Characterizing Sleep Behavior of the Wild Black Rhinoceros in Addo Elephant National Park, South Africa

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Sleep Background

All animals studied to date engage in some form of sleep,

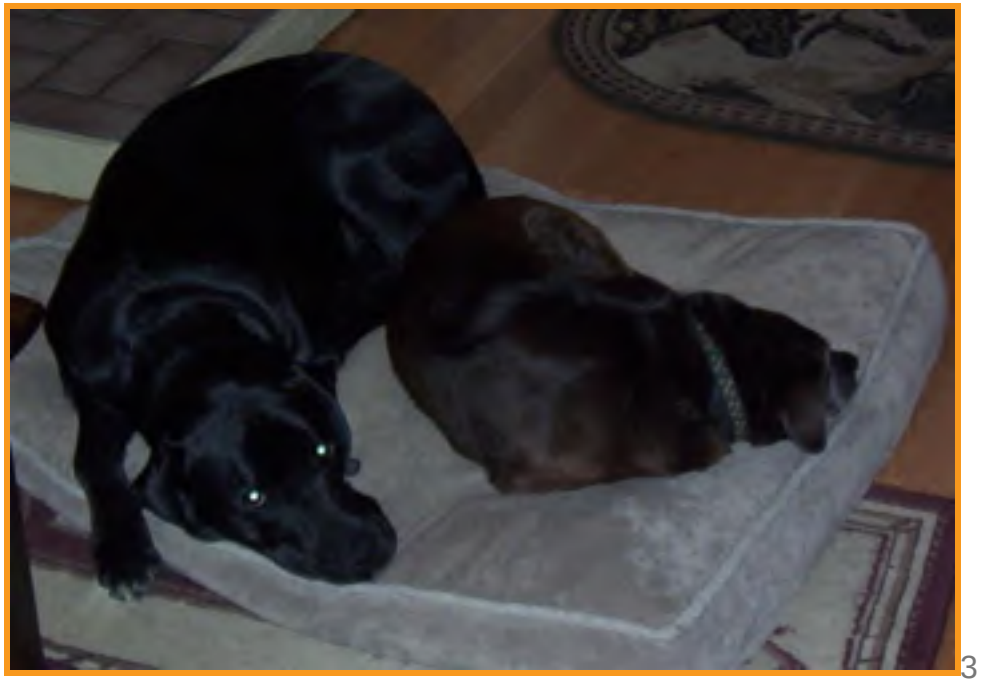
- Sleep one of the most prevalent animal behavior

- Definitions of sleep in vertebrates are typically based upon behavioral and electro-physiological criteria.
  - REM (Rapid Eye Movement)
    - Rapid-wave
    - 20-30% of total sleep time (TST)
    - Memorable dreams
  - Non-REM
    - Slow-wave
    - 70-80% of TST
    - Deeper sleep

Sleep Behavior

Behaviorally, sleep is distinguished by:

- Distinctive sleeping site;
- Species-specific body posture;
- Reduced motor activity;
- Elevated arousal threshold;



Total Sleep Time (TST)

Varies widely across mammals:

- 18 - 20 hr/day in bats and opossums
- 12 – 16 hr/day in domestic cat
- 3 – 6.5 hr/day in giraffe and elephants
- 3 hr/day horses
- 1 hr/day in marine mammals like dolphins
- 3 - 5 hr/day graduate students


Della Garelle


Dullneon


Baltimore Zoo


Buzz.com

Factors That Affect Sleep

- Basal metabolic rate
- Brain and body weight
- Sex differences
  - Parental investments (lactation)
  - Hormones
- Nutrition
  - Herbivore vs. carnivore/omnivores
  - Caloric density of food; predation risks
- Environmental conditions
- Stress

Captive vs. Wild Sleep Studies

- Several studies on captive animals
  - Laboratory animals (rats/mice/primates)
  - Zoo-housed and circus Asian elephants
    - ~2 hr recumbent & ~3 hr standing sleep
  - Zoo-housed giraffe
  - ~1 hr recumbent & ~2 hr standing sleep
- But, these may not reflect true sleep behavior
  - Different environment
  - Nutrition
  - Predation risk

Captive vs. Wild Sleep Studies

- Wild African elephant sleep behavior
  - Recumbent sleep for 2 hr/day for bulls;
  - 40 min for cows
- Can we use sleep behavior as indicator of environmental pressures, such as
  - Predation risk
  - Resource availability
  - Anthropogenic pressures

