Iowa State University

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2014

Linking social behavior and stress physiology in feral mares (Equus caballus): Group transfers elevate fecal cortisol levels

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James S. Adelman
Jessica Smith, *Princeton University*
Laurence Gesquiere, *Princeton University*
Daniel I. Rubenstein, *Princeton University*

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Linking social behavior and stress physiology in feral mares (*Equus caballus*): Group transfers elevate fecal cortisol levels

Cassandra M.V. Nuñez*, James S. Adelman*, Jessica Smith†, Laurence Gesquiere†, and Daniel I. Rubenstein†

*Virginia Tech, †Princeton University

Feral horses: A special case

Feral horse management Shackleford Banks, NC

- Immunocontraception with porcine zona pellucida
  - Highly effective
  - Administered remotely
  - Inexpensive
  - Complex social system
  - Reproductive physiology attuned to the social environment

Feral horse management Shackleford Banks, NC

Does contraception management affect mare behavior and/or physiology?

A day in the life of a feral horse…

- Social groups– Bands
  - Male (stallion), females (mares), offspring (foals)

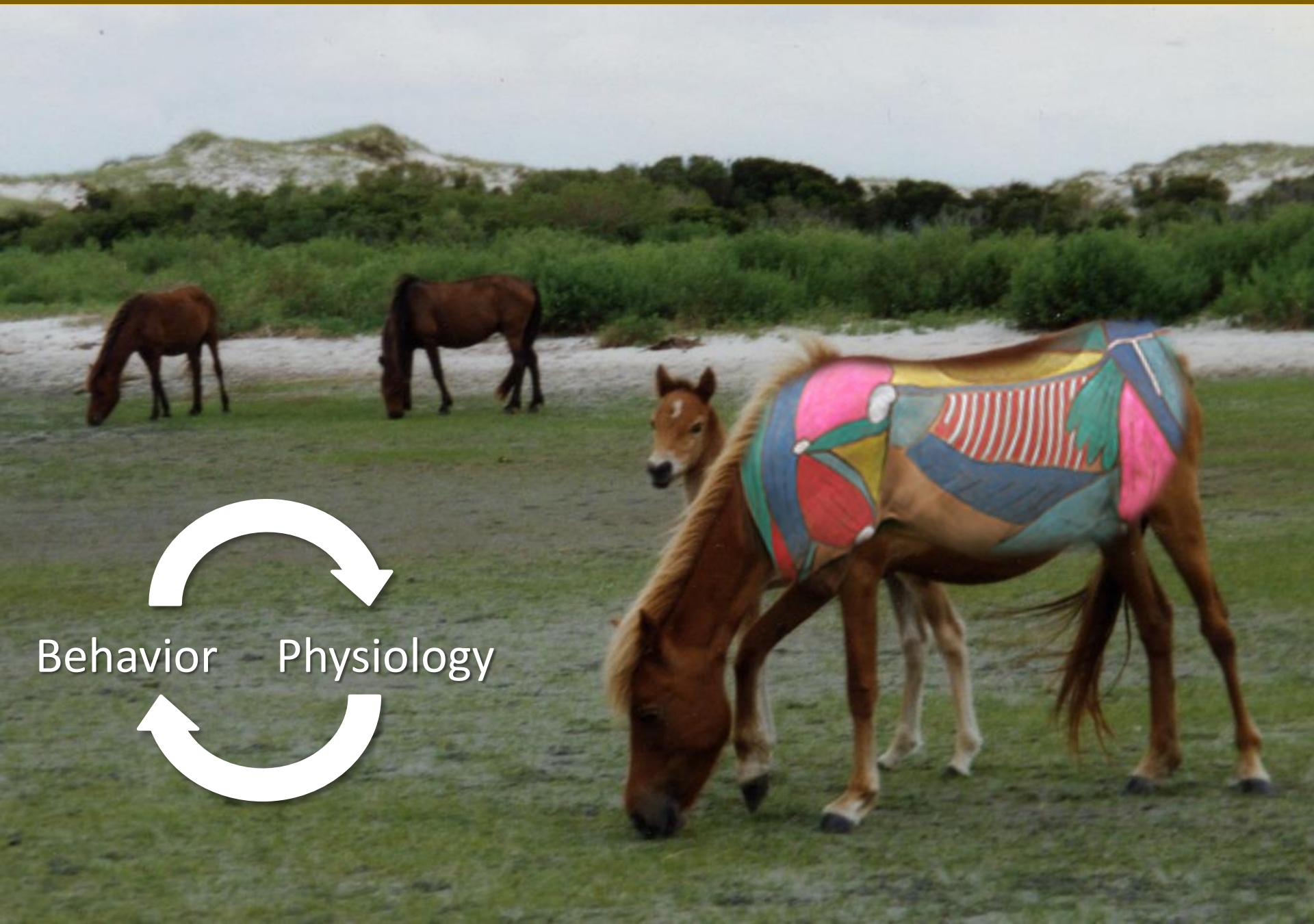
Feral horse behavior and social structure

Feral horse behavior and social structure

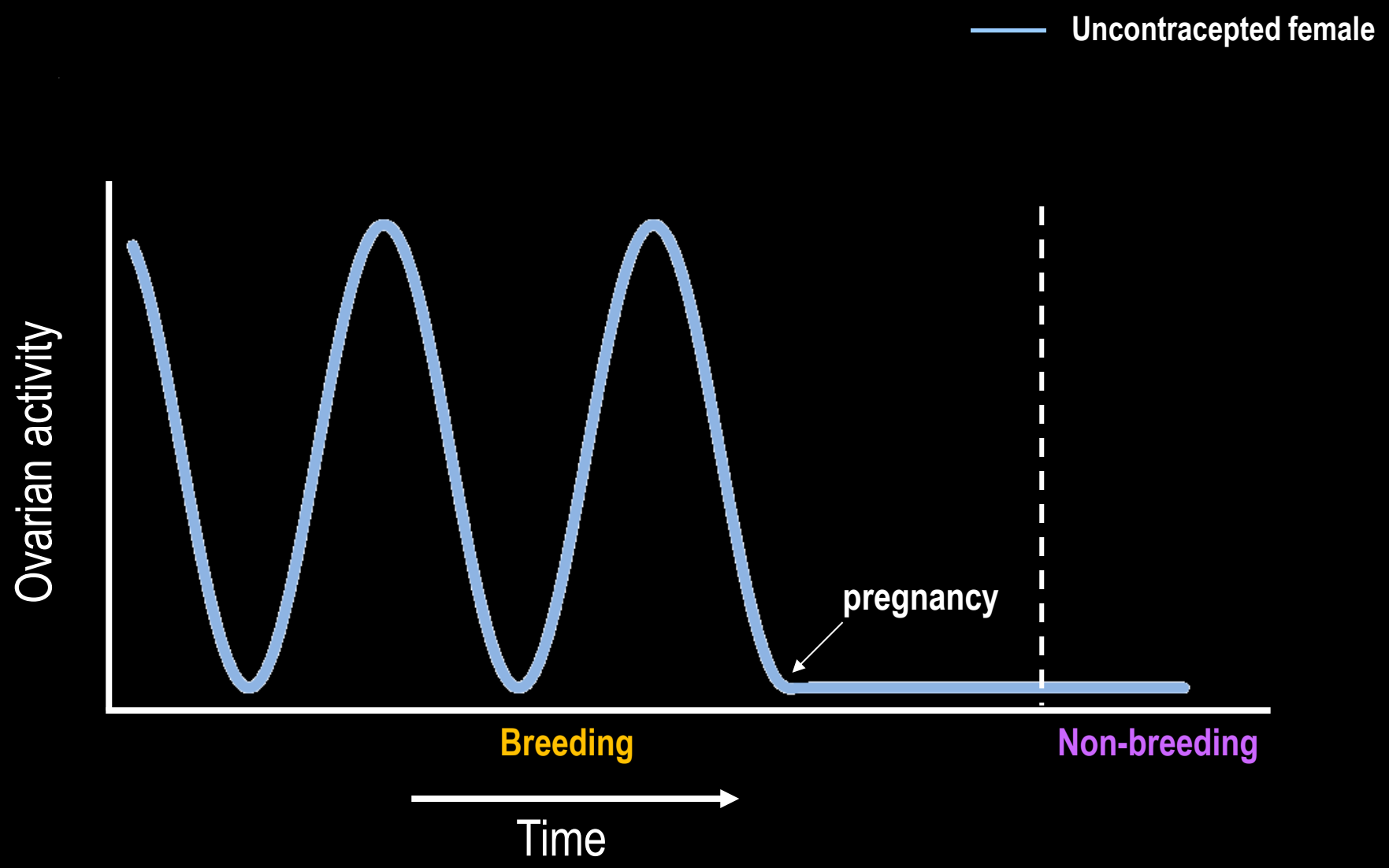
A day in the life of a feral horse…

- Social groups– Bands
  - Male (stallion), females (mares), offspring (foals)
  - Stable, long lasting
  - Decreases in band stability (↑ female turnover):
    - ↓ Body condition
    - ↓ Reproductive success
    - ↑ Parasite load
    - ↑ Offspring mortality

