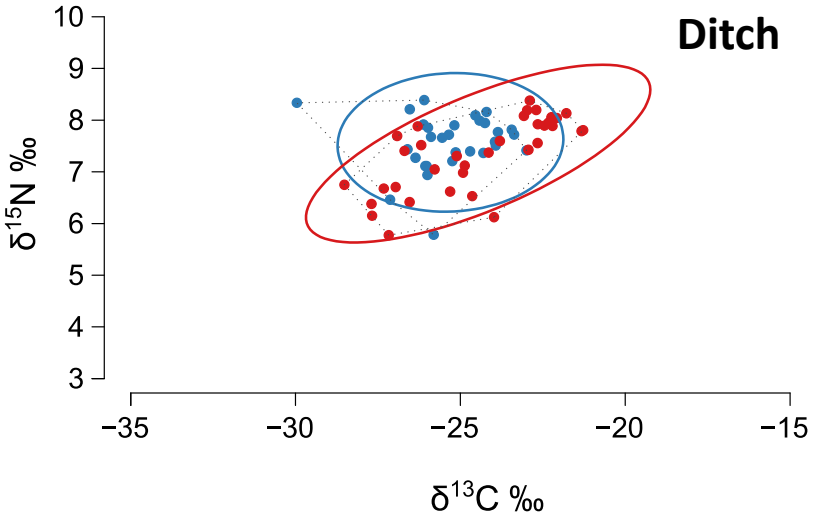
Same trophic level

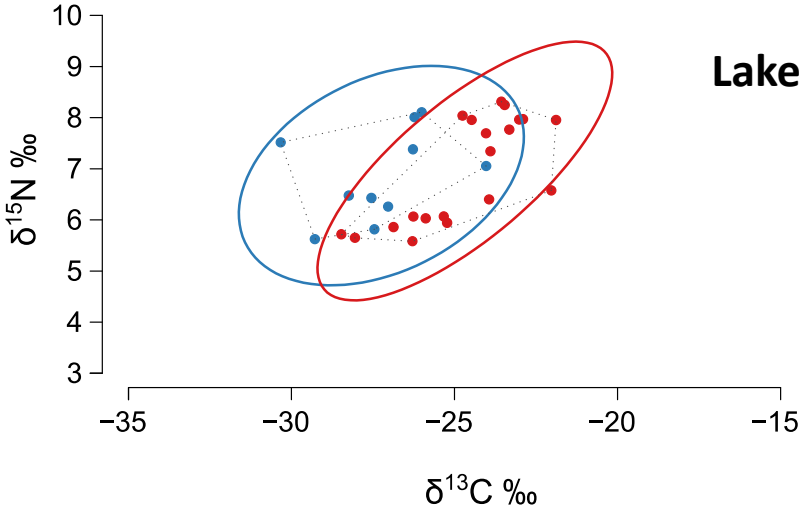
Females

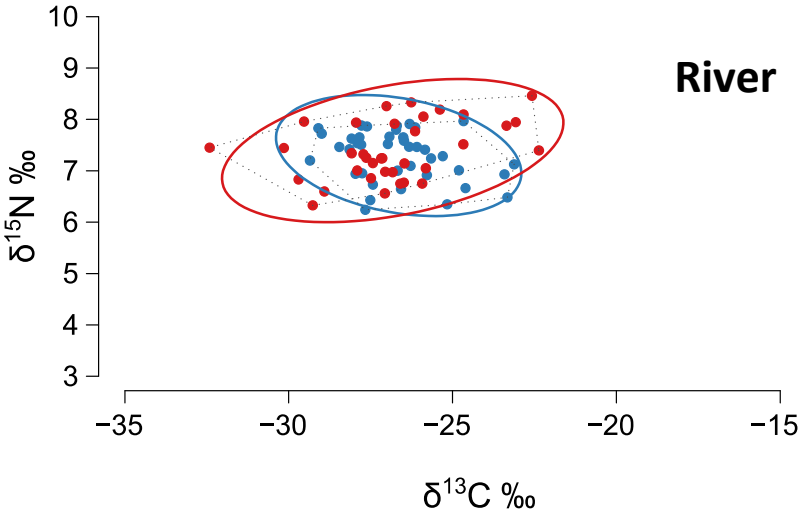
- Larger niche width
- Wider resource use

