

BOMA ADAPTATION AND DEVELOPMENT OF A SCORING SYSTEM FOR RECENTLY CAPTURED WHITE RHINOCEROS (*CERATOTHERIUM SIMUM*) IN SOUTH AFRICA

Michele Miller, DVM, MPH, PhD
Rare Species Conservatory Foundation

Acknowledgements

- Melandi Kruger
- Marius Kruger
- Ben Baloyi
- Dr. Francisco Olea-Popelka
- Jenny Joubert
- Khosi Mathebula
- Guy Hausler
- Dr. Peter Buss
- South African National Parks
- Colorado State University
- ABAXIS
- International Rhino Foundation



Background

- Risks of white rhino anesthesia and translocation complicated by transport and adaptation to boma
- Mortality estimated to be 5%
 - Morbidity likely to be higher



Study Purpose

- Assess factors influencing individual rhino adaptation to boma conditions
 - Minimize morbidity and possible mortality associated with confinement



Materials and Methods

- 109 white rhinos captured in Kruger National Park, South Africa (2009-2012)
- Immobilized with etorphine, azaperone, hyaluronidase and butorphanol (IV or in dart)
- Received diprenorphine (M50-50) and zuclopethixol acetate (Clopixol-Acuphase) in crates
- Received azaperone and naltrexone prior to release into bomas



Materials and Methods

- Placed in 25 x 50m bomas with vertically spaced wooden poles



Materials and Methods

- Data collection
 - Immobilization data
 - Drugs
 - Distances run
 - Physiological parameters
 - Blood gases
 - Weight
 - Hematology, biochemistry, vitamin D&E, mineral panels
 - Release data
 - Drugs
 - Weight
 - Hematology, biochemistry, vitamin D&E, mineral panels
 - +/- Blood gases
 - +/- Physiological parameters



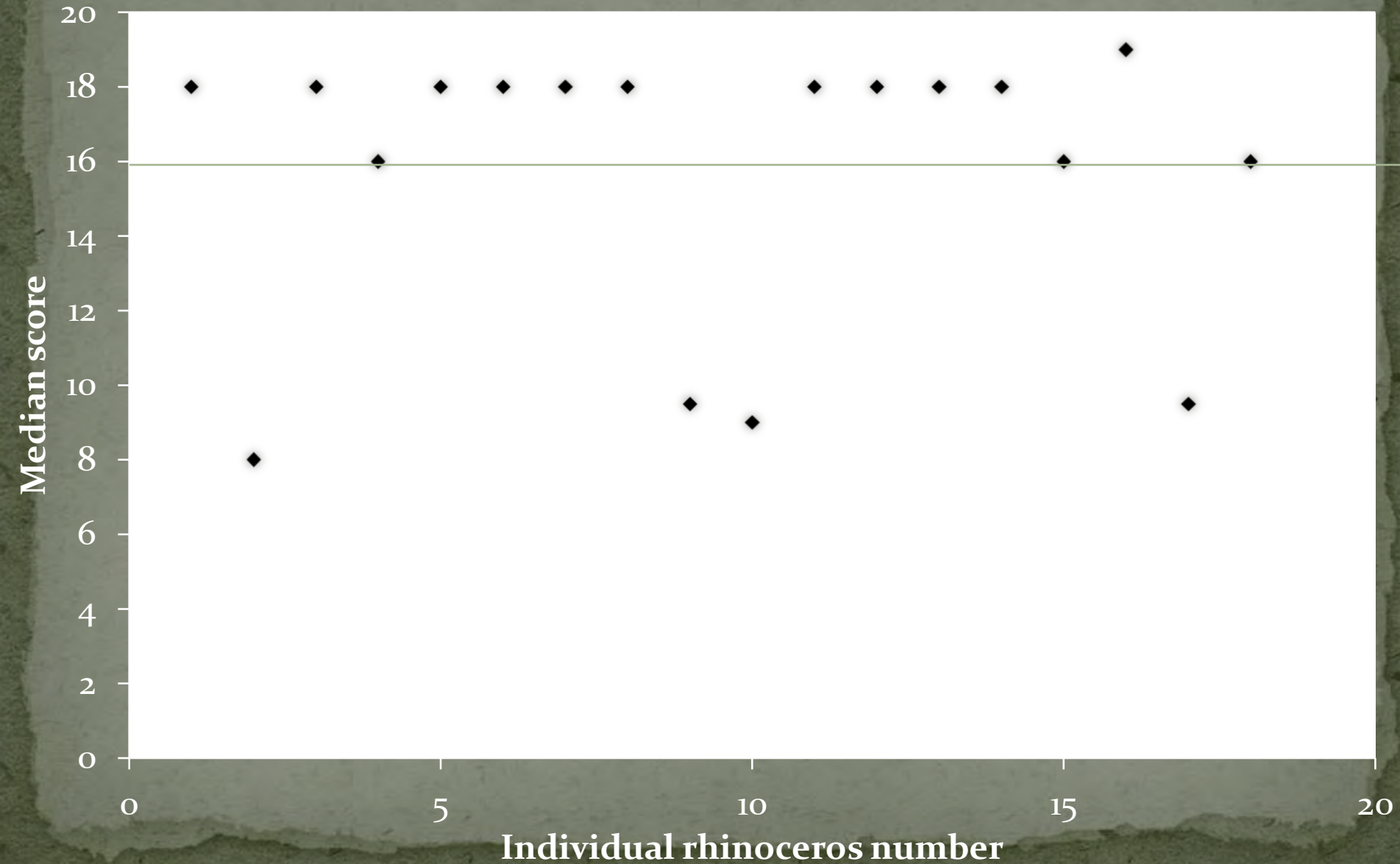
Materials and Methods

- Scoring system used daily to score adaption
 - Appetite, defecation, demeanour, activity
 - Scored 1-5 for healthy rhinos
 - Scores for ill rhinos (-1, -3, -5)
- One of two boma managers scored rhinos daily until released

