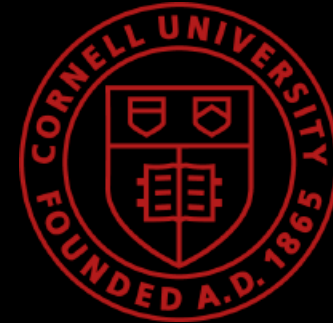
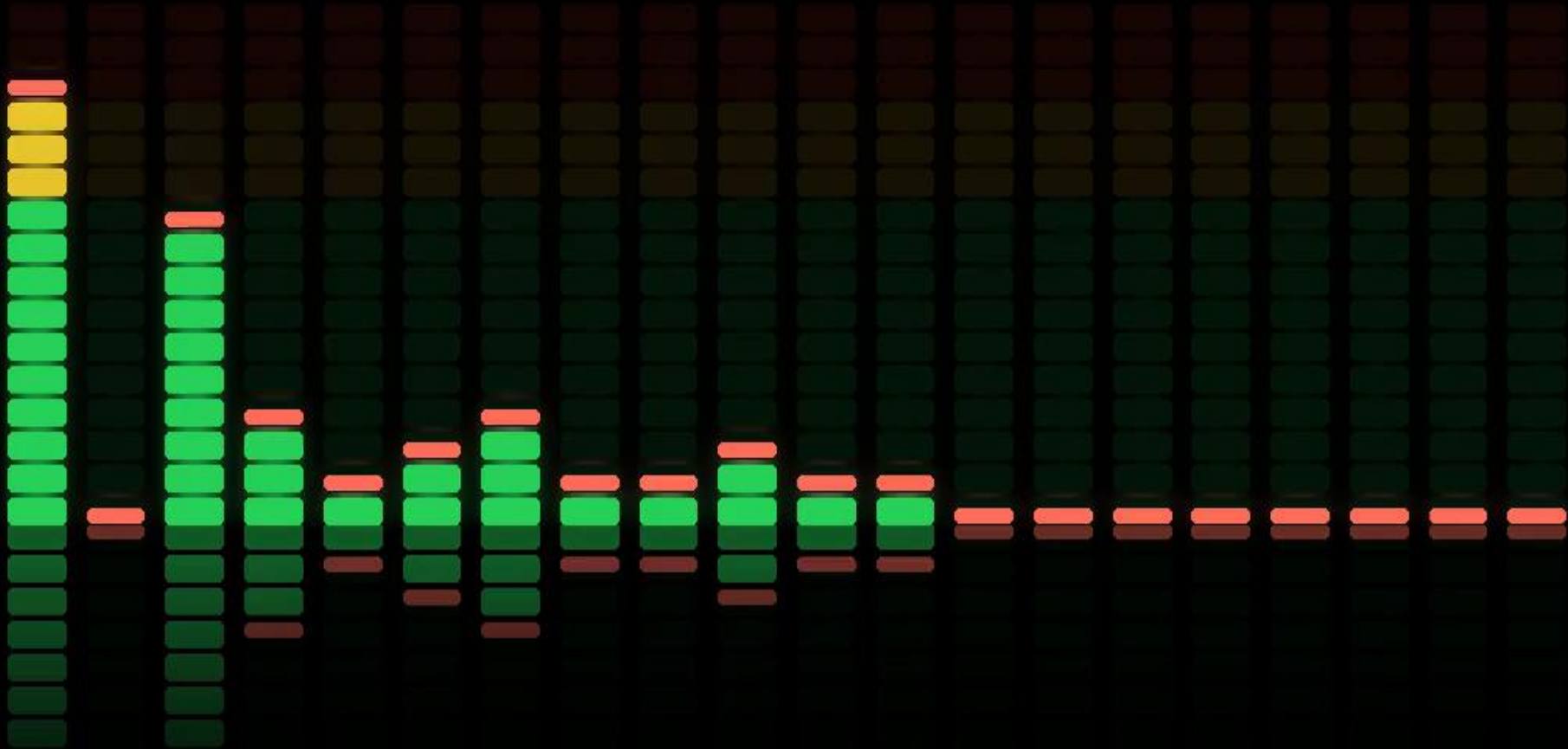


Hematology and Blood Chemistry Analysis and Its Utility for Health Assessment of the Smalltooth Sawfish

Jennifer Wyffels, Ashley Dawdy, R. Dean Grubbs, Tonya Wiley, Andrew Wooley⁵, Lukas. Heath, Dyla Yakich, Whitney Greene, Lynne Byrd, Shannon Modla, Stephen Anderson, Kady Lyons, Chris Malinowski, Chris Buckner, Shane Boylan, Nicole Stacy, Tracy Stokol, Jill Arnold, Carolyn Cray, and Gregg Poulakis





Elasmobranch Blood



1. Plasma
2. Red Blood Cells (RBCs)
3. White Blood Cells (WBCs)

* NO Platelets & NO Albumin



Biomarkers



1. Sugar- Diabetes
2. Thyroid Hormones-Metabolism
3. Cholesterol- Heart Disease
4. BUN- Kidney Function
5. AST/ALT- Liver Disease
6. Cancer- PSA, AFP, CEA
7. WBCs- Inflammation/Infection

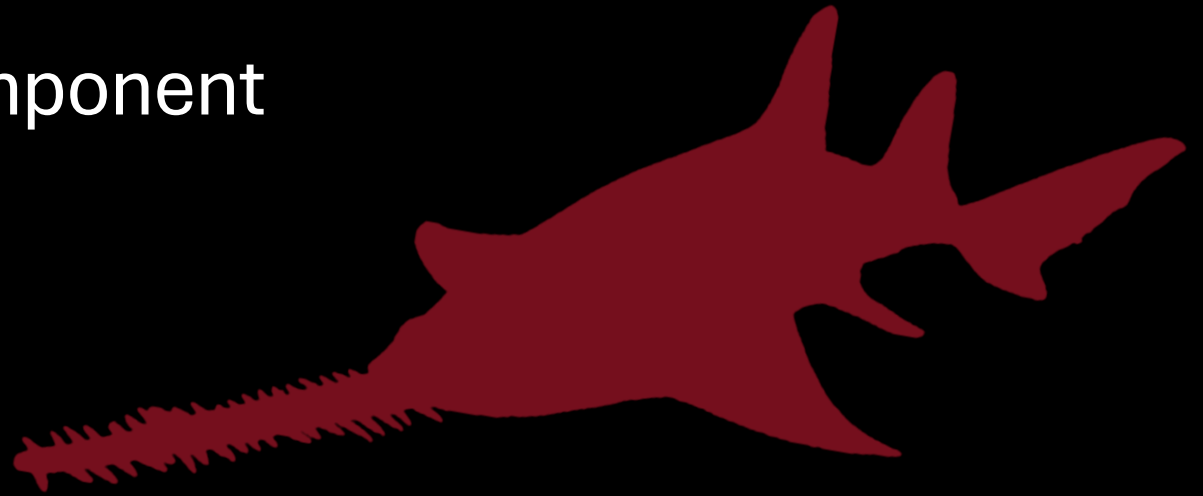


Biomarkers?

Cellular Component



Non-Spinning



Spinning

Whole Blood

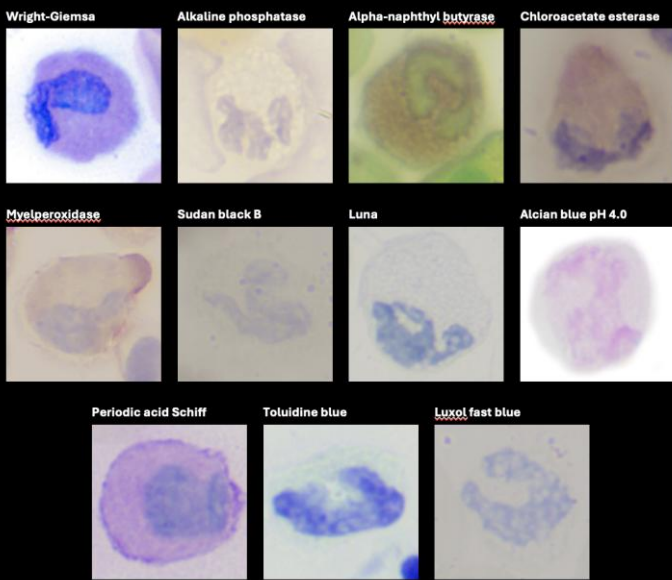


Blood Smears

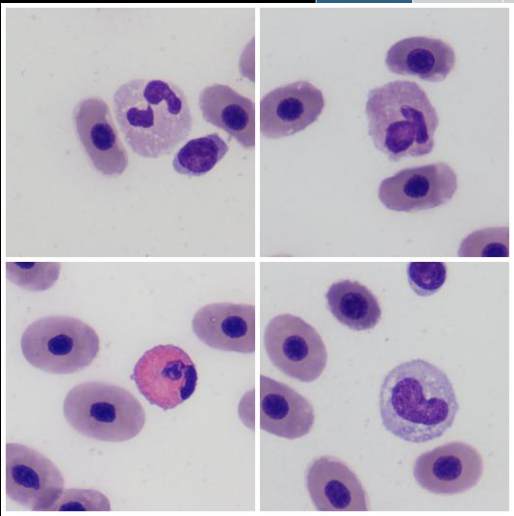
Complete Blood Profile (CBC)

Cytochemical Assays

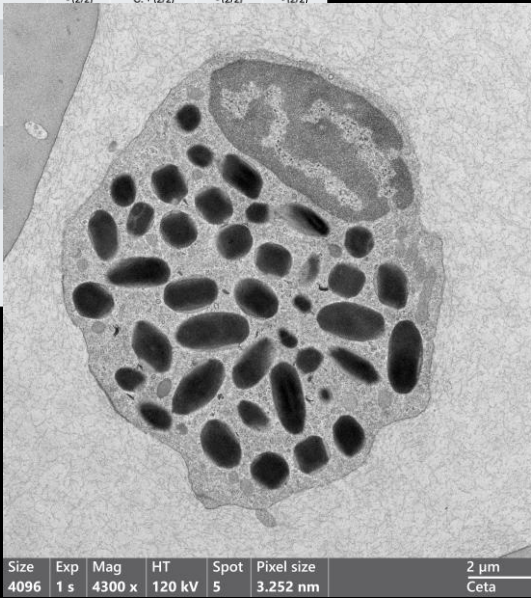
Microscopy



			AE	MPx	SBB	Luna	Alcian blue pH 4.0		PAS	TB	LFB
Heterophil/FEG	- (4/4)	C: +++ (4/4)	G: + (4/4)	C: + (4/4)	- (4/4)	- (4/4)	- (2/2)	C: + to ++; darker around edges (2/2)	- (2/2)	- (2/2)	
Eosinophil/CEG	- (4/4)	- (4/4)	C: + (4/4)	- (4/4)	- (4/4)	G: +++	- (2/2)	C: + (2/2)	- (2/2)	- (2/2)	
Basophil	- (3/4 presumed negative; n=1 NI)	- (4/4)	- (4/4)	- (2/2); - presumed (2/2)	- (4/4)						



C: ++ diffuse (3/4; n=1 NI)	GrC: +/- (stippled granular) (4/4)	- (4/4)	- (4/4)
G: + diffuse to multifocal granular, small and large (4/4)	G: ~ 30% positive focal granules, some large granules (4/4)	- (4/4)	- (4/4)
: +++ globules (4/4)	G: + to ++ globules 2/4	- (4/4)	- (4/4)