Sex niches in the habitats

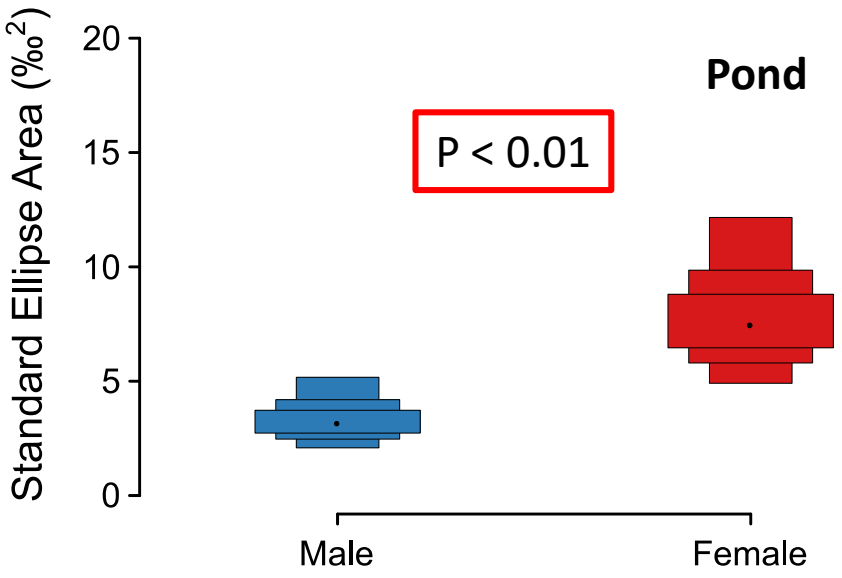


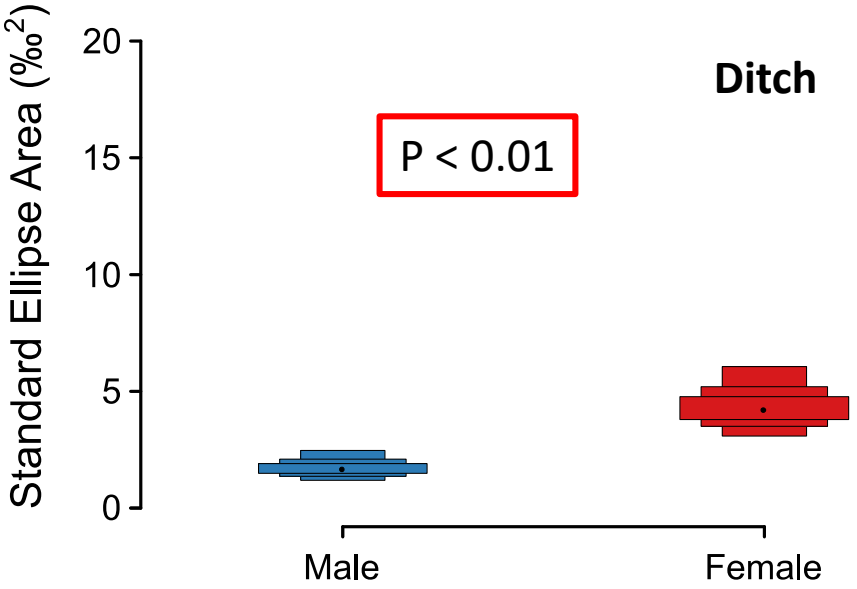


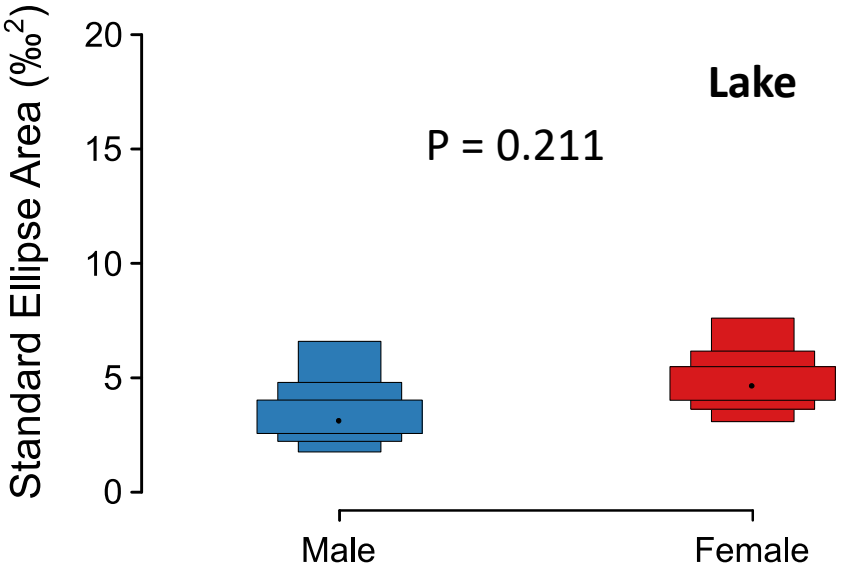


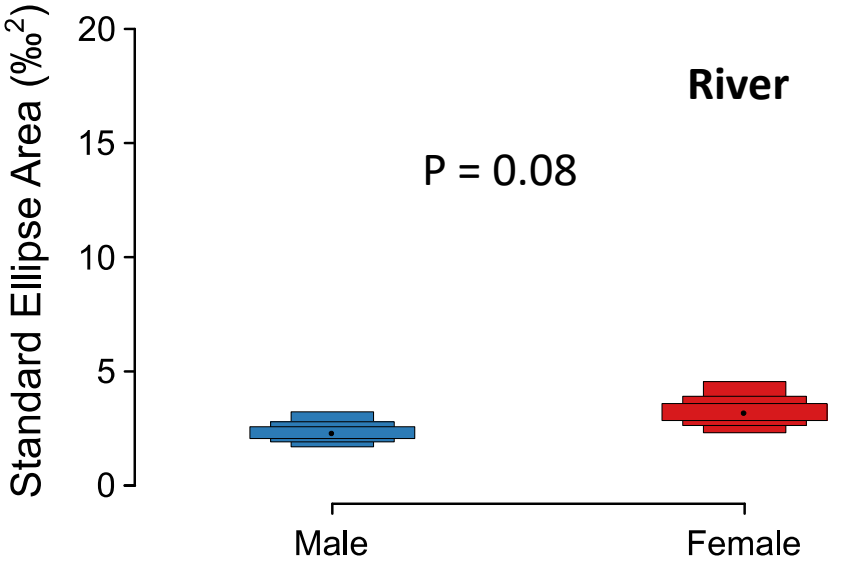


Sex niche widths

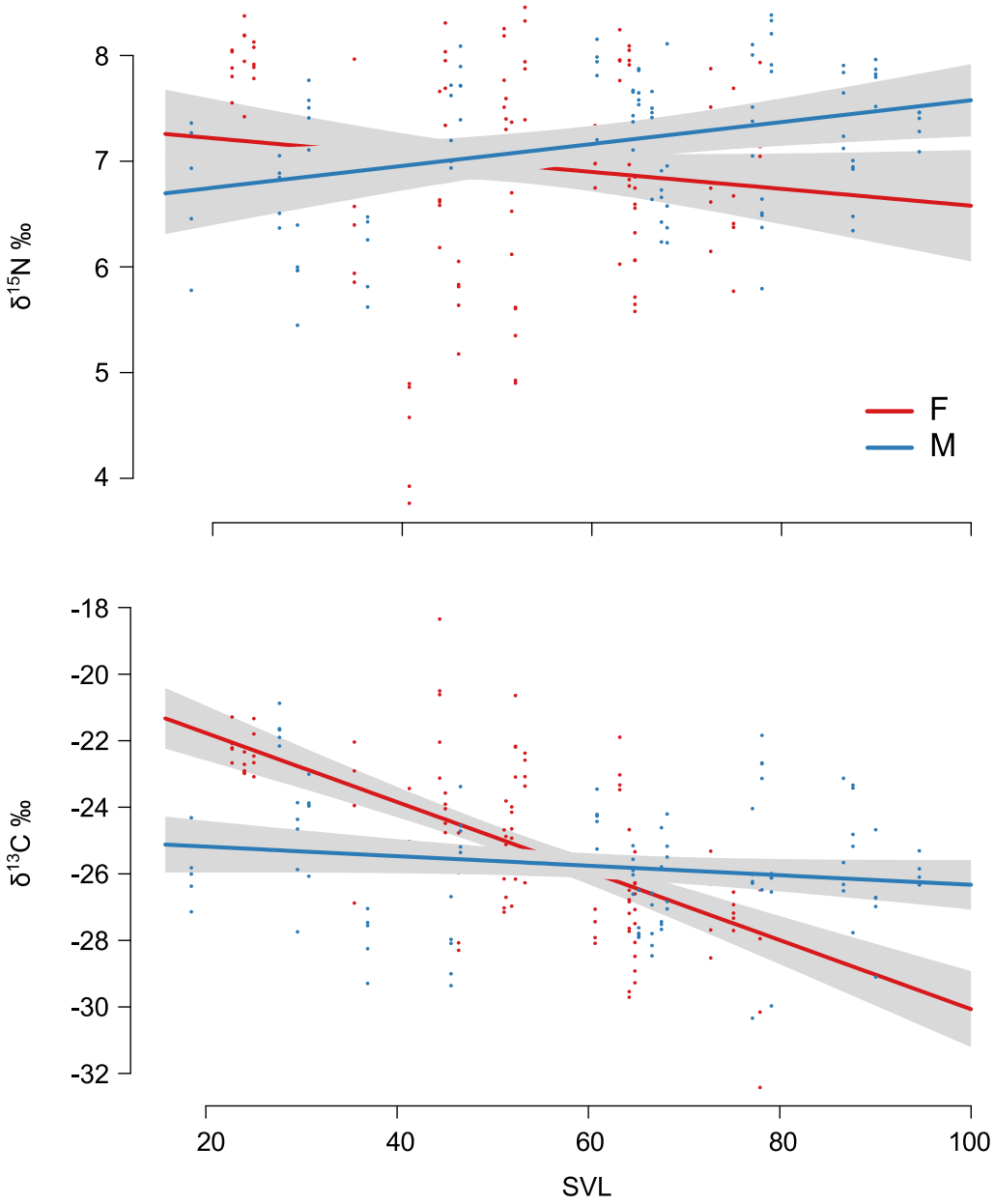








SVL:Sex interaction

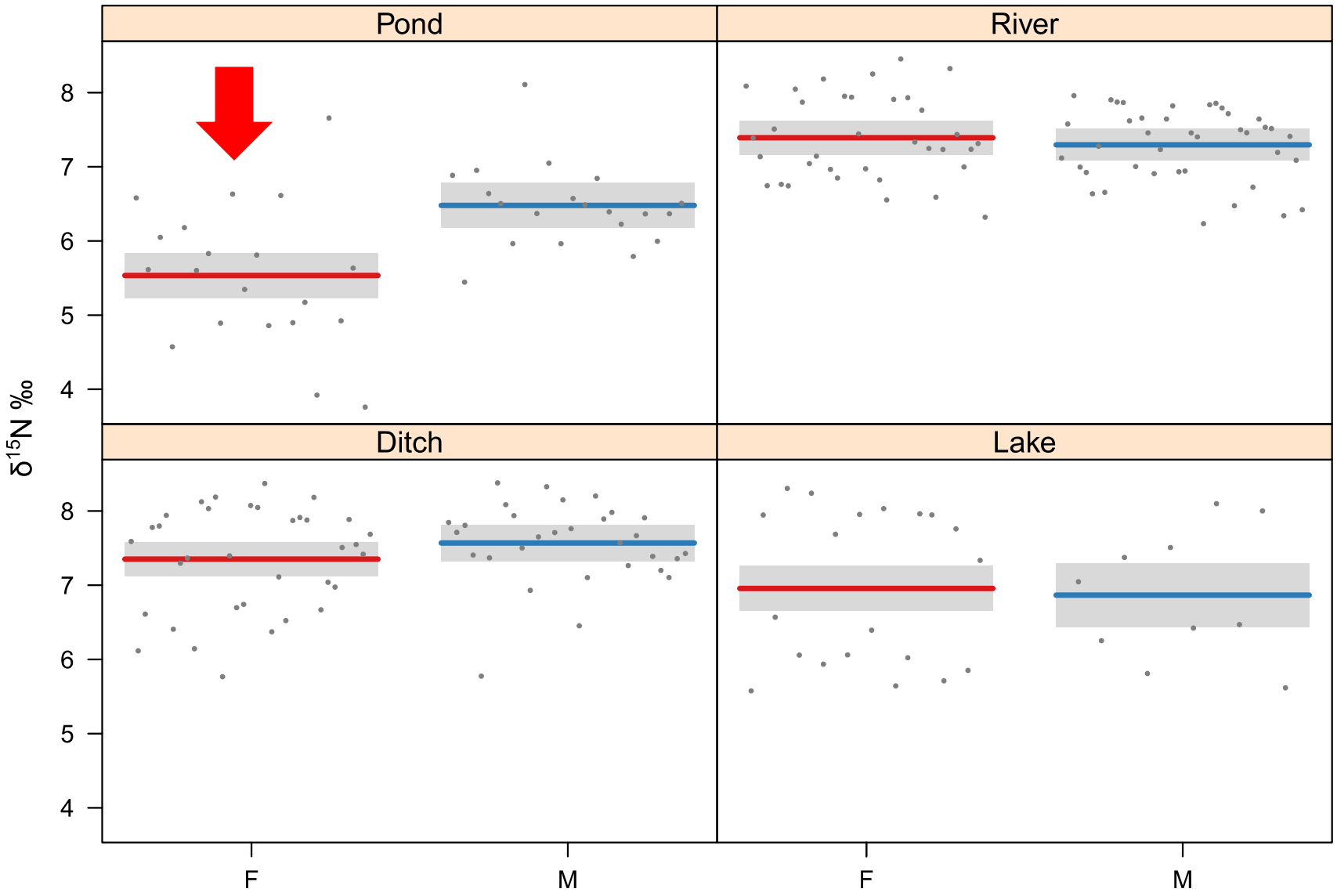


$\delta^{15}N$ – SVL relationship was distinct in sex

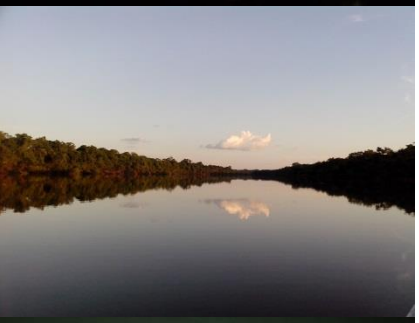