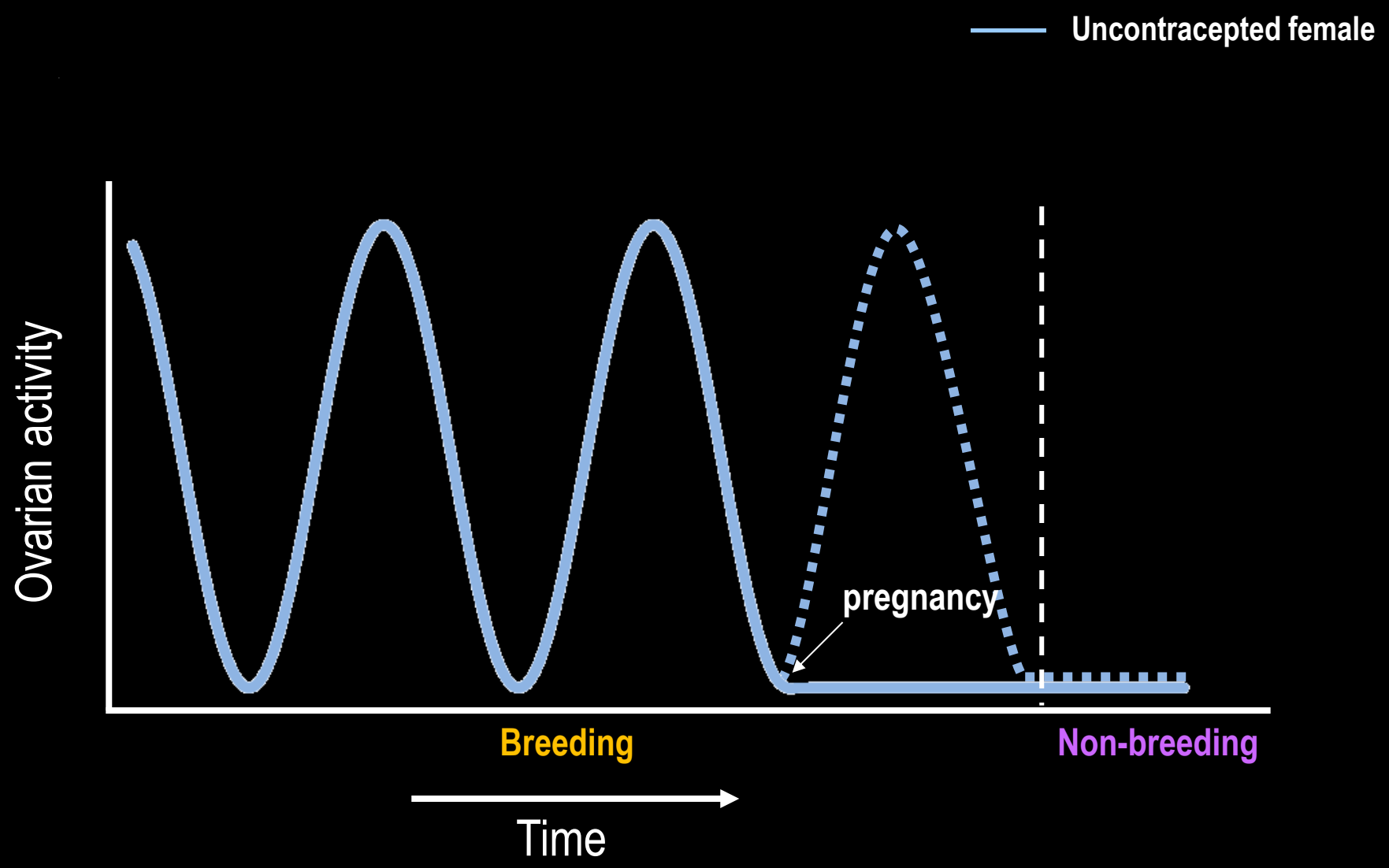
Mare reproductive physiology



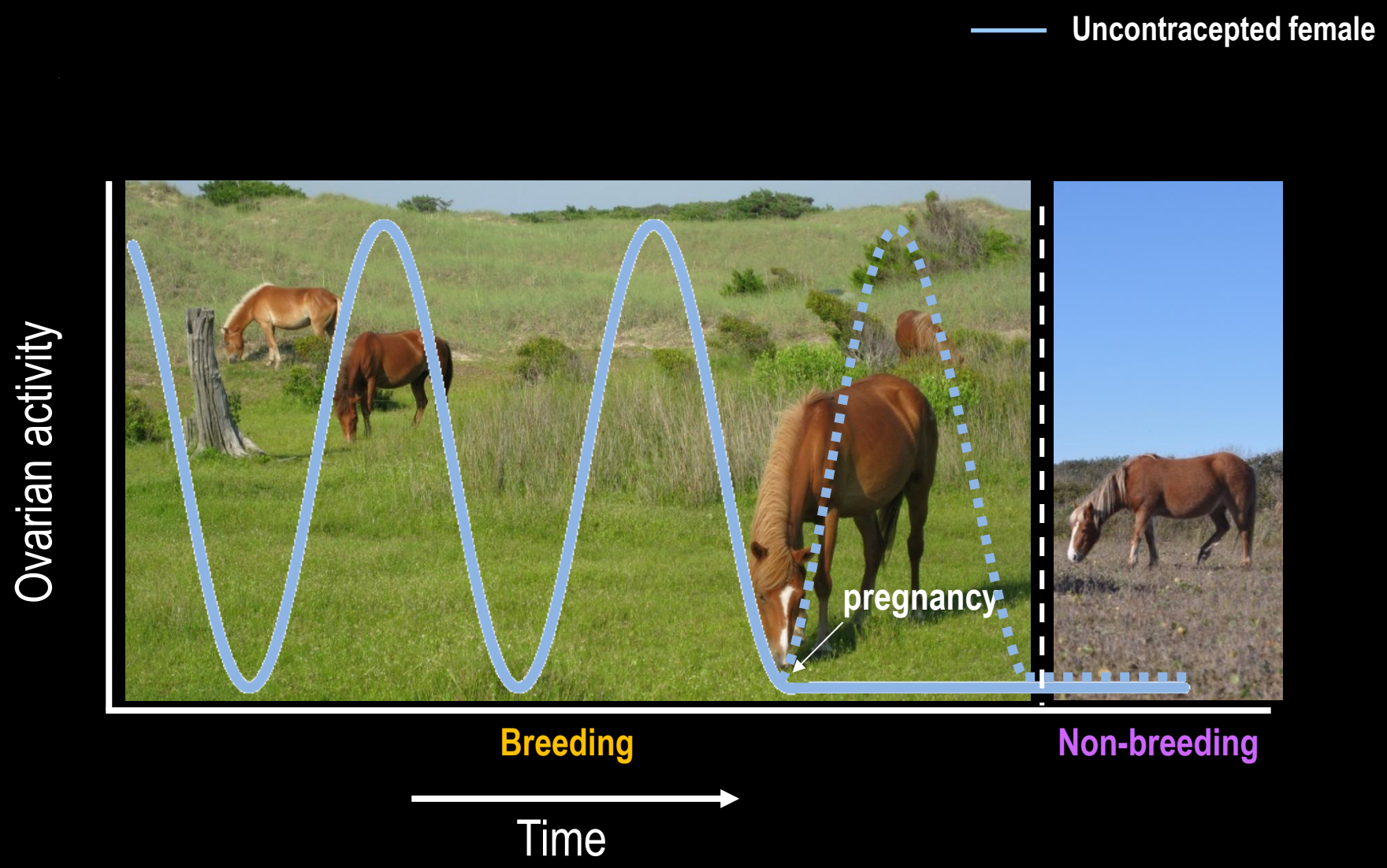
Mare reproductive physiology



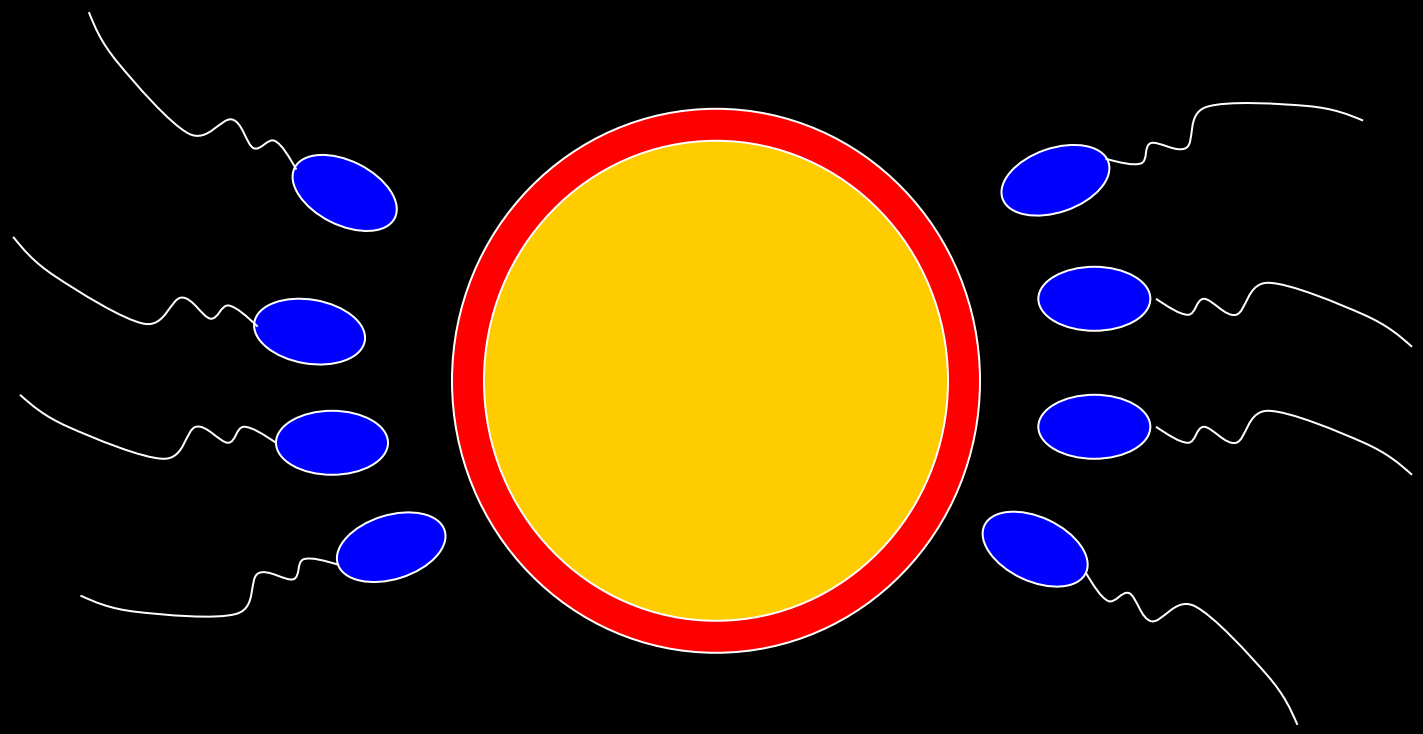
Mare reproductive physiology



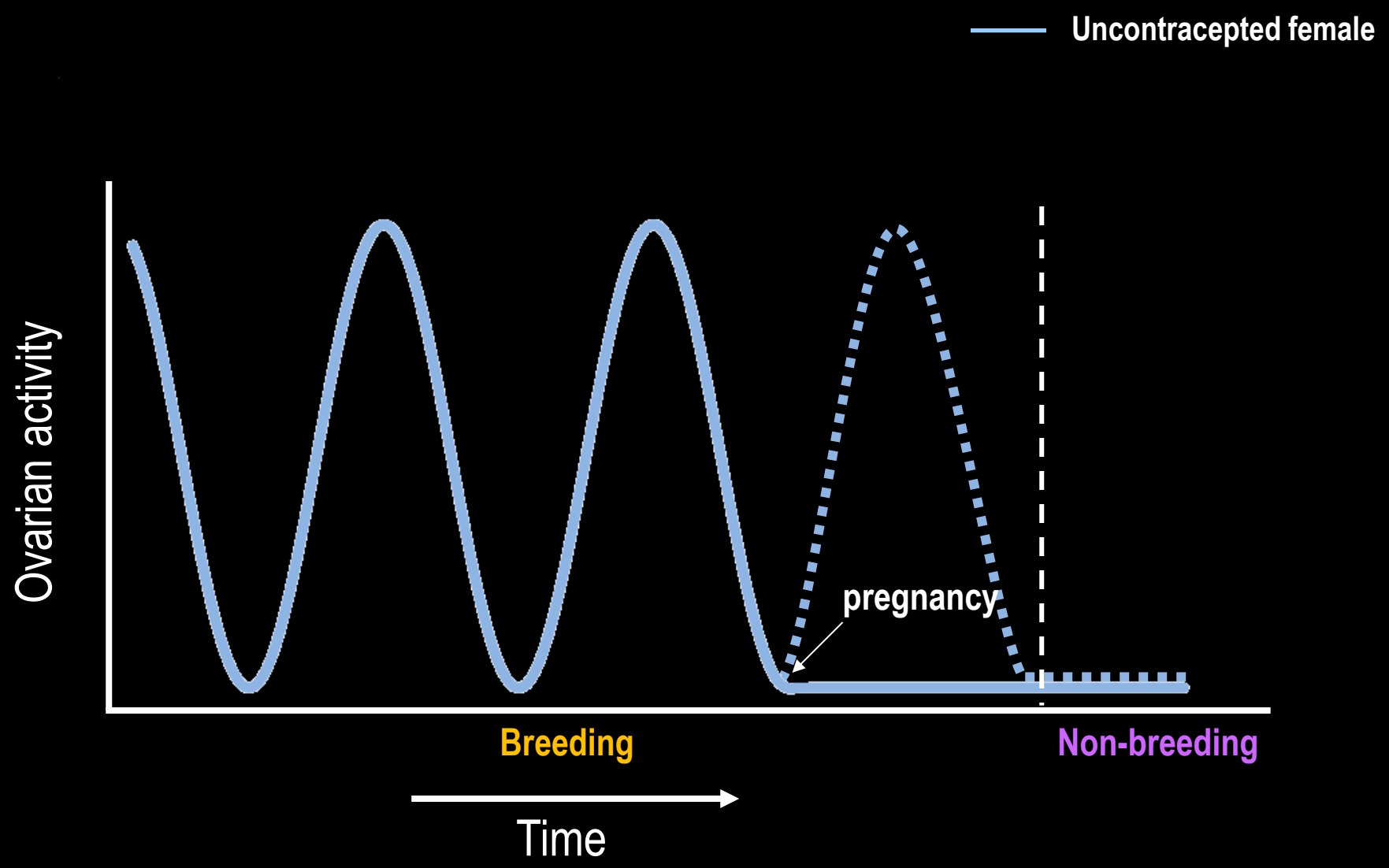
Mare reproductive physiology



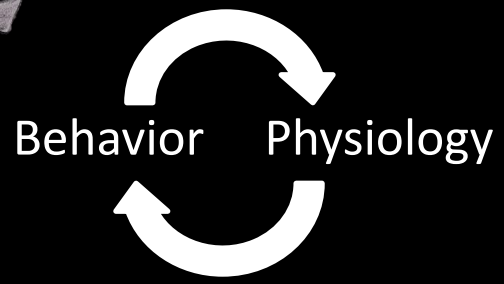
Traditional forms of hormonal contraception