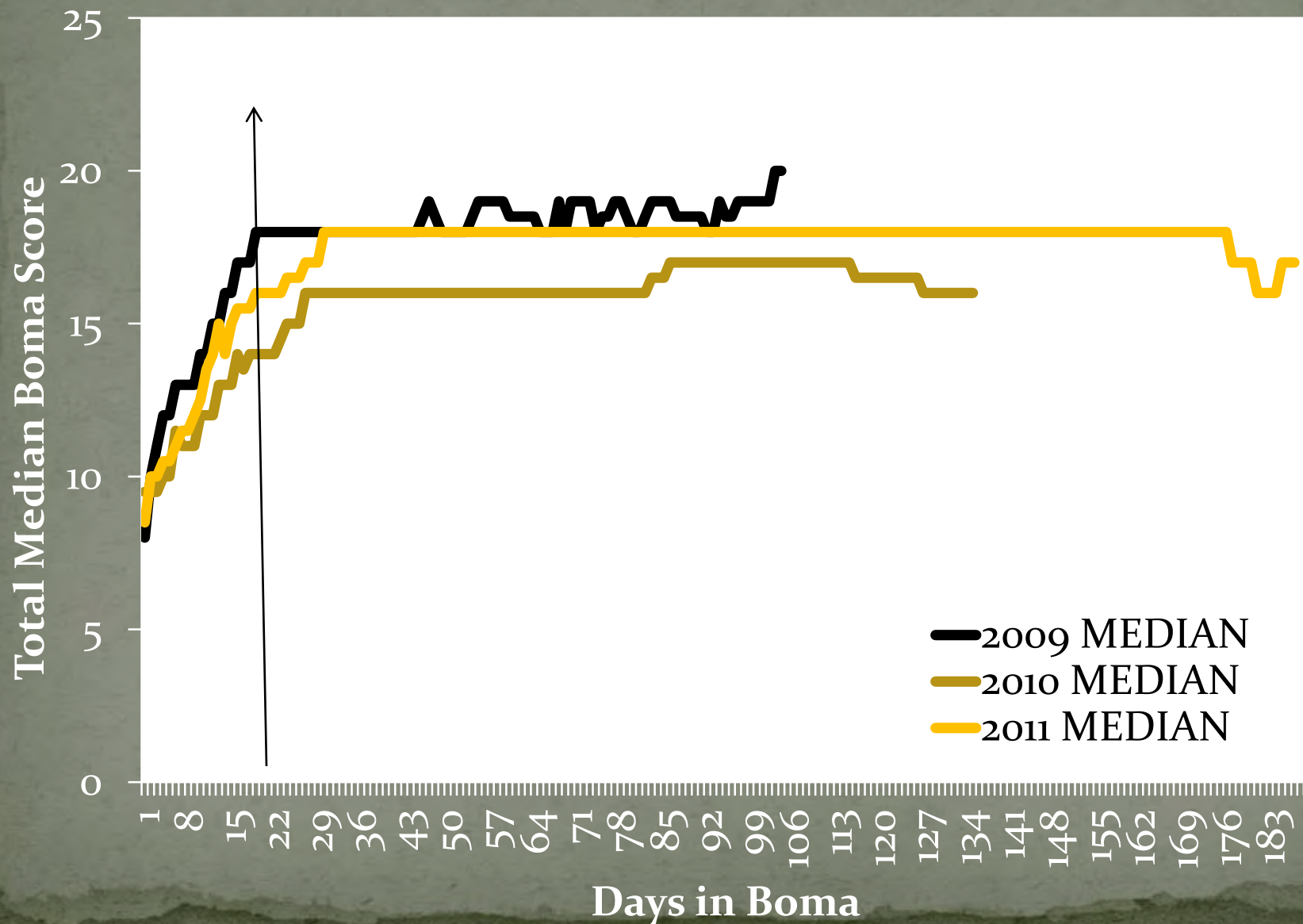


Healthy animal	Score	Appetite		Defaecation	Demeanour/Behaviour	Activity levels
	5	Eating 90% to 100% of normal intake		Brownish / green large stool (multiple defaecations per day)	Very calm	Standing stationary or sleeping and turns head and / or ears towards stimulus*
	4	Eating 50% to 75% of normal intake		Dark brownish / green medium stool (3 to 5 balls more than once a day)	Calm and not nervous	Walks away slowly or stands their ground in response to stimulus*
	3	Eating 25% to 50% of normal intake		Dark small stool (1or 2 balls more than once a day)	Mildly nervous and / or aggressive	Trots and / or walks for a short distance in response to stimulus*
	2	Eating 0% to 25% of normal intake		Putty-like dark, small stool or loose faeces	Moderately nervous and / or aggressive	Runs or trots away and charges once or twice in response to stimulus*
	1	Not eating at all		Not defaecating	Extremely nervous and / or aggressive	Runs around and / or frequently charges and / or hits poles / doors in response to stimulus*
Sick / ill animal	- 1	-	Stool is loosely formed (similar to domestic cow)		Mildly depressed	Walks a short distance in response to stimulus*
	- 3	-	Diarrhoea (light brown or green in colour)		Moderately depressed	Standing stationary or sleeping and turns head and / or ears towards stimulus*
	- 5	-	Profuse watery diarrhoea (dark brown / black in colour)		Very depressed	Recumbent with no response to stimulus*