- $\delta^{15}N$ decreased with SVL for females
- $\delta^{15}N$ increased with SVL for males

$\delta^{13}C$ decreased with SVL

$\delta^{15}N$ Habitat:Sex interaction







Discussion

- Under irrigated rice crops, C_3 source can be provided by this plant

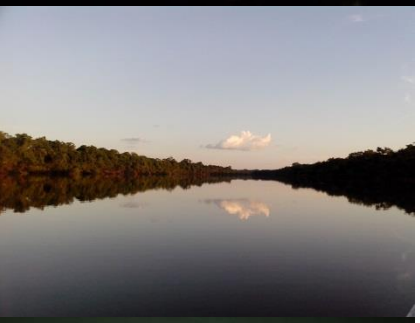
- Pond and Lake can be suffering impact of pasture
  - High niche width
  - More generalist organisms
  - C_4 source introduction

- Impacts of human land use can cause homogenization of resource, lower prey diversity, consequently invariable isotopic values of C. crocodilus over time

- High overlap linked to
  - Movement patterns among habitats
  - Reproductive status
  - More frequent opportunistic foraging along terrestrial and aquatic environment, mainly females

- Anthropogenic impact can affect food web with effect on trophic relationship according to size and sex





Conclusion

Hypothesis: Populations of *Caiman crocodilus* in anthropogenic habitats have larger niche width due impacts of human land uses, including in sexual covariate

- Corroborated

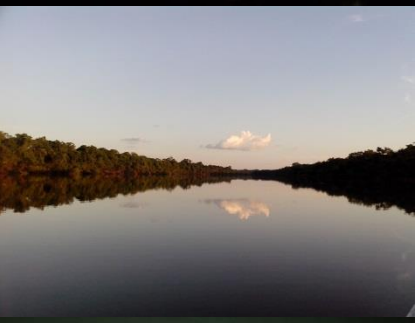
Hypothesis: Populations of *C. crocodilus* in anthropogenic habitats occupy distinct niche position in relation to populations in natural habitats, including in sexual and body size covariates