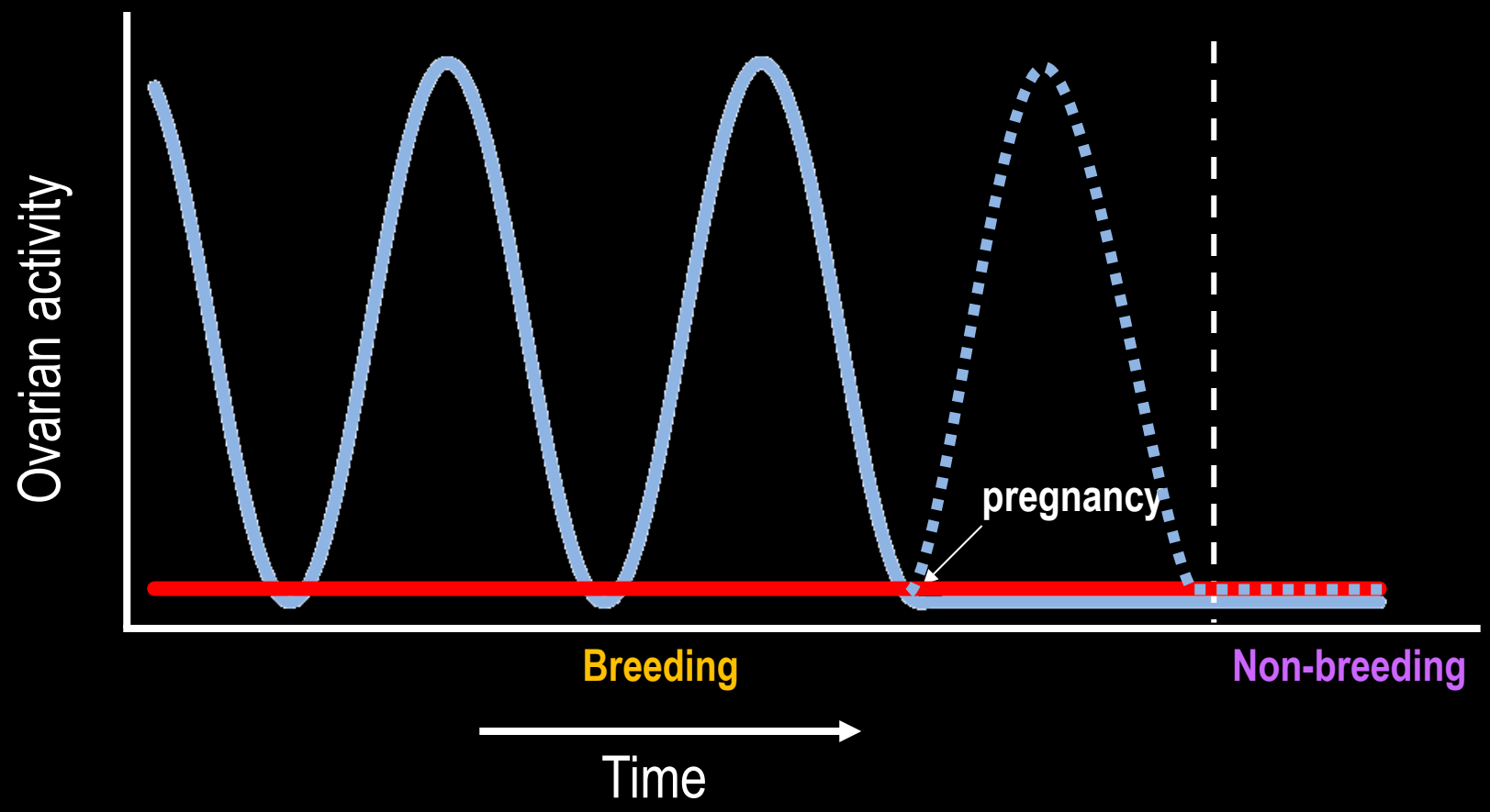


Contraception

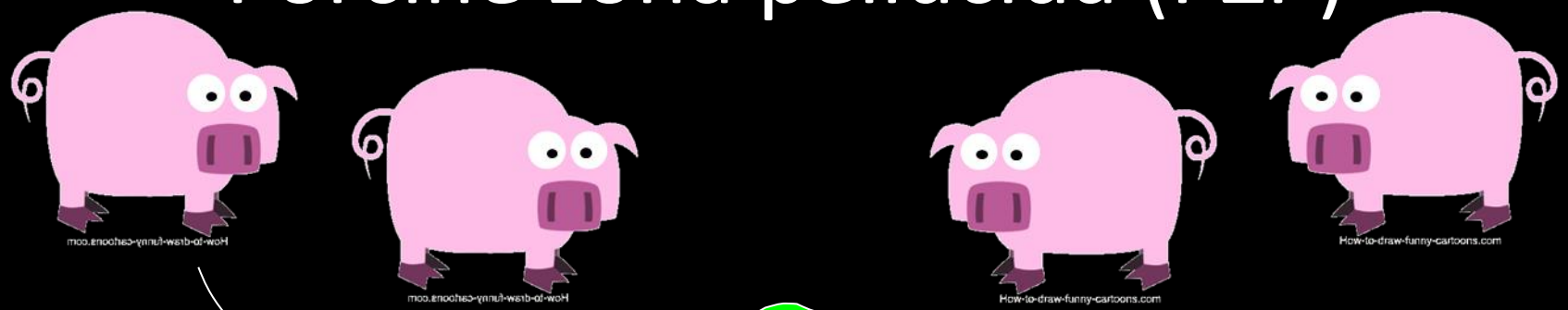


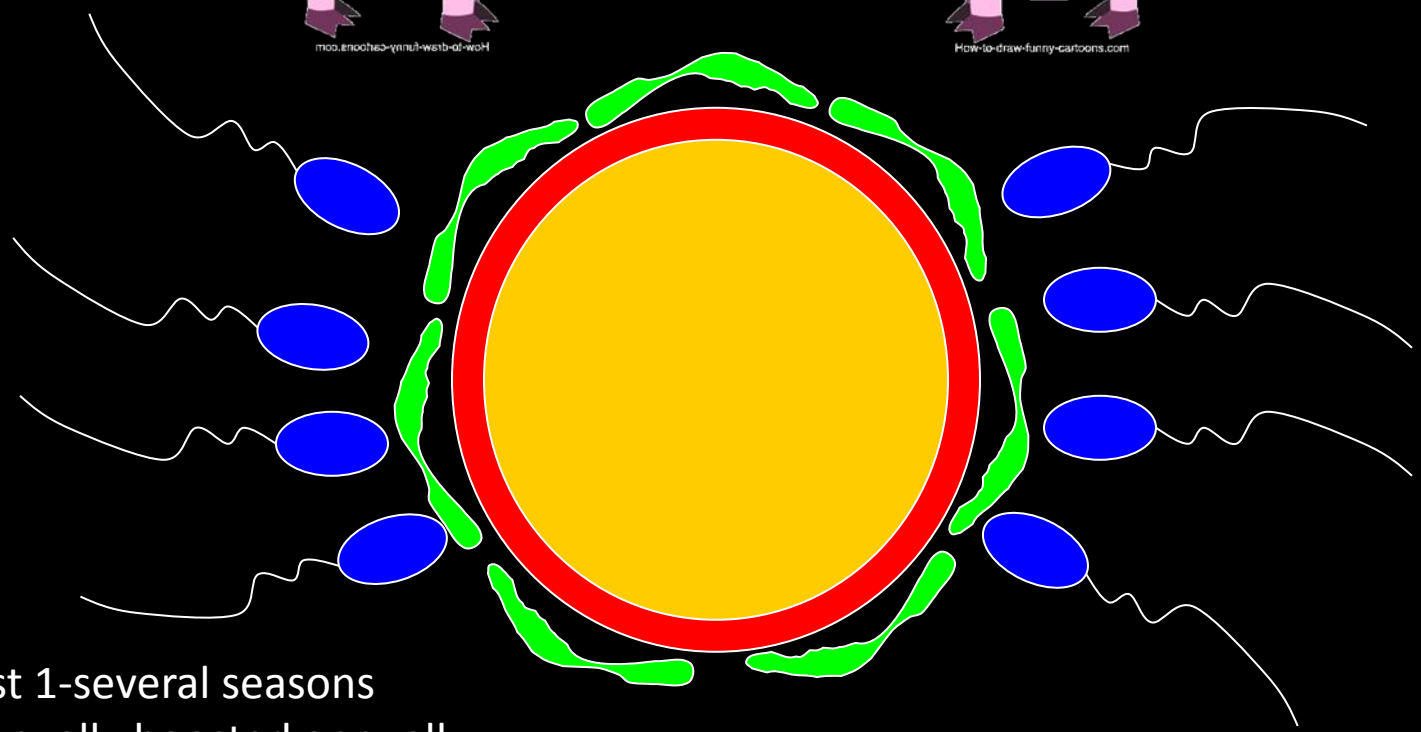
Contraception





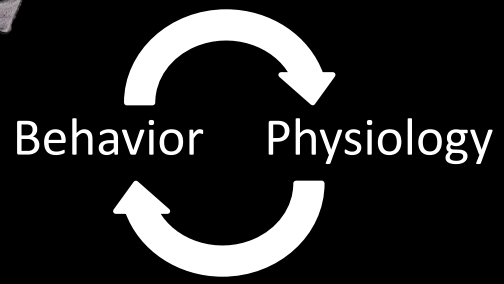
Immunocontraception
Porcine zona pellucida (PZP)

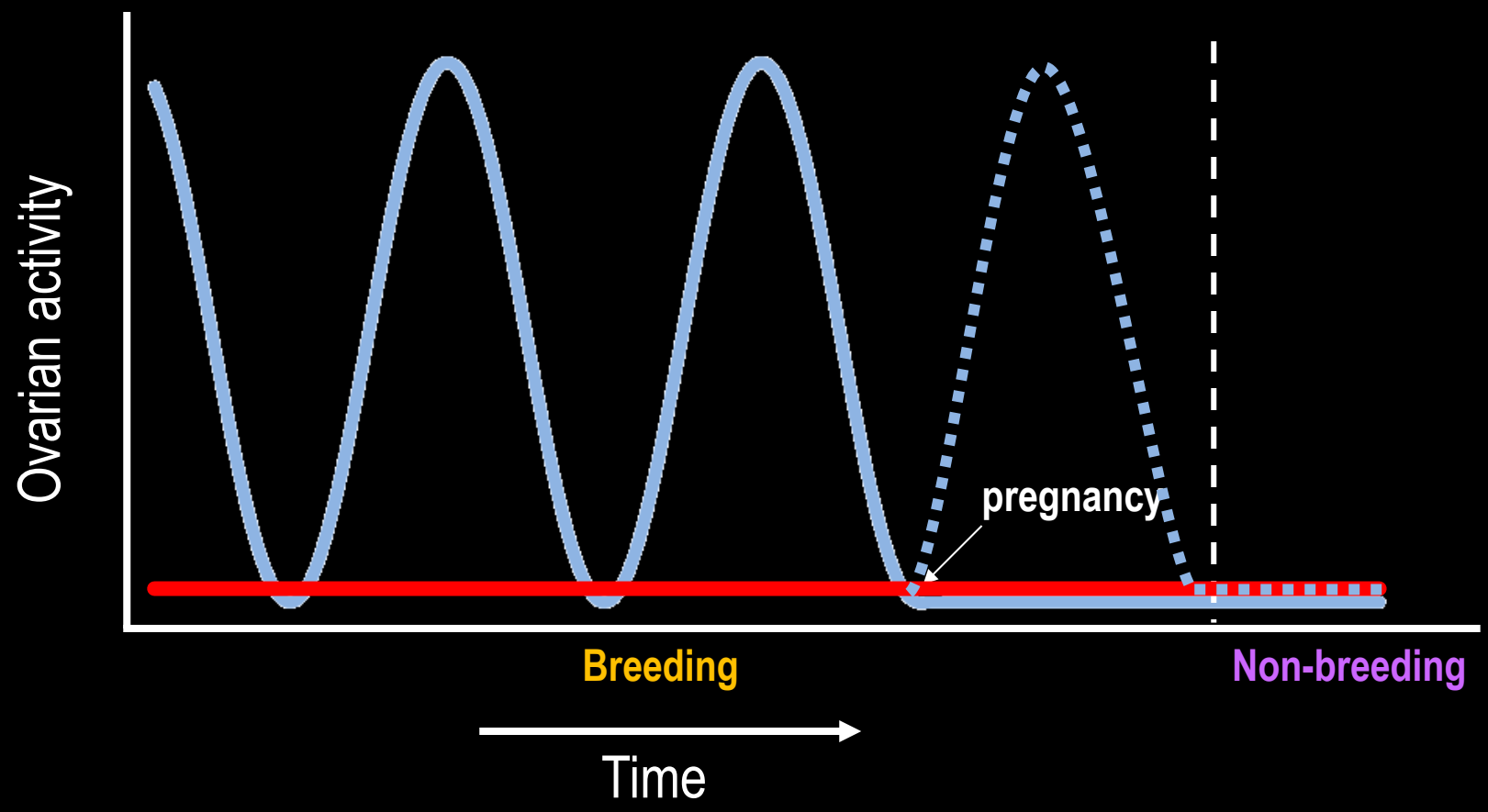




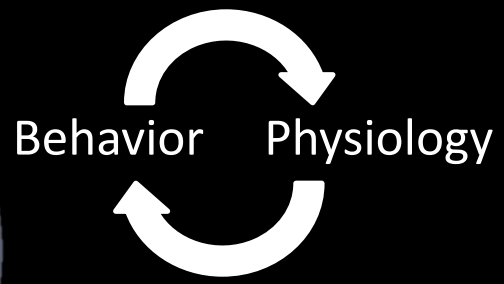
Effects last 1-several seasons
Females usually boosted annually

