

White rhinoceros reproduction: Insights from the wild and semi-wild

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Driving question behind research: Why do captive-born female white rhinos fail to reproduce?



Testing hypotheses for Reproductive Failure of Captive- born Females

Reproductive Suppression

By the mother

By other (older, dominant) wild-caught females

Enclosure Size

Social Group Composition

Nutrition

Methods

Questionnaire

INFORMATION FOR MALE GIANT PANDAS

Studbook # _____ Name _____ Your institution _____

1. Is this panda **captive or wild** born?

2. If captive born, was this panda raised by mother or by humans?

3. Did this male mate in 1996? ___ Yes ___ No

4. If your answer is **Yes**, circle the number of females with which he mated:
1 2 3 4 5 6 7 8

4. If your answer to Question 3 is **No**, please tick the reason (only one reason) in the sections below:

a. For males that were **not** paired with an estrous female:

He is afraid of females

He is too aggressive with females

He is not interested in mating, so doesn't do anything

He is in poor health

Other reason, write out _____

b. For males that were paired with females for mating purposes:

He avoided the female, stayed away from her

He attacked the female

He did not respond to the female, ignored her

He tried to mate, but did not mount properly

He was rebuffed by the female (she was aggressive or avoided him)

Other reason, write out _____

_____ Studbook number and name of this female

_____ Name of person who is to be listed as author on this report

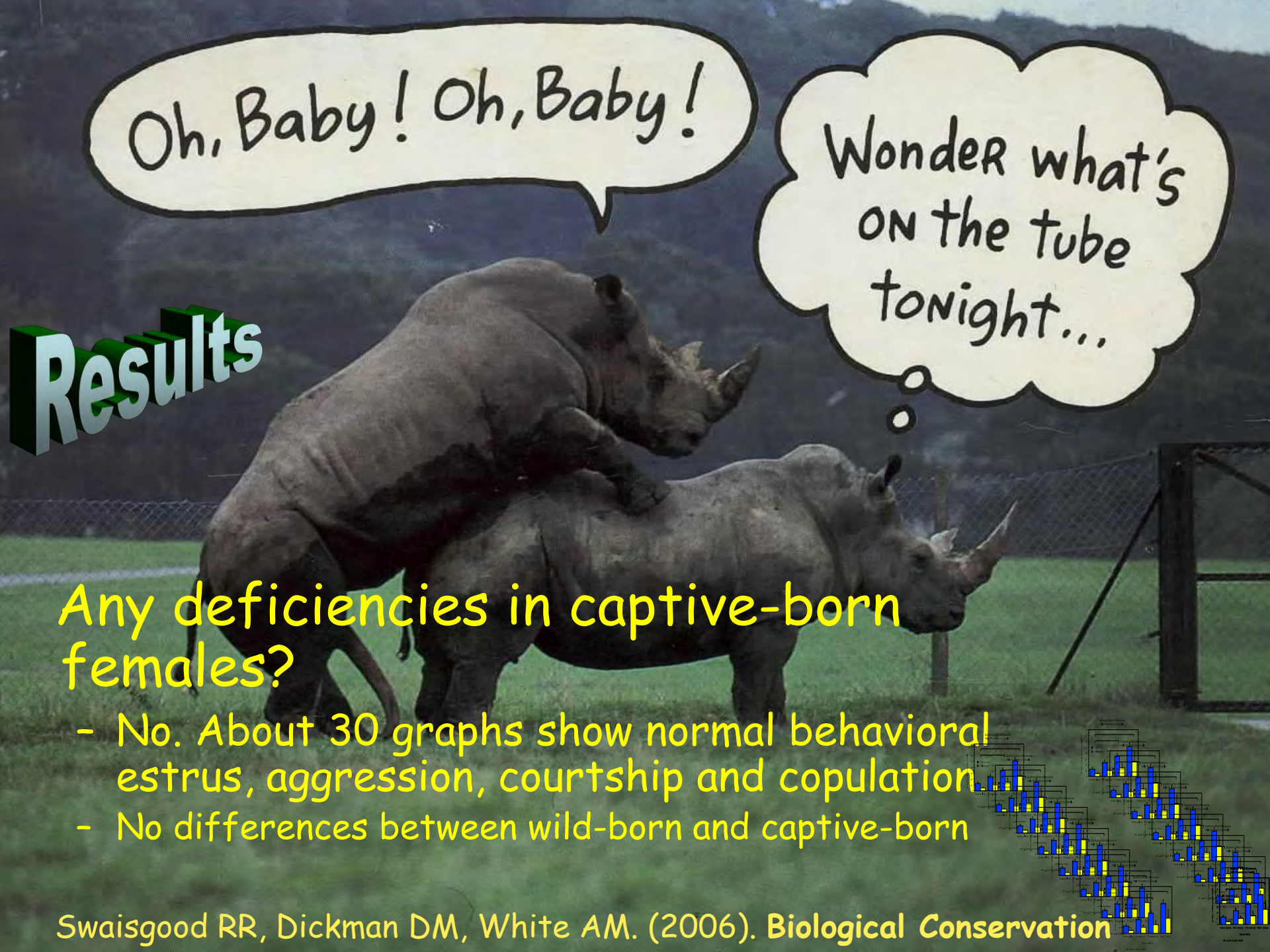


Daily observations of SDWAP rhinos
3 hours/day, 7 days/week, 4 years
5 captive-born, 6 wild-caught