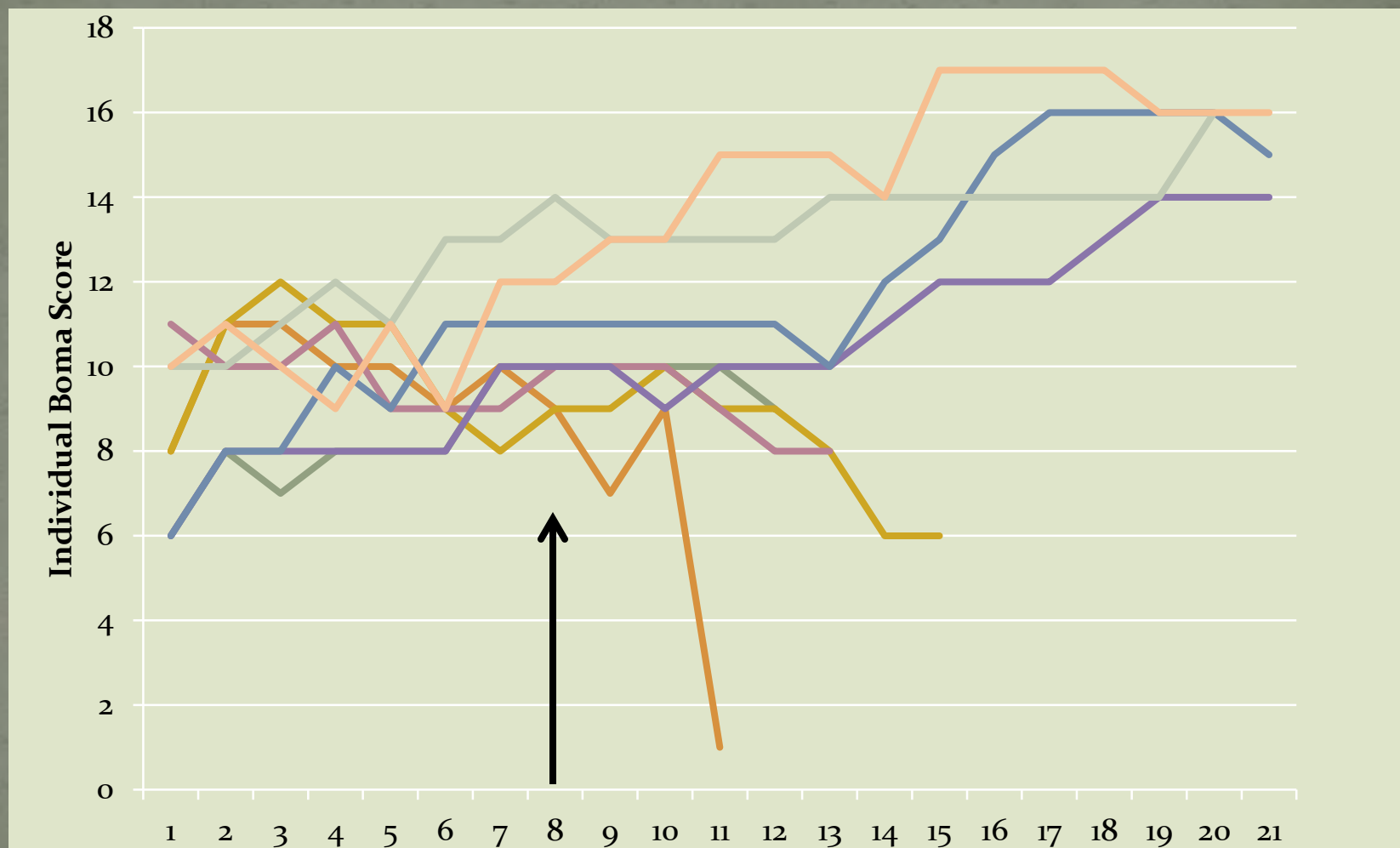
Individual Median Rhino Boma Scores 2011



Median Daily Boma Scores for White Rhino by Year



Individual Rhino Boma Score by Day (First 21 Days) 2011



Distribution (25th percentile, median and 75th percentile) for Total Score Each Day Among Rhinos That Adapted and Those That Did Not Adapted to Boma Conditions 2009-2011