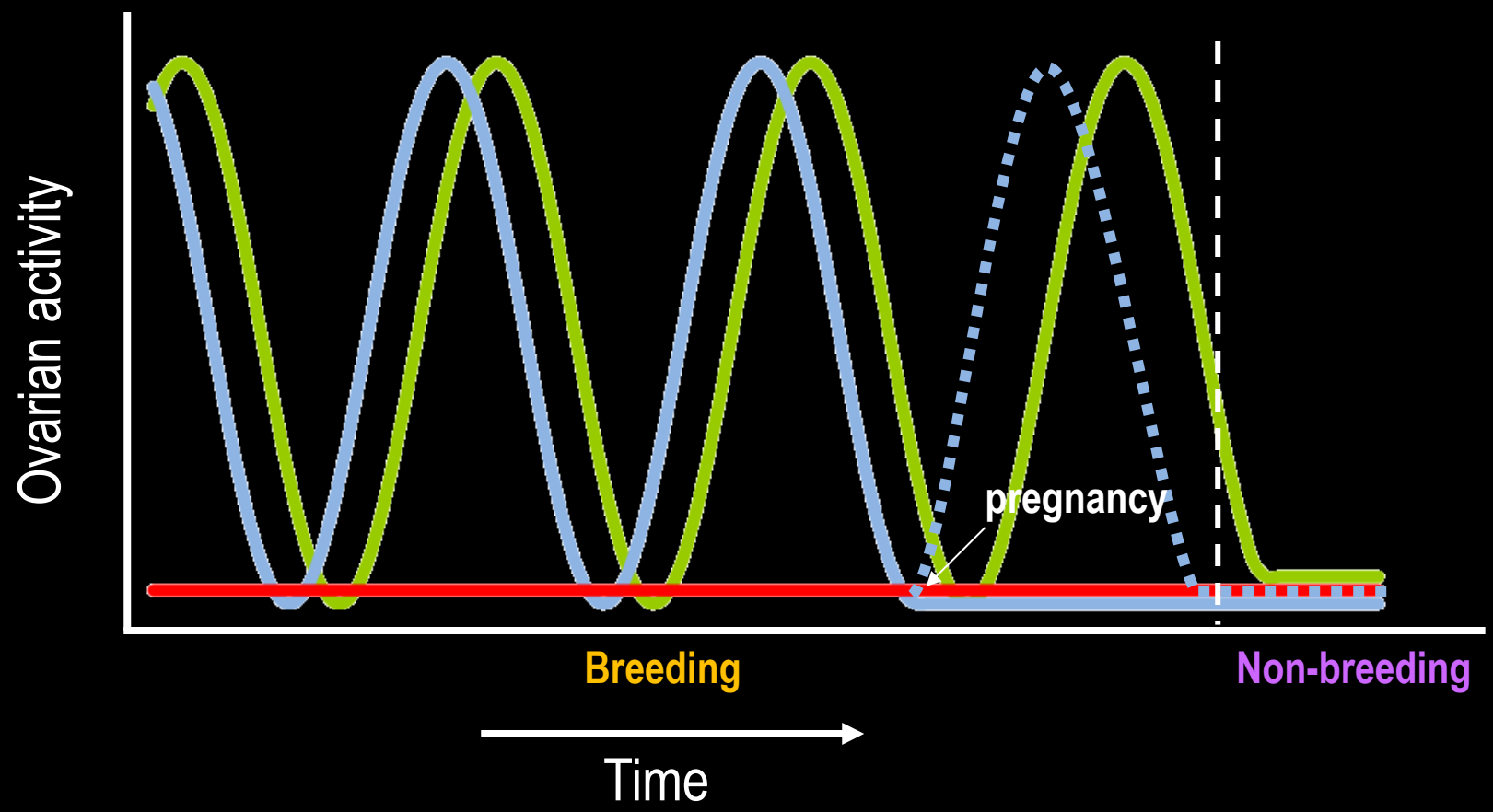
Immunocontraception



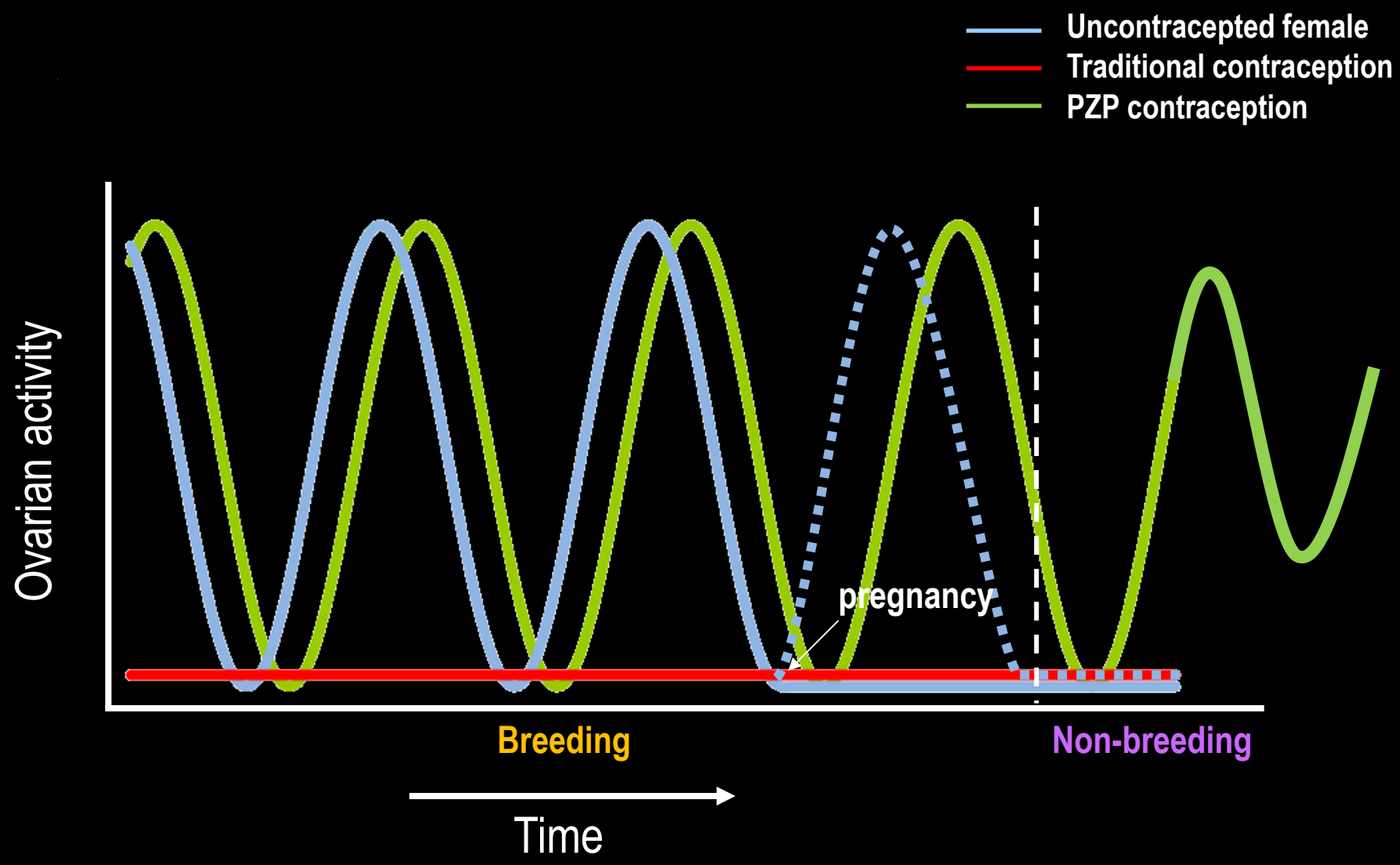


Immunocontraception

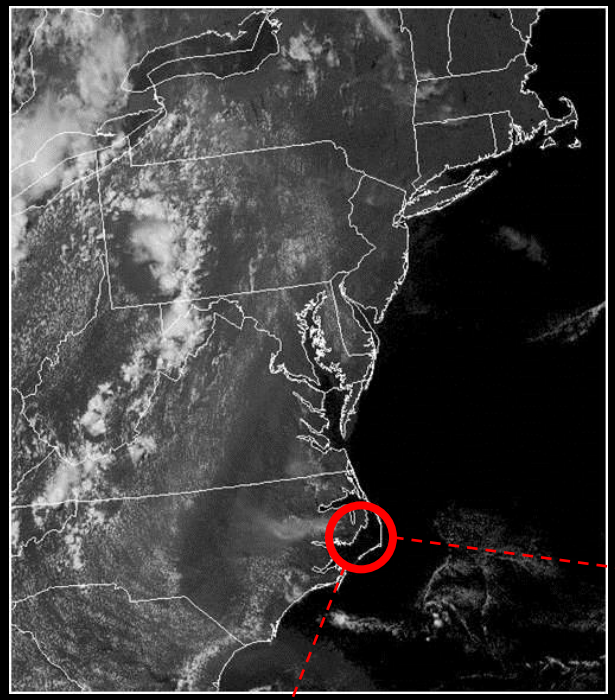




Immunocontraception



Changes to mare behavior and physiology



Shackleford Banks, North Carolina

- National Park Service
- Foundation for Shackleford Horses

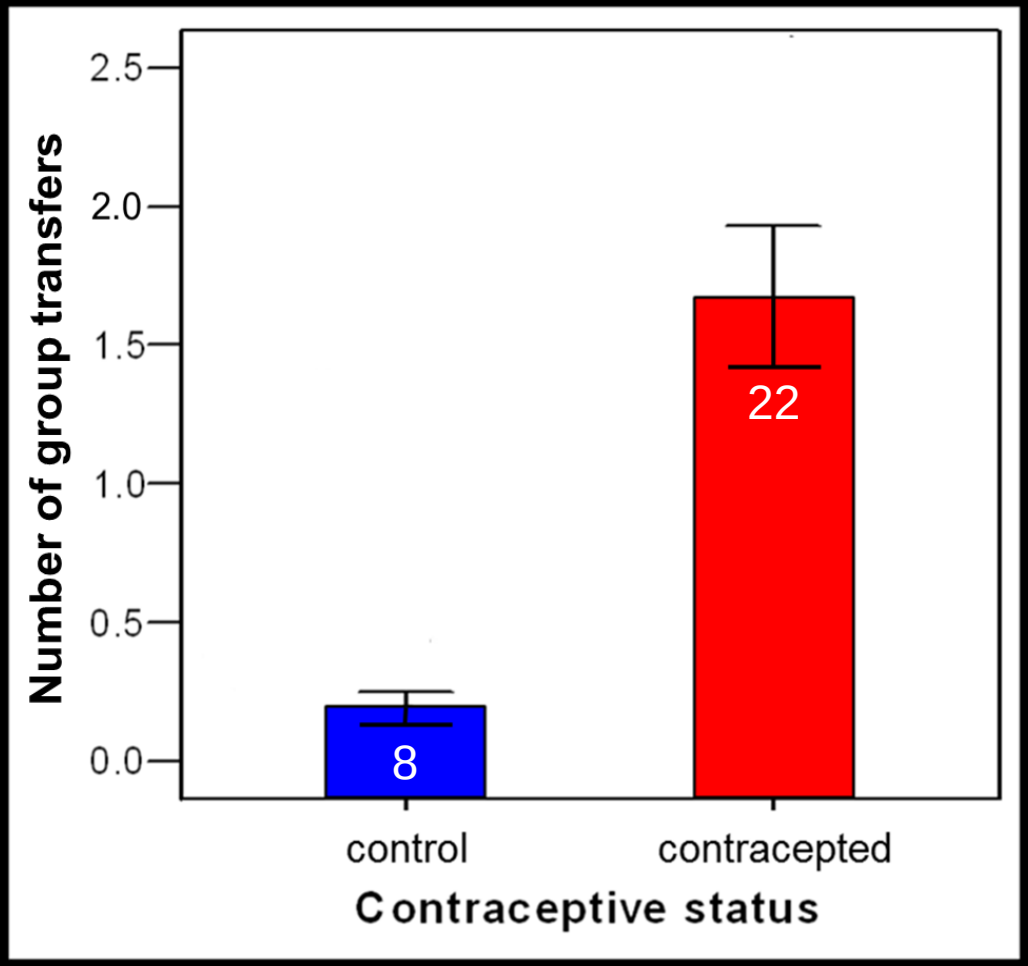
200 → 100-120
PZP contraception

Group transfer behavior

- Number of group transfers
- 30 ♀ in 13 bands
- Contracepted ♀(n=22); Control ♀(n=8)
- Non-breeding season (December 2005 - February 2006)

Photo by Doug Schooley

Number of group transfers during study period



Generalized Linear Model; $F_{2,27}$ = 6.73, *P* = 0.004
- PZP treatment, est. = 1.99, t = 2.11, *P* = 0.04

Nuñez et al., *App Anim Beh Sci*, 2009

Changes to mare behavior

Changes to mare behavior

Changes to mare behavior

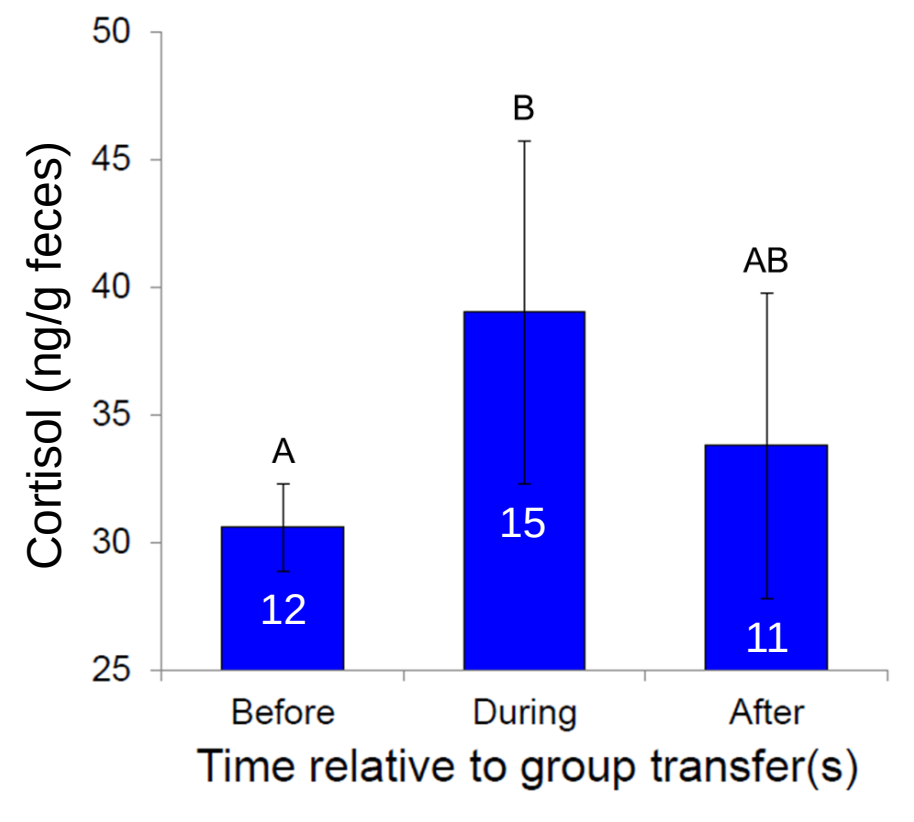
Stress physiology

- Female fecal cortisol levels
  - Steroid hormone
  - Response to acute physical/social challenge (stress)