40 captive-born
28 wild-caught
Location effect constant

Swaigood RR, Dickman DM, White AM. (2006). **Biological Conservation**





Oh, Baby! Oh, Baby!

Wonder what's
ON the tube
tonight...

Results

Any deficiencies in captive-born females?

- No. About 30 graphs show normal behavioral estrus, aggression, courtship and copulation.
- No differences between wild-born and captive-born

Any effects of other females on captive-born female reproduction?

Results

- No evidence for female-female dominance
- Presence of mother or other (older) wild-caught females increases reproduction



Swaigood RR, Dickman DM, White AM. (2006). *Biological Conservation*



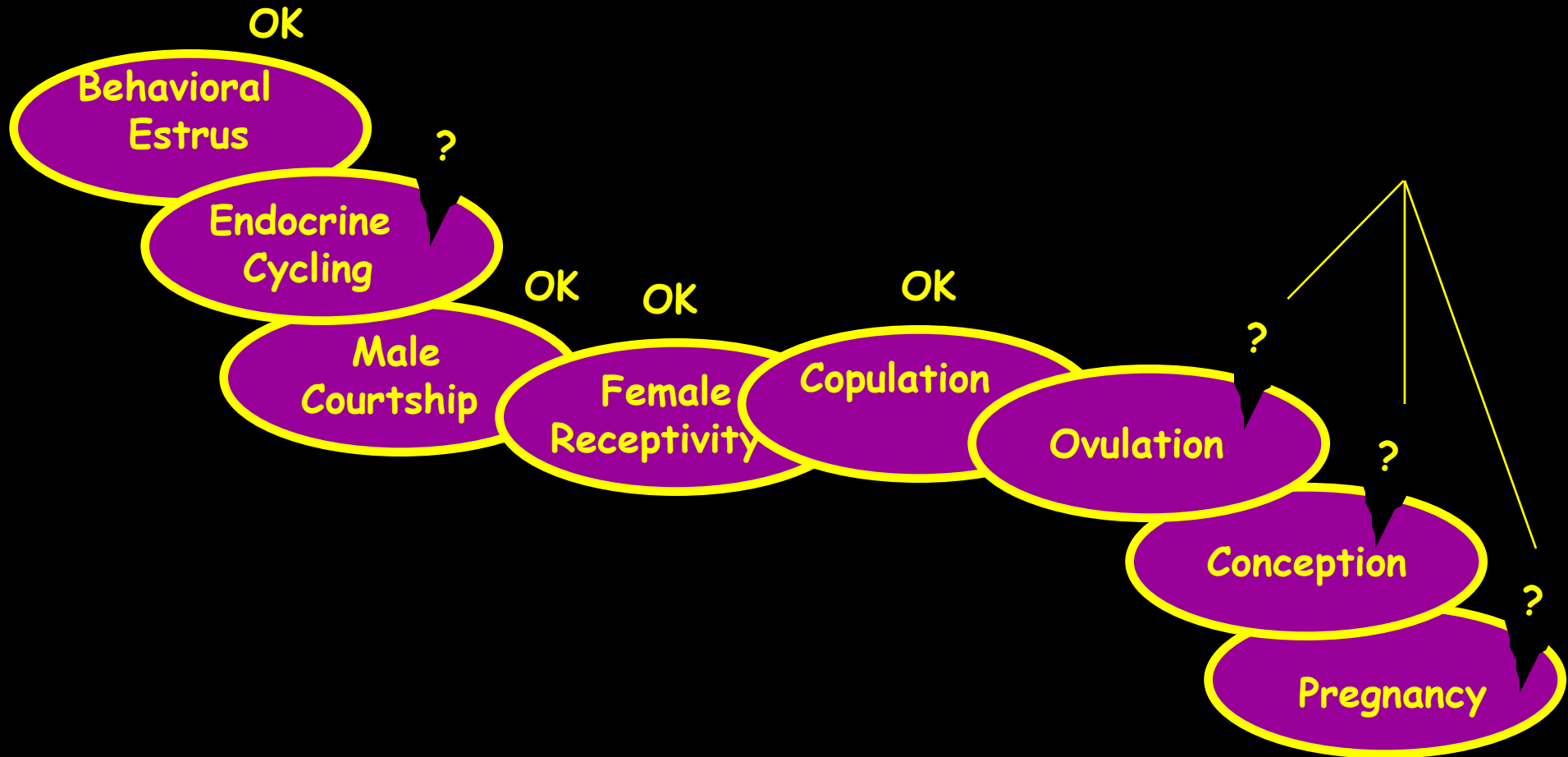
$F_1 = 34\%$
 $F_0 = 78\%$
 $p = 0.003$
Control for
--location,
--years of opportunity
--copulation