Black Rhino Sleep Behavior

- Have multiple bedding sites within home ranges
- Rest in daytime when temperatures are high
- Weigh ~800-1400kg; Brain weighs 400-600g
  - Predicted to sleep 3.5 to 4.5 hr/day
  - Polyphasic=multiple, short sleep bouts

IRF 2011

Objectives

Our objectives were to:

1. Characterize sleep patterns in the wild
2. Determine factors that influence black rhino sleep
    - Sex
    - Age
    - Season (wet vs. dry)
    - Environmental pressures

South African
NATIONAL PARKS
BLACK RHINO MONITORING

Addo Elephant National Park

- **In 1931 its goal was to protect the remaining 11 elephant. Now there are >400 individuals!!**
- **AENP will be the third largest national park in South Africa.**

AENP Black Rhino Sub-populations

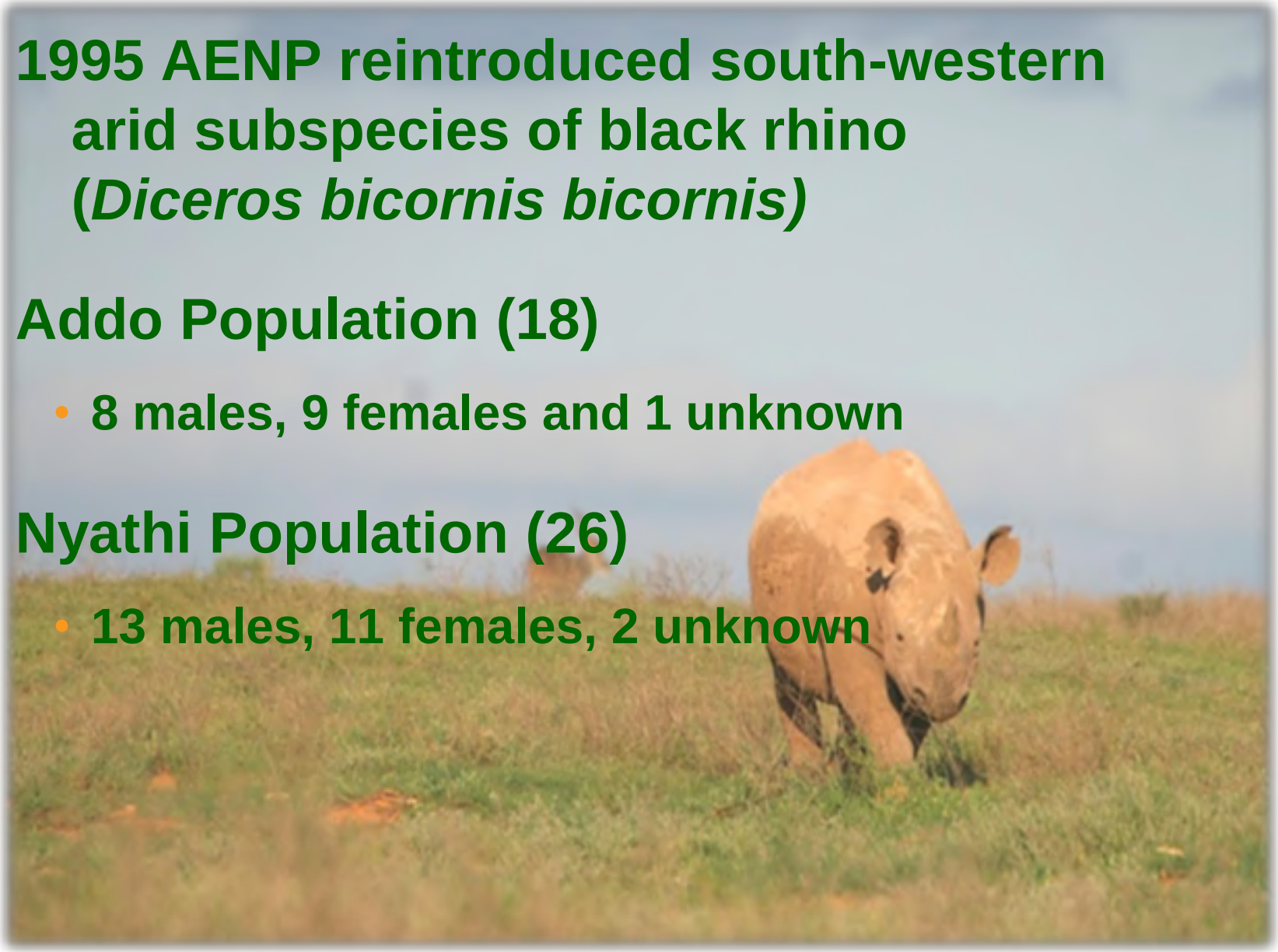
1995 AENP reintroduced south-western arid subspecies of black rhino (*Diceros bicornis bicornis)*