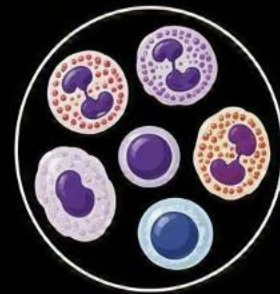


Size	Exp	Mag	HT	Spot	Pixel size	
4096	1 s	4300 x	120 kV	5	3.252 nm	2 µm Ceta

Whole Blood*



Plasma



WBCs



Cells



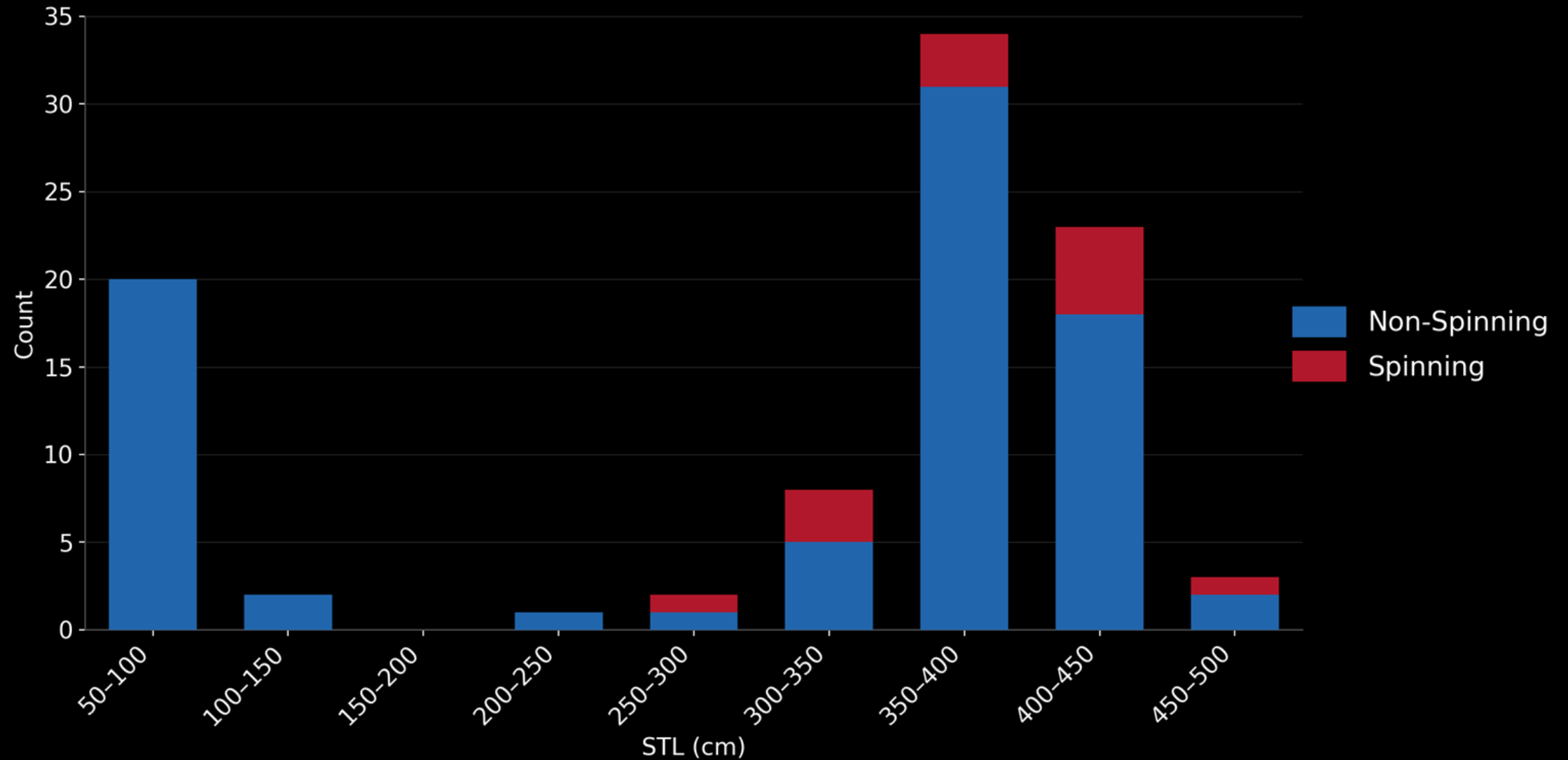
RBCs

Chemistry Panel
Trace Nutrients
Acute Phase Proteins

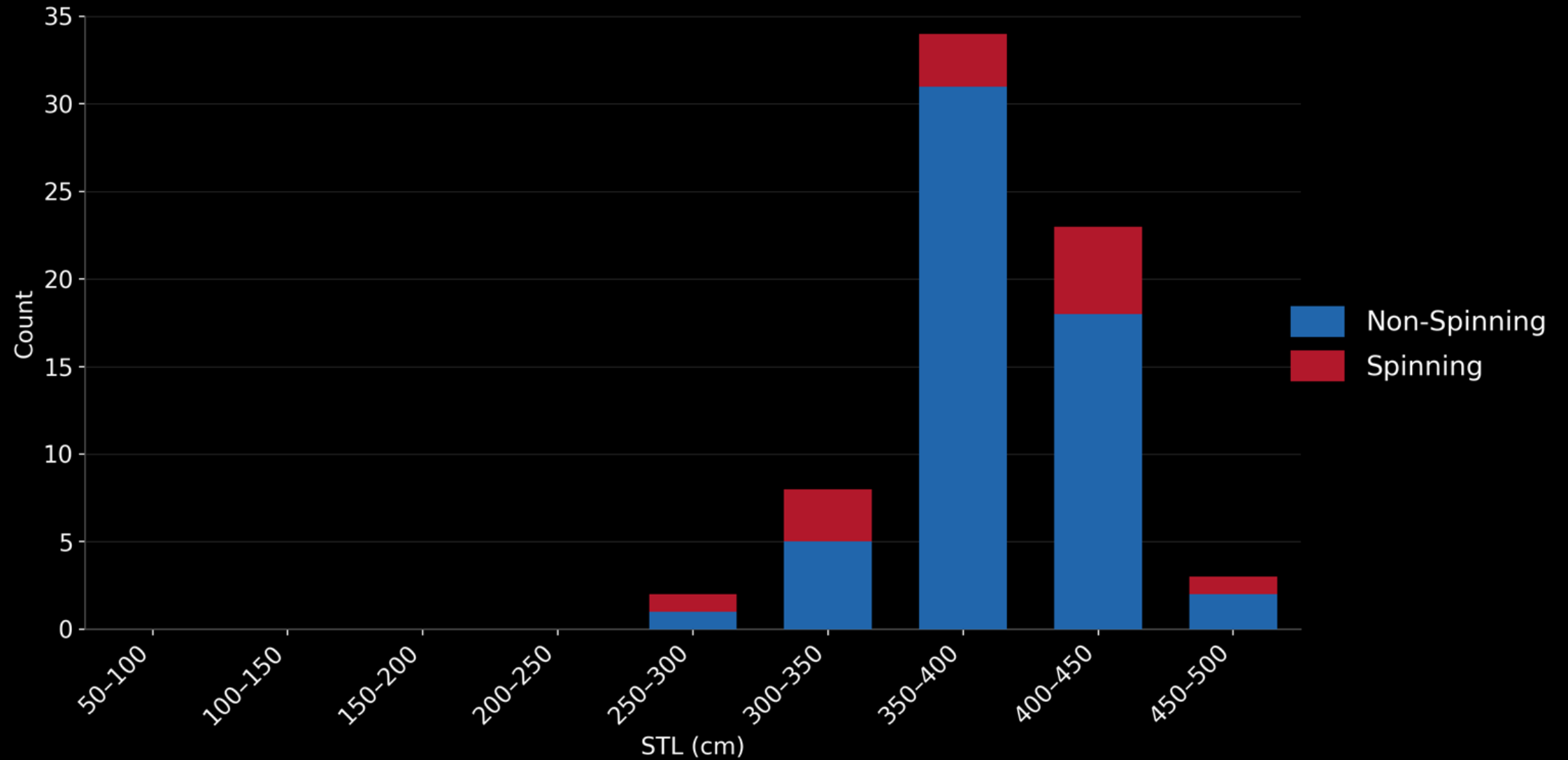
*heparinized

Sawfish Blood Samples

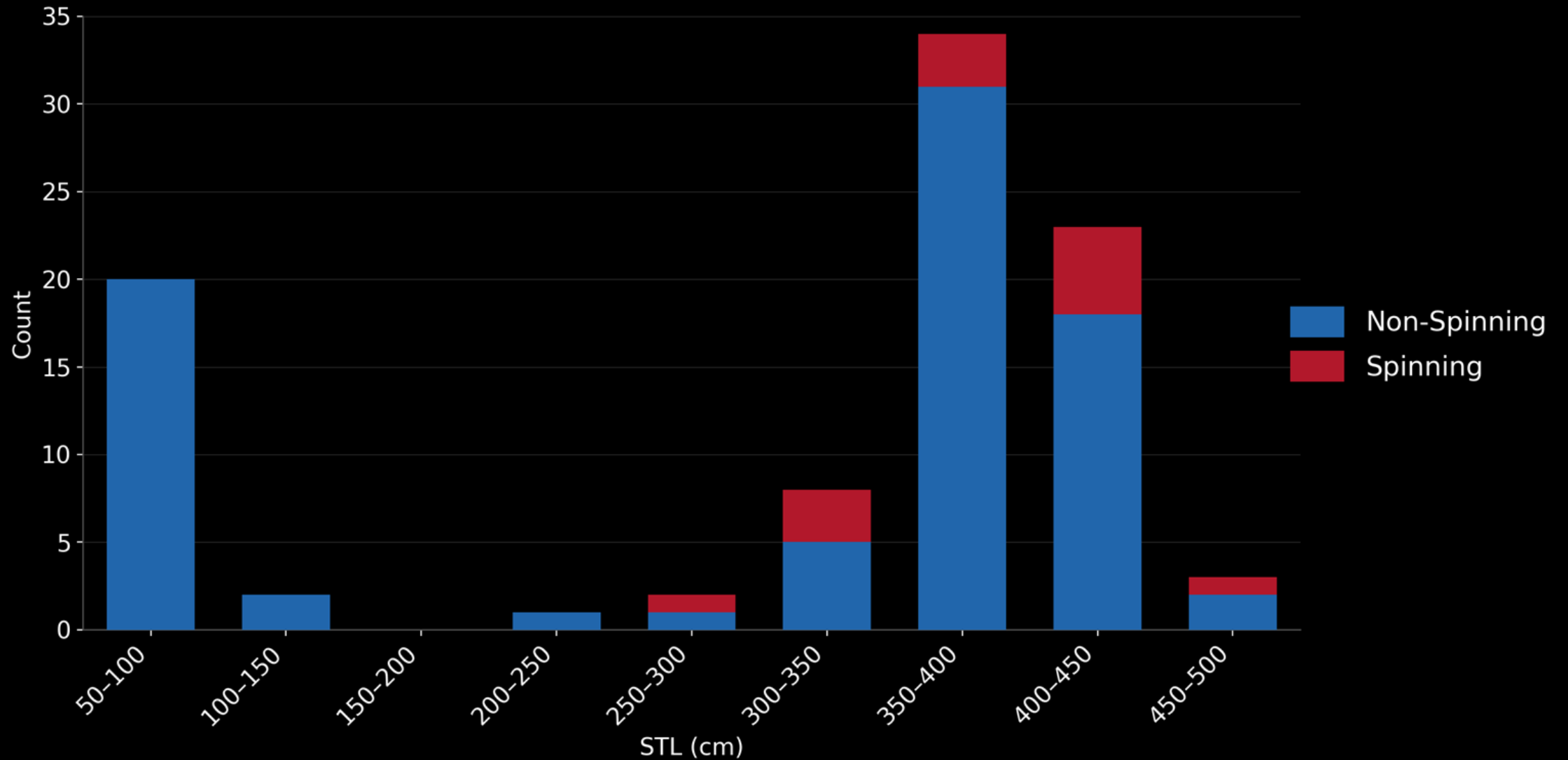
(n=93)