Conclusions

- Reproductive suppression is not the cause of the F1 problem.
- Weak link is postcopulatory
- It's the development



Weak Links in the Chain of Events Leading to Successful Reproduction

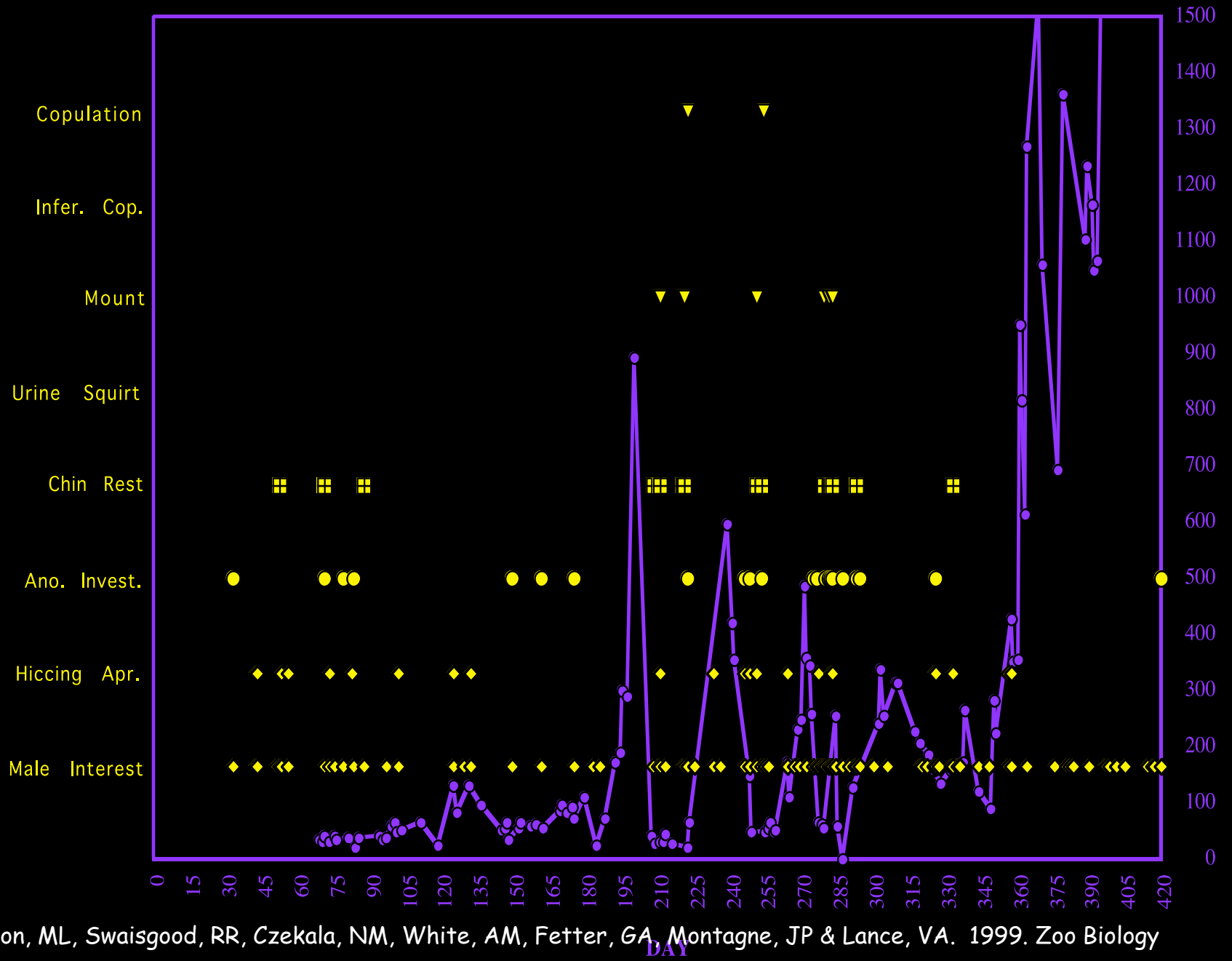


Reproductive cycles



- Behavioral observations
- Radioimmunoassay for progesterone metabolites in feces

UJIMA 1997-98



Individual cycle lengths (days)