Addo Population (18)

- **8 males, 9 females and 1 unknown**

Nyathi Population (26)

- **13 males, 11 females, 2 unknown**



Environmental Factors

Factors	Addo	Nyathi
Sex ratio	Female-biased	Male-biased
Elephant density	High (~300)	Moderate (~100)
Predators	Present	Absent
Vegetation	Limited	Abundant
Tourism	High	Low
Size of section	11,500 ha	14,000 ha

Hypotheses

Our hypotheses are:

1. **Similar to the study on wild African elephants, we predict that sex will influence sleep patterns**

2. **Due to the differences in biotic and abiotic factors, we expect to observe differences in sleep behavior between the subpopulations**

Photo by Jed Bird

Methods

How do you study an elusive animal?

Lincoln Park Zoo

Field Methods: Looking for Rhinos

Lincoln Park Zoo

Finding Black Rhinos in AENP

Lincoln Park Zoo

Look for Black Rhino Activity

Non-invasive Sampling

Identify individuals by:

- **ear notch**
- **horns**

Get sleep bout date, time and length

Sand pit in Addo

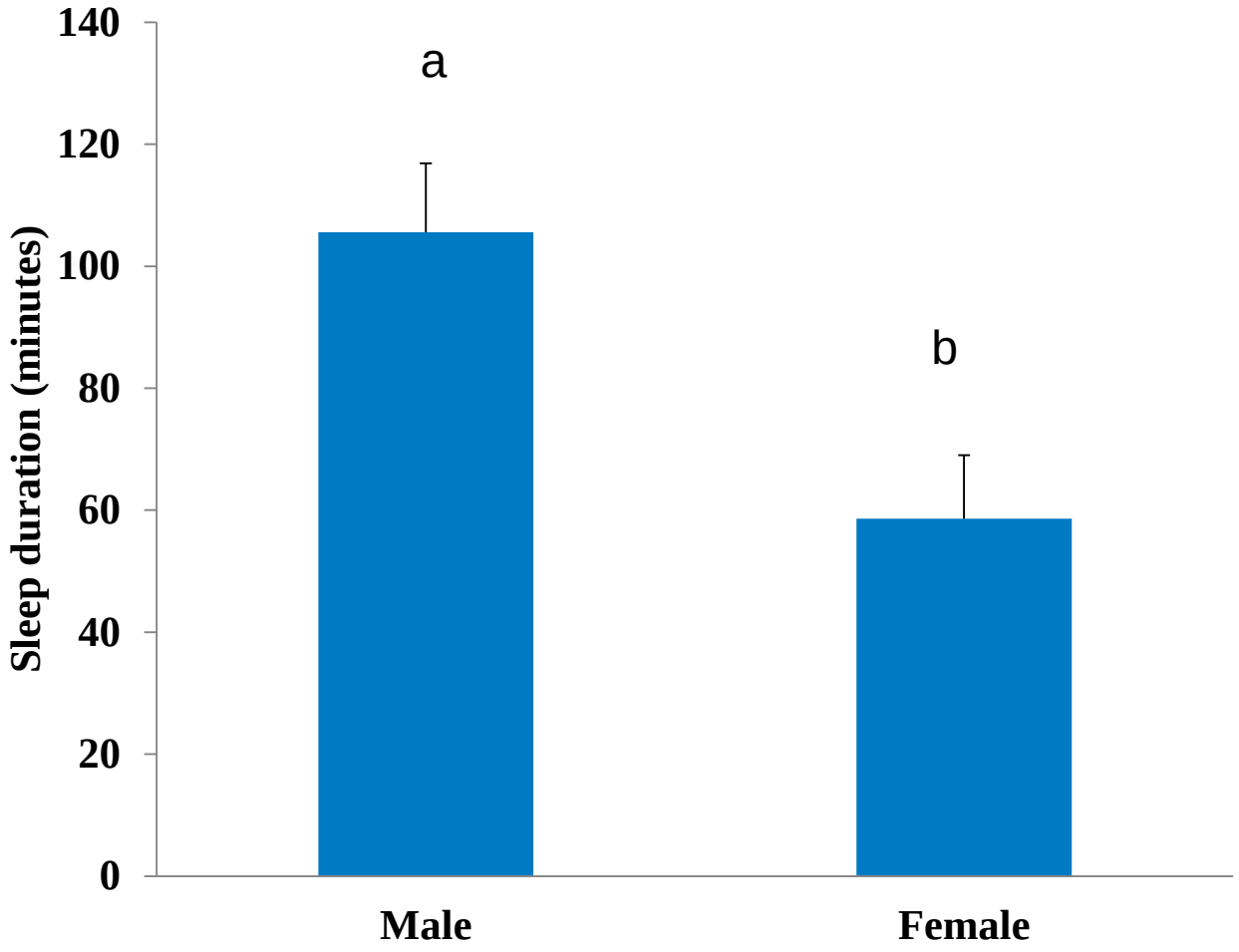
Dust pan in Nyathi

Results

- **Recorded 40 sleep bouts in 8 individuals (4 males; 4 females) with age ranging from 2.5 to 18 years old.**
- **Overall, rhino slept ~90 mins in recumbent sleep at night.**
- **Age and season did not affect (P>0.05) sleep behavior**

Results

Sex did influence (P=0.01) the duration of sleeping bouts

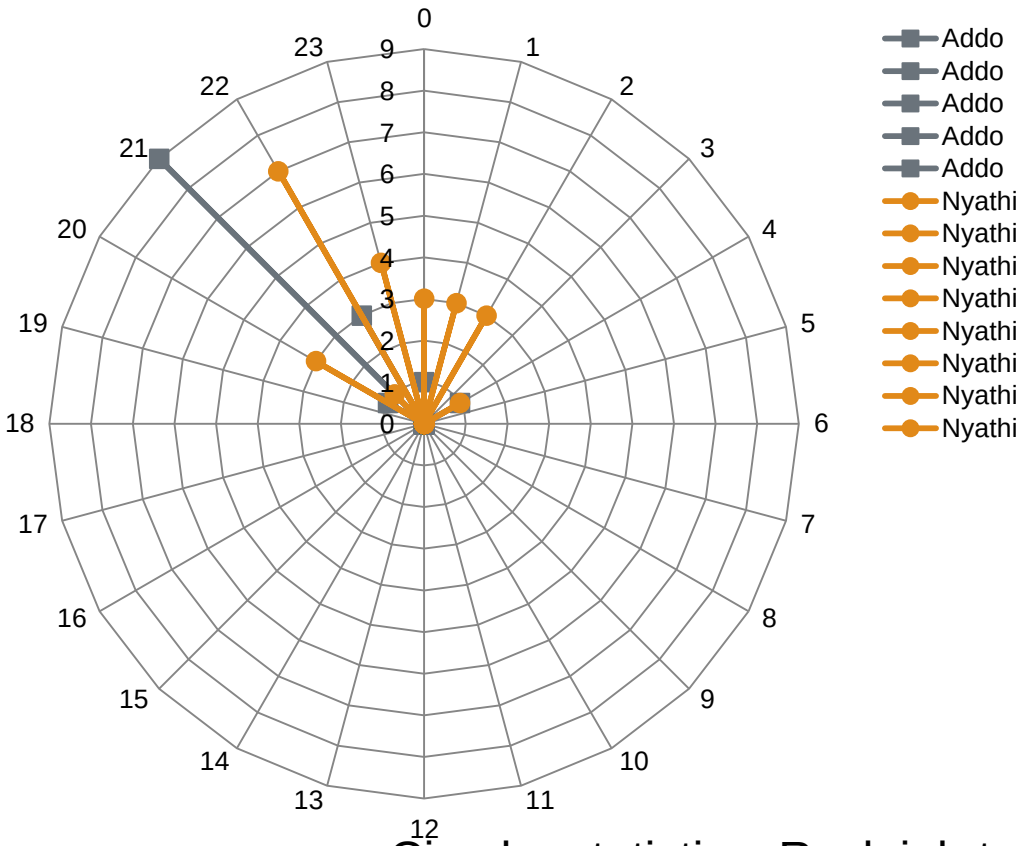


($F_{1,48} = 6.93$, $p = 0.01$)