Adaptation	Statistics	Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8	Day9	Day10	Day11	Day12	Day13	Day14	Day15	Day16
Adapted	25th percentile	8	8	9	9	10	11	11	11	11	12	12	12	13	13	13	14
	Median	8	10	11	11	11	12	12	13	13	13	14	14	15	14	15	15
	75th percentile	10	11	11	12	13	13	13	15	15	15	16	16	16	17	17	18
	count	61	73	73	75	74	74	75	75	75	75	75	75	75	75	75	75
Maladapted	25th percentile	8	10	10	10	10	9	9	9	9	9	8.5	9	8	9.5	9	9
	Median	9	10	11	11	11	12	10	10	10	10	10	10	10	10	10	10
	75th percentile	10	11	12	12	13	13	13	12	13	11	11.5	11	11	11	11	10
	count	15	17	17	17	17	17	17	17	17	17	16	13	11	8	8	5
Total	25th percentile	8	9	9	10	10	11	10	10.5	11	11	11	11	12	12	13	13
	Median	9	10	11	11	11	12	12	12	13	13	13	13.5	14	14	14	15
	75th percentile	10	11	11	12	13	13	13	14	14	15	16	16	16	16	17	17
	count	76	90	90	92	91	91	92	92	92	92	91	88	86	83	83	80
Wilcoxon Rank Sum Test ^a	p-value	0.706	0.3835	0.2205	0.8946	0.9055	0.2774	0.0688	0.0012	0.0003	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0003

^a The Wilcoxon Rank sum test compares the median score value between adapted and maladapted rhinoceros

Distribution of Adapted/Maladapted Rhinos

	2009	2010	2011	2012	Total
Adapted rhinos	35	25	13	9	82
Rhinos with complications not requiring release*	4	1	1	0	6
Maladapted rhinos – released/relocated	11	2	4	4	21 ^a
Total	50	28	18	13	109

^a19.3% maladapted (95% CI 12.3%-27.9%)

Maladaptive vs. Adaptive capture related data

		Mean	SD	95% Conf. Interval		n	P-Value
Ataxia							
<i>(minutes)</i>	Adaptive	3.86	2.36	3.22	4.5	54	0.46
	Maladaptive	3.35	1.86	2.28	4.4	14	
Down Time							
<i>(minutes)</i>	Adaptive	8.78	4.85	7.43	10.1	52	0.44
	Maladaptive	9.94	5.63	6.82	13.1	15	
Crate Time							
<i>(minutes)</i>	Adaptive	25.15	5.47	23.70	26.6	57	0.76
	Maladaptive	24.68	5.59	21.81	27.6	17	
Dist. Before Dart							
	Adaptive	756.64	619.17	590.8	922.5	56	0.036
	Maladaptive	415.63	260.59	276.8	554.5	16	
Dist. After Dart							
	Adaptive	830.09	400.14	722.9	937.3	56	0.14
	Maladaptive	662.50	386.22	456.7	868.3	16	

* P-Value was acquired using T-tests comparing each parameter between adapted and maladapted rhinos at time of capture** (1st sample)

Physiological Values at Capture Comparing Maladaptive vs. Adaptive Rhinos (2009-2011)

		Mean	SD	95% CI		n	P-Value
Resp. Rate	Adaptive	13.42	4.04	12.45	14.39	69	0.93
	Maladaptive	13.31	3.64	11.11	15.51	13	
Heart Rate	Adaptive	112.94	25.15	106.95	118.94	70	0.44
	Maladaptive	106.83	26.83	89.79	123.88	12	
pH	Adaptive	7.18	0.11	7.16	7.21	77	0.18
	Maladaptive	7.23	0.08	7.18	7.27	13	
PaCO ₂ mm/Hg	Adaptive	61.26	11.32	58.69	63.82	77	0.81
	Maladaptive	60.45	10.29	54.23	66.67	13	
PaO ₂ mm/Hg	Adaptive	46.42	13.19	43.41	49.44	76	0.75
	Maladaptive	47.75	13.4	38.02	57.48	12	
Beecf mmol/L	Adaptive	-4.66	7.28	-6.32	-3.01	77	0.29
	Maladaptive	-2.38	6.13	-6.09	1.32	13	
HCO ₃ mmol/L	Adaptive	23.42	5.77	22.11	24.73	77	0.29
	Maladaptive	25.23	5.25	22.06	28.40	13	
TCO ₂ mmol/L	Adaptive	25.38	6.07	24.00	26.75	77	0.37
	Maladaptive	27.00	5.49	23.68	30.32	13	
SaO ₂	Adaptive	65.57	19.22	61.17	69.96	76	0.60
	Maladaptive	68.67	18.13	57.15	80.19	12	
Lactate mmol/L	Adaptive	11.29	5.62	9.87	12.70	63	0.25
	Maladaptive	9.04	6.24	4.58	13.50	10	

*P-Value was acquired using T-tests comparing each parameter between adapted and maladapted rhinos at time of capture (1st sample)