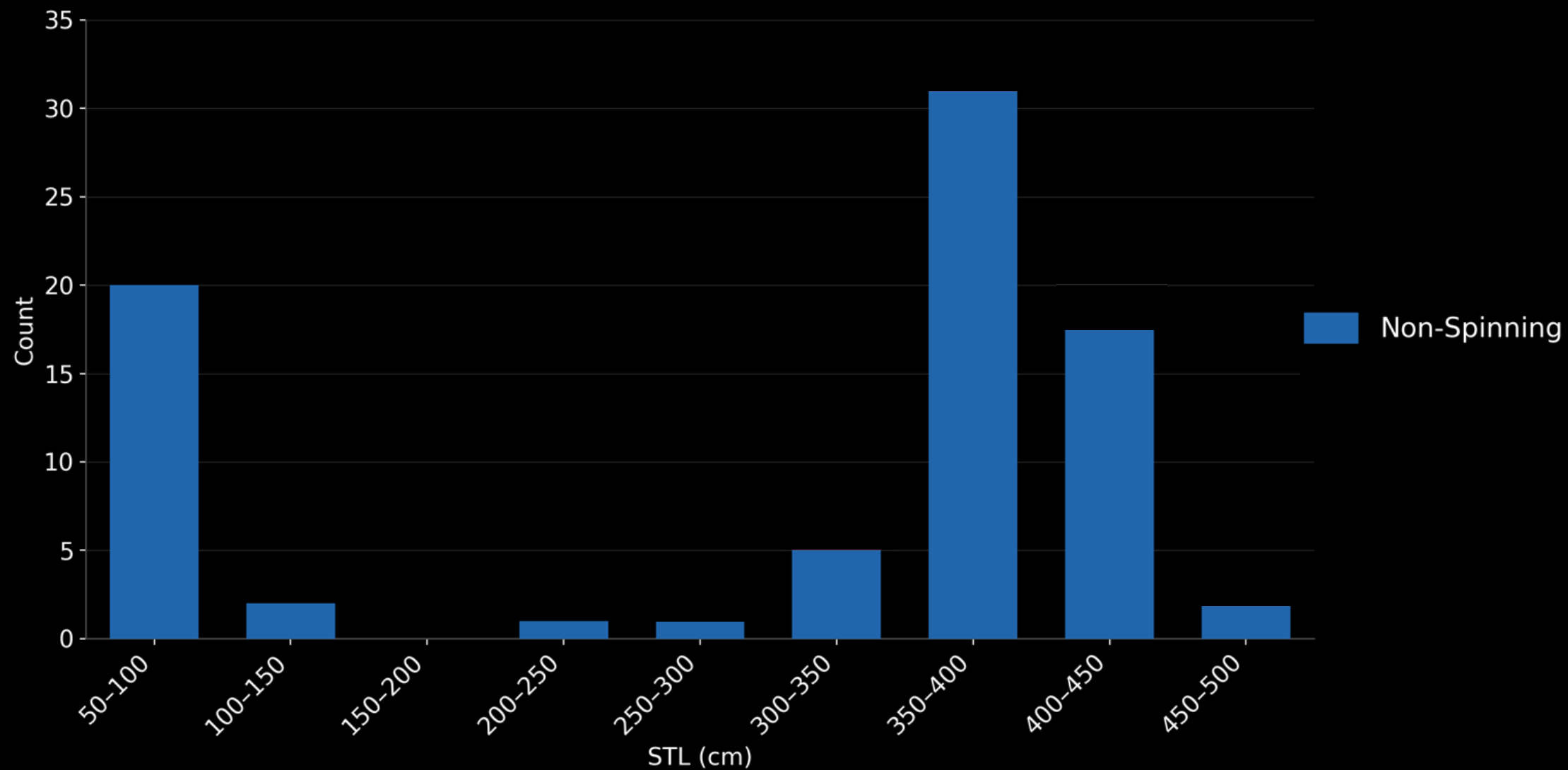
Sawfish Blood Samples



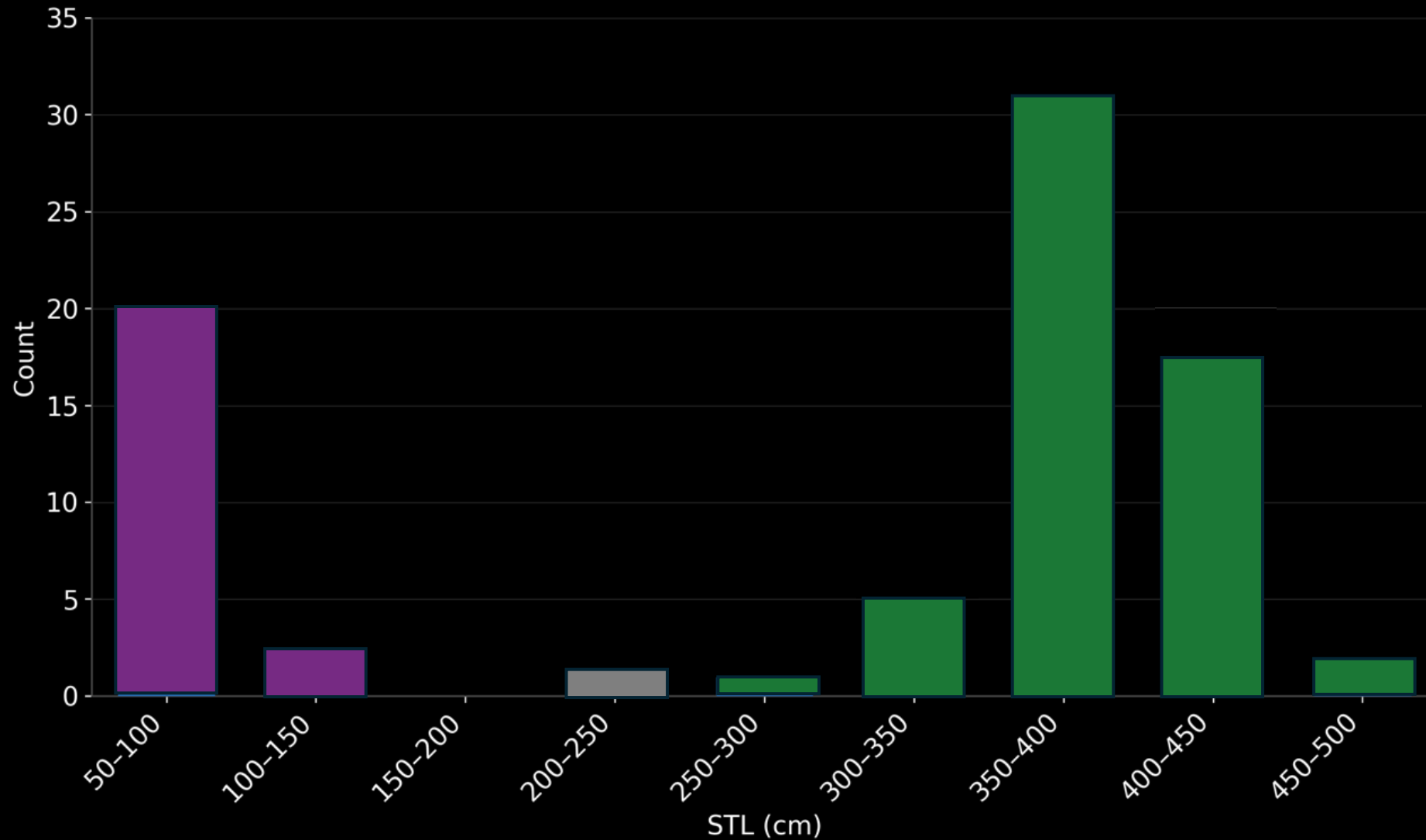
Sawfish Blood Samples

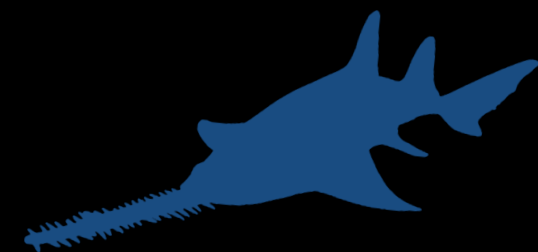


Sawfish Blood Samples



Sawfish Blood Samples Ontogeny



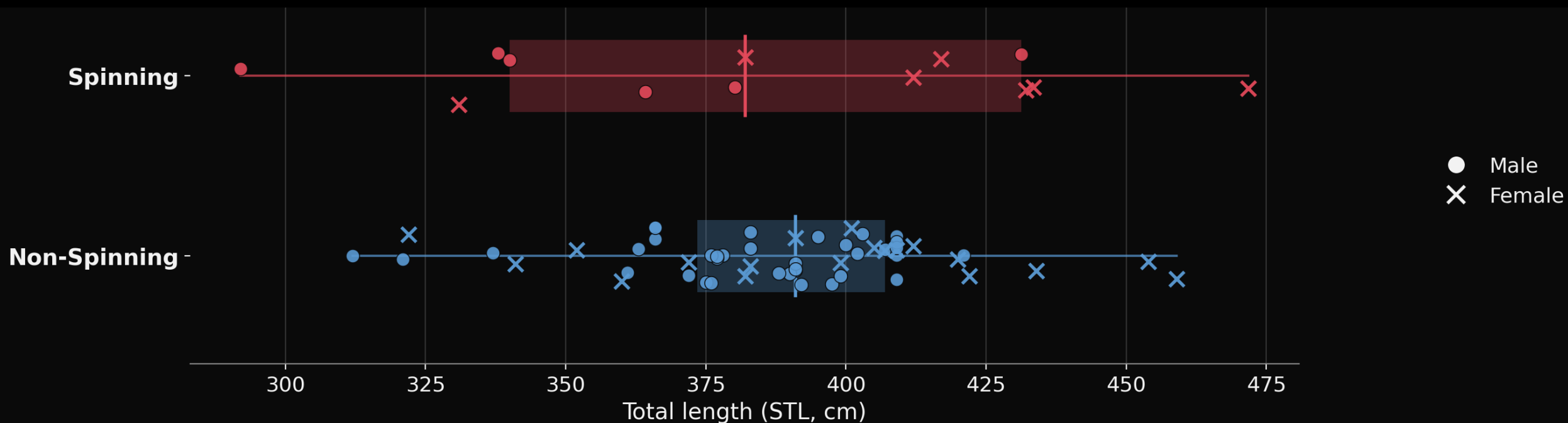


Disease Status

Matched Size Distribution 292-472 cm

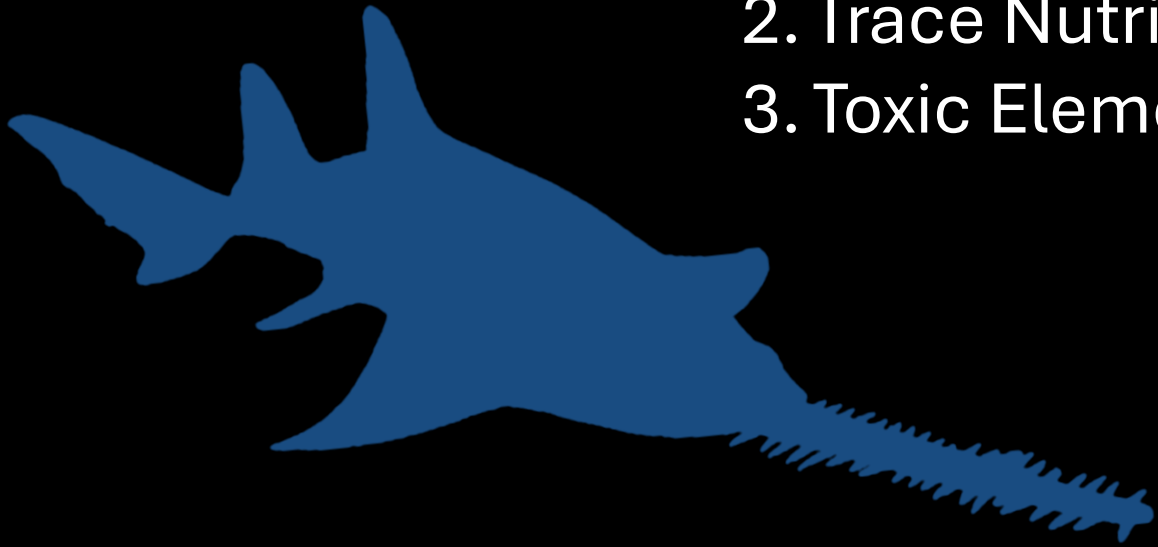
Spinning (n=13)

Non-Spinning (n=55)

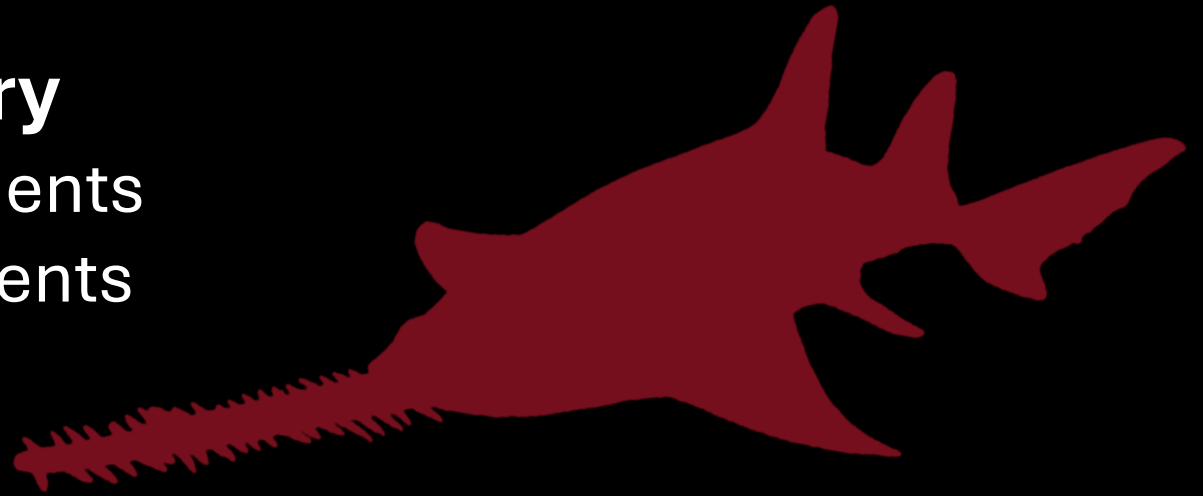


Biomarkers?