Type I Cycles				Type II Cycles			
Animal	Interluteal	Luteal	Cycle	Animal	Interluteal	Luteal	Cycle
Dumisha	16	21 ^a	37	Dumisha	8.4 ^a	48.5 ^a	56.9
Dumisha	8.4 ^a	34 ^a	42.4	Dumisha	8	56	64
Michelin	8	25	33	Dumisha	17.5	44.5	62
Michelin	8.4 ^a	26	34.4	Sinyaa	2.5	66.5	69
Mjuba	8.4 ^a	32.5	40.9	Sinyaa	14	61	75
Sinyaa	7	25	32	Sinyaa	10.5	60.5	71
Sinyaa	4	27	31	Sinyaa	10.5	50.5	61
Ujima	18.5	19.5 ^a	38				
Ujima	9	23	32				
Ujima	5.5	23.5	29				
Average	9.3	25.7	35.0		10.2	55.1	65.6
SEM	2.1	2.1	2.1		2.2	2.9	2.5



Ultrasound findings:

- These long cycles were not always cycles...sometimes they were pregnancy and early embryonic death.
- They also had chronic uterine infections.

A black rhinoceros is shown in a natural, grassy environment. The rhino is the central focus, with its head and front legs visible. It has a large, dark, pointed horn on its snout. The background is a soft-focus field of green grass. The text is overlaid on the left side of the image.

Normality must be defined:

- In the field
- In a reproductively healthy population

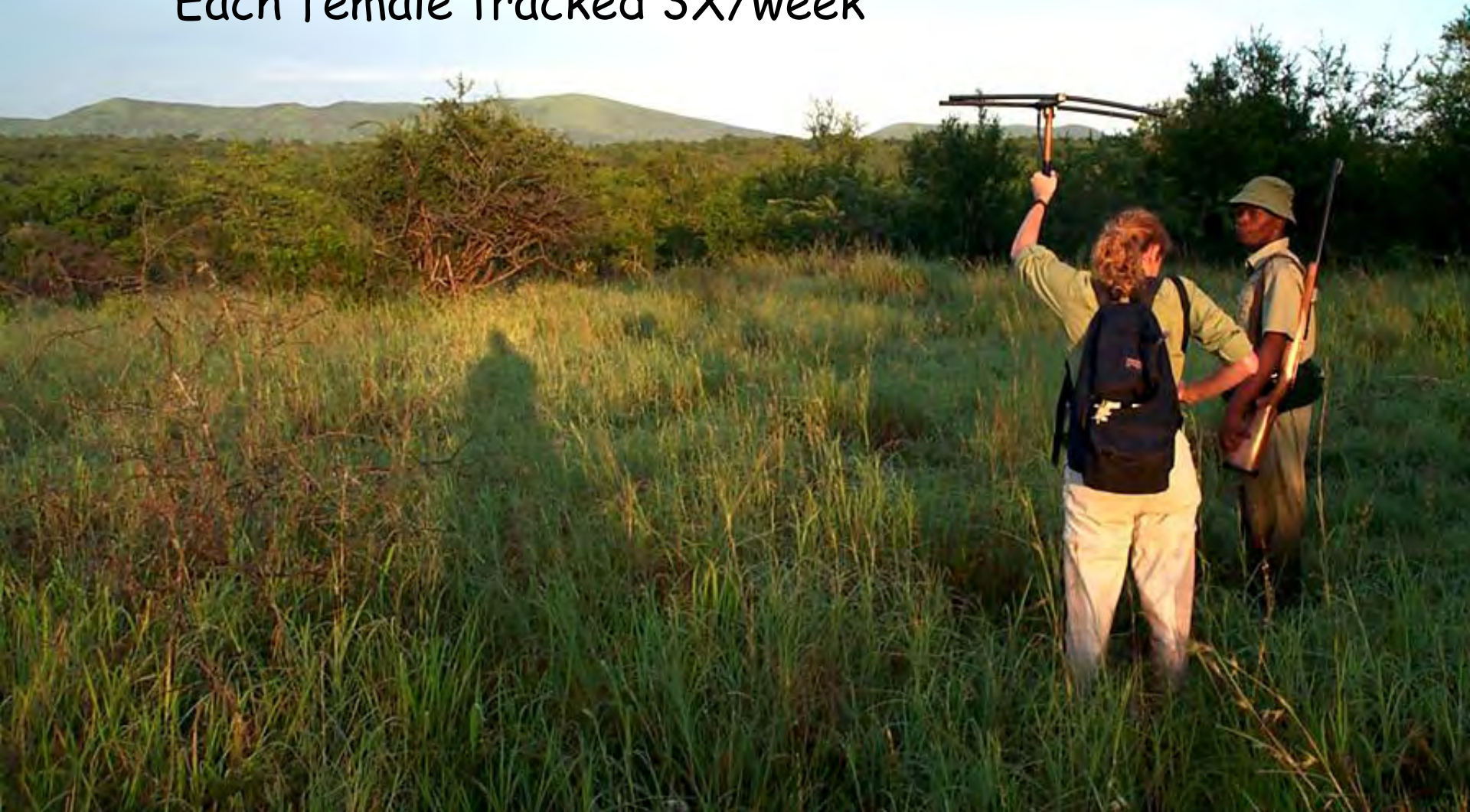
iMfololzi Game Reserve South Africa







Radiotracked 16 female rhinos for 2+ years
Each female tracked 3X/week





Reproductive cycles

- Documented 17 cycles in 6 females
- All were approximately 30 days (25-36)
- Short cycles are normal

