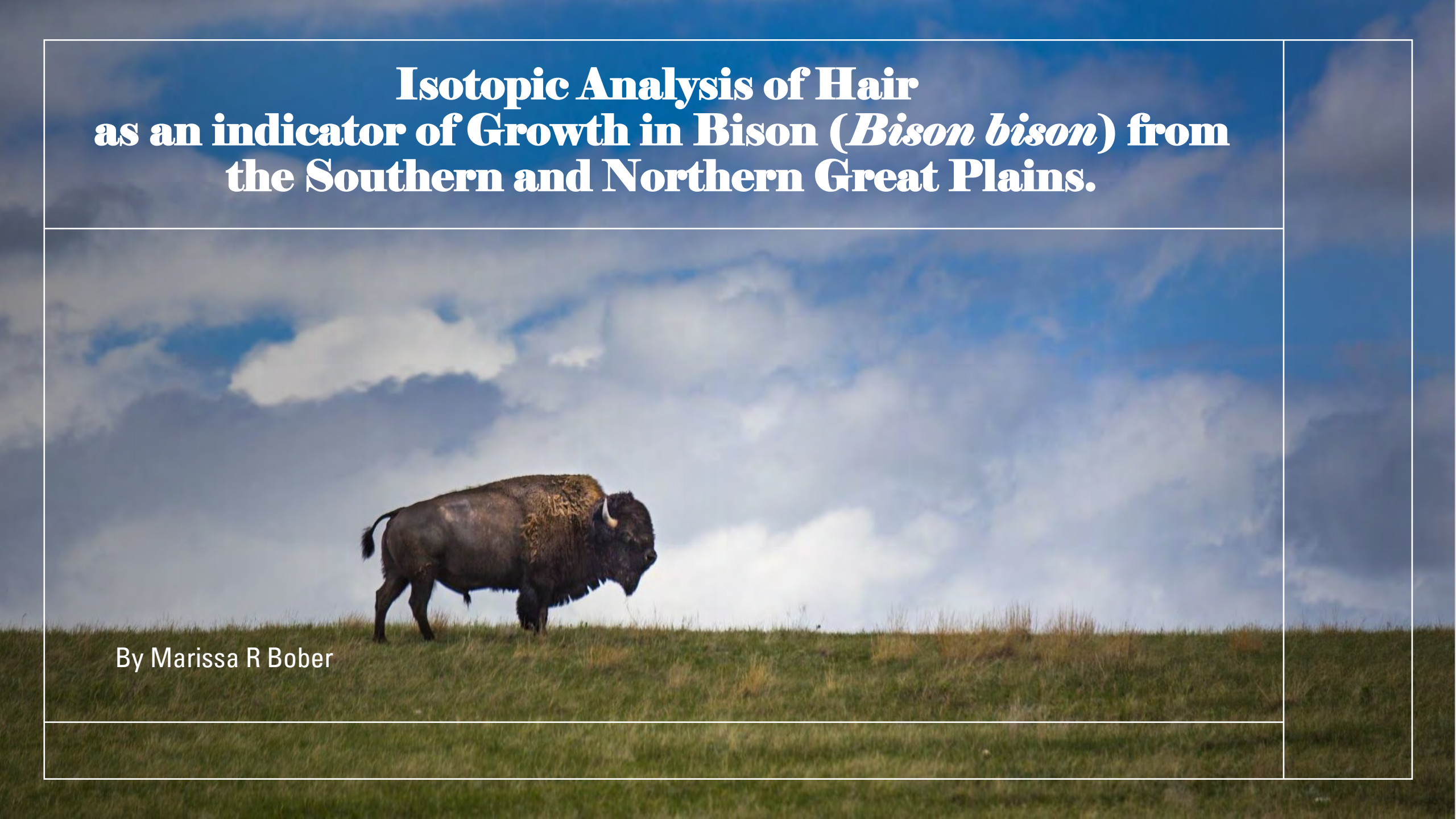
Isotopic Analysis of Hair as an indicator of Growth in Bison (*Bison bison*) from the Southern and Northern Great Plains.



By Marissa R Bober

Introduction: Great Plains

- Saskatchewan to southern Texas
- Rising temperatures & drought
- Forage decrease in quality
- warm-season (C4) vs cool-season (C3)
- Diets: less digestible, lower protein
- Nutritional stress

Photo: https://www.unl.edu/plains/about/map.shtml

Introduction: Bison

- Decline in height & projected body mass
- Similar live mass (403 kg)
- Carcass was 45 kg lighter (213 vs 258 kg)

- Check ups focus: reproduction and growth
- Noninvasive tool: monitor stressors (Public and Private)

Photo: https://www.worldwildlife.org/species/plains-bison

Introduction: Stable Isotopes & Hair

- Carbon ($\delta^{13}C$) and Nitrogen ($\delta^{15}N$)
- Track diet & metabolism in tissues

13C:

- C4 & C3 photosynthesis pathways
  - C4 (warm) plants: tropical grasses & corn
  - C3 (cool) plants: grasses, trees, & shrubs (Higher nutritional quality)

15N

- Varies w/ grasses, browse, & lichen
- Metabolism: lean muscle, rise

Bison Tail Hair

- Hair: continuous deposit of keratin (protein)
  - Reflects diet & recirculating amino acids
- Long record, no molting
- Rate: 0.076 cm/d, 20 cm = 263 days

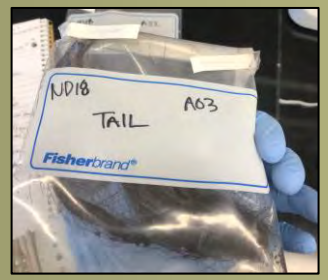
Photo: https://a4.pbase.com/o2/81/978781/1/132612808.2M8azlvK.2007Yell14.jpg

Introduction: Hypothesis

- Smaller carcass mass in south
- South will have more variable growth within tissues.
- Tail hair of the southern bison: mass, thickness, composition, and isotopic values.