Wild Black Rhino Sleep Patterns

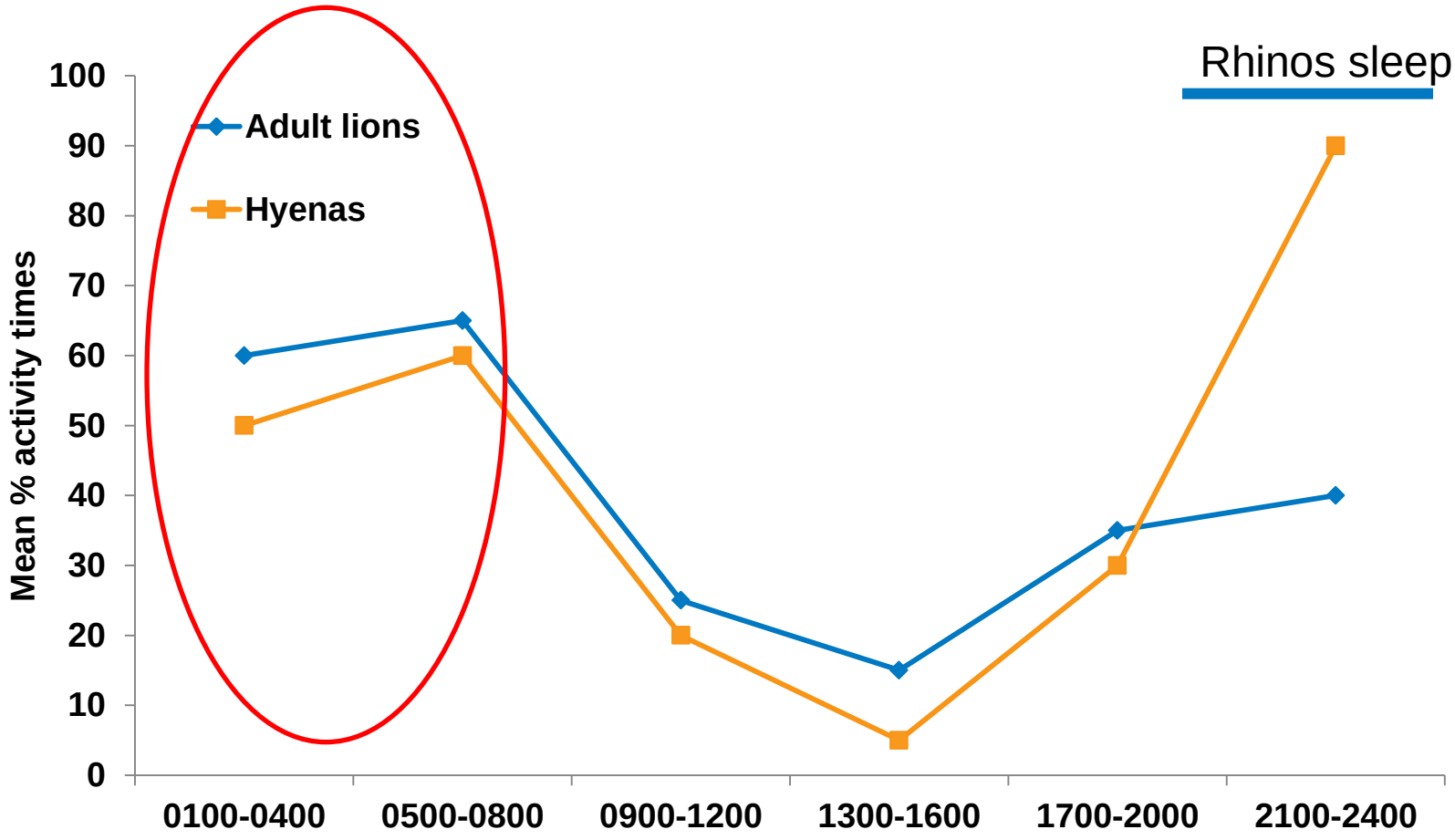
- **Rhino slept between the hours of 8pm and 4am**
- **Park sections (Addo vs. Nyathi) did not influence the duration of sleep, but did affect the time at which the rhinos slept.**