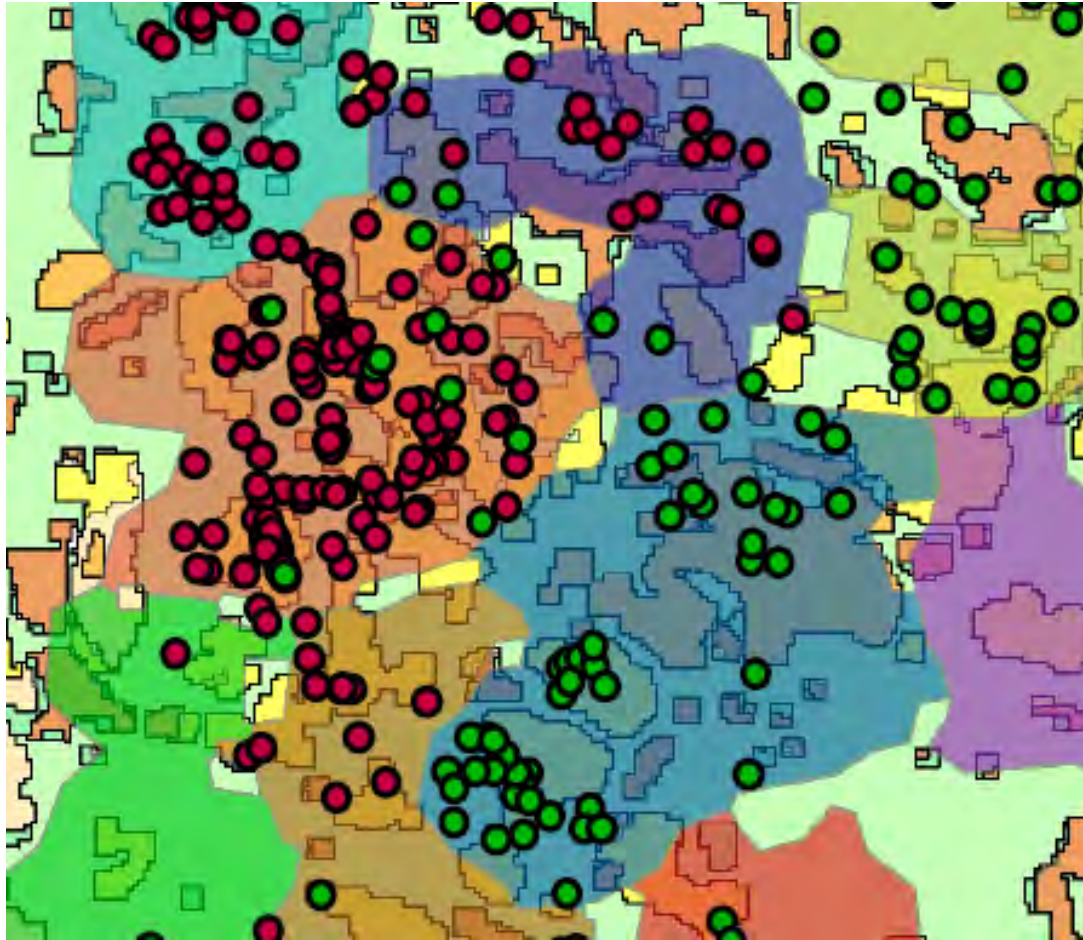


Female ranging patterns: implications for mating strategies



White, AM. Swaisgood, RR & Czekala, NM. (2007). **Animal Behaviour**

Female home range overlap with male territories



- "Passive" female mate choice
- Mate with familiar males

Where does reproductive breakdown occur on the C-W continuum?