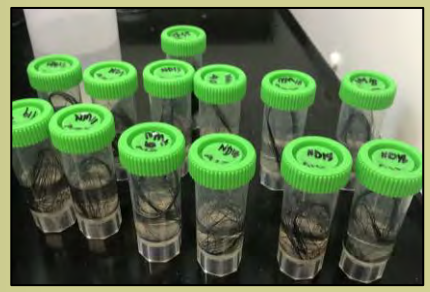
Photo:
https://images2.minutemediacdn.com/image/upload/c_fill,g_auto,h_740,w_1100/v1555921694/shape/mentalfloss/

Methods: Sample Selection & Preparation

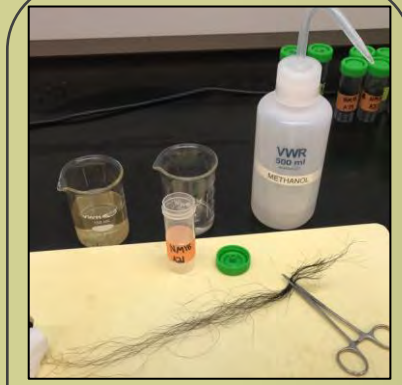


Length of 20 cm

Cut



Soaked in methanol



Manually scrapped

- 24 healthy female bison (2-3 years)
- Saskatchewan & Texas; North Dakota & New Mexico
- Internal organs and tail: frozen, cleaned, and dried

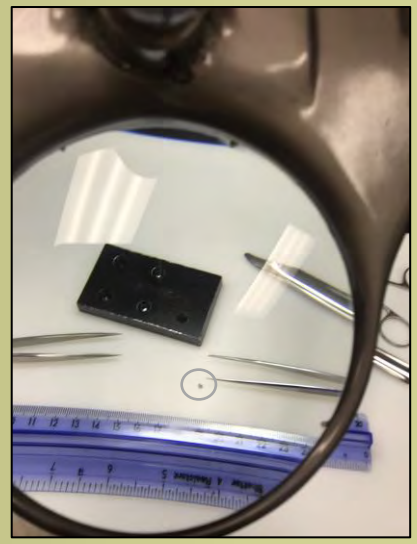
*Repeated (methanol and scrapping), decanted, and air dyed

Methods: Preparation @ Stable Isotopes for Biosphere Science Lab

- Basal Roots = 1cm of 2-4 hairs
- Serial segments = segments of 1 cm of 1 whole hair (20-34 cm)
- Samples: 235 μg
- Isotope Ratio Mass Spectrometer

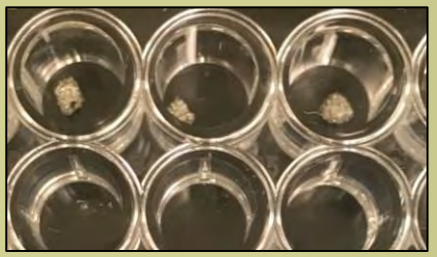
- Set up

- Hair under Magnification

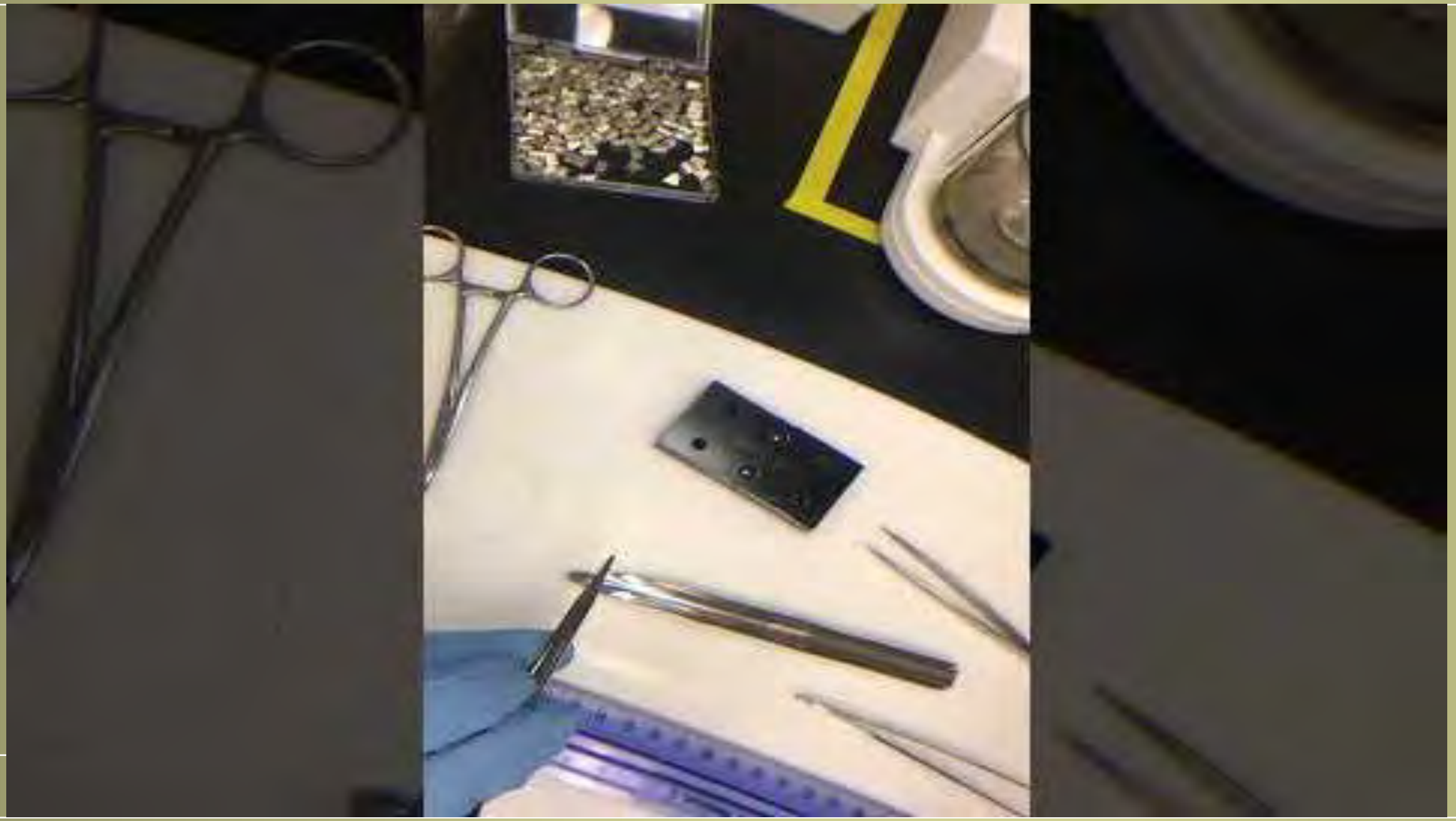


- Completed Tin under Magnification

- Tray (96)