Comparison of Adapted/Maladapted Rhinos at Time of Capture

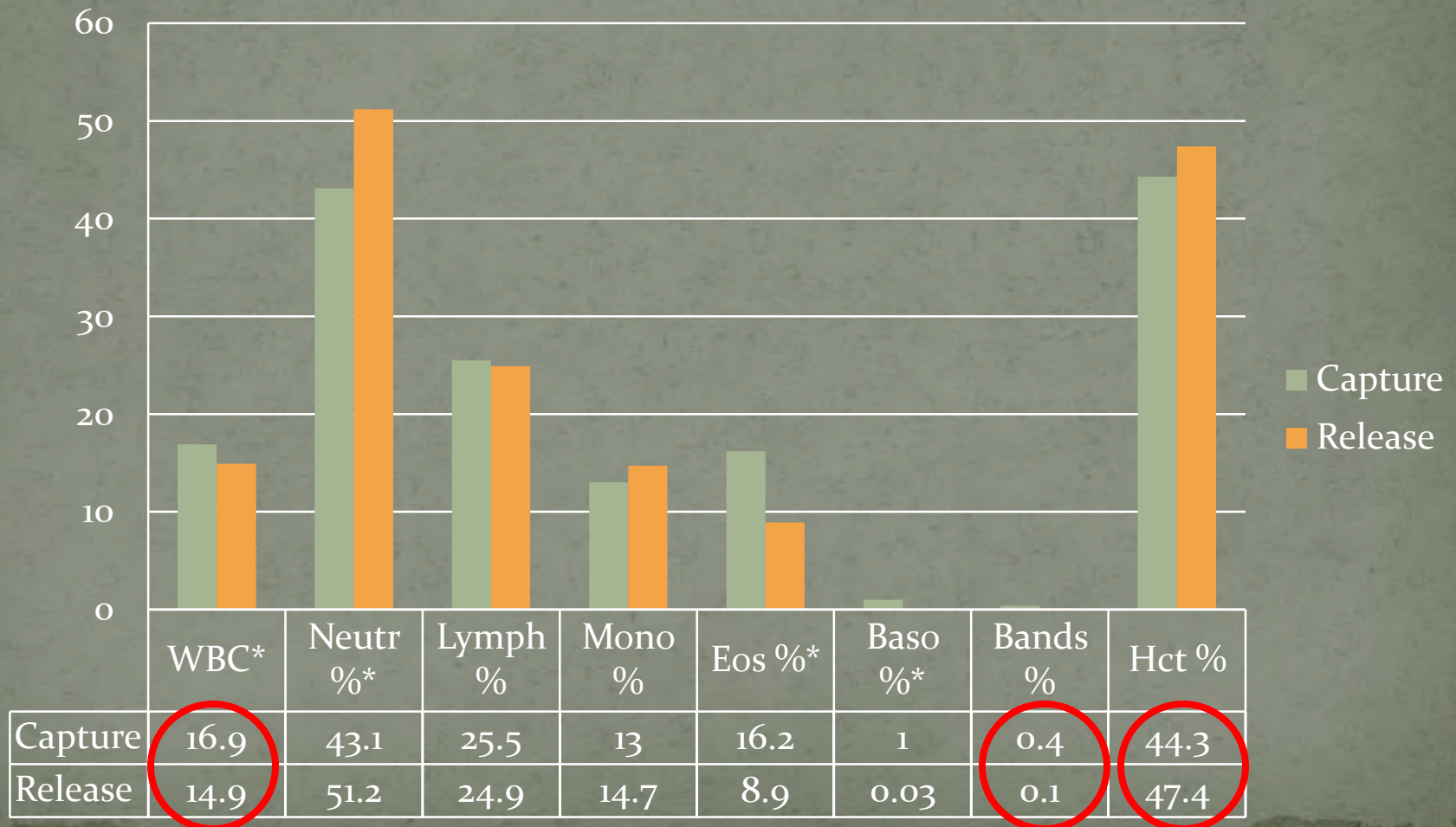
- No differences in age, sex, body weight
- No differences in hematologic parameters
 - Wbc, hct, differential counts
- No differences in biochemical parameters EXCEPT
 - BUN (11.1 vs 9.1 mg/dl)
 - AST (68.9 vs 52.8 U/L)
 - Adapted vs maladapted ($p < 0.05$)