- 1. Chemistry**
2. Trace Nutrients
3. Toxic Elements



Non-Spinning

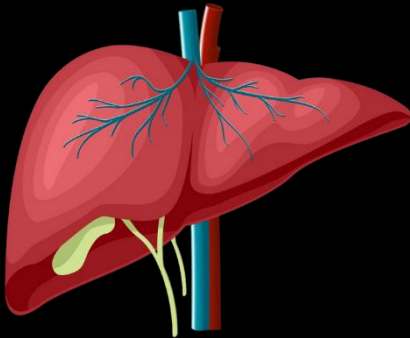


Spinning

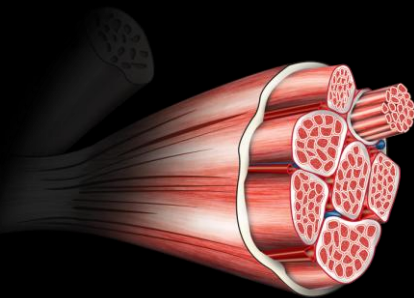
Plasma Chemistry Panel

16 analytes

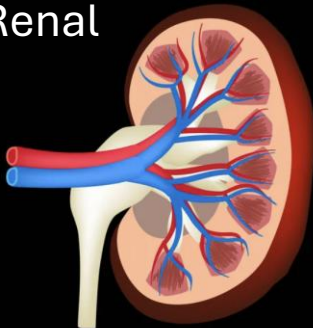
Hepatic



Nutrition/Metabolic



Renal



Chemistry

Verified on: 03/13/24

Test	Level	Comment	Range Low	Range High	Units of Measure
Hemolysis Index	0	--	0	0	
Lipemia Index	0	--	0	0	
Yellow Appearance	0				
AST	13				U/L
Calcium	13.3				mg/dL
Phosphorus	5.1				mg/dL
Ca/Phos Ratio	2.6				
Cholesterol	99				mg/dL
CPK	<20				U/L
GGT	<10				U/L
Potassium	3.5				mmol/L
Magnesium	3.3				mg/dl
Total Protein	3.5				g/dl
Triglycerides	149				mg/dL
Uric Acid	<0.5				mg/dL
Sodium	228	Value obtain. by dilution			mmol/L
Chloride	210				mmol/L
CO2	<5				mmol/L
Glucose	33				mg/dL
BUN	914	Value obtain. by dilution			mg/dL
Osmolality (Calc)	752				
Anion Gap	ua				mmol/L

GLDH

Verified on: 03/13/24

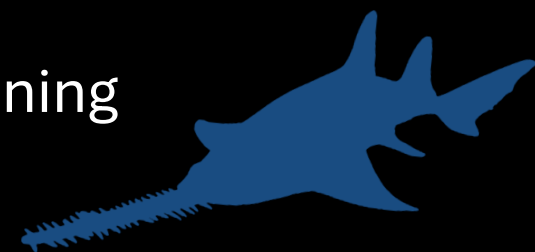
Test	Level	Comment	Range Low	Range High	Units of Measure
GLDH	0.80				U/L



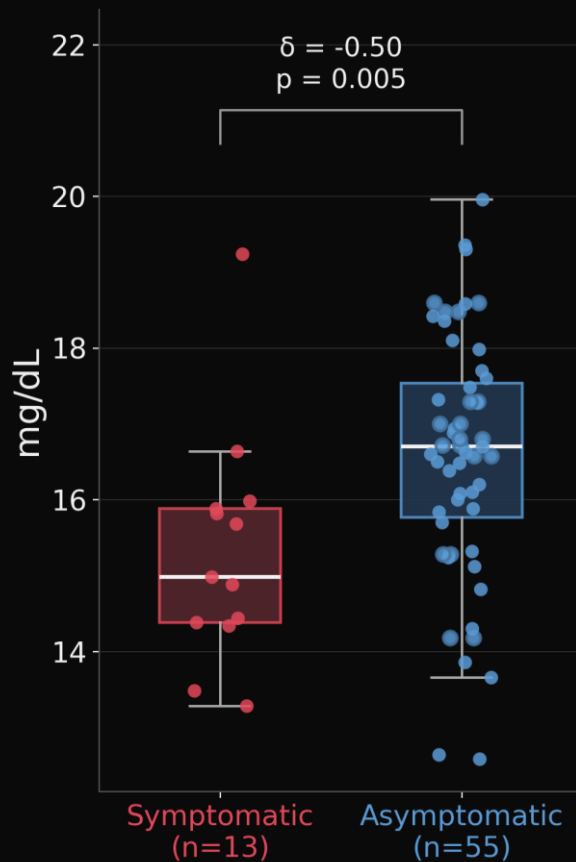
Spinning

Disease Status

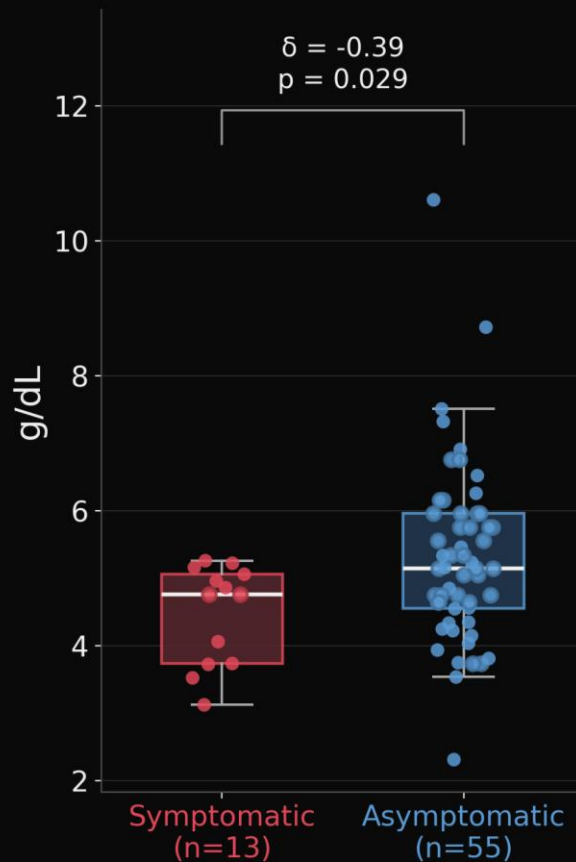
Non-Spinning



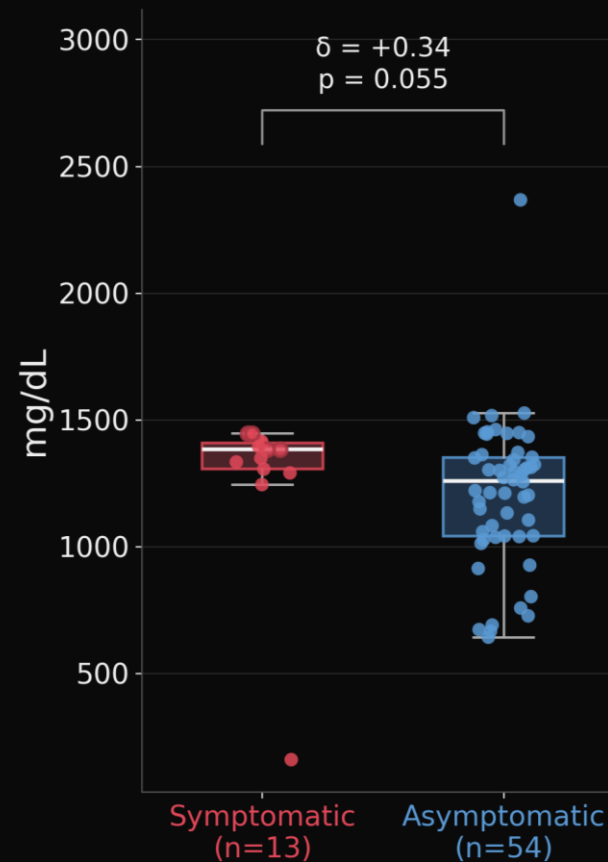
Calcium



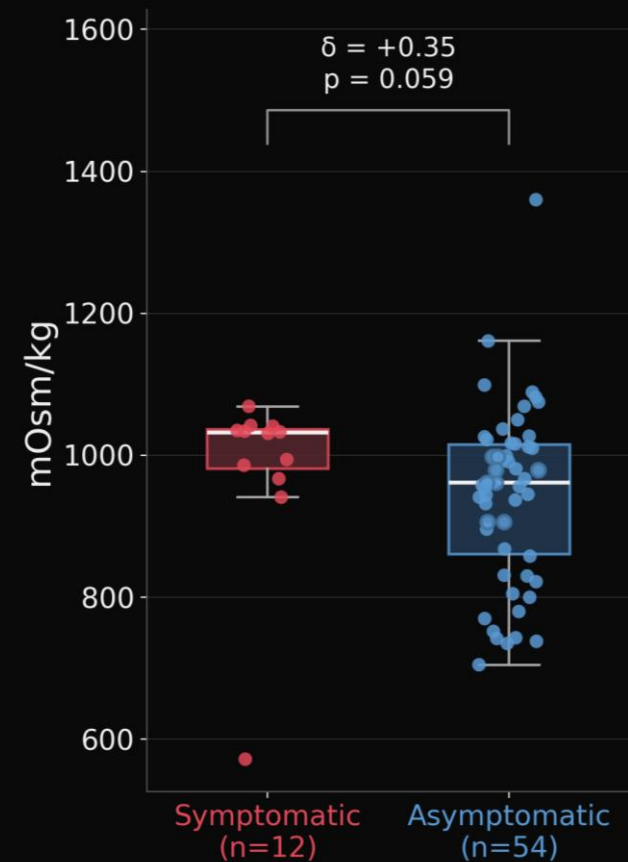
Total Protein



BUN



Osmolality



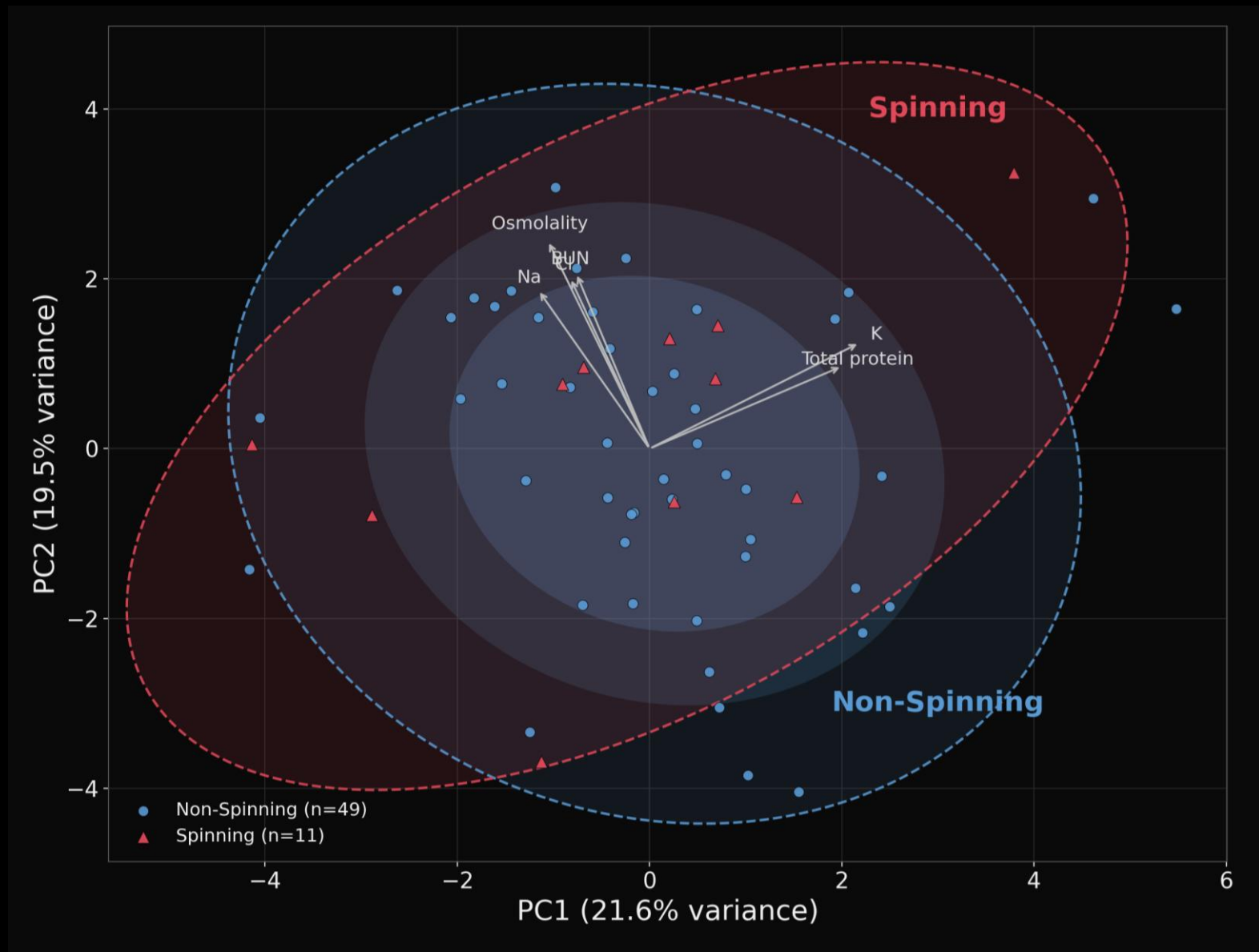


Spinning



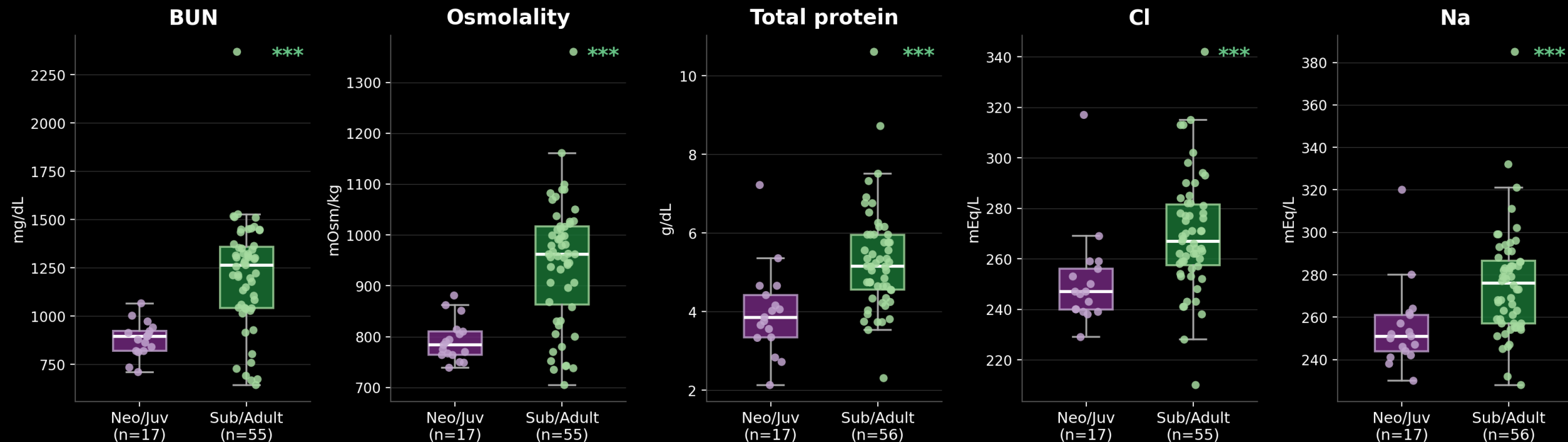
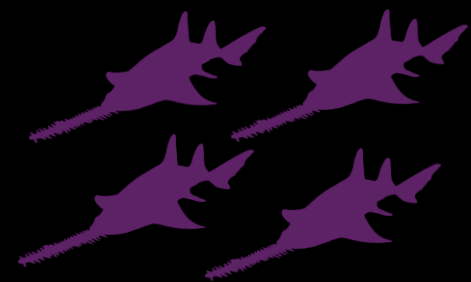
Non-Spinning