Captive



Semi-wild



Wild



South Africa game reserve survey



- Interviewed managers at 96 "game farms"
- 7-page questionnaire
- Data for 234 individual females on 47 properties
- Largest detailed database on rhinos on private reserves

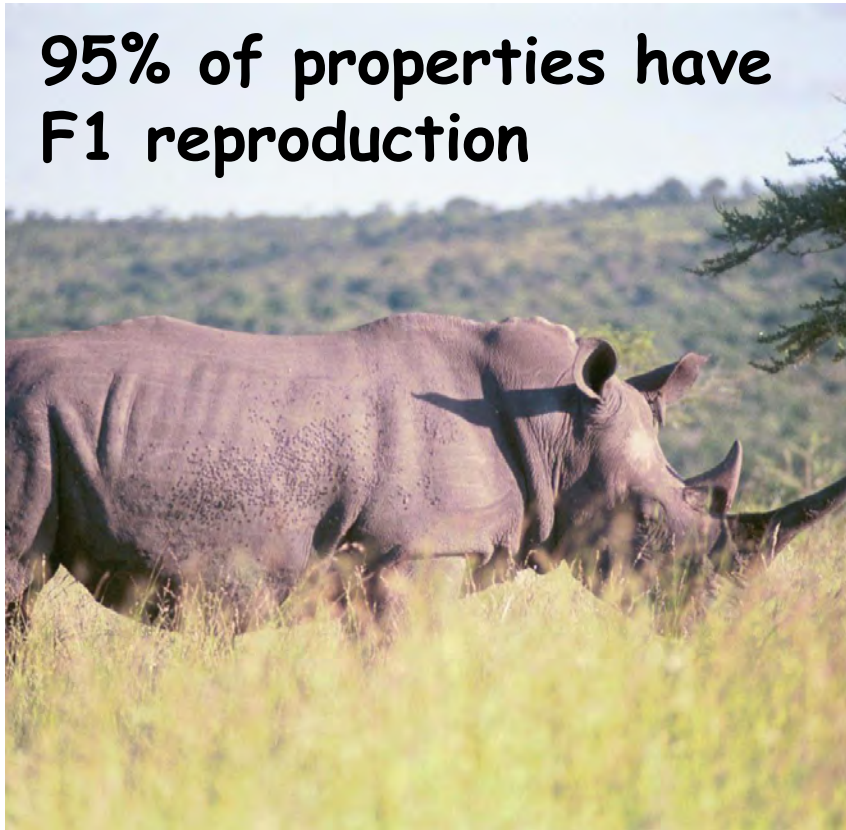
Characteristics of game reserves



- Fenced, managed
- Natural and exotic plant communities
- Varying space
 - 1 to 1250 ha
- Variable social density
 - 0.0006/ha to 2.0/ha
- Variable pop size
 - 2-111; mean = 12
- "Age" of rhino reserve
 - 1-40 ; mean =12
- Calves born on property
 - 0-130; mean = 8.3

Is there a difference in reproduction between F_0 and F_1 females in semi-wild white rhinos?

95% of properties have F_1 reproduction






No differences

	F_0	F_1	P-value
Repro rate	0.30 \pm 0.17	0.30 \pm 0.14	0.94
IBI	32.3	30.7	0.94
% Repro	92%	98%	
N	113	117	

cf. F_1 repro rate in NA zoos = 0.01
ca. 2008

What factors in the adult environment influence reproduction in semi-wild white rhinos?

	Environmental Factor	Statistic	Significance
	Pattern of Supplemental Feeding	$F_{3,79}=0.61$	$p=0.611$
	Supplemental Feeding Intensity	$F_{3,75}=1.58$	$P=0.201$
	Supplemental Feed Combined Scale	$F_{2,71}=6.60$	$p=0.002$
	Male Social Environment	$F_{1,76}=0.00$	$p=0.949$
	Female Social Environment	$F_{1,76}=0.00$	$p=0.999$
	Overall Social Density	$F_{1,68}=5.26$	$p=0.025$
	Male Social Density	$F_{1,81}=0.00$	$p=0.993$
	Female Social Density	$F_{1,68}=5.25$	$p=0.025$
	Rainfall	$F_{1,80}=0.84$	$p=0.361$
	Property Size	$F_{1,81}=0.52$	$p=0.474$