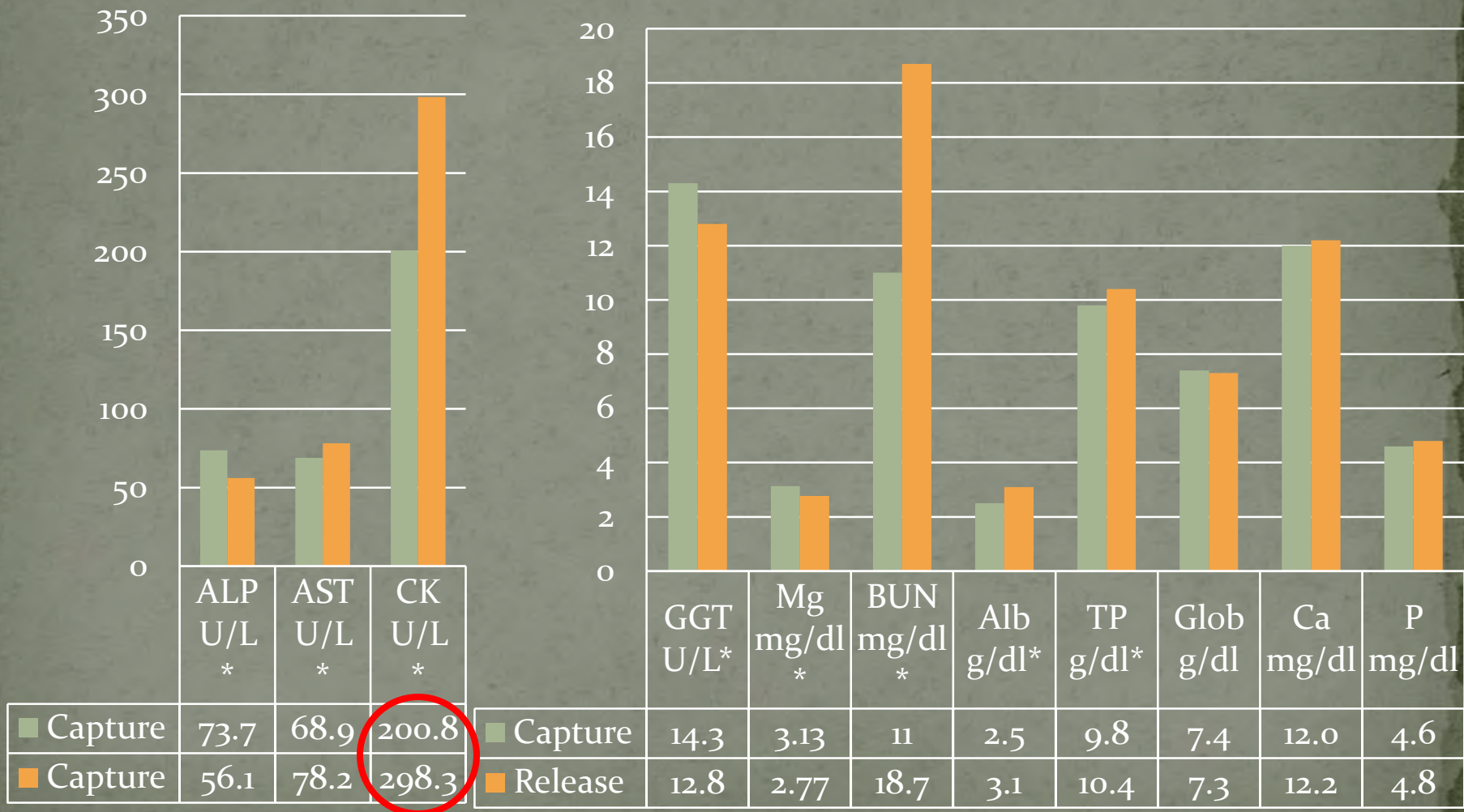
ParkerScottMedia

Changes During Boma Confinement

Hematology of Adapted Rhinos at Capture and Release