- Tray cell with Tins inside



500 tins

Methods: Stable Isotope Ratios

- Ratio: heavy to light over standard in delta notation (‰ or δ)
- Samples: calibrated relative to Standards
  - In-house and USGS

$$\delta^{13}\mathrm{C} = \left(\frac{\left(\frac{^{13}\mathrm{C}}{^{12}\mathrm{C}}\right)_{\mathrm{sample}}}{\left(\frac{^{13}\mathrm{C}}{^{12}\mathrm{C}}\right)_{\mathrm{standard}}} - 1 \right) \times 1000$$

Statistics

- Mixed model regression
  - Basal hairs within individuals
  - Hair segments within individuals

https://www.google.com/url?sa=i&url=https%3A%2F%2Fen.wikipedia.org%2Fwiki%2F%25CE%259413C&psig=AOvVaw3fx0wCiKLD_B0PQqIG_WEg&ust=1627915865970000&source=images&cd=vfe&ved=0CAsQjRxqFwoTCJiah8WJkPICFQAAAAAdAAAAABAD

Results: Mass and Thickness

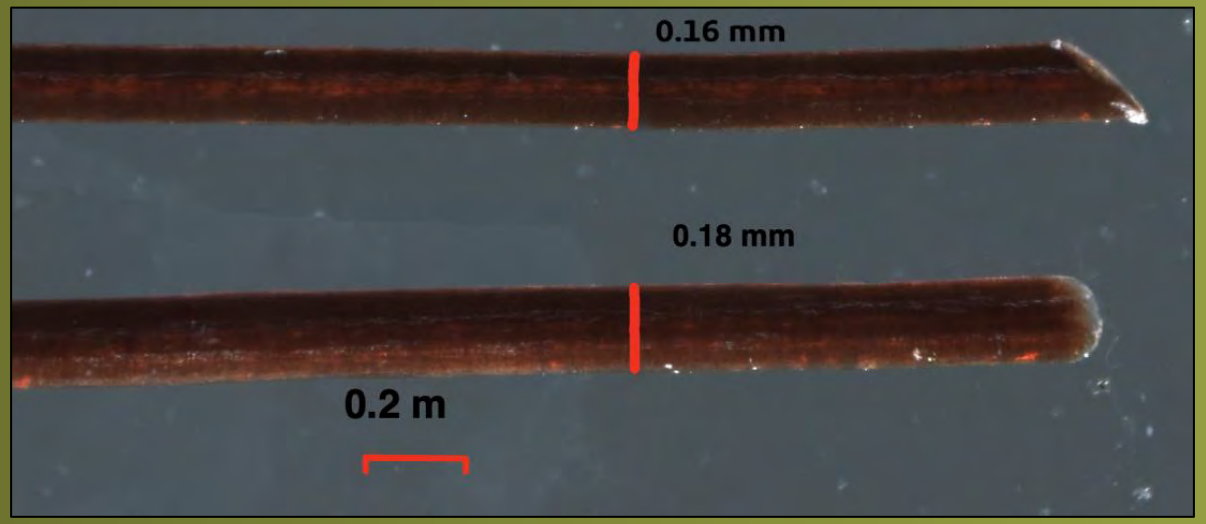


Fig 1.