- Corroborated

Hypothesis: Impacts of different land uses cause invariability in the niche width and position along time;

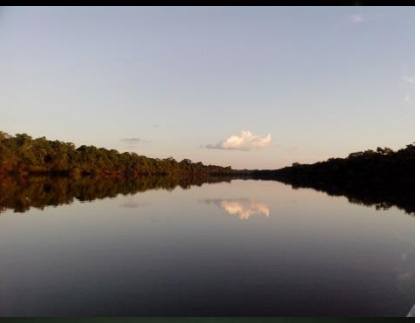
- Corroborated





Future directions

- Sample more areas under different land uses
- Continue assessing trophic niche of *C. crocodilus* under different land uses
- Assess body condition and demography of *C. crocodilus* under different land uses
- Model the relationships between suitable landscape features (e.g., number and connectivity of forest patches, total waterbody area, agricultural matrix area) and trophic niche, body condition, and demography for impact assessment
- Provide landowners and managers of protected areas in the region with critical information for promoting the sustainable use of this unique landscape and the conservation of its natural populations and communities.



Acknowledgements

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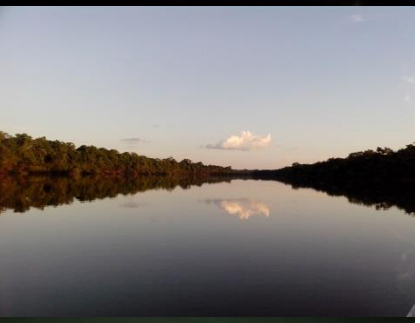

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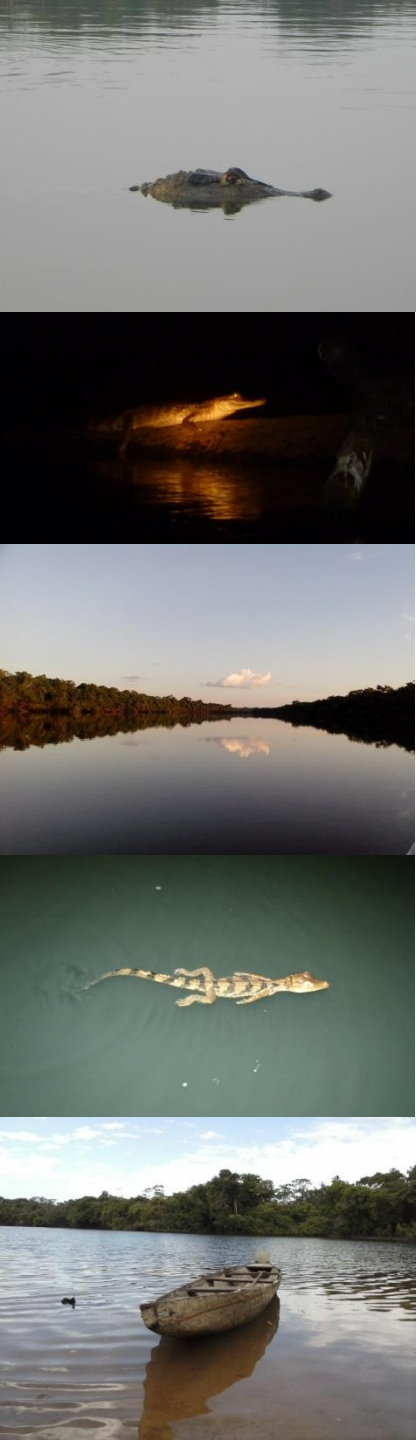

Acknowledgements

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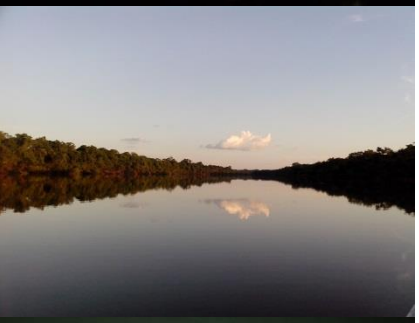

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