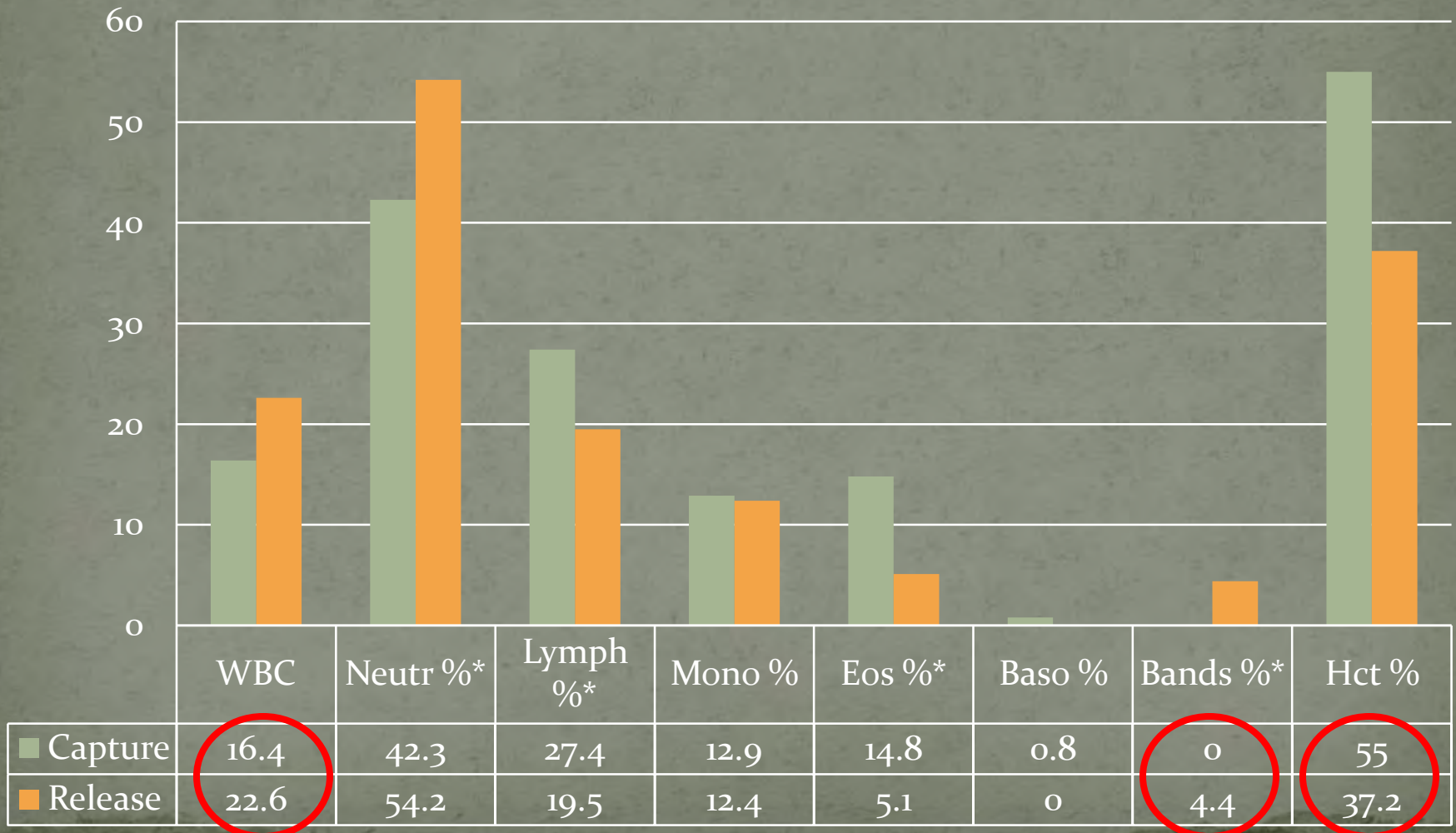


Changes During Boma Confinement

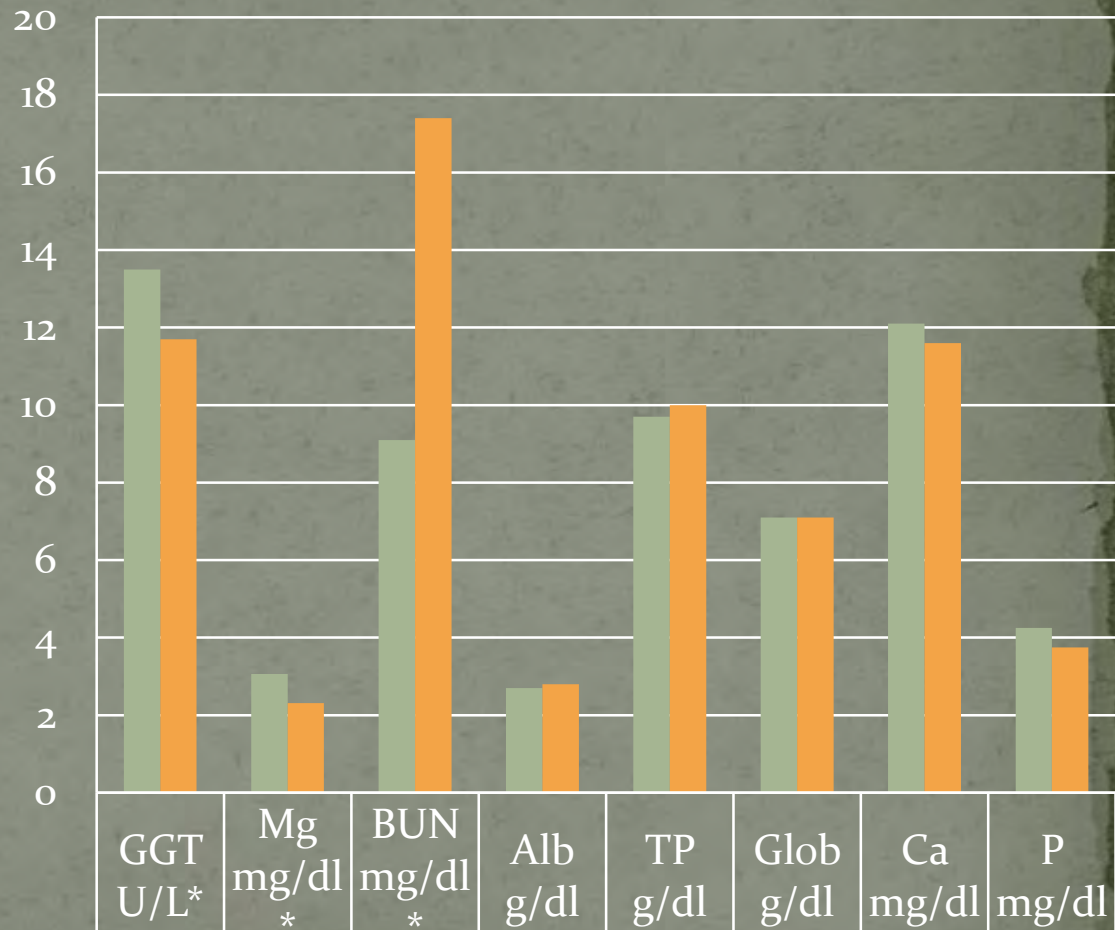
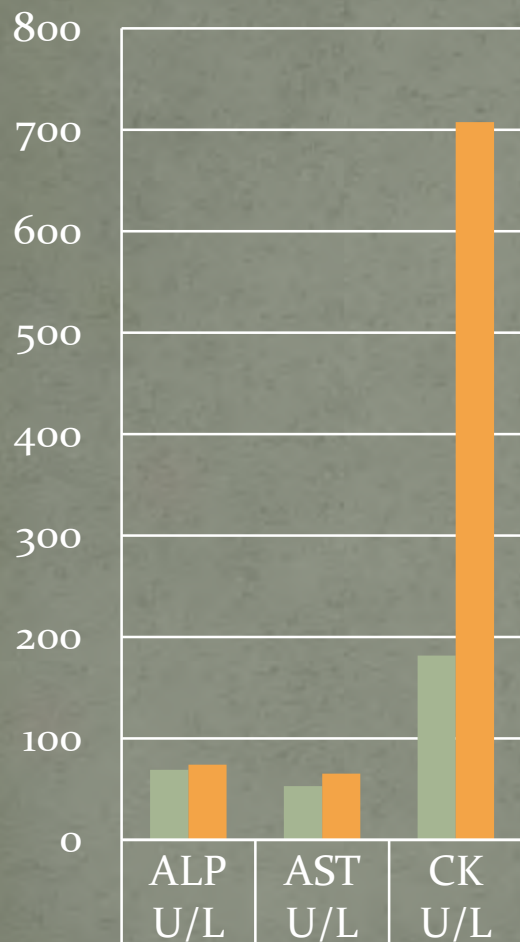