- Visual thickness of hair within a northern bison

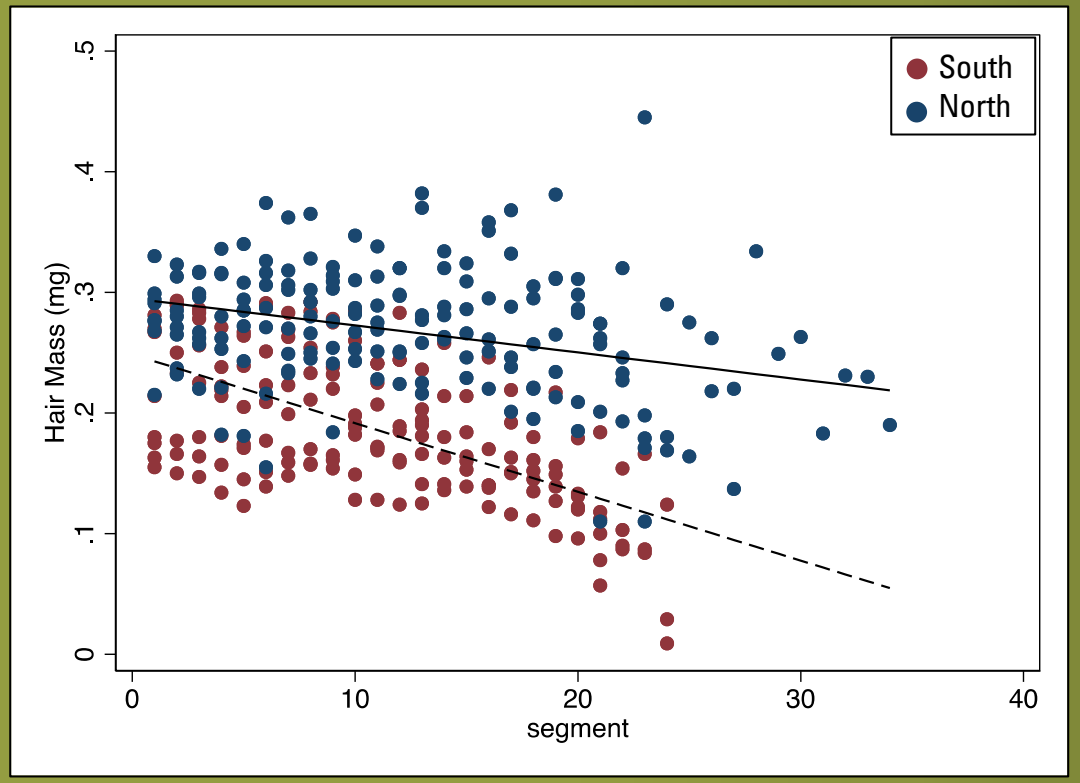


Fig. 2

- Changes over length
- South loss more
- South: 0.243mg, North: 0.293 mg

Results: $\delta^{13}C$ Basal Hair and Organ Isotopes

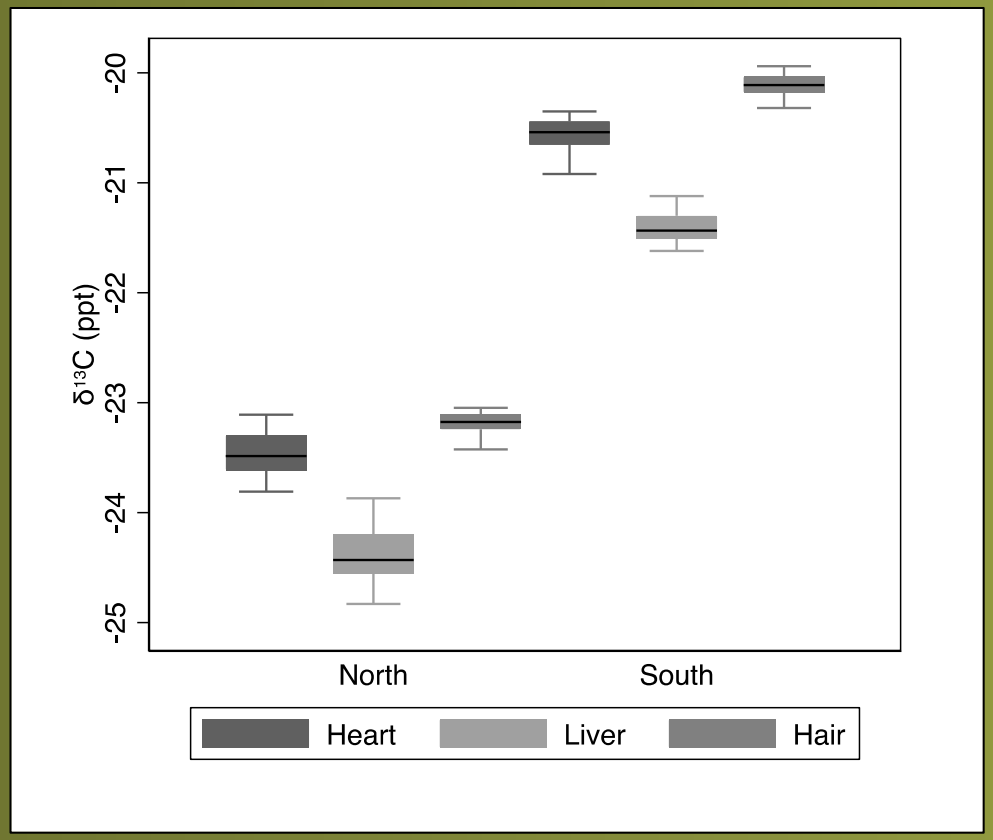


Fig. 3

- South greater $\delta^{13}C$ than North
- Basal hair: greater heart (0.36 ± 0.04)