Stress physiology

- Fecal cortisol as a metric of stress level
- Cortisol levels before, during, and after group transfers
- Cortisol levels and the number of group transfers made
- Breeding and non-breeding seasons (June-August and December, 2009)

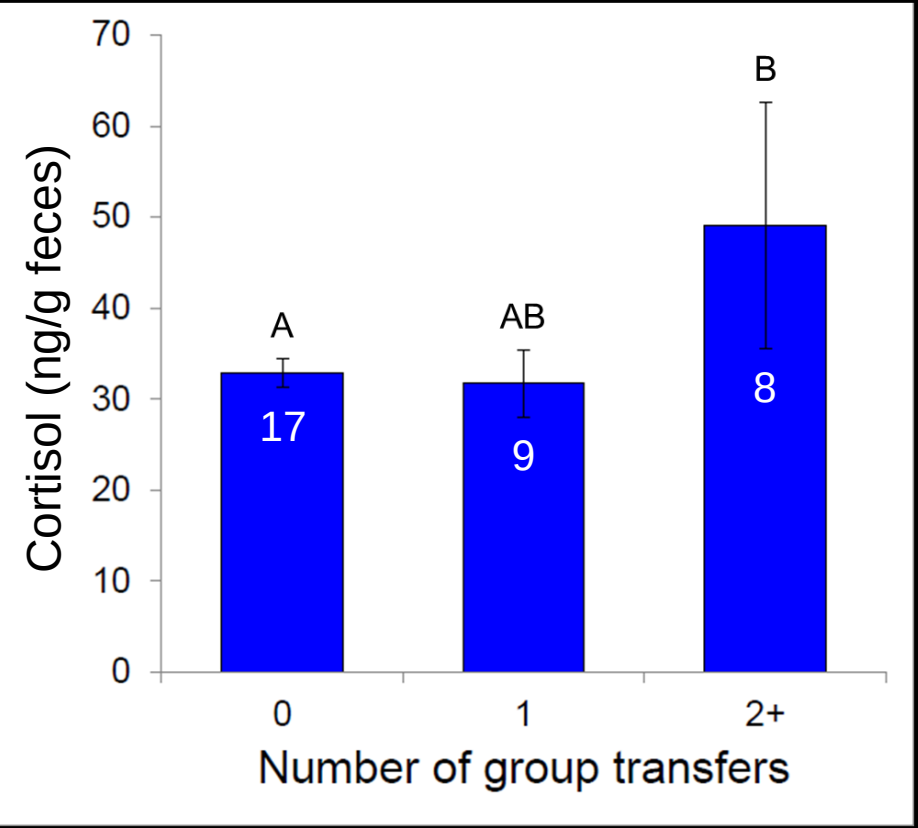
Cortisol levels and the timing of group transfers



Linear Mixed Effects Model: before vs. during; est. = 7.22, t = 2.33, *P* = 0.02;
before vs. after; est. = 1.90, t = 0.54, *P* = 0.59;
during vs. after; F-test for linear combinations, $F_{1, 56} = 2.83$, *P* = 0.10

Nuñez et al., *Gen. Comp. Endo.,* 2014

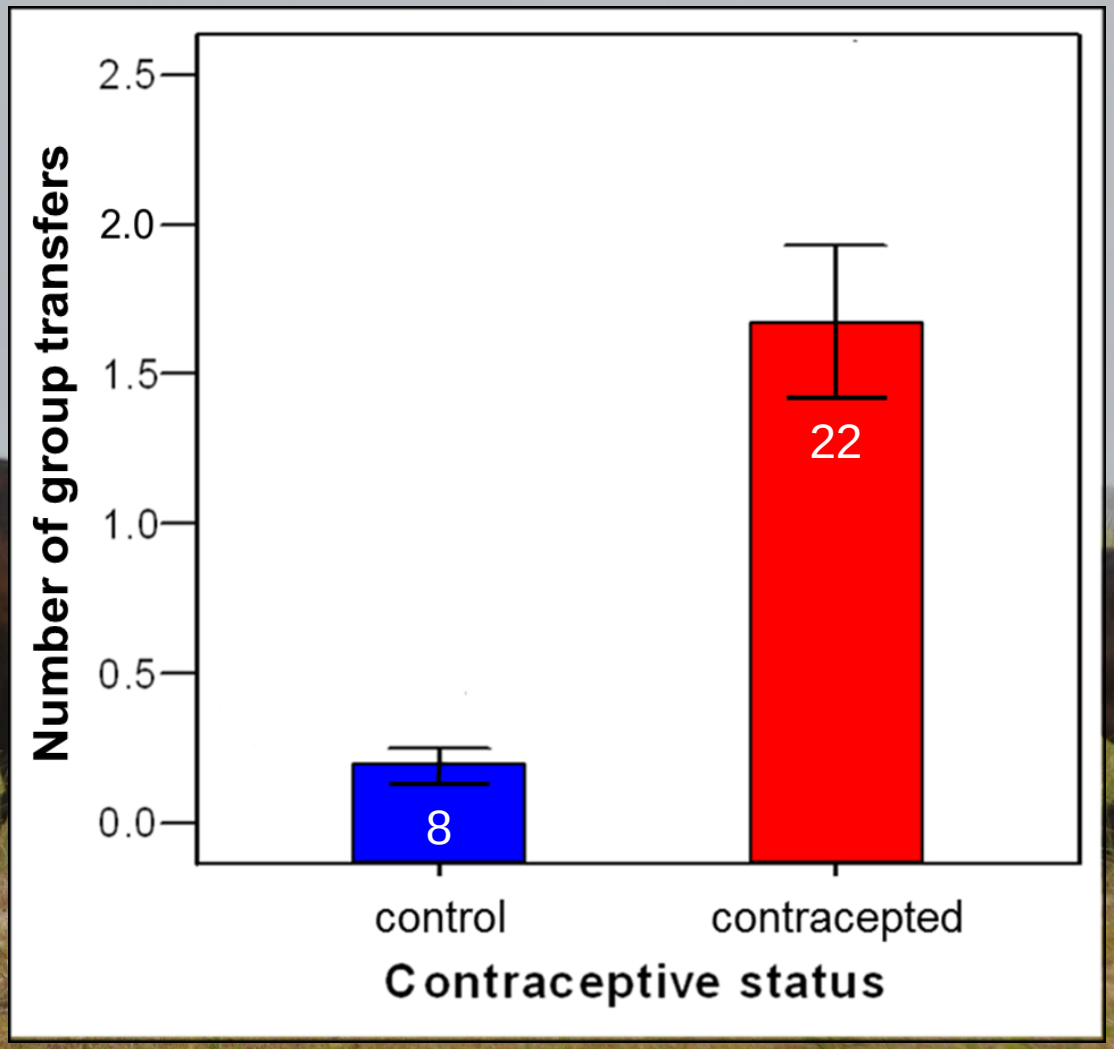
Cortisol levels and the number of group transfers



Linear Mixed Effects Model: 2+ vs. 0 transfers; est. = 9.61, t = 2.58, *P* = 0.01
2+ vs. 1 transfers; $F_{1, 73}$ = 3.32, *P* = 0.07;
1 vs. 0 transfers; est. = 0.24, t = 0.07, *P* = 0.94

Nuñez et al., *Gen. Comp. Endo.,* 2014

Changes to mare physiology



Why should we care?

Why should we care?

Management for numbers?
Management for healthy populations?
Photo by Sue Stuska

Thanks!

Jim Adelman, Virginia Tech
Dan Rubenstein, Princeton University
Jessica Smith, Princeton University
Laurence Gesquiere, Duke University
Jeanne Altmann, Princeton University
Susan Stuska, National Park Service
Carolyn Mason, Foundation for Shackleford Horses
National Science Foundation
Princeton University

Wild Horses of Shackleford Banks

Questions?

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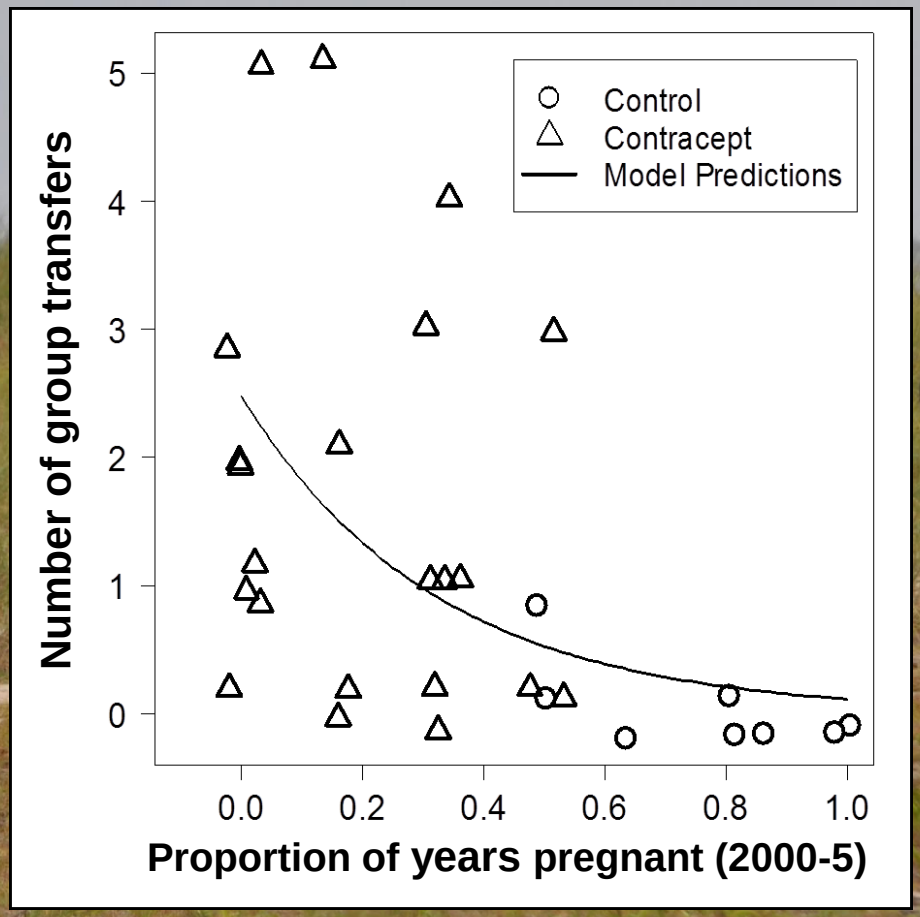
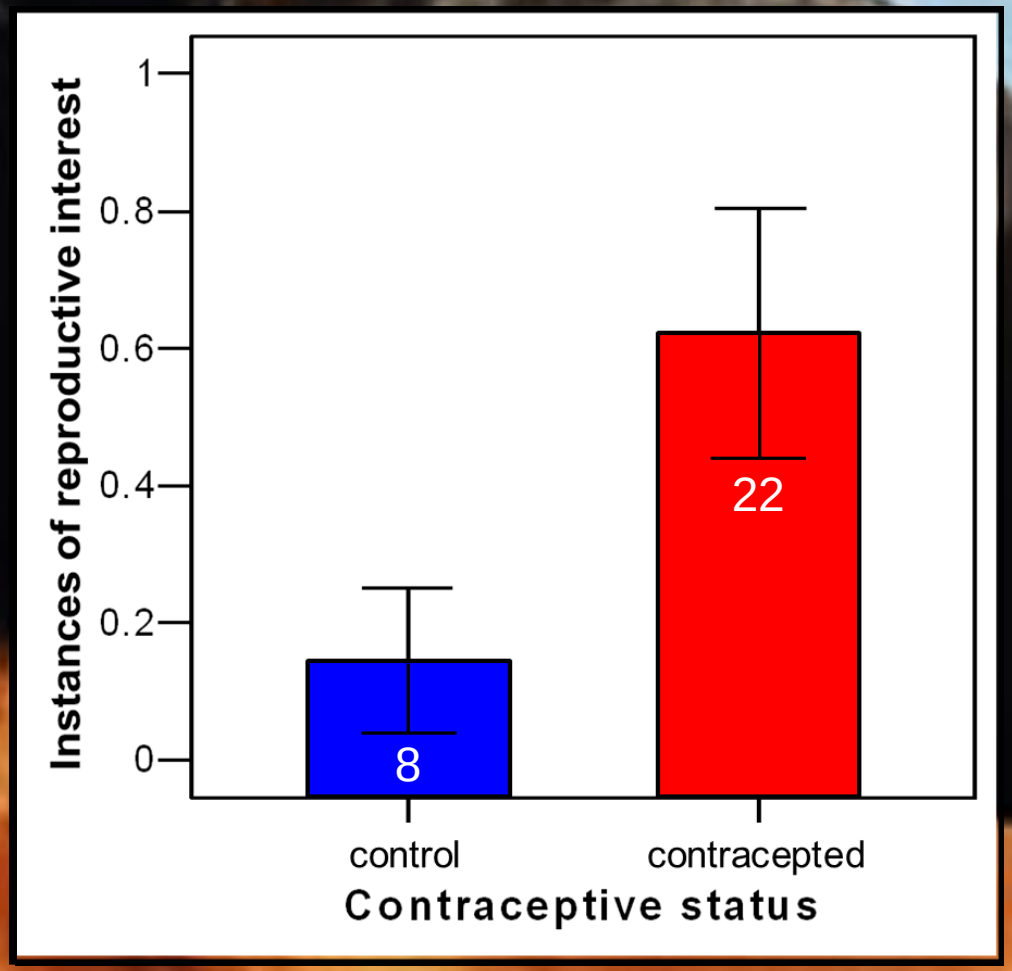
Years pregnant and the number of group transfers