Addo 8pm-mignight
Nyathi 8pm-4am



Circular statistics: Rayleigh test

Activity of Addo Predators



Hayward and Hayward 2006; Afr J Ecol

Next Steps

- Determine the relationship among sleep behavior, hormones (stress & reproduction) and health
- Determine sleep behavior of zoo-housed black rhino

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Besides Rhinos…

Besides Rhinos…

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Besides Rhinos…

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Besides Rhinos…

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Besides Rhinos…

Captures

	Main	Nyathi		Main	Nyathi
Aardvark	0	6	Honey Badger	0	2
Baboons	0	61	Kudu	41	101
BBJ	6	20	Leopard	0	1
Brown Hyaena	0	1	Lion	3	0
Buffalo	12	69	Ostrich	0	19
Bushbuck	0	124	Porcupine	2	12
Bushpig	0	1	Rhino	12	104
Caracal	0	4	Spotted Hyaena	9	0
Eland	0	32	Vervet Monkeys	0	13
Elephant	49	53	Warthog	32	79
Hartebeest	1	52	Zebra	1	90

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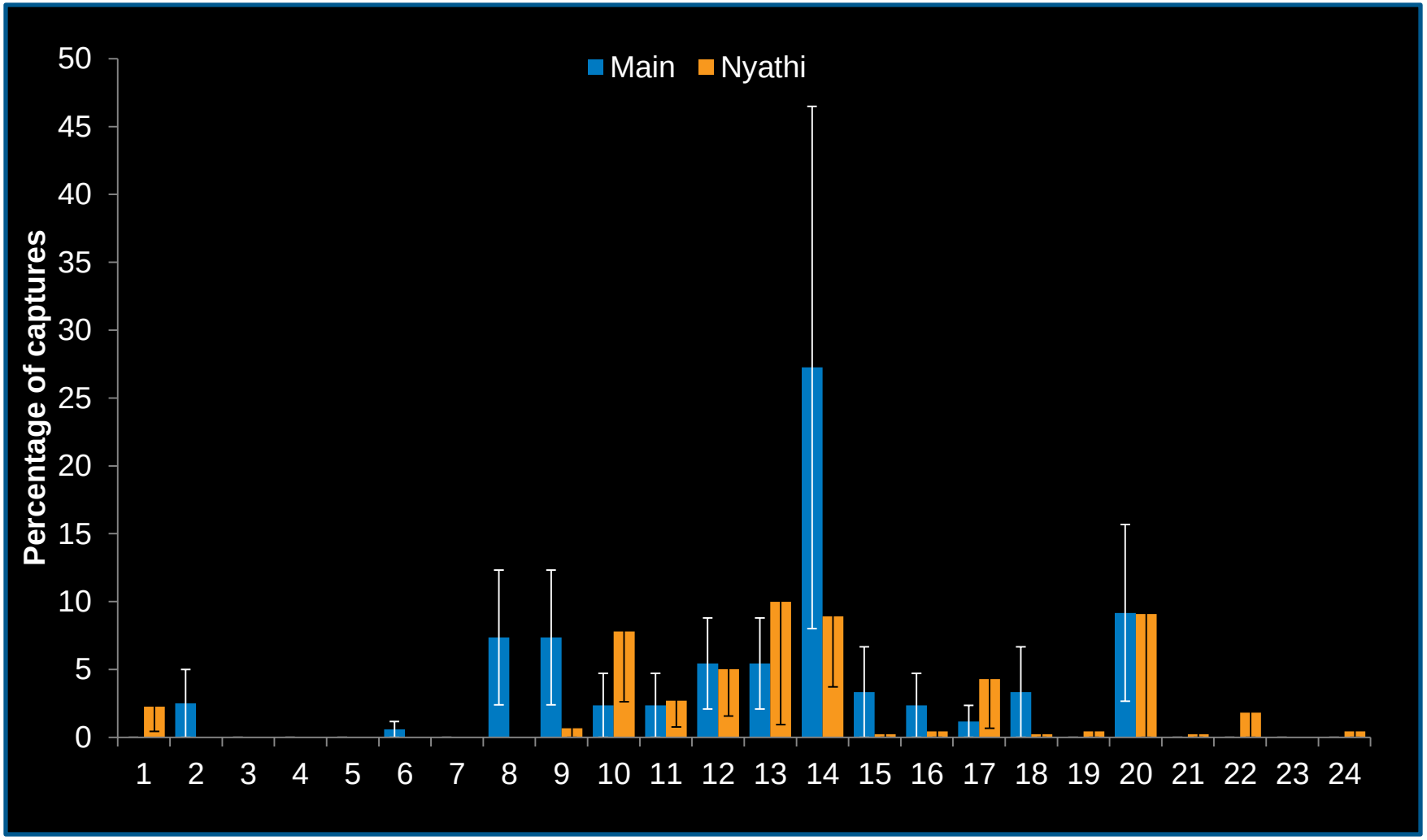
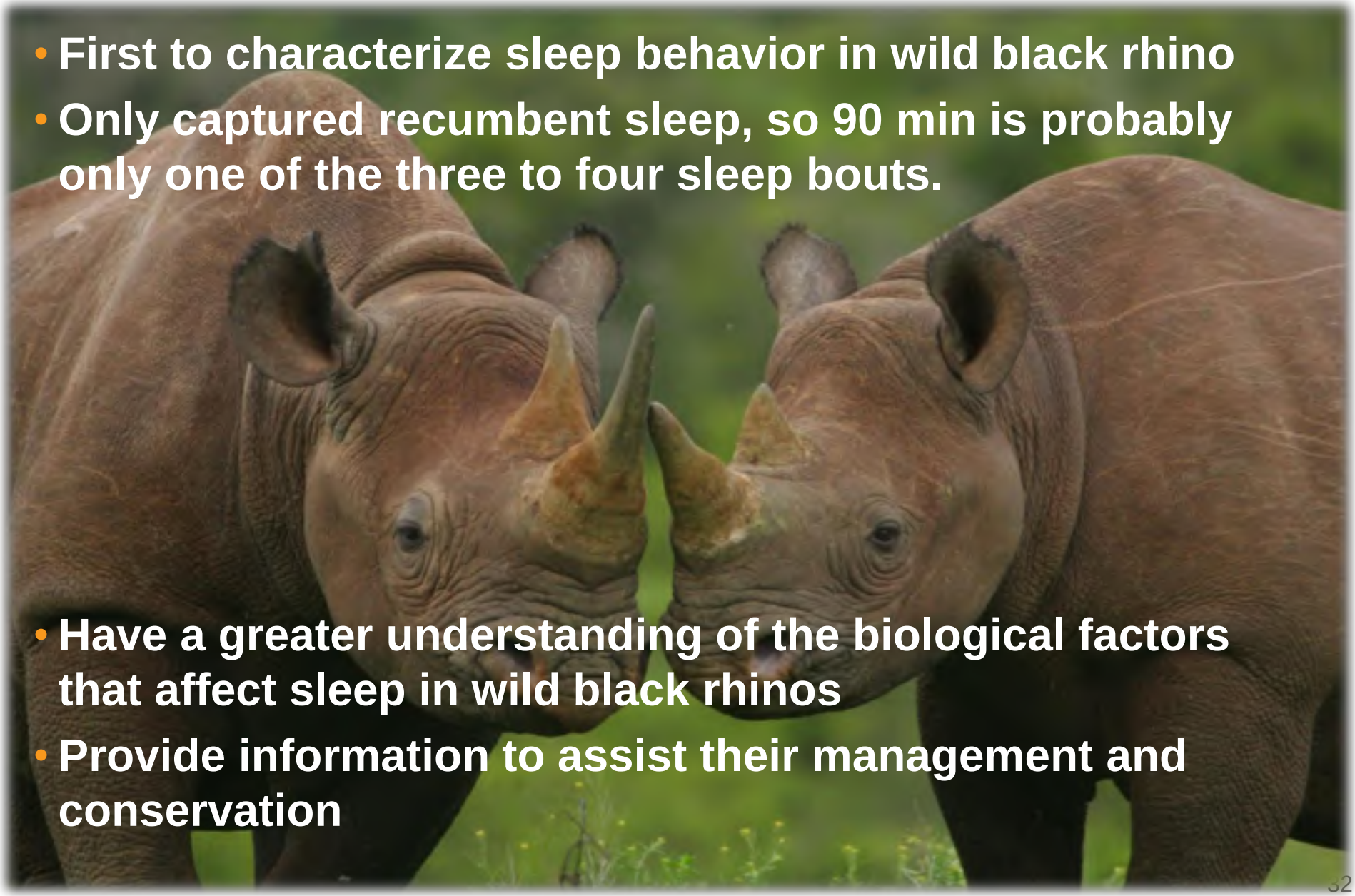
Elephant



Summary



- First to characterize sleep behavior in wild black rhino
- Only captured recumbent sleep, so 90 min is probably only one of the three to four sleep bouts.
- Have a greater understanding of the biological factors that affect sleep in wild black rhinos
- Provide information to assist their management and conservation

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Questions?