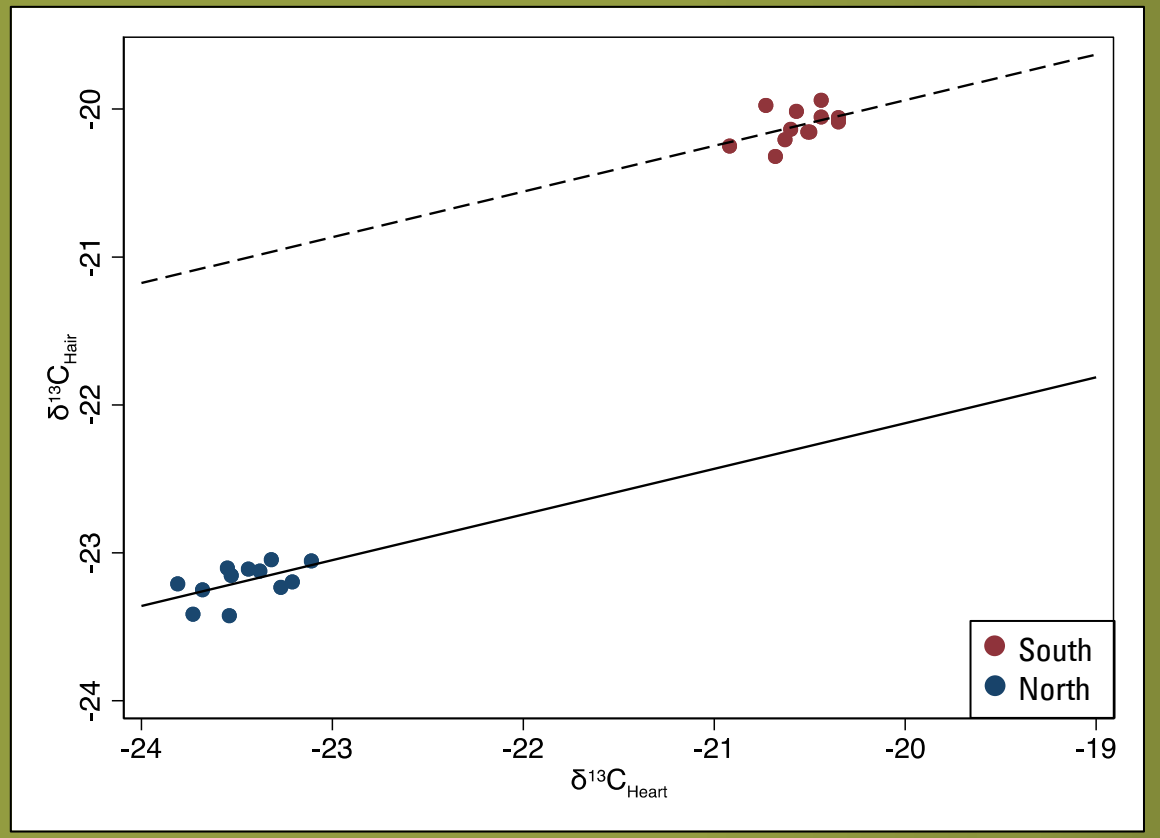


Fig. 4

- Sites were distinct
- $\delta^{13}C$ Heart and hair: parallel relationship

Results: δ^{15}N Basal Hair and Organ Isotopes

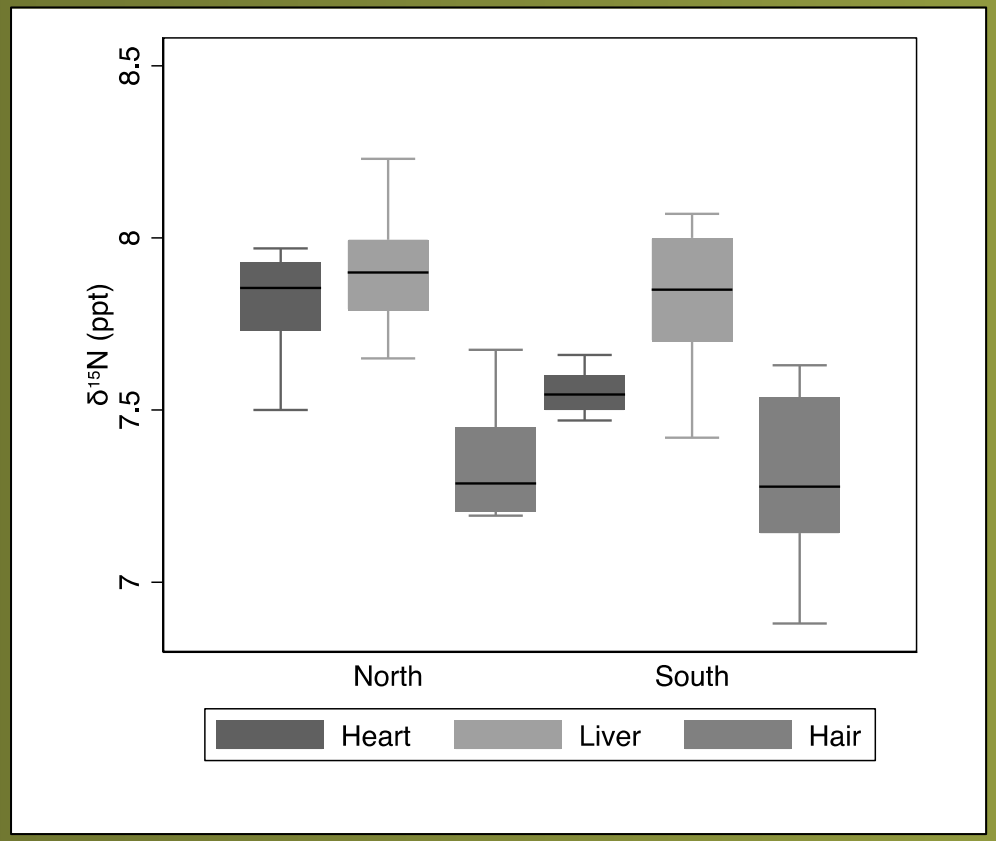


Fig.5

- South & North similar δ^{15}N
- Hair lower δ^{15}N

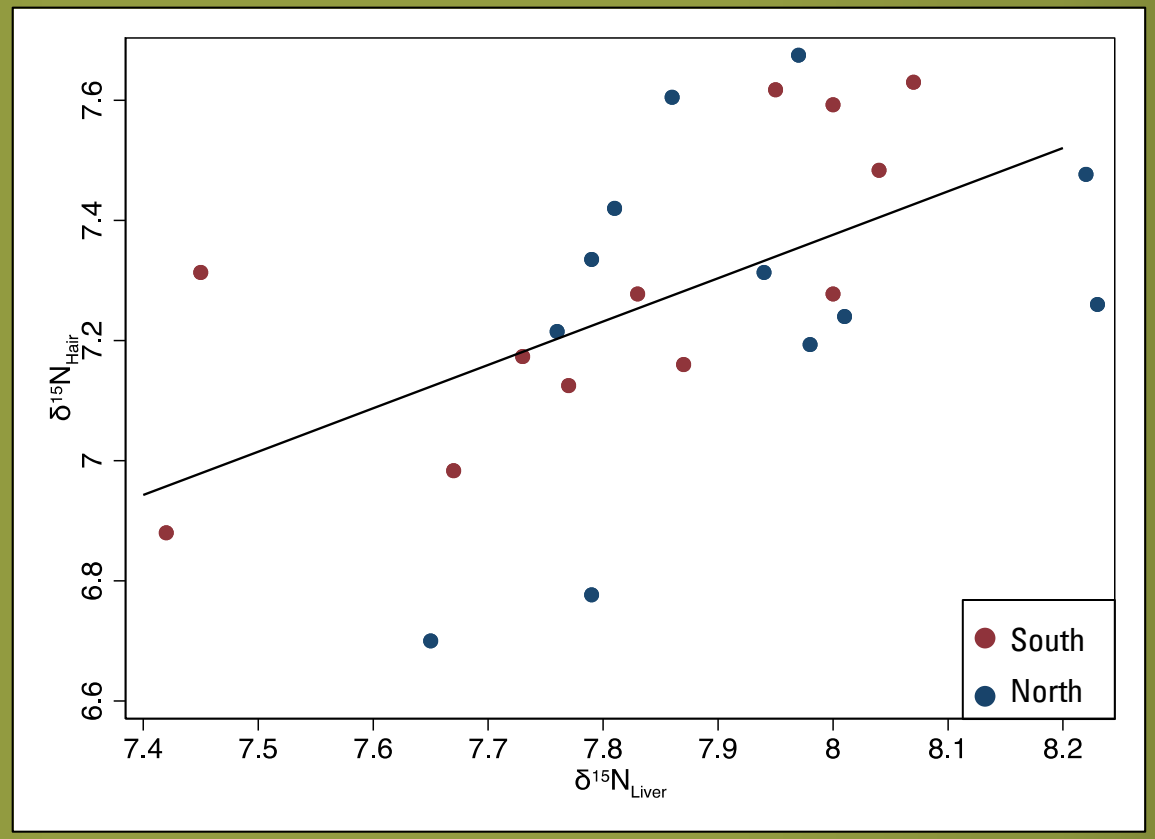


Fig.6

- δ^{15}N Hair & liver similar distribution
- Positive relationship

Results: $\delta^{13}C$ & $\delta^{15}N$ of Serial Segments

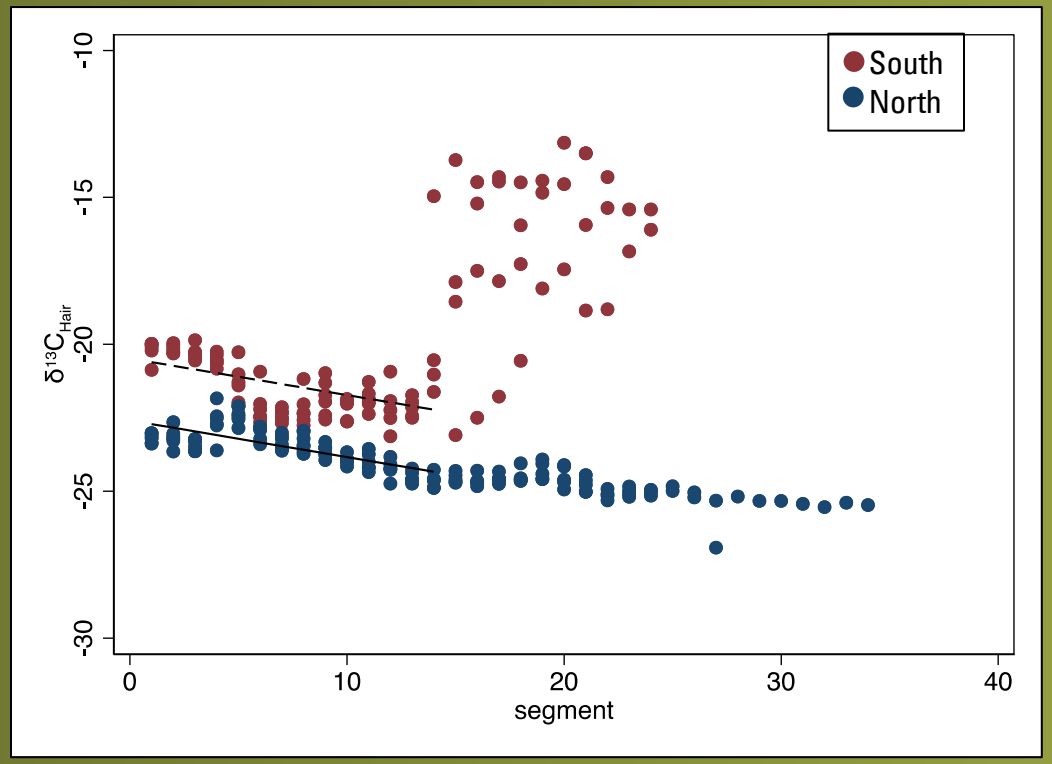


Fig.7

- Downward slope
- $\delta^{13}C$ differed: beginning
- South: rose higher & more variable $\delta^{13}C$
- North: slight decline

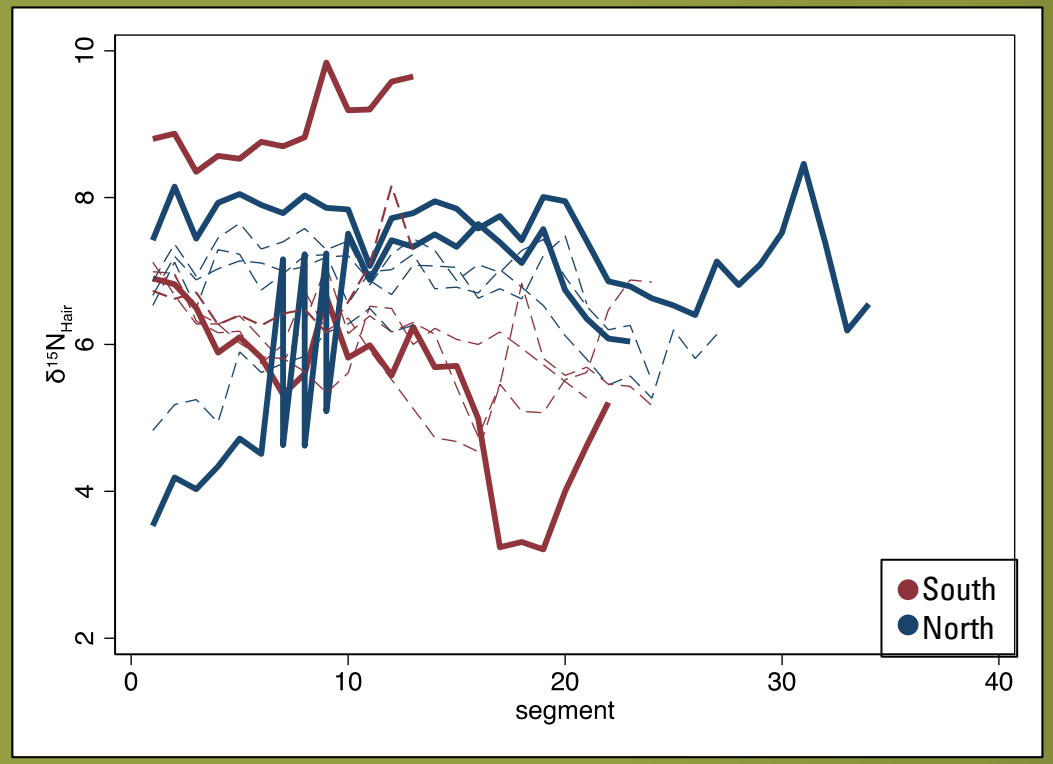


Fig.8

- $\delta^{15}N$: stats, depleted at similar rates
- Spans: 4 del range
- More variation in individuals

Discussion

- Variation in $\delta^{13}C$
- $\delta^{15}N$ along individual hair
- Different $\delta^{13}C$ of basal hair: diet/ location

- Can be a beneficial and cost-effective management tool
  - Changes in supplements or water helped over the year

Photo: https://www.doi.gov/sites/doi.gov/files/uploads/rocky_mtn_arsensal_nwr_john_carr_usfws_bison.jpg

Questions?

Thank you to Dr. Perry Barboza, Dr. Jason West, Dr. Chris Maupin, Dr. Kevin Conway and Dr. Mary Bryk

Results: Carbon and Nitrogen Concentration

	Mass	Carbon Concentration	Nitrogen Concentration
Basal (Roots)	Similar among sites ($z = -1.92$; $P > 0.05$)	Slight difference ($z = 2.00$; $P < 0.05$)	Similar among sites ($z = 1.44$; $P > 0.05$)
Serial Segments	Declined over length: south thinned faster	Similar: segments and sites ($z = -0.72$, $p > 0.05$)	Decrease by 0.5% outliers ($z = -2.46$, $p < 0.05$)

Table 1.