Generalized Linear Model; $F_{1,29} = 10.75$, $P = 0.003$
- PZP treatment, est. = -3.11, t = -2.79, $P = 0.01$

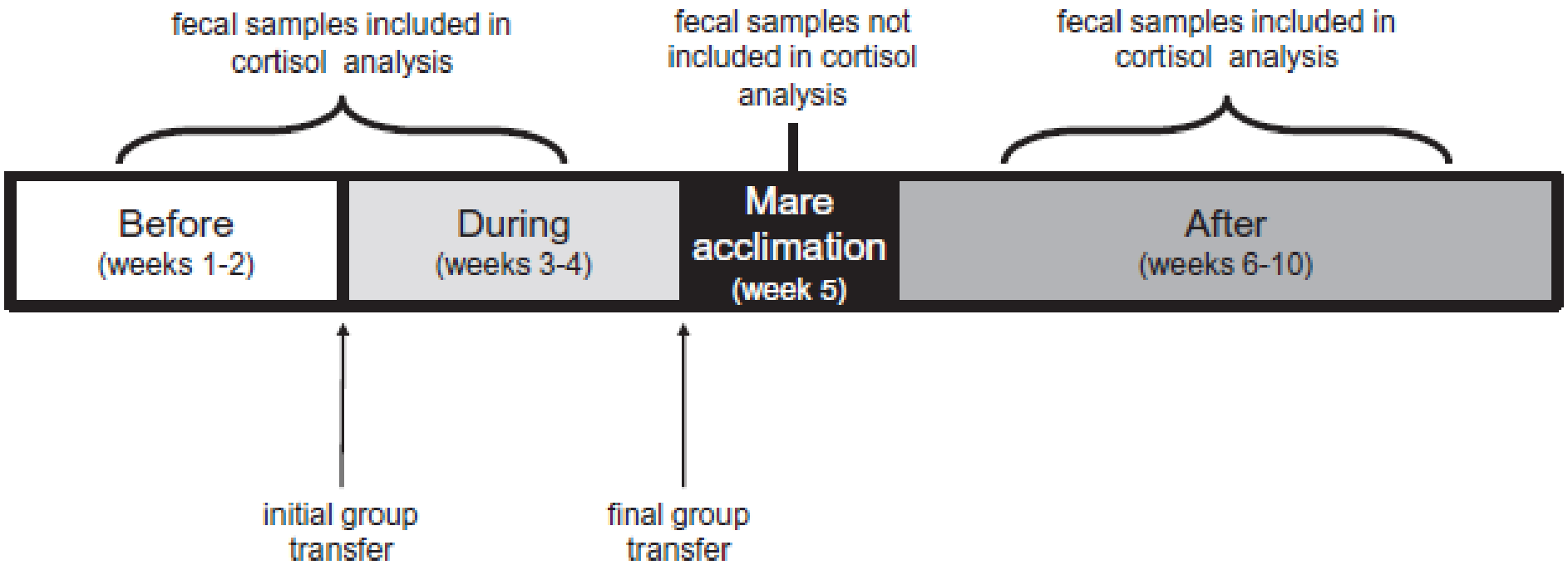
Nuñez et al., *App Anim Beh Sci*, 2009

Reproductive behavior during study period



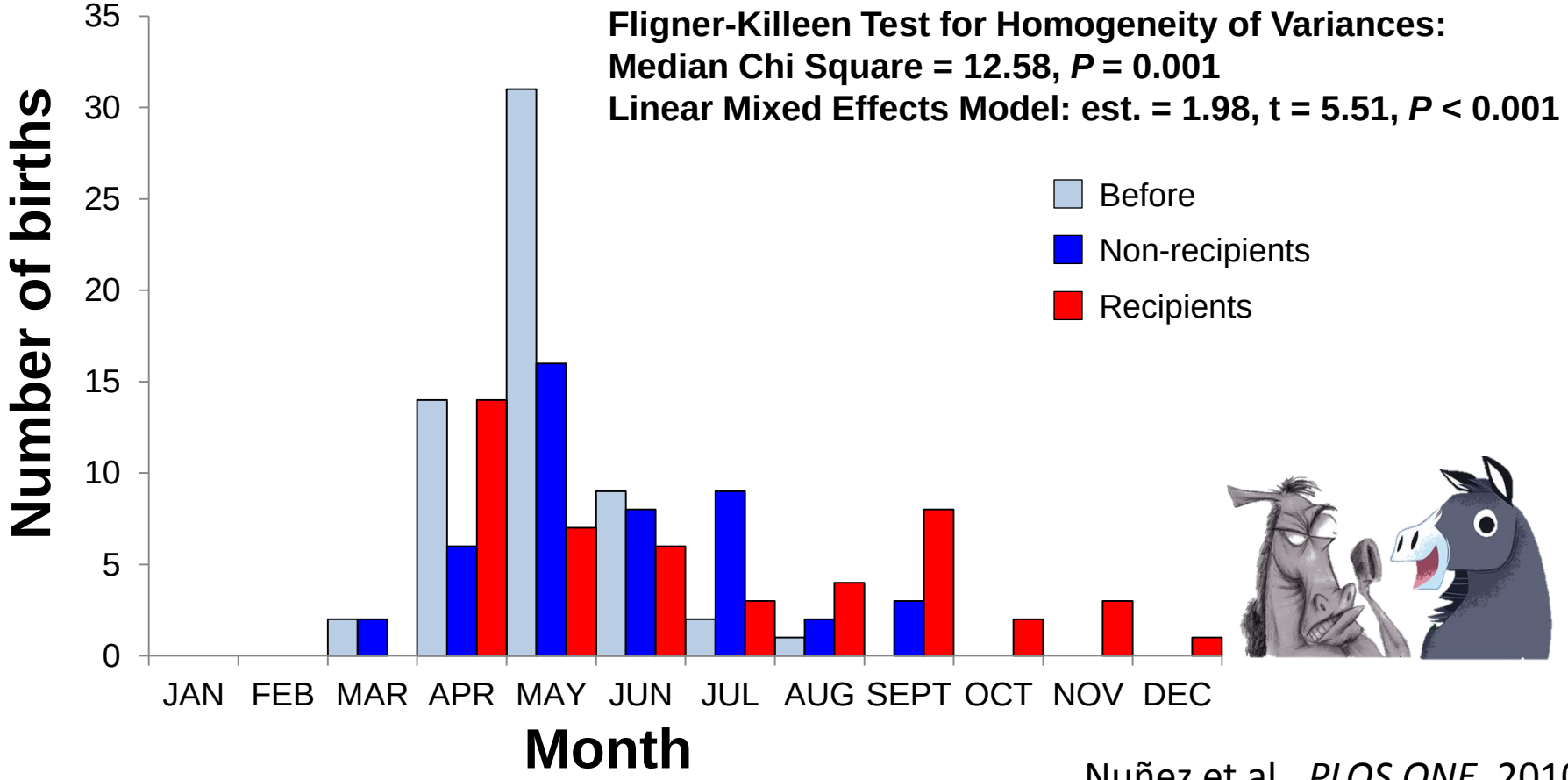
Generalized Linear Model; $F_{1,28} = 9.69$, $P = 0.004$
- PZP treatment, est. = 2.04, t = 2.26, $P = 0.03$

Nuñez et al., *App Anim Beh Sci*, 2009

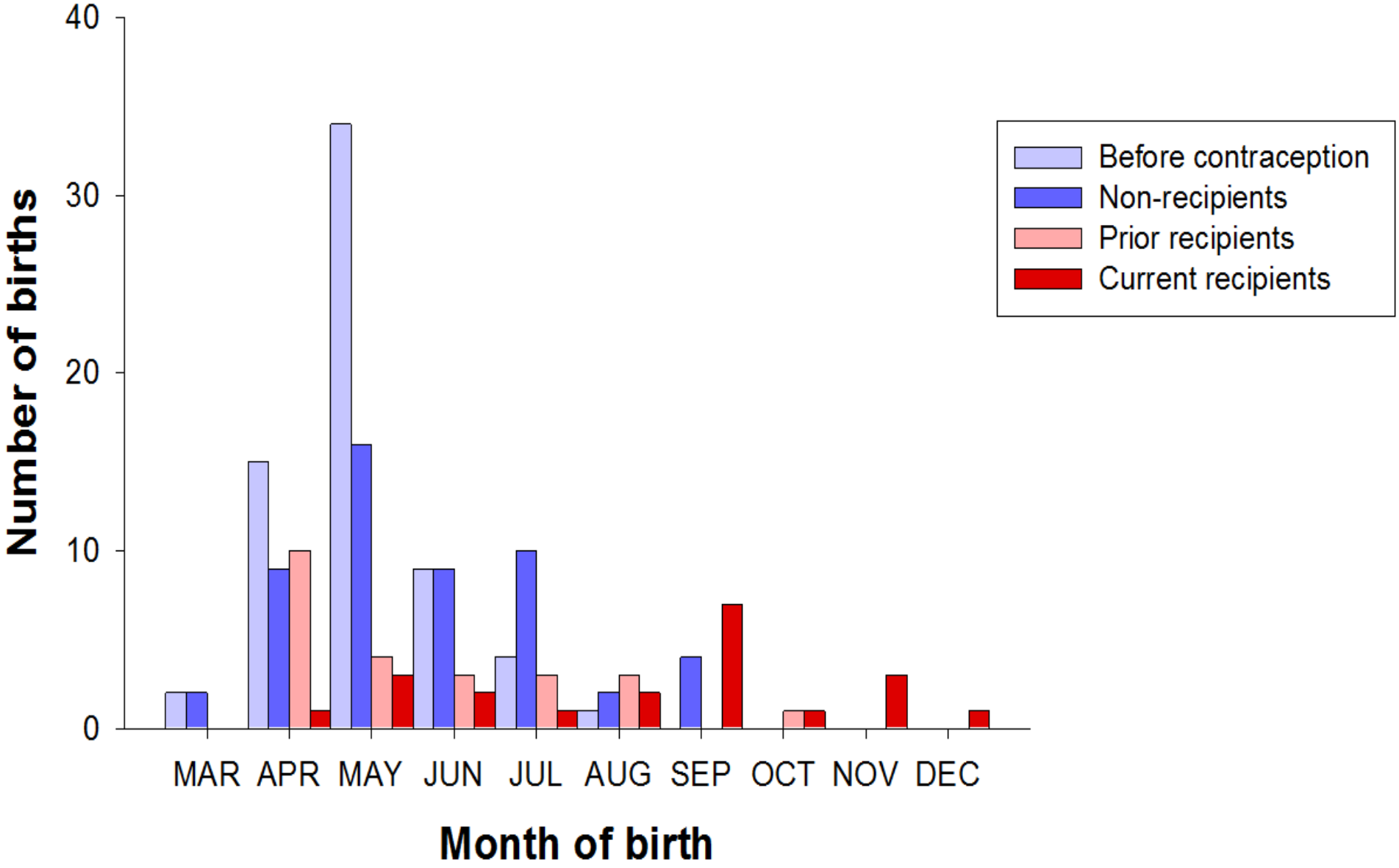

fecal samples included in cortisol analysis
fecal samples not included in cortisol analysis
fecal samples included in cortisol analysis
Before
(weeks 1-2)
During
(weeks 3-4)
Mare acclimation
(week 5)
After
(weeks 6-10)
initial group transfer
final group transfer