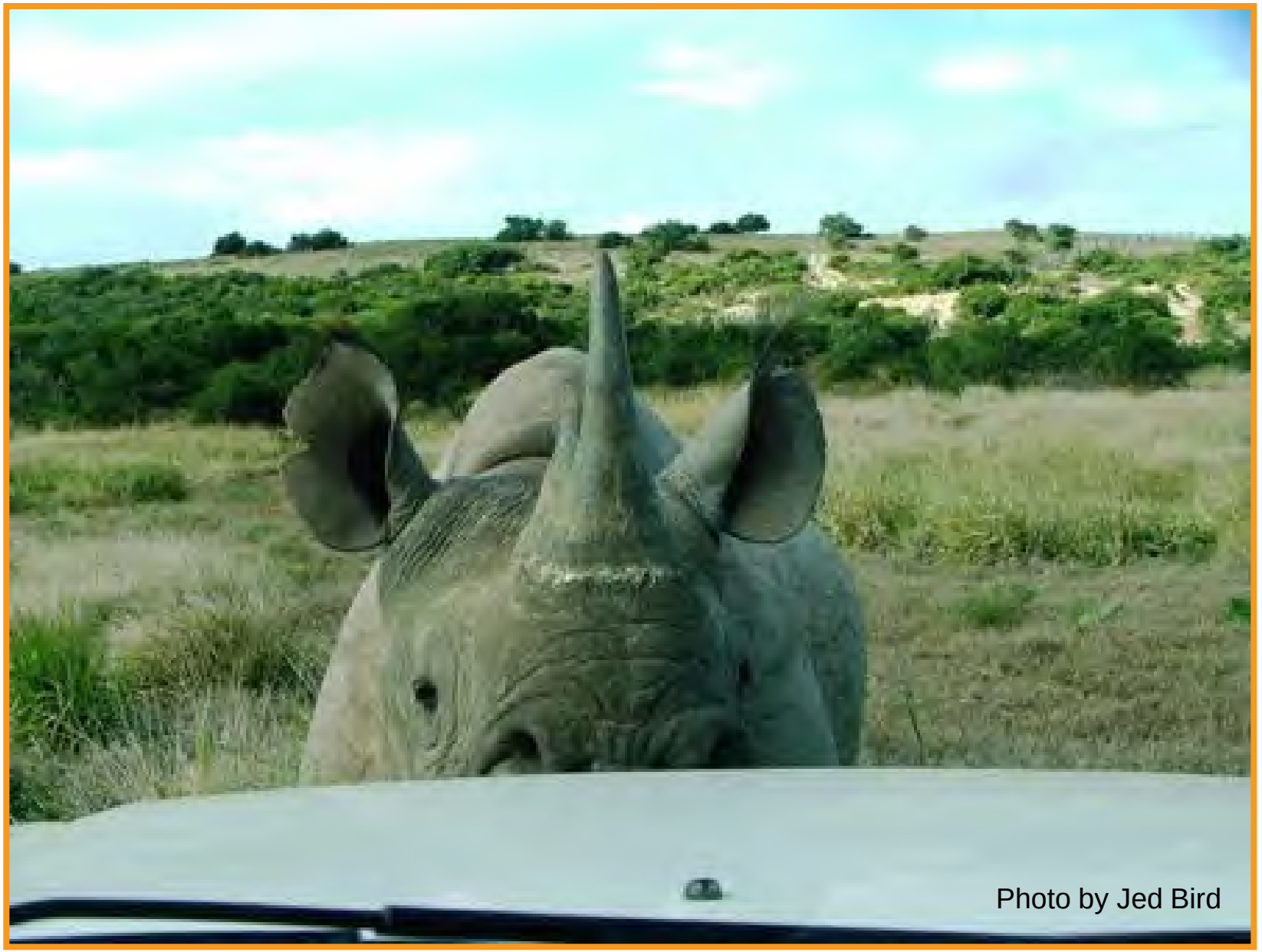

Photo by Jed Bird