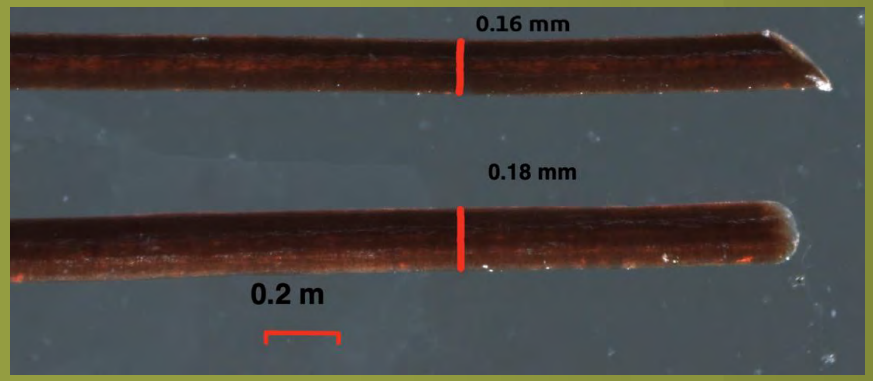


Fig. 1

✧ Visual thickness of hair within a northern bison

Results: Serial Segments Carbon and Nitrogen Concentration

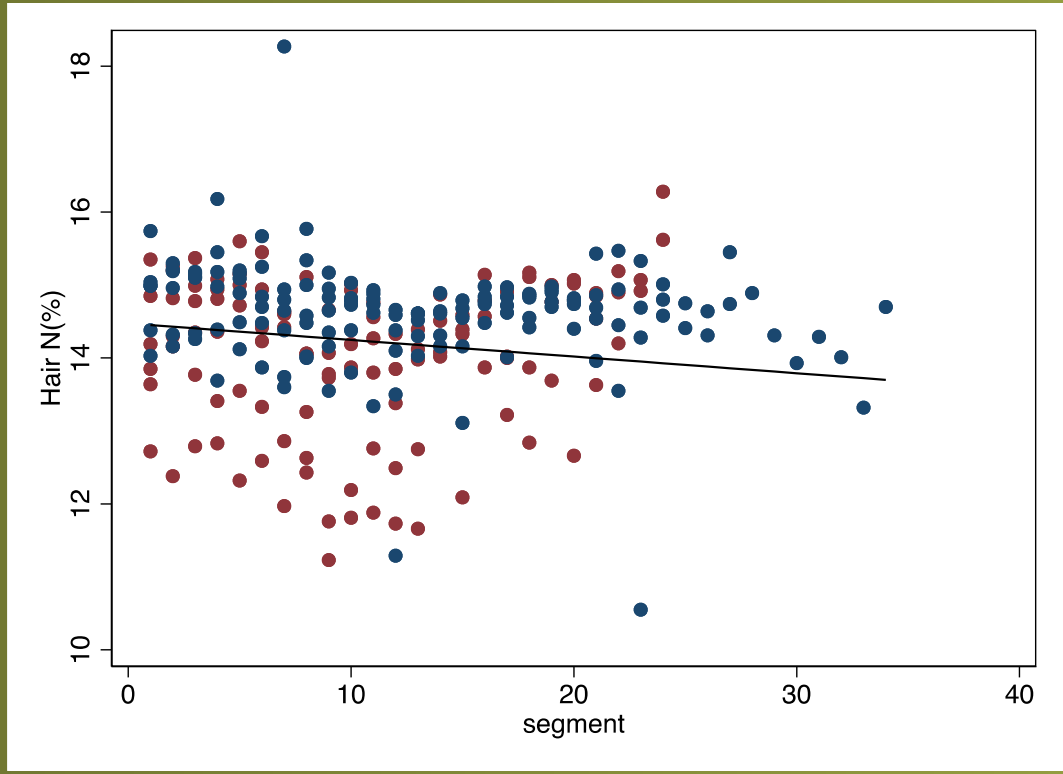


Fig 2.

- Nitrogen concentration: decreased only 0.5% N ($z = -2.63$, $p < 0.05$)

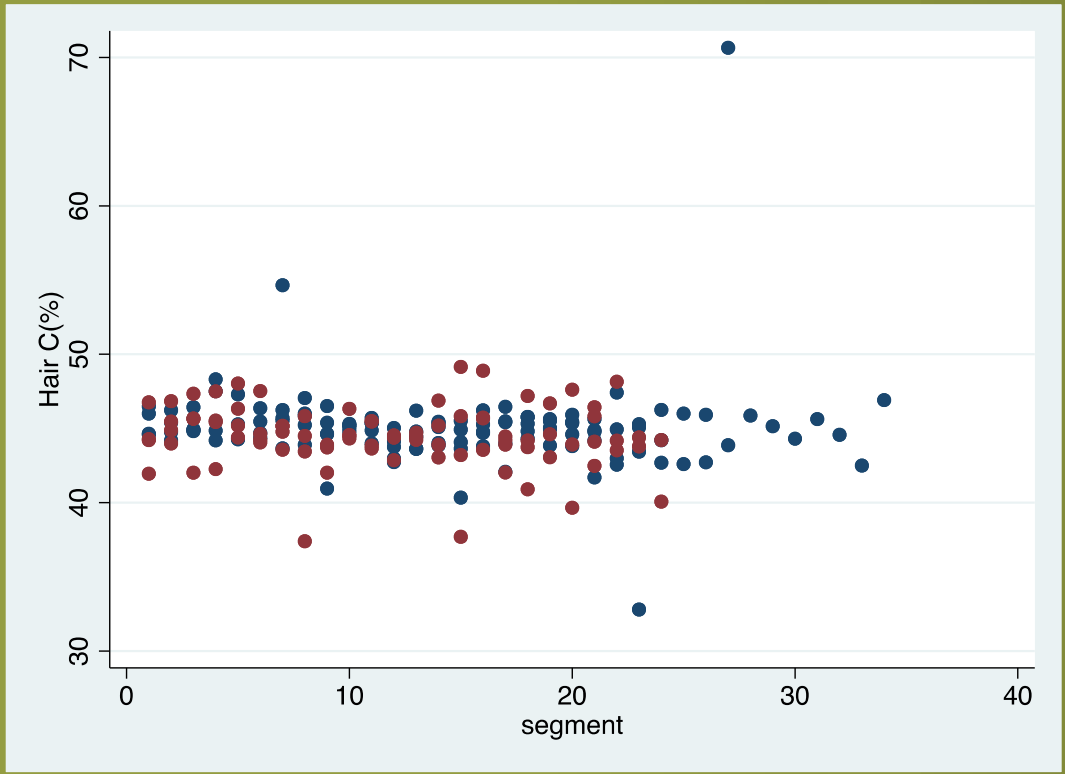


Fig. 3

- Carbon concentration: similar across segments and sites ($z = -0.83$, $p > 0.05$)