Foaling date as a proxy for reproductive cycling

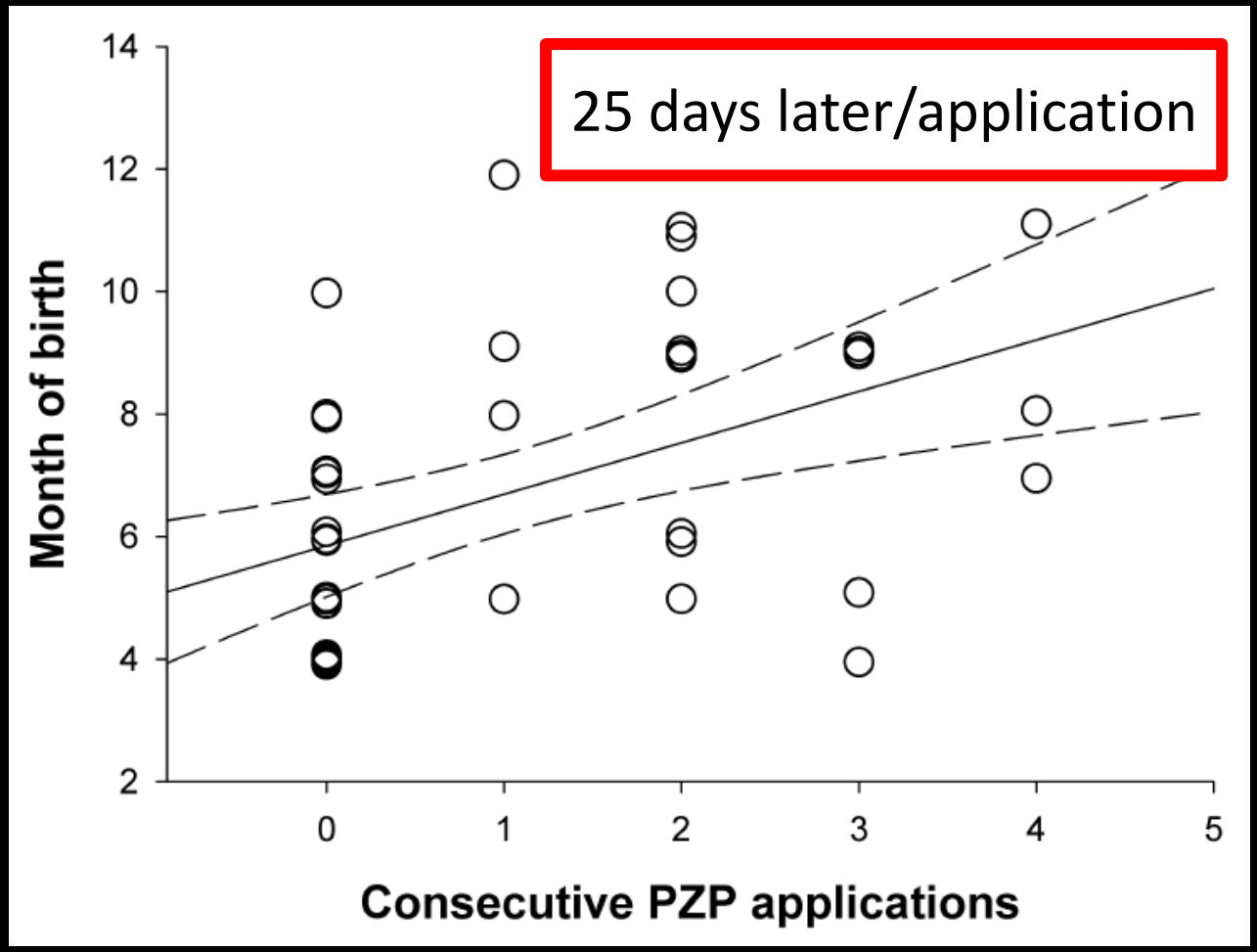
- Gestation lasts 11-12 months
- Conception can be reliably estimated from foals' birth date
- Birth dates of foals born before and after contraception management



Nuñez et al., *PLOS ONE*, 2010

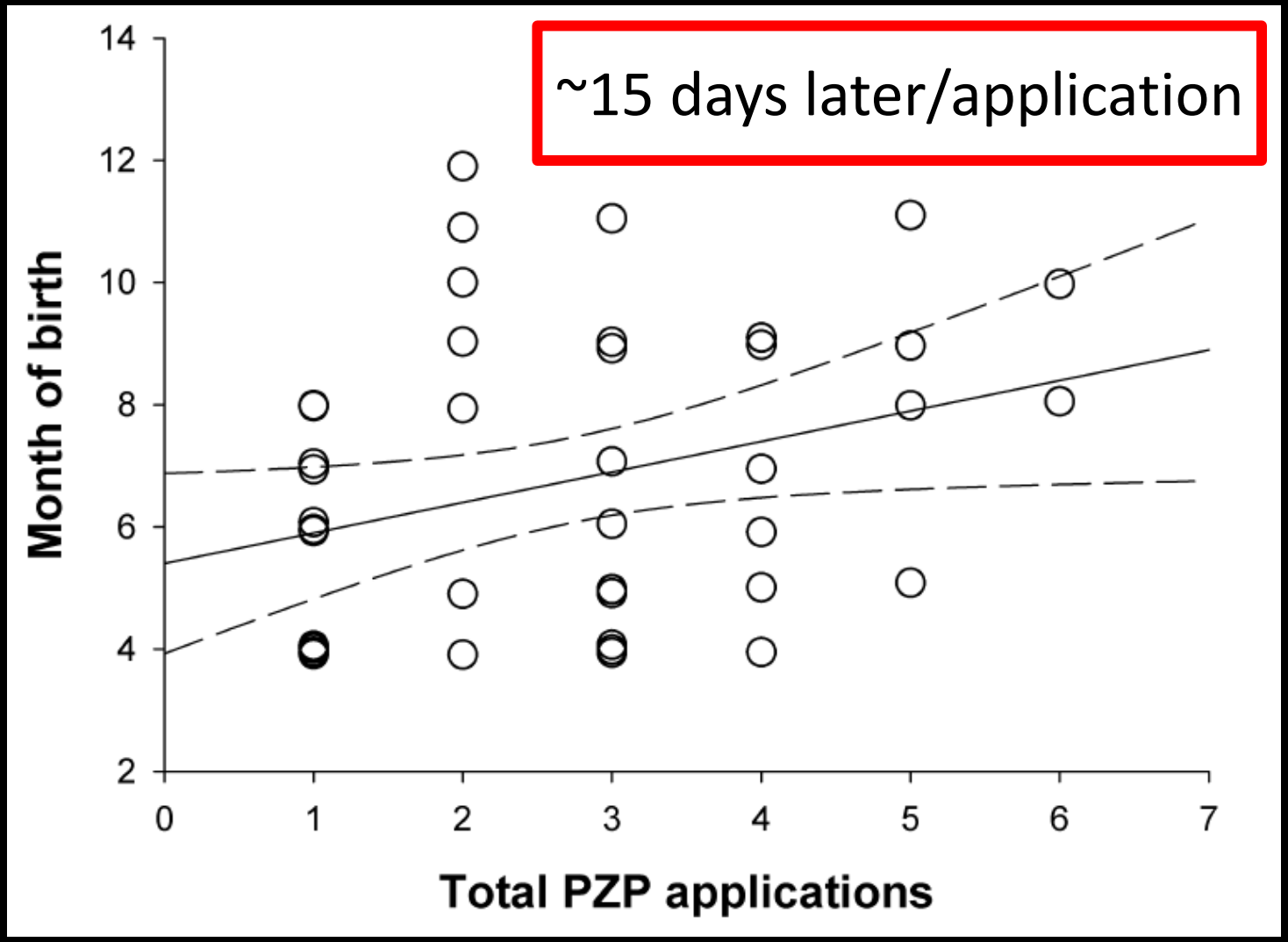

Number of births
40
30
20
10
0
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month of birth
Before contraception
Non-recipients
Prior recipients
Current recipients

Number of consecutive PZP applications and foaling date



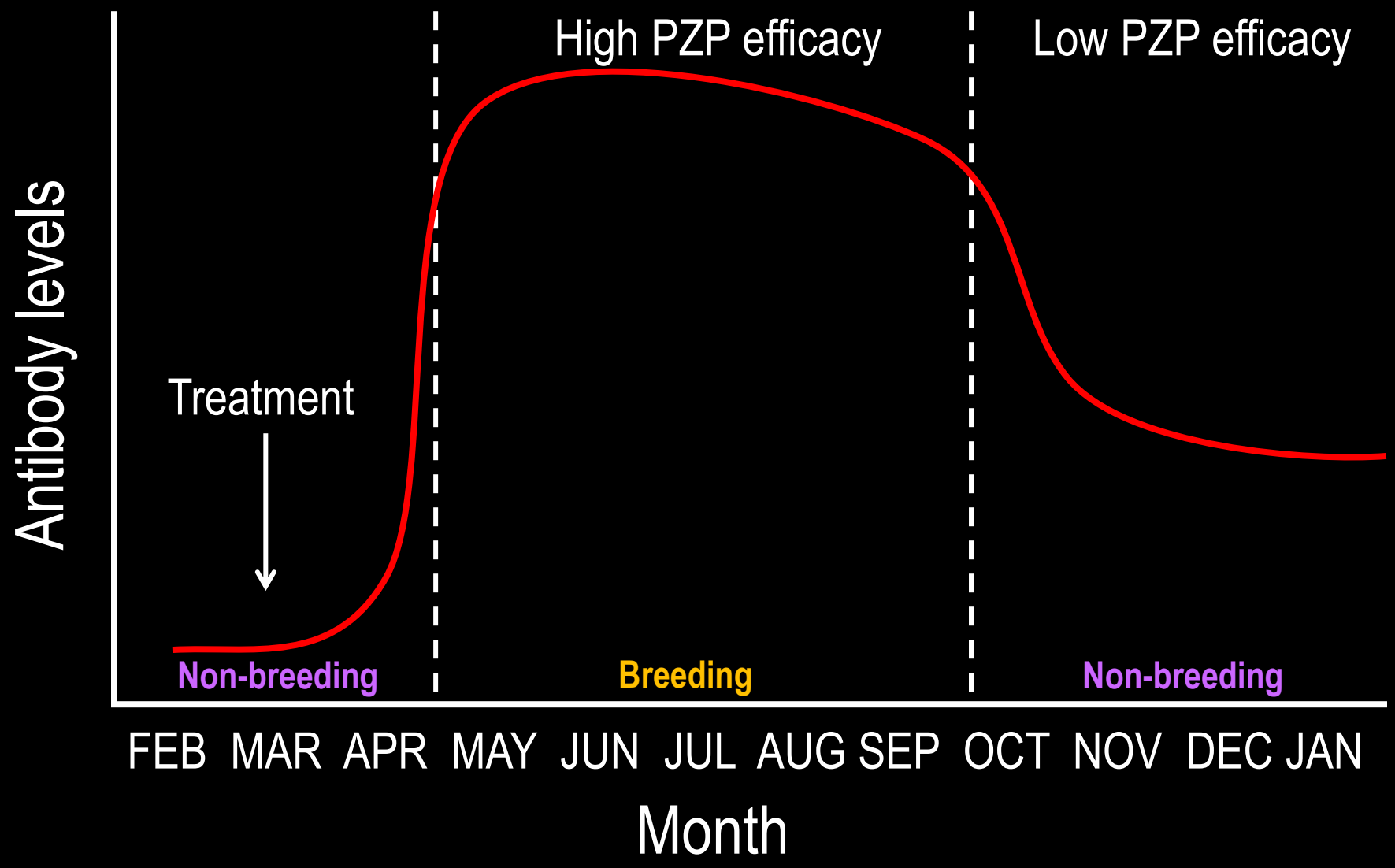
Linear Mixed Effects Model: est. = 0.83, t = 3.64, r^2 = 0.65, *P* < 0.0008

