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University of Massachusetts Amherst

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A Thesis Presented

by

TANYA M. LAMA

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ABSTRACT

BOTSWANA’S ELEPHANT-BACK SAFARI INDUSTRY – STRESS RESPONSE IN WORKING AFRICAN ELEPHANTS AND ANALYSIS OF THEIR MOVEMENTS POST-RELEASE

MAY 2017

TANYA M. LAMA, B.S. UNIVERSITY OF CONNECTICUT
M.S. UNIVERSITY OF MASSACHUSETTS AMHERST

Directed by: Professor Curtice Griffin

Understanding how African elephants (Loxodonta africana) respond to human interactions in ecotourism operations is critical to safeguarding animal and human welfare and sustaining wildlife ecotourism activities. We investigated the stress response of elephants to a variety of tourist activities over a 15-month period at Abu Camp in northern Botswana. We compared fecal glucocorticoid metabolite (FGM) concentrations across three elephant groups, including: eight elephants in an elephant-tourism operation (Abu herd), three elephants previously reintroduced back into the wild from the Abu herd, and wild elephants. There were no differences in FGM concentrations between the three groups of elephants. The highest observed FGM concentrations were associated with episodic events (e.g. intraherd conflict, loud noise, physical injury) unrelated to tourist activities. FGM concentrations differed between the elephant-tourist activities with ride only and mixed ride/walk activities eliciting higher FGM concentrations compared to days when there were no elephant-tourist interactions.

The elephant experience tourism industry faces challenges in managing elephants who’s aggressive or unpredictable behavior makes them ill-suited to captivity, training, and interaction with handlers and tourists. Reintroduction of these elephants back into the wild may be a favorable solution if the welfare of released individuals, recipient wild animal populations, and human populations can be ensured. We describe the post-release movements of two African elephants, one female and one bull, from an elephant-back-safari enterprise in the Okavango Delta, Botswana. We compared the movements of the female with that of two wild females.
collared in the same wildlife management concession. We assess their home range size, proximity to human dwellings, and fidelity to their former home range as former members of their semi-captive, working herd from which they were released. We found significant differences between the home range size of our released elephant and that of the two wild elephants. Additionally, the released female and released bull occurred more frequently in close proximity (within 250 m) to tourist lodges throughout the Delta. The released elephants also frequented sites used by the working Abu herd with greater frequency than the wild elephants, and this visitation rate did not significantly decline during respective four- and two-year post-release monitoring periods, despite the positive growth in home range size.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>iii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>ix</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>x</td>
</tr>
<tr>
<td>ABBREVIATED TERMS</td>
<td>xii</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td><strong>1. ELEPHANT EXPERIENCE TOURISM IN SOUTHERN AFRICA: MONITORING TOOLS</strong></td>
<td></td>
</tr>
<tr>
<td>FOR RESPONSIBLE