Results: Basal Roots Carbon and Nitrogen Concentration

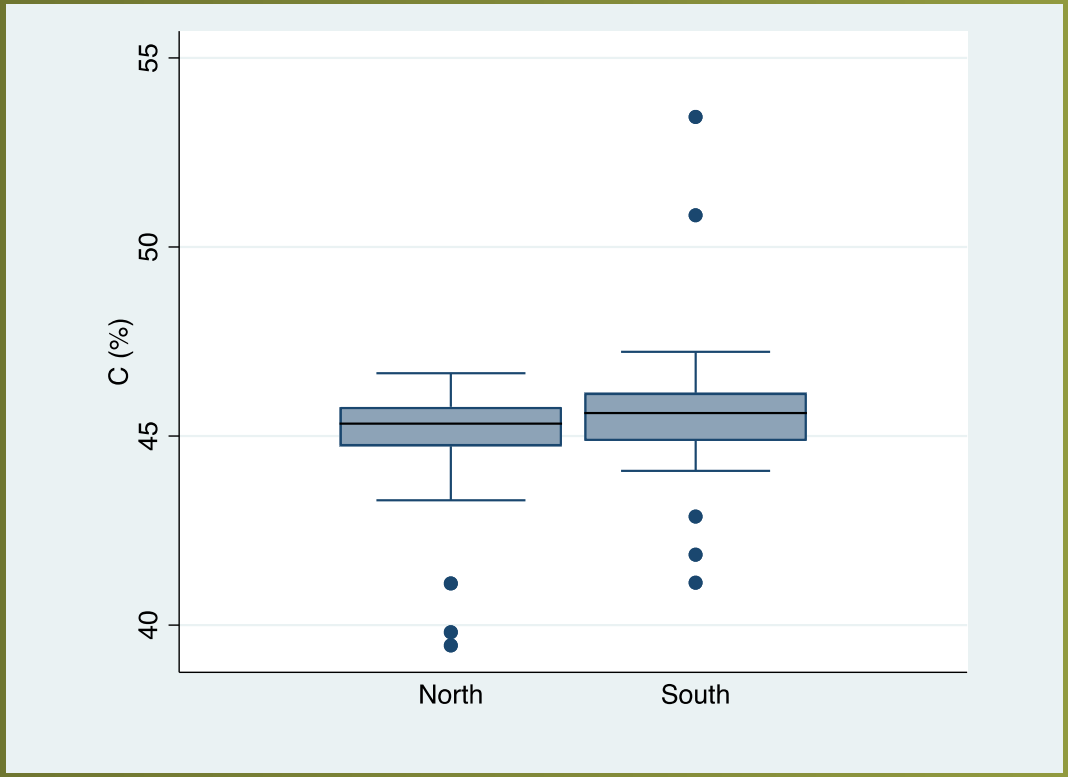


Fig 4.

✧ Carbon concentration: slight difference in between sites ($z = 2.00$; $P < 0.05$)

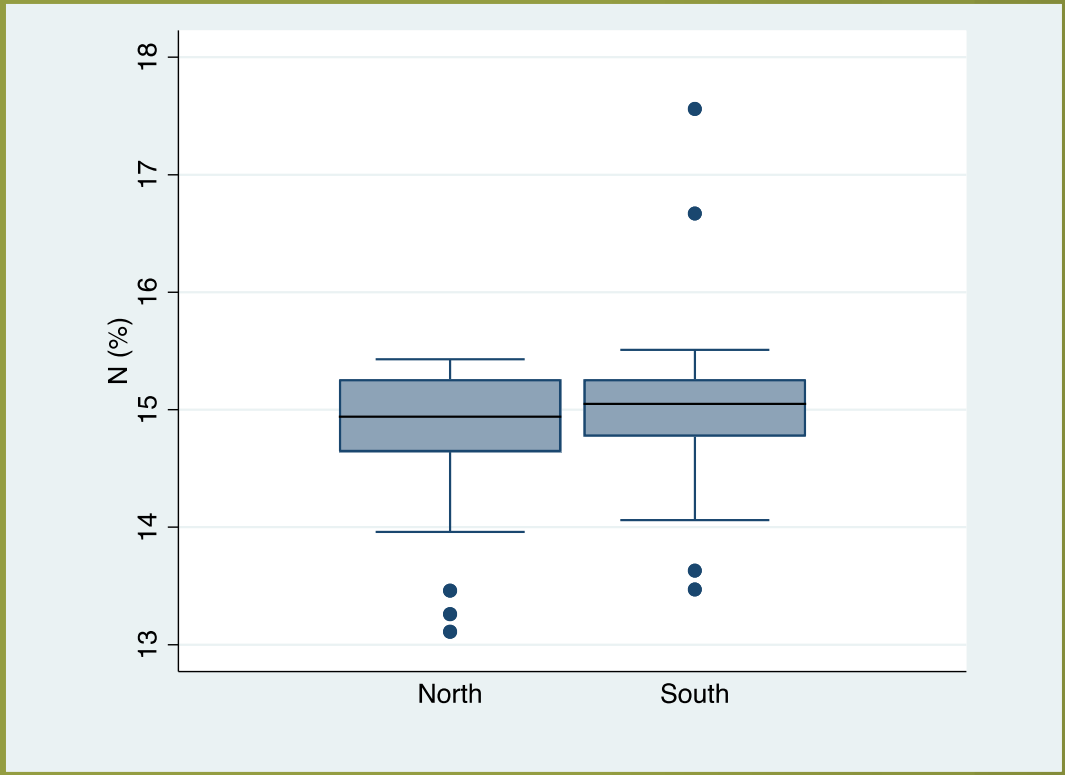


Fig. 5

✧ Nitrogen concentration: similar among sites ($z = 1.44$; $P > 0.05$