Groups Overlap



Ontogeny

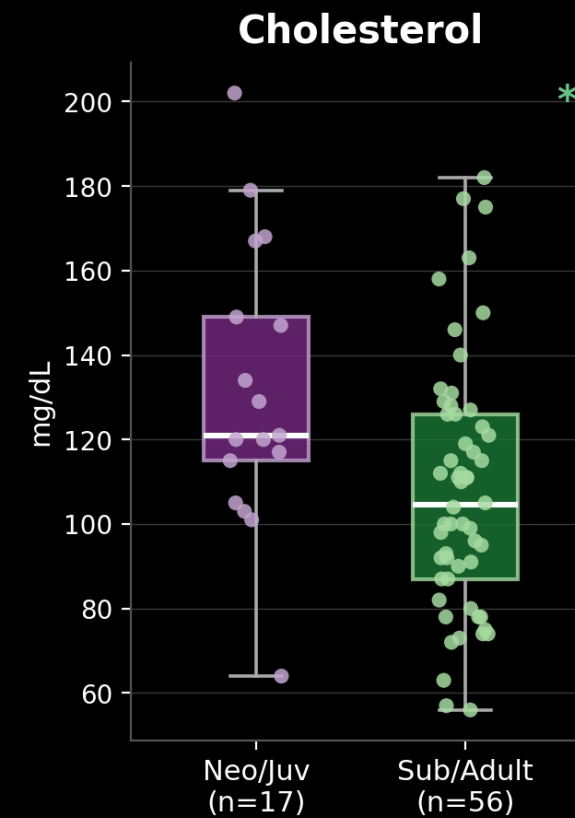
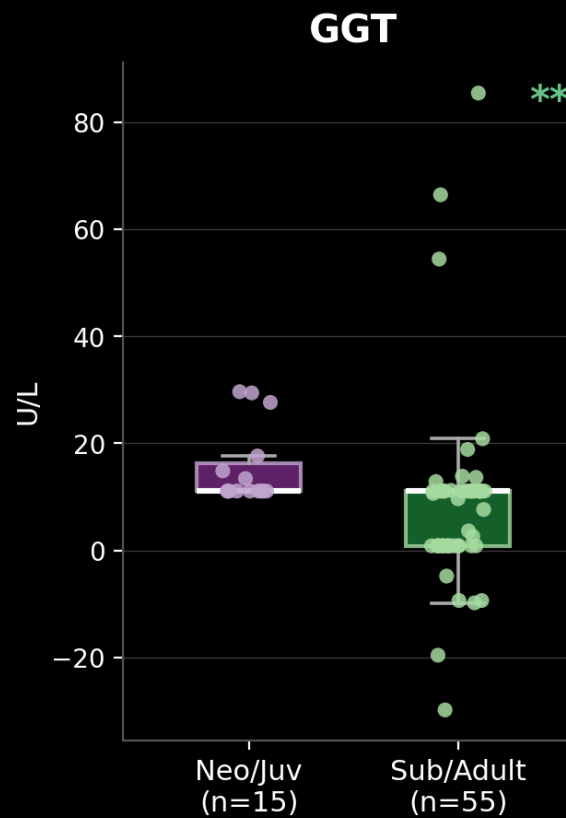
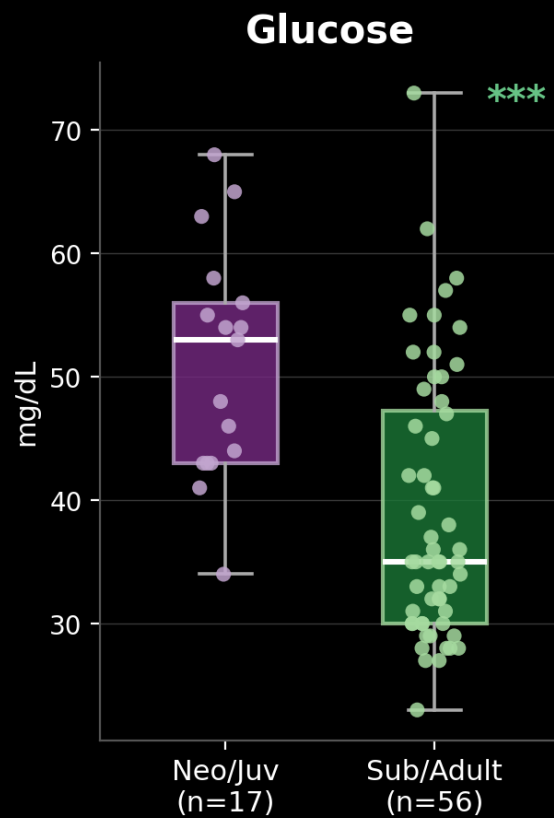
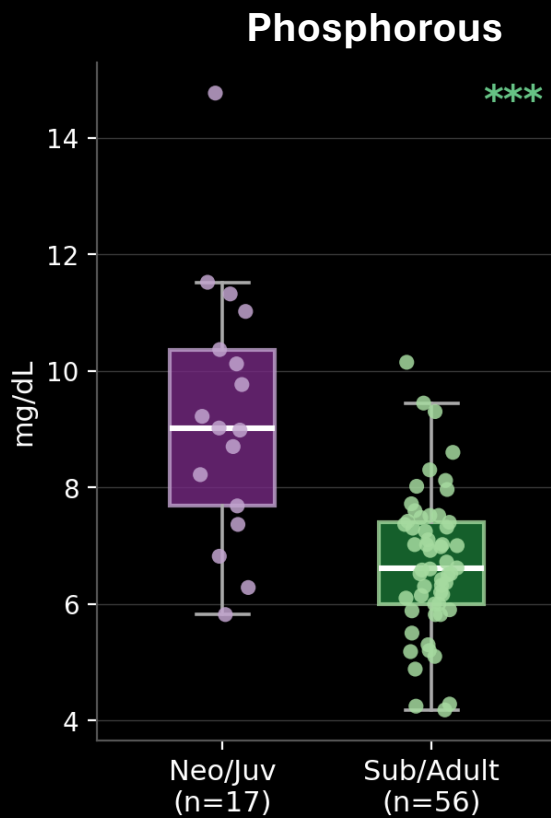
OSMOREGULATION