Changes During Boma Confinement

Hematology of Maladapted Rhinos at Capture and Release



Changes During Boma Confinement



Capture	69.1	52.8	181.6	Capture	13.5	3.06	9.1	2.7	9.7	7.1	12.1	4.3
Release	74.2	65.3	707.6	Release	11.7	2.31	17.4	2.8	10	7.1	11.6	3.8

Physiological Values at Release for Maladaptive vs Adaptive

		Mean	SD	p25	Median	p75	N	P-Value
WBC	Adaptive	14.89	4.28	12	14.2	18.4	63	0.0006
	Maladaptive	22.55	14.91	15.7	21.1	23.6	15	
Lymph (%)	Adaptive	24.94	9.07	19	25	31	63	0.0458
	Maladaptive	19.47	10.62	6	23	28	15	
Eos (%)	Adaptive	8.92	5.06	4	9	12	63	0.0088
	Maladaptive	5.07	4.64	0	5	9	15	
Bands (%)	Adaptive	0.13	0.61	0	0	0	63	<0.0001
	Maladaptive	4.40	7.69	0	0	13	15	
Hct (%)	Adaptive	47.4	5.3		47.6		14	0.01
	Maladaptive	37.2	10.2		37.9		4	
Ca mg/dl	Adaptive	12.19	0.87	11.8	12.3	12.7	73	0.0146
	Maladaptive	11.59	0.99	11.2	11.7	12.2	17	
Fe ppm	Adaptive	2.55	1.04	1.51	2.76	3.56	14	0.0117
	Maladaptive	0.97	0.64	0.54	0.74	1.41	4	
CK U/L	Adaptive	298.30	174.47	190	246	344	73	0.0083
	Maladaptive	707.65	1267.55	184	312	726	17	
PHOS mg/dL	Adaptive	4.78	0.80	4.4	4.8	5.3	73	<0.0001
	Maladaptive	3.75	0.97	3.1	3.8	4.4	17	
MG mg/dl	Adaptive	2.77	0.38	2.5	2.8	3	73	0.0001
	Maladaptive	2.31	0.59	1.8	2.6	2.7	17	

*P-Value was acquired using T-tests comparing each parameter at release by adaptation group

Results



- 4 year period 2009-2012
 - 21/109 captured rhinos maladapted (19.3%)
 - Additional 5.5% with minor complications
 - 1 mortality (suspected acute Salmonellosis)
- Score of 16/20= successful boma adaptation
 - Median period for 2009-2011 period – 19 days
 - Consistent with managers' observations of 3-4 weeks
 - Similar to recommendations for boma adaptation for black rhinos

Results

- Mean length of boma confinement
 - Adapted rhinos - 89.9 days (range 39-187 days)
 - Maladapted rhinos - 13 days (range of 8-16 days)
- No significant differences in the gender, age, or weight of rhinos initially placed in the bomas
- Capture-related and physiological measurements did not correlate with rhino boma adaptation status
- No significant differences in hematologic, biochemical, mineral and vitamin panels at the time of capture between adapted and maladapted rhinos

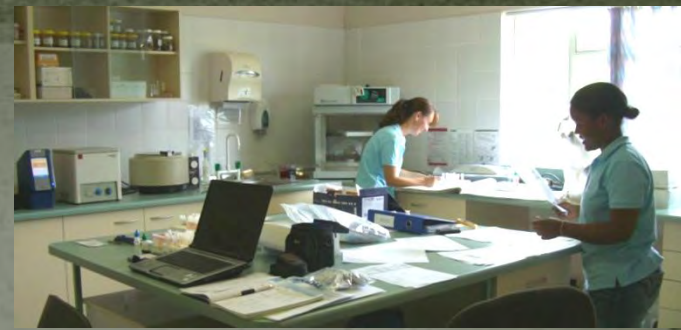


Results

- Boma-adapted rhinos had minor hematological and biochemical changes between capture and release suggestive of mild-moderate negative energy balance (increased CK and BUN).
- Mean weight loss was 65.9 kgs (SD 77.8 kgs) while in the bomas.
- Vitamin D (92.0 to 78.8 ng/ml) and E (2.70 to 1.46 ng/ml) values were significantly lower at release compared to capture



Results



- Boma-maladapted rhinos showed significant stress hemograms (22,600 white blood cells with 4.4% bands) at the time of release despite the short time in confinement.
- Decreased mean hematocrit (55 to 37.2%) and drop in mean iron (3.01 to 0.97 ppm) indicated possible blood loss through gastrointestinal ulceration.
- Biochemical values suggested significant catabolic states due to negative energy balance.
 - Consistent with the larger mean weight loss (224.0 +/- 61.1 kgs) – approximately 14.7% of body weight.

Conclusions

- White rhinos appear to take an average of approximately 3 weeks to adapt to boma confinement (minimum)
- Significant difference between maladapted and adapted rhinos were detected starting at **day 8**
- **Second week in boma critical monitoring period**



Conclusions

- Individuals that do not show a steady increase in scores over the first 7-10 days should be considered release candidates



Conclusions

- The scoring system for boma adaptation could be modified for other rhino species and systems, minimizing subjectivity in assessing rhino relocation management.

Ziwa Rhino Sanctuary, Uganda



Questions?