Analysis of F_1 and F_0 females combined

Relationship between social density and reproductive rate

Density of all rhinos

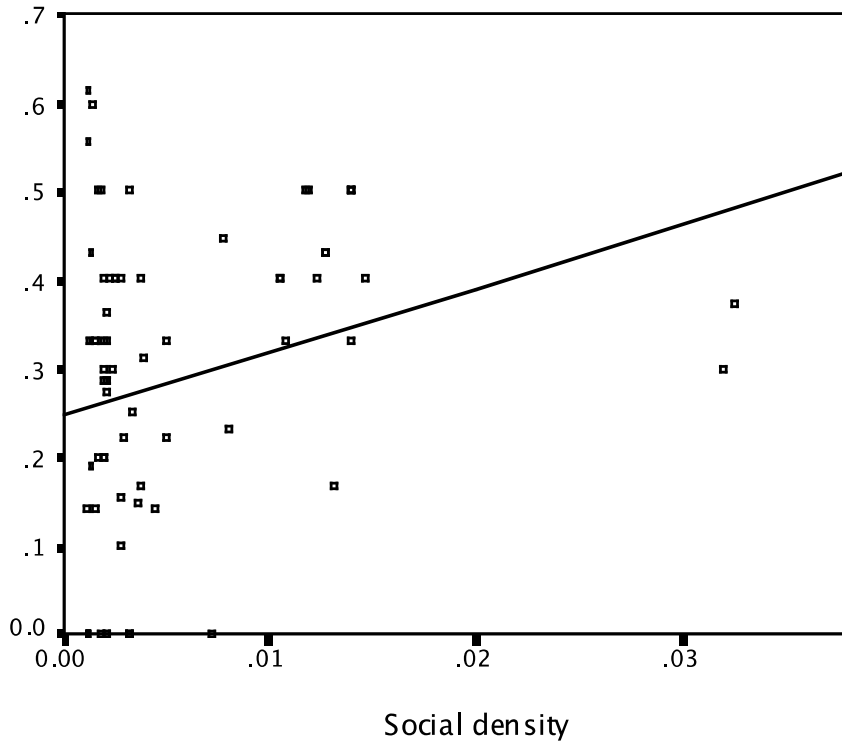


Fig. 1a-Social density during adulthood and reproductive rate

Density of adult female rhinos

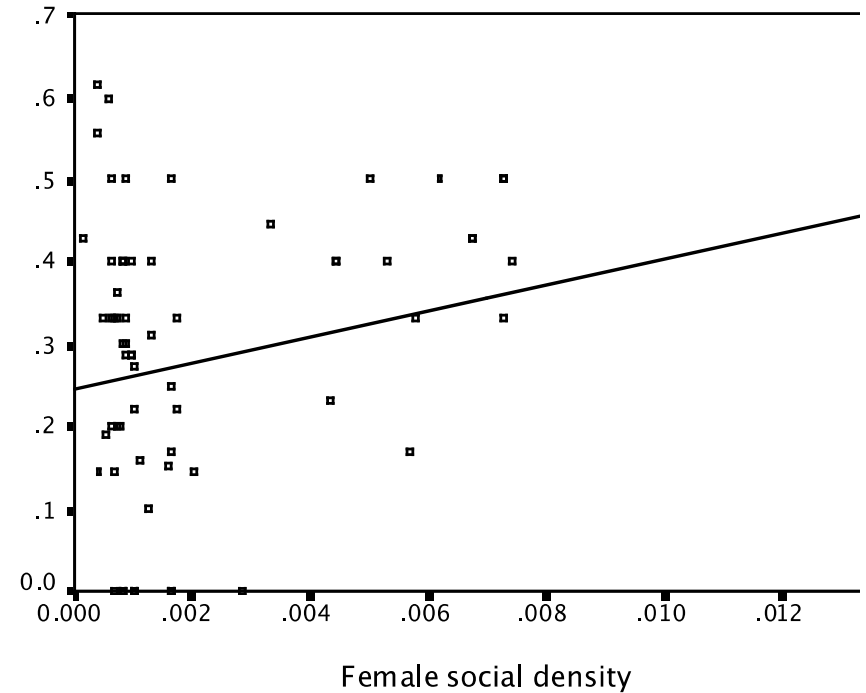


Fig. 1b-Adult female social density during adulthood and reproductive rate

Supplemental feeding increases reproductive rate

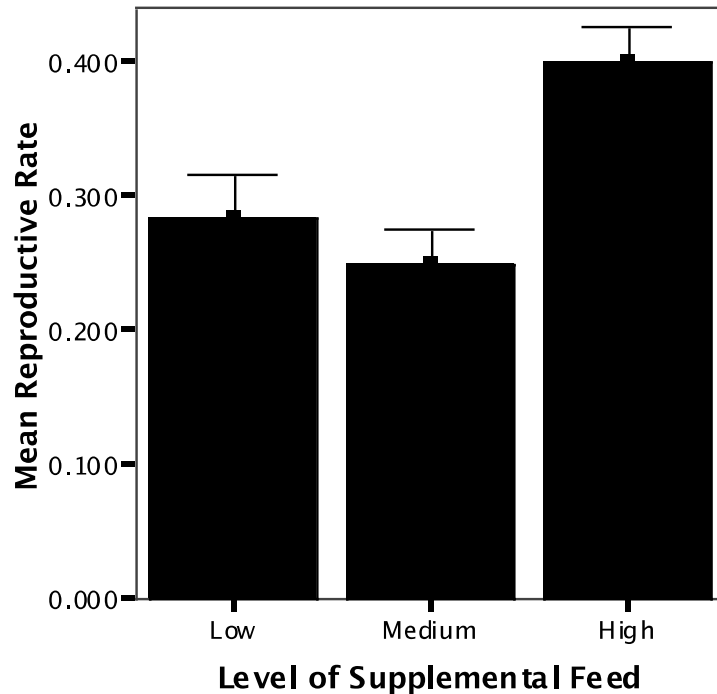






Fig. 2- The effect of level of supplemental feed (a combined measure of feed pattern and intensity) on reproductive rate as mean reproductive rate + standard error.