*** $q < 0.001$ ** $q < 0.01$ * $q < 0.05$ | BH FDR across 16 analytes

Ontogeny

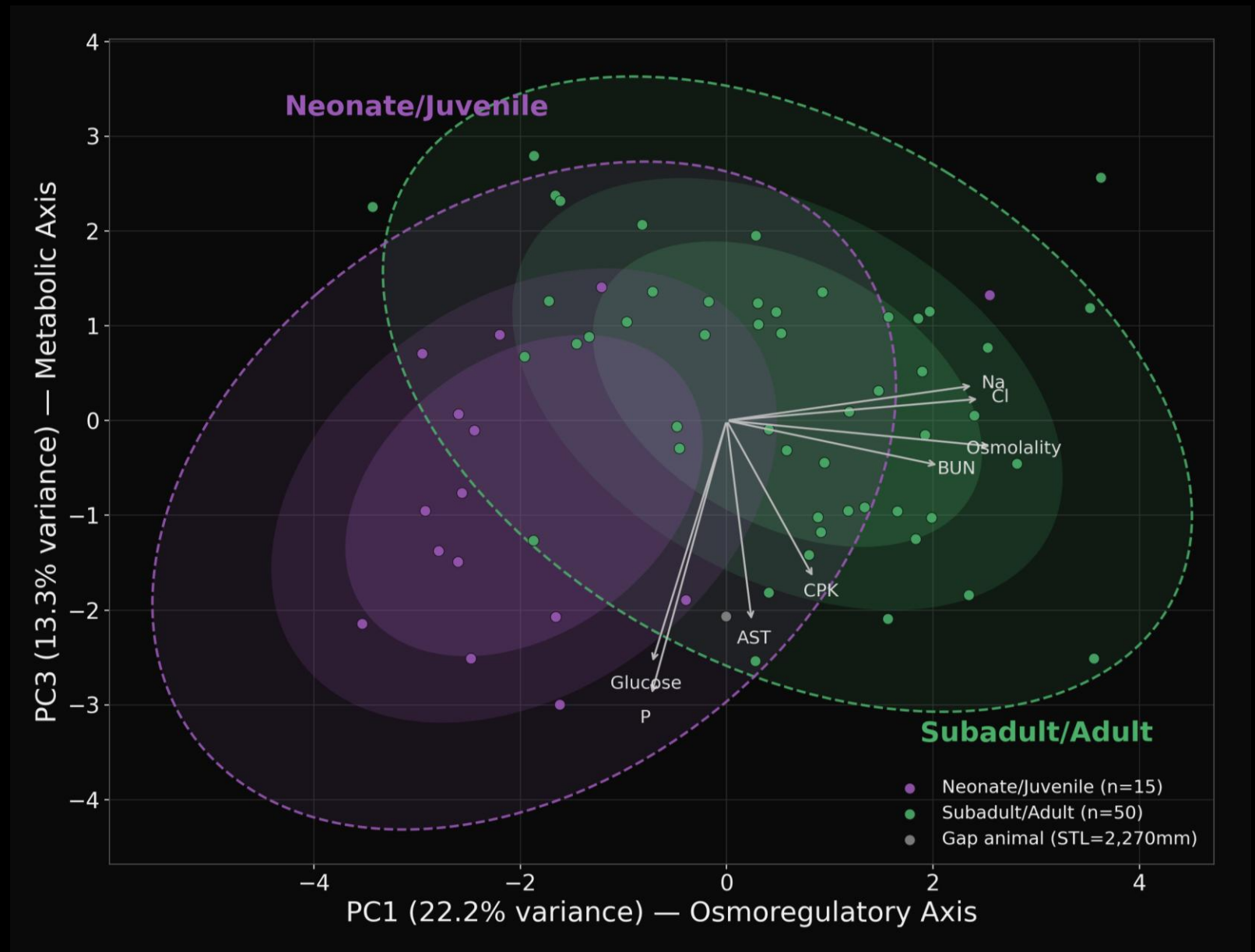
GROWTH / METABOLISM



*** $q < 0.001$ ** $q < 0.01$ * $q < 0.05$ | BH FDR across 16 analytes

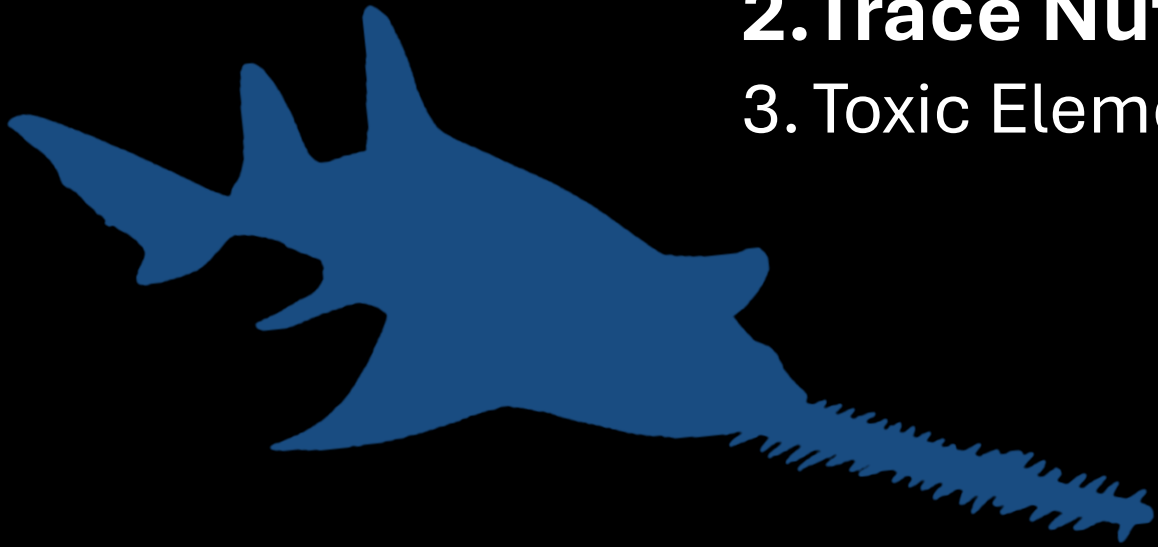
Blood
Plasma
Chemistry

***Size
Matters***

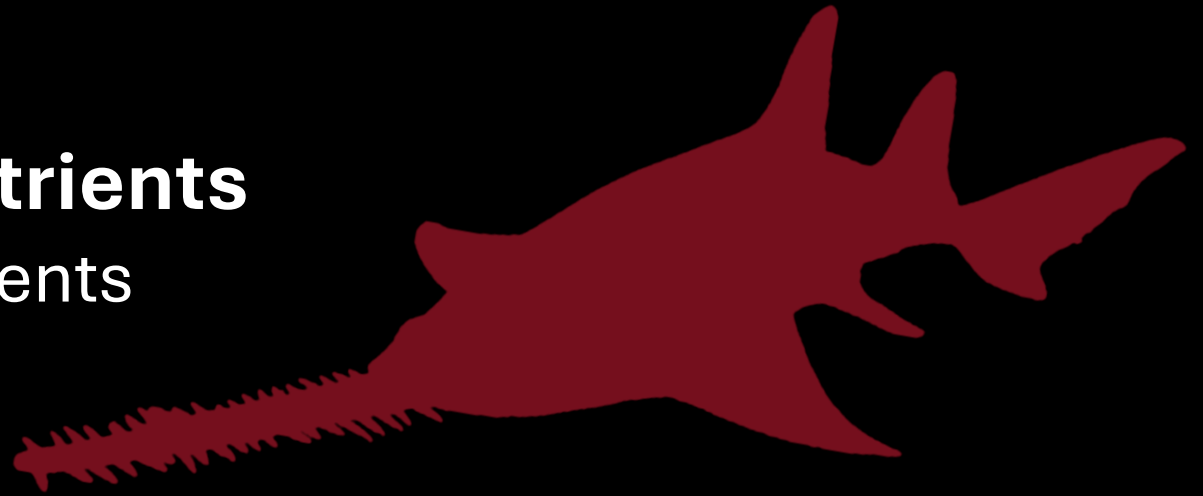


Biomarkers?

1. Chemistry
- 2. Trace Nutrients**
3. Toxic Elements



Non-Spinning



Spinning

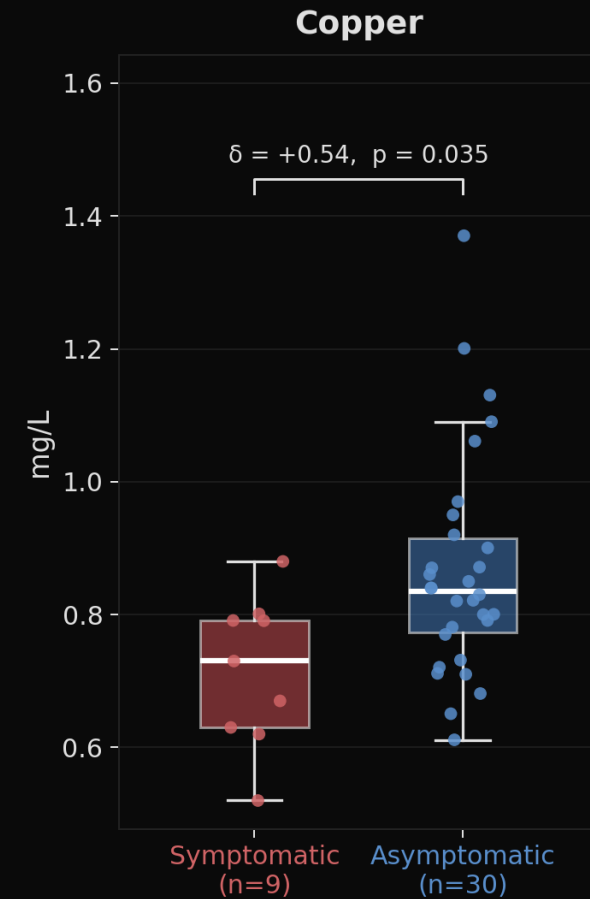
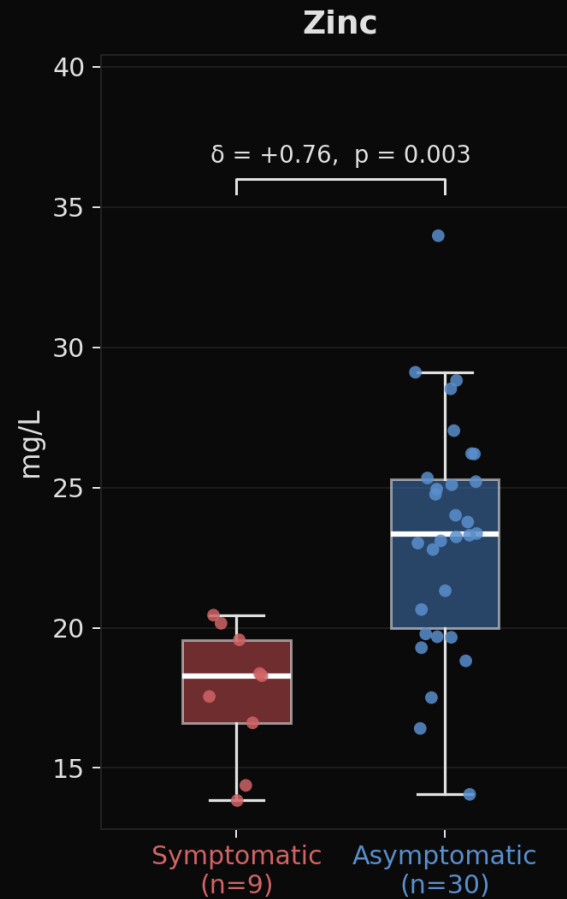
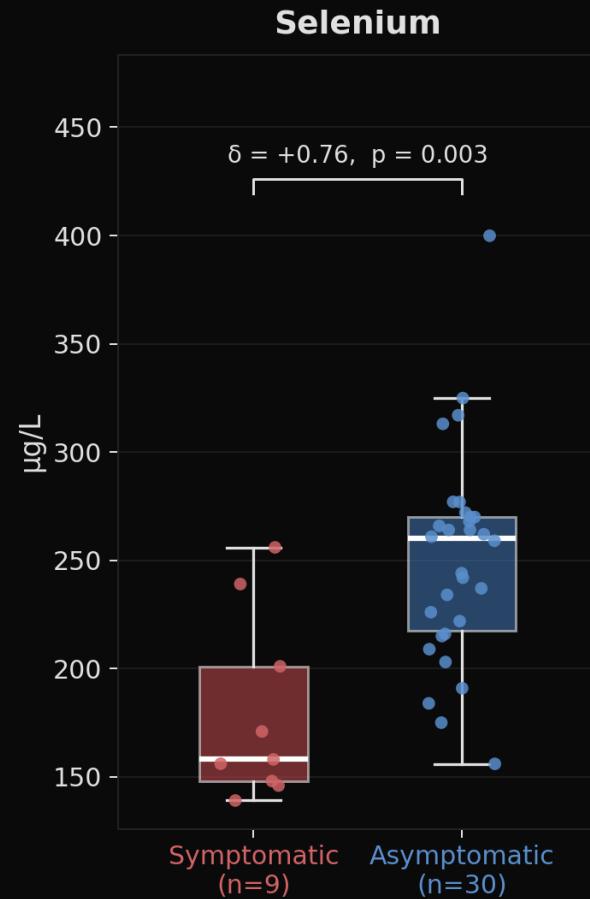
Primary Trace Nutrient Panel

Cobalt, Copper, Iron, Manganese, Molybdenum, Selenium, and Zinc

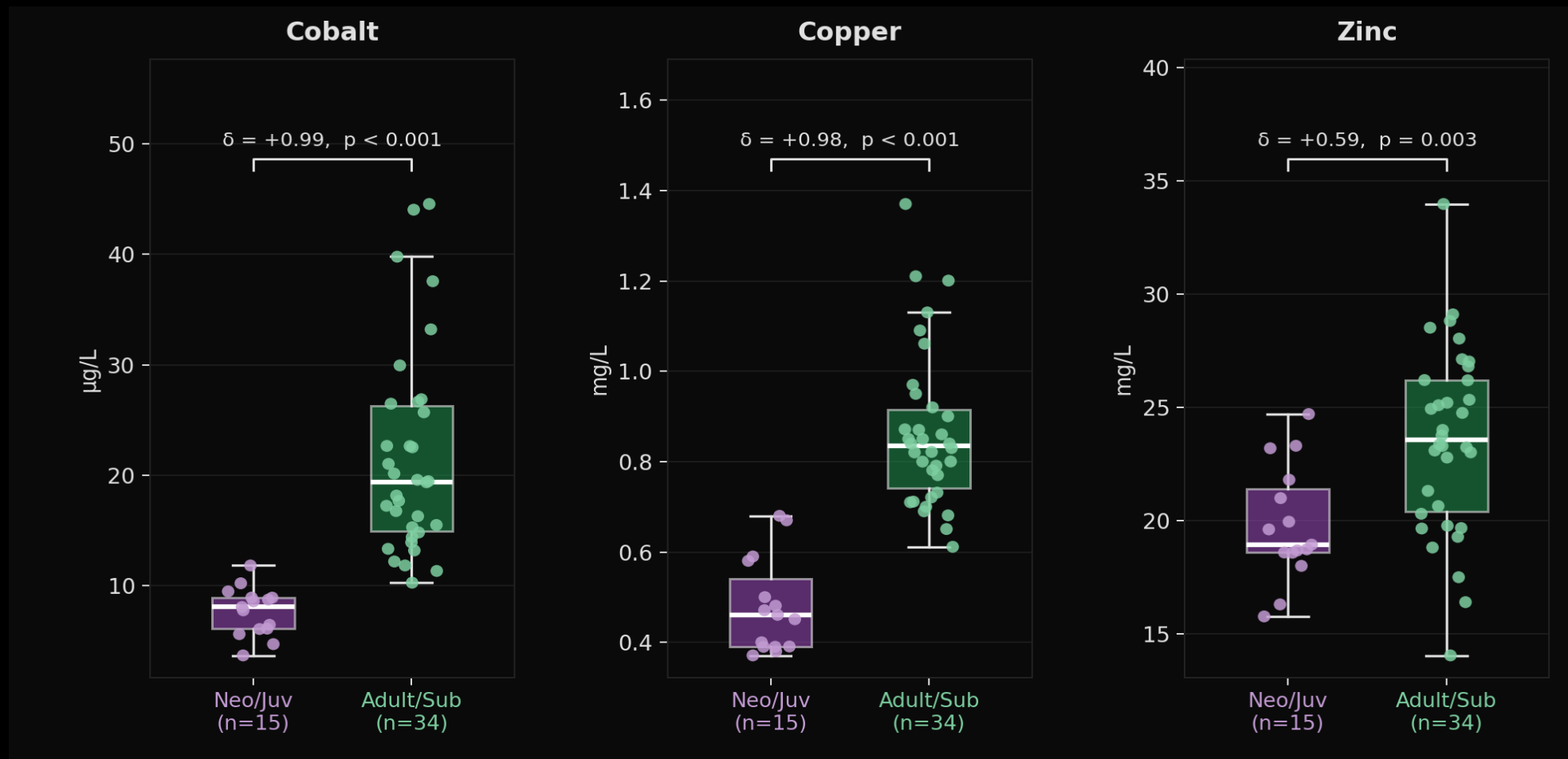
Spinning

Disease Status

Non-Spinning

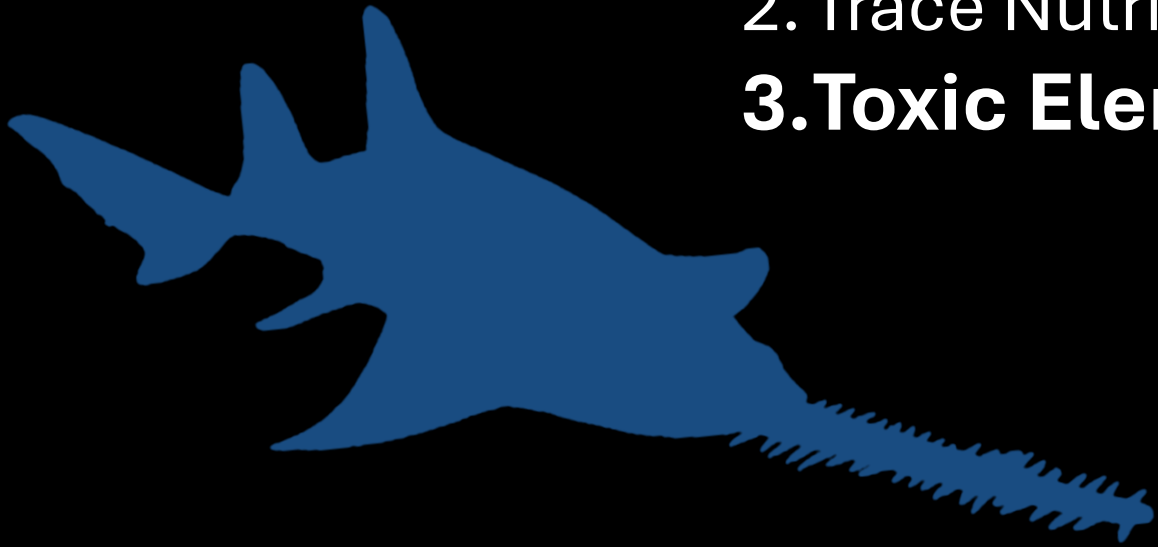


Ontogeny

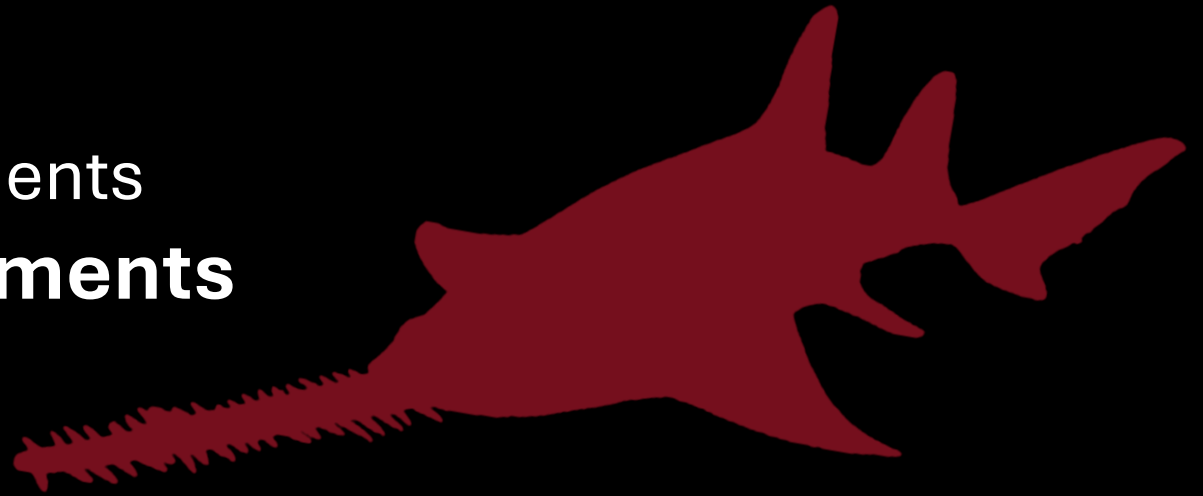


Biomarkers?

1. Chemistry
2. Trace Nutrients
- 3. Toxic Elements**



Non-Spinning



Spinning

Toxic Elements in Whole Blood

Arsenic, Cadmium, Lead, Mercury, Selenium, Thallium

Toxic Elements in Whole Blood

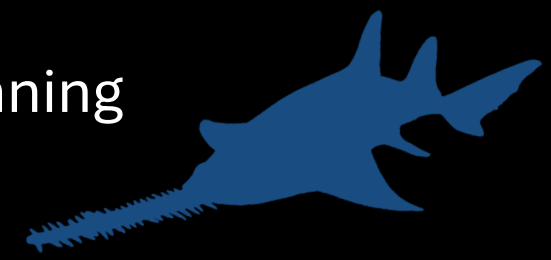
Arsenic, Lead, Mercury, Selenium



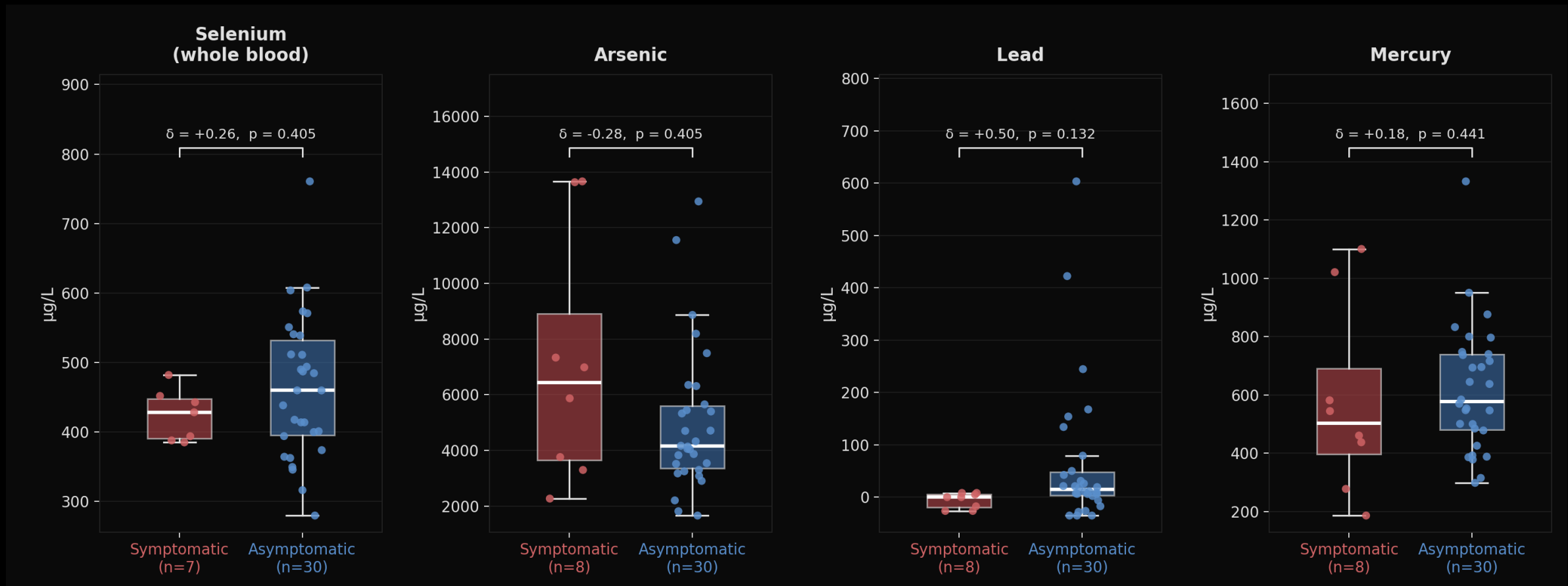
Spinning

Disease Status

Non-Spinning



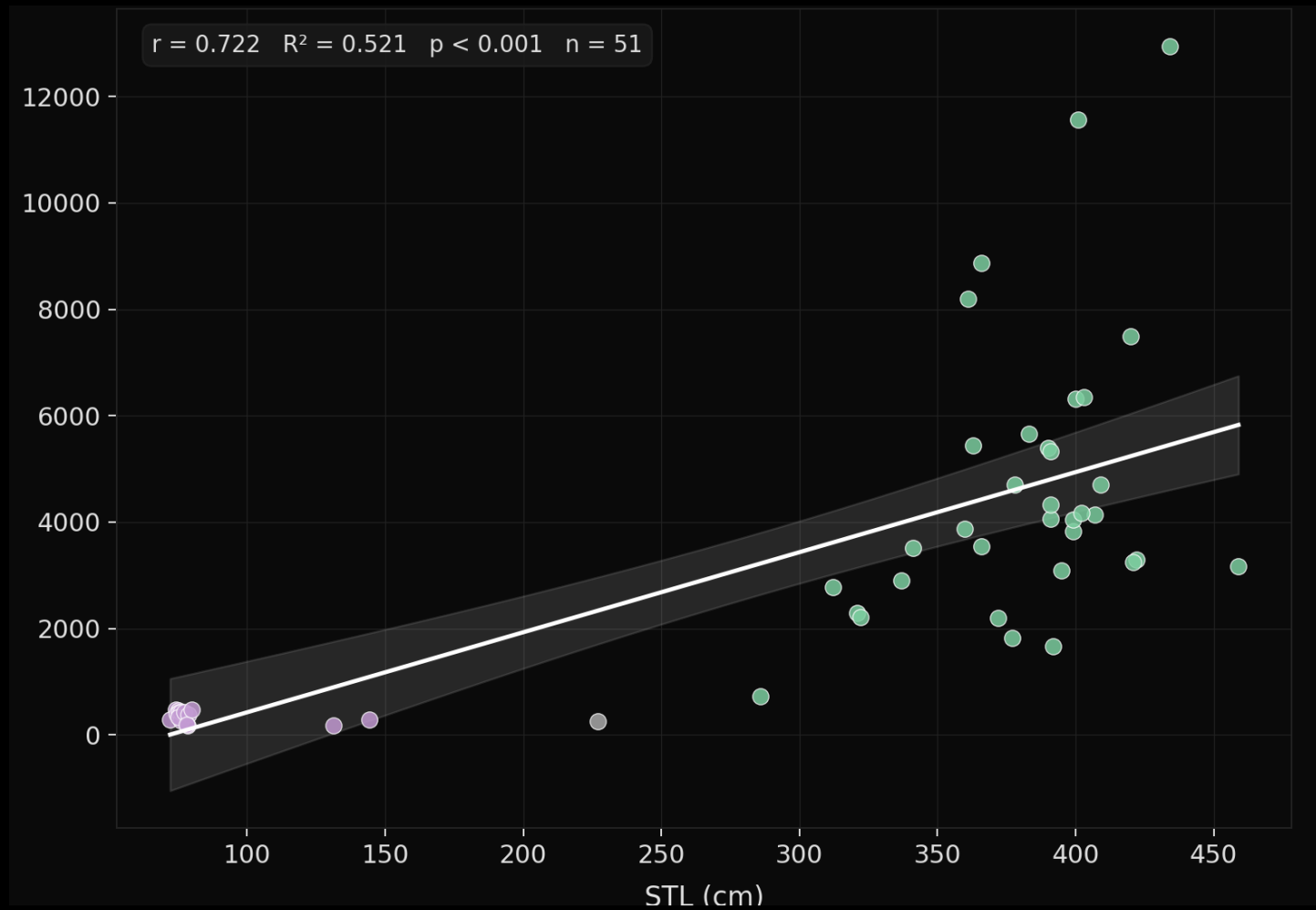
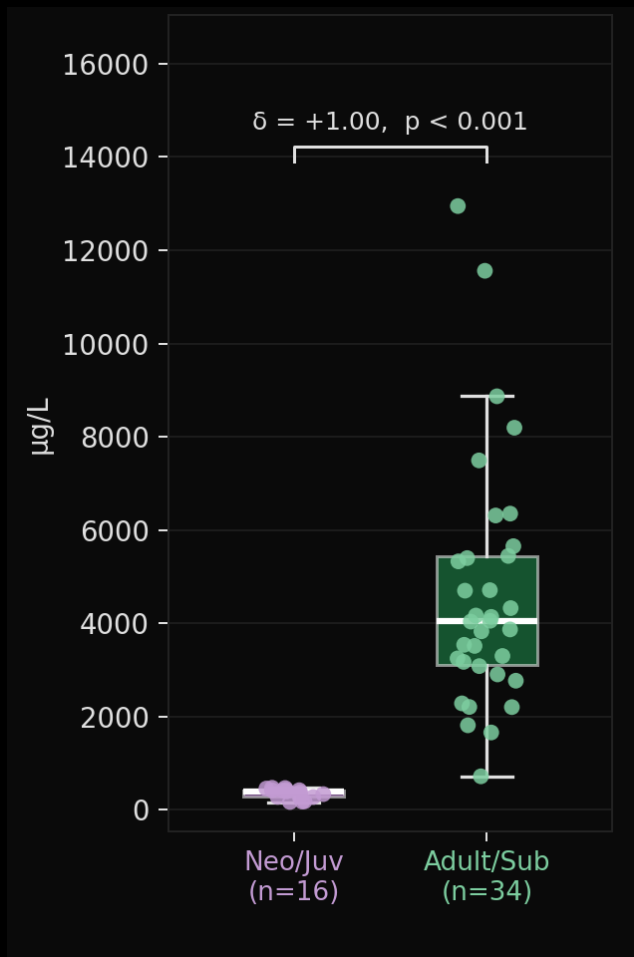
No Difference



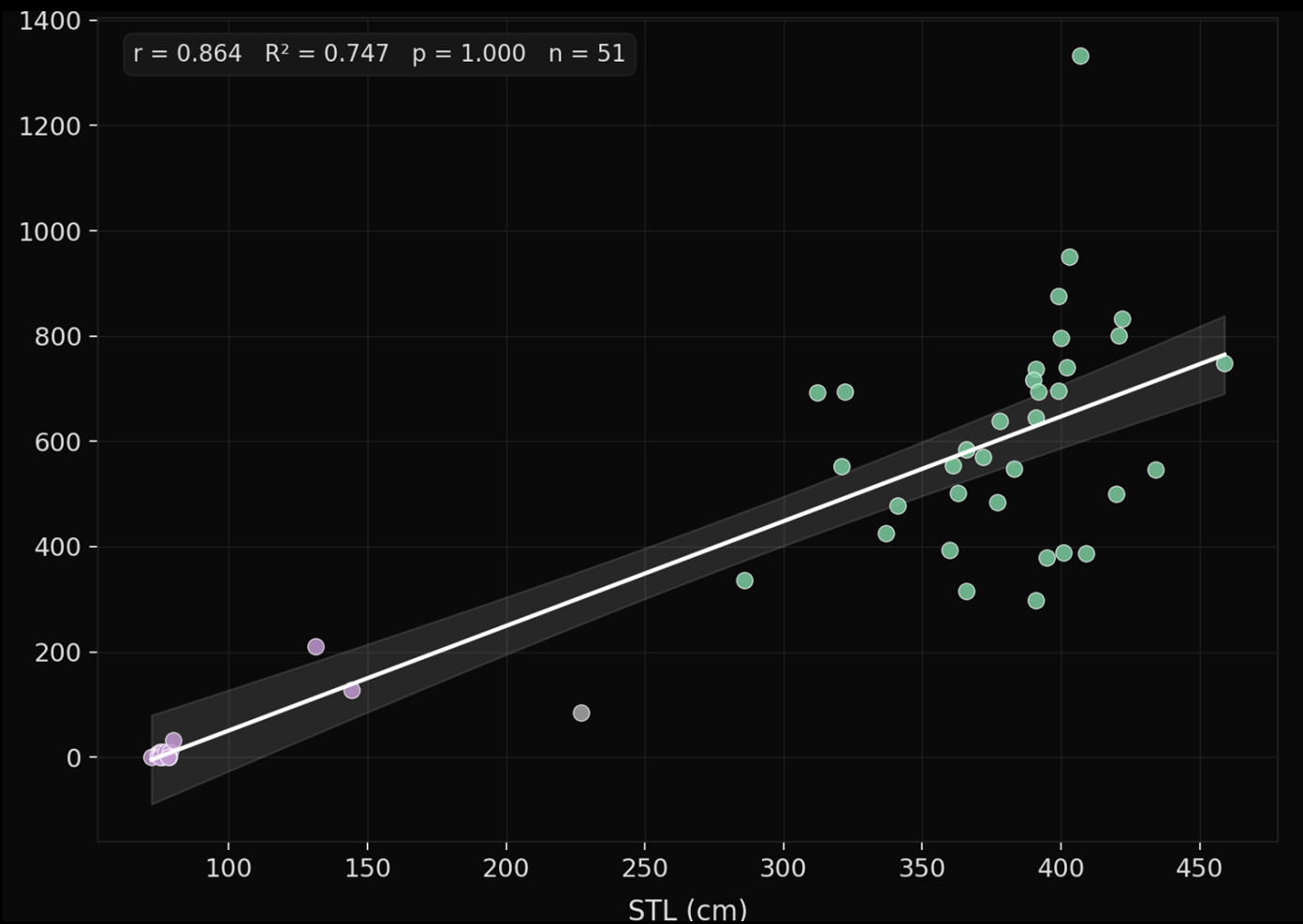
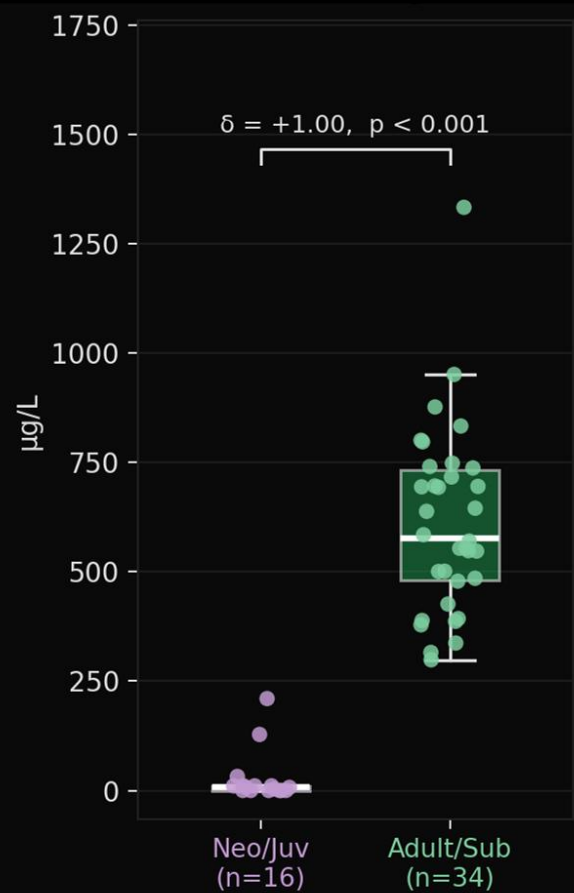
Ontogeny



Arsenic



Mercury





Non-Spinning

No strong signals

Chemistry

Trace Nutrient

Toxic Elements



Spinning



Non-Spinning

Chemistry

No strong signals

Trace Nutrient



Se, Cu, Zn

1) Dietary Intake

2) Oxidative Stress

3) Acute Phase Reactions

Toxic Elements

Spinning





Non-Spinning

Chemistry

No strong signals

Trace Nutrient



Se, Cu, Zn

1) Dietary Intake

2) Oxidative Stress

3) Acute Phase Reactions

Toxic Elements

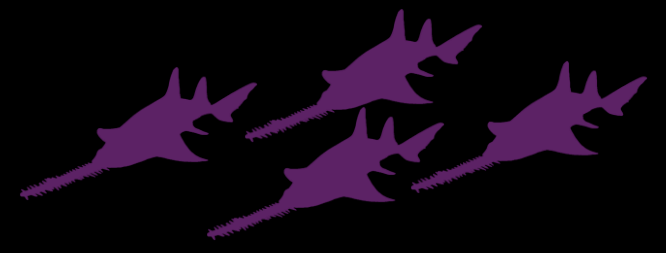
NOT toxic element exposure

Spinning





Non-Spinning



Chemistry

Trace Nutrient



Se, Cu, Zn

Toxic Elements



Spinning



Chemistry



Non-Spinning



n=5 Growth & Metabolism



Trace Nutrient



Se, Cu, Zn

Toxic Elements



Spinning

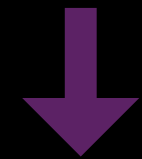




Non-Spinning



n=5 Growth & Metabolism



n=4 Osmolality



Se, Cu, Zn



Spinning



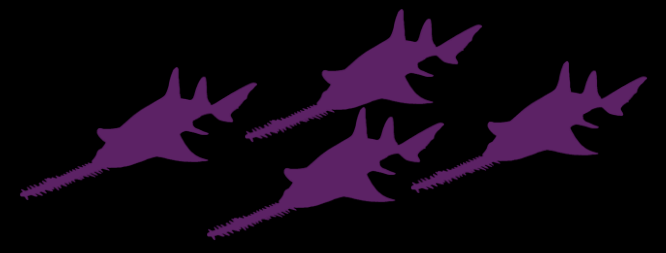
Chemistry

Trace Nutrient

Toxic Elements



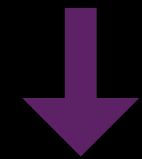
Non-Spinning



Chemistry



n=5 Growth & Metabolism

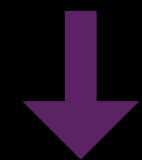


n=4 Osmolality

Trace Nutrient



Se, Cu, Zn



Co, Cu, Zn

Toxic Elements

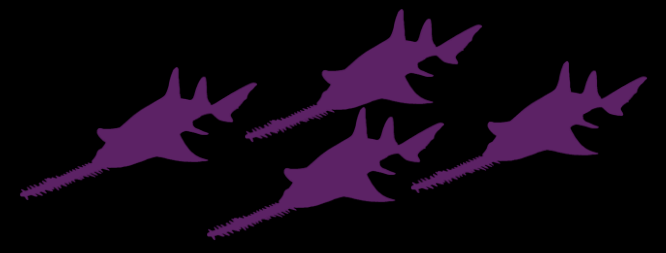


Spinning





Non-Spinning



Chemistry

Trace Nutrient

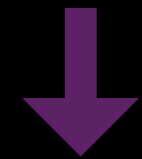
Toxic Elements



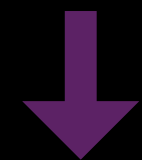
Se, Cu, Zn



n=5 Growth & Metabolism



n=4 Osmolality



Co, Cu, Zn



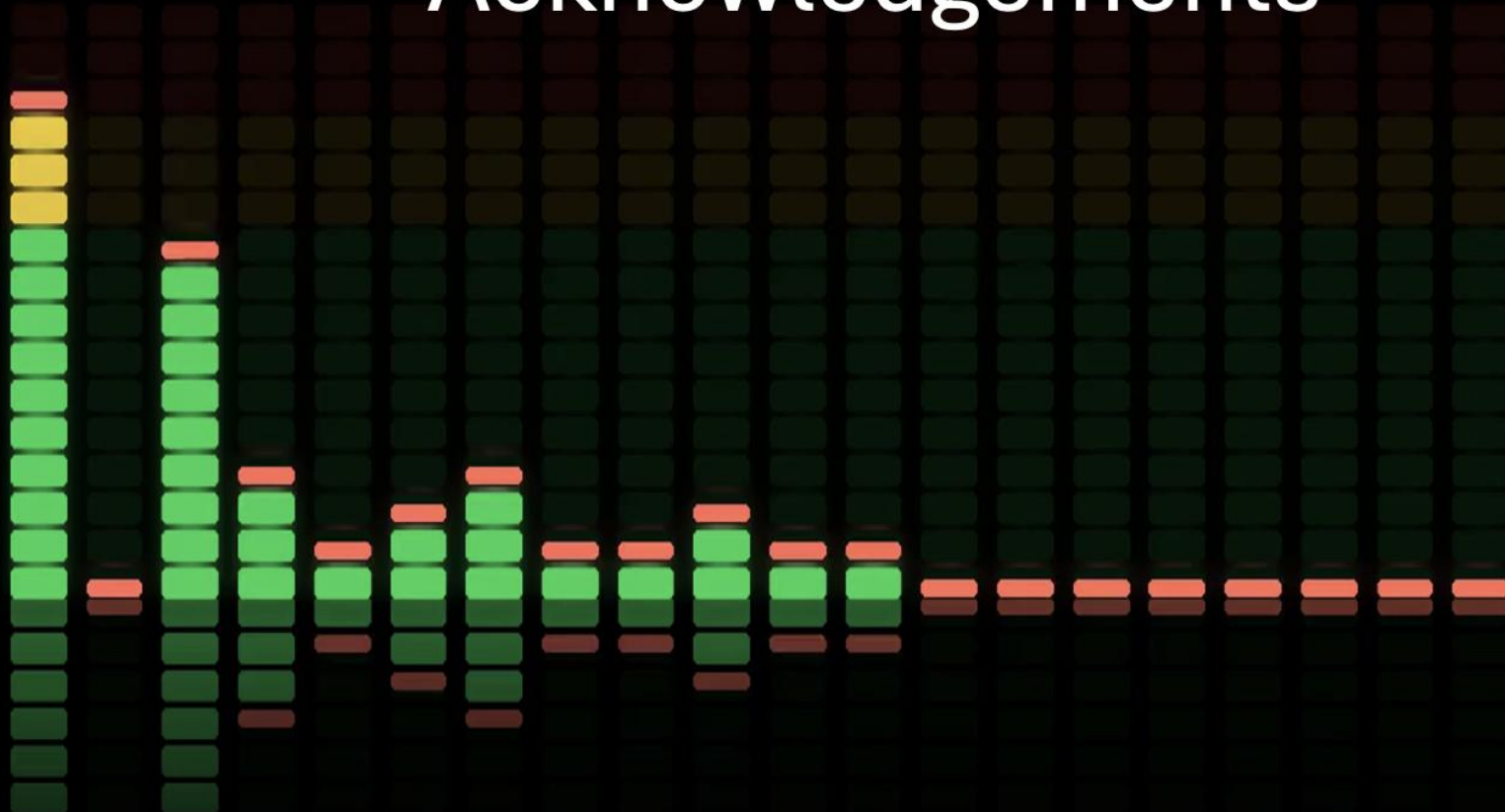
n=2 Hg and Arsenic



Spinning



Acknowledgements



Thank You Symposium Sponsors!



save our seas
foundation



All activities during the
“spinning fish events”
performed under the authority
and guidelines of
NOAA Fisheries Emergency
Section 7 Consultation
#SERO-2024-00402

Non-spinning-event research
activities performed under
authority of current
ESA Section 10 permits
#25864 to Gregg Poulakis,
#21857 to Tonya Wiley,
and #22078 to John Carlson or
their previous permits

Acknowledgements