Nuñez et al., *PLOS ONE*, 2010

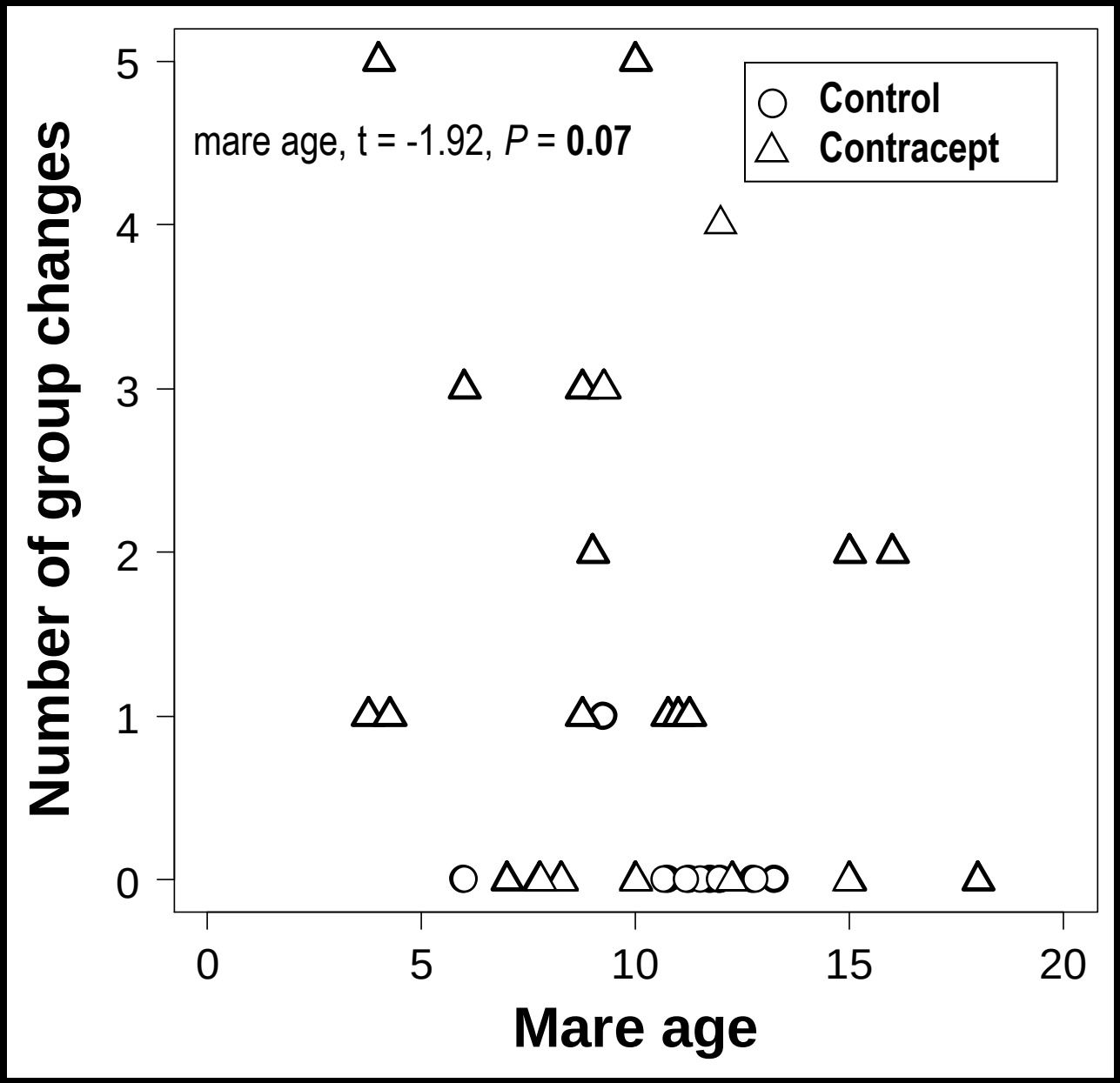


Linear Mixed Effects Model: est. =0.55, t =2.61, r2 =0.65, *P* = 0.01

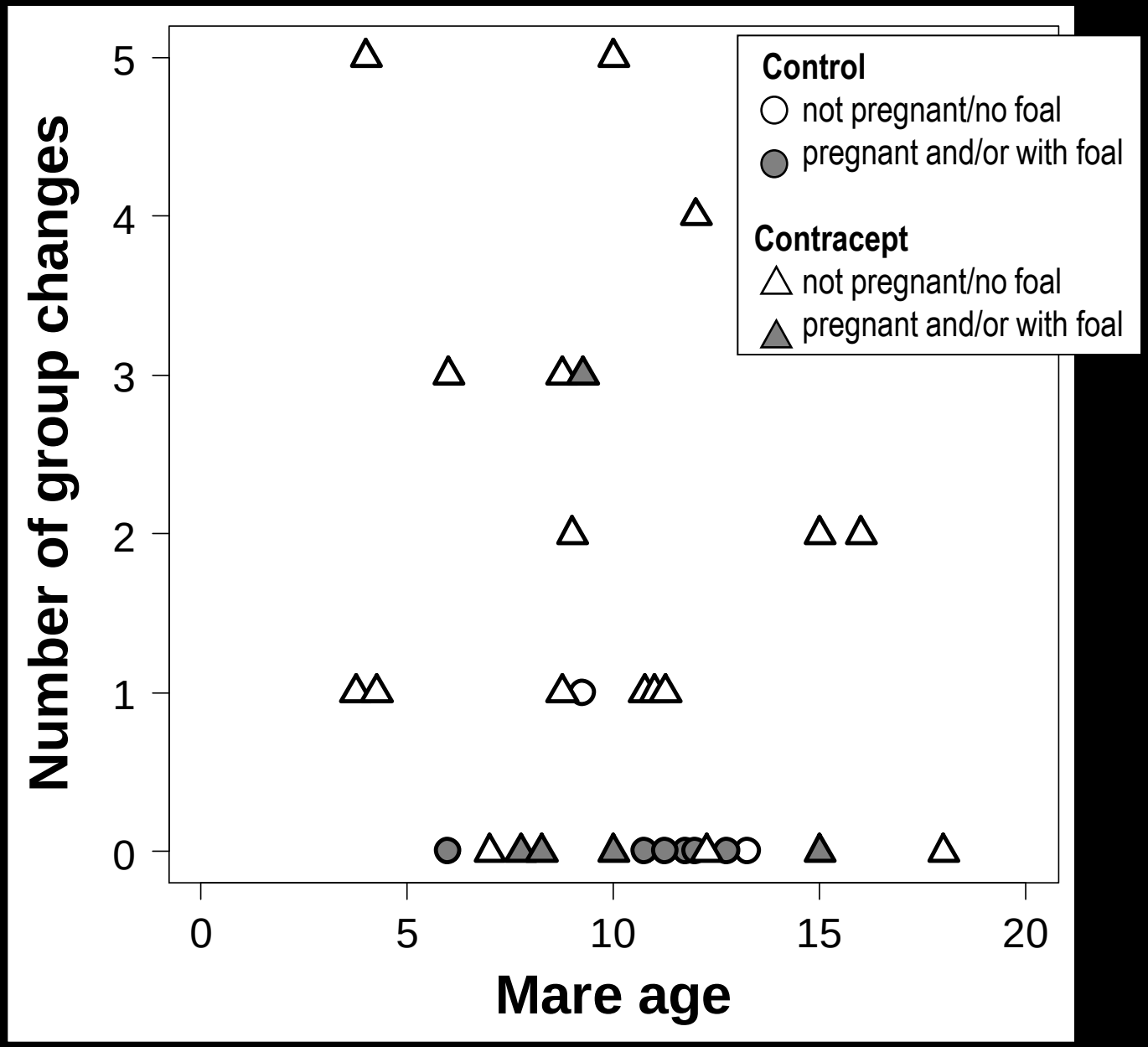
Immunocontraception



Number of group transfers



Number of group transfers



Foal removal and mare pregnancy

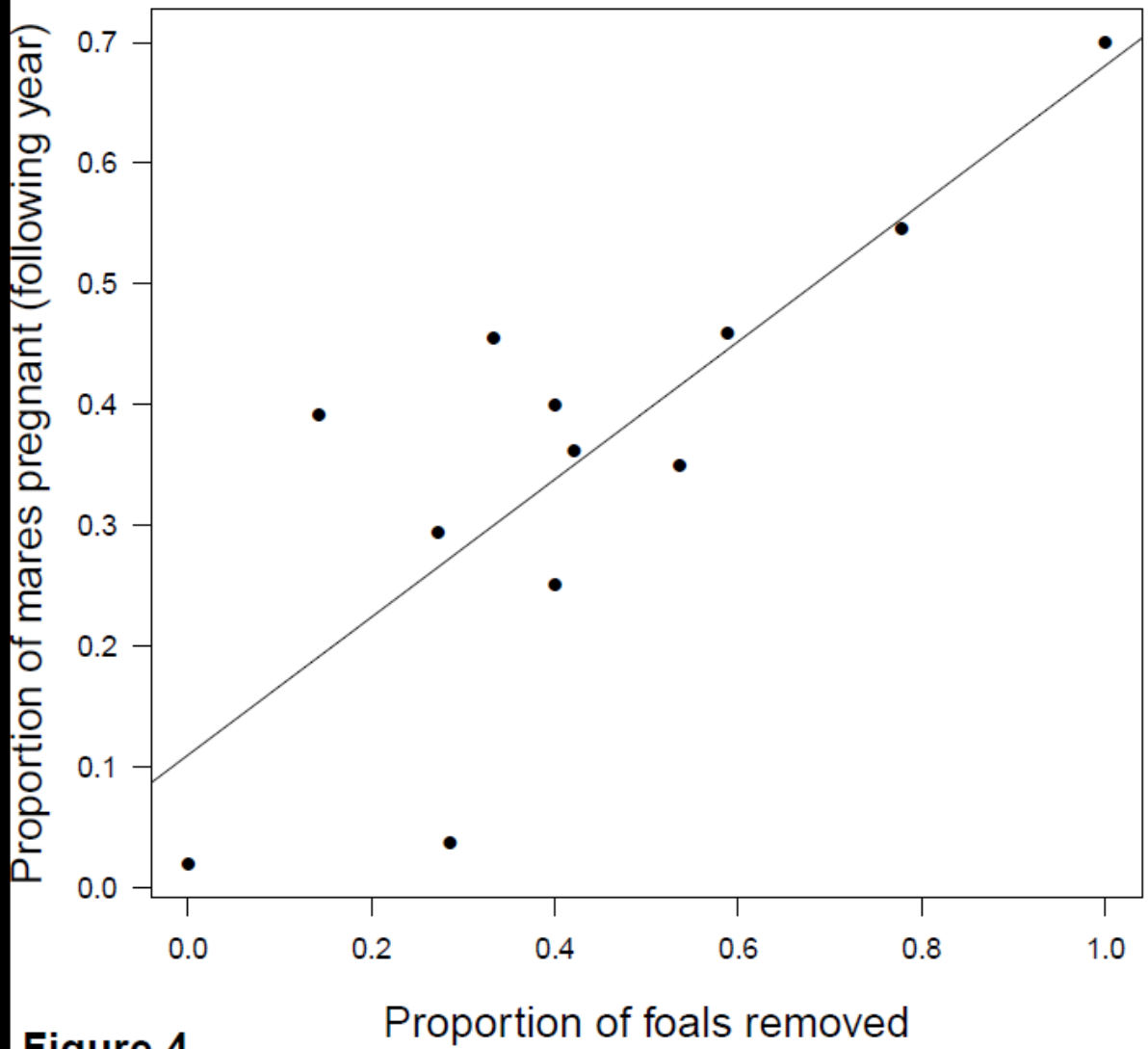
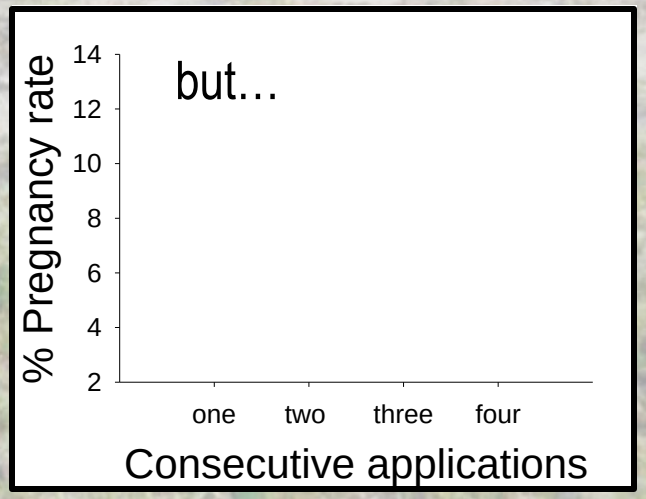


Figure 4

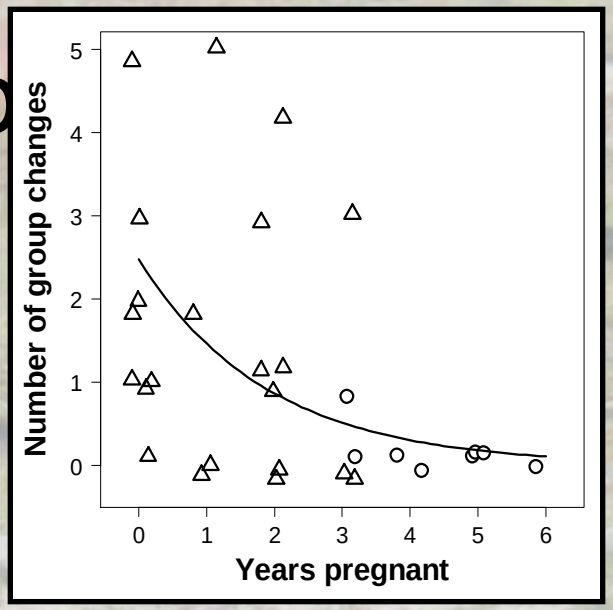
PZP is effective over multiple years

- 1st year, 5.9% pregnancy rate
- 2nd year, 14.0% pregnancy rate
- 3rd year, 32.0% pregnancy rate
- 4th year, 47.5% pregnancy rate



Turner et al. 2006

Birth rates on Shacklefo



Current management strategy

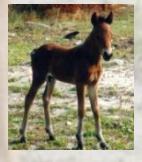
(8 controls x 66% PR) + (50 pzp x 6% PR) =

8.24 foals

Contraception every 2nd year

(8 controls x 66% PR) + (25 pzp x 6% PR) + (25 pzp x 14% PR)=

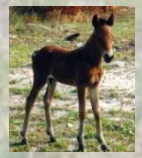
10.26 foals



Contraception every 3rd year

(8 controls x 66% PR) + (13 pzp x 6% PR) + (13 pzp x 14% PR) + (13 pzp x 32% PR) =

12.03 foals



Questions?

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