What environmental factors during development influence reproduction in semi-wild white rhinos?

	Environmental Factor	Statistic	Significance
	Supplemental Feeding Pattern ^a	$F_{1,23}=3.590$	$p=.071$
	Supplemental Feeding Intensity ^b	$F_{1,22}=.304$	$p=.587$
	Male Social Environment	$F_{1,16}=.085$	$p=.774$
	Female Social Environment	$F_{1,17}=.250$	$p=.624$
	Overall Social Density	$F_{1,8}=19.354$	$p=.003$
	Male Social Density	$F_{1,15}=9.754$	$p=.007$
	Female Social Density	$F_{1,8}=22.604$	$p=.002$
	Rainfall	$F_{1,18}=.078$	$p=.783$
	Property Size	$F_{1,21}=1.649$	$p=.214$

Developmental social density effects on F1 reproduction

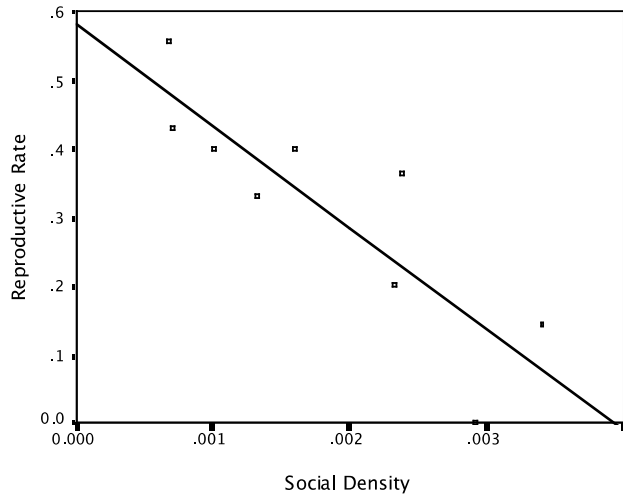


Fig. 3a—Social density during development and reproductive rate.

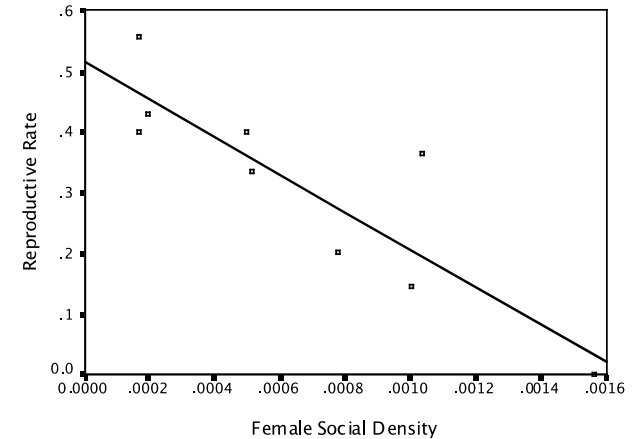


Fig. 3c—Adult female social density during development and reproductive rate.

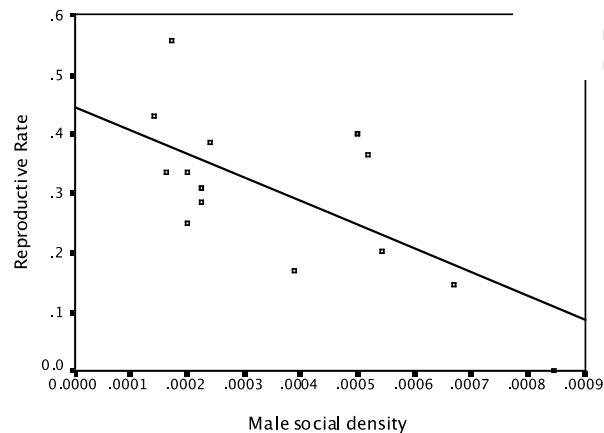


Fig. 3b—Adult male social density during development and future reproductive rate

Tentative conclusions

- Increased social density is good for adult females
- Bad for developing females
- Social environment has lasting developmental effects
- Why?
 - Nutritional limitation/competition
 - Social stress

Other findings



- Single-male, multi-female reserves had normal reproduction
- 1.1 (Noah's ark) did not reproduce, even with large space in native habitat
- Mean AFB = 7.5y
- Mean AF Cop = 6.0y
- Mean AF Court = 5.2y

The view from Africa...



- Normal cycle is 30 days
- No F1 problem in small game reserves
- No female reproductive suppression
- Conspecific density influences reproduction
 - In complicated ways
- Nutrition influences reproduction

The way forward...



Hey! It's the hay!

- Remaining plausible hypotheses:
 - Diet during development
 - Phytoestrogens (Tubbs et al. 2012)
 - Social interactions during development
 - Precocious copulation

More answers on the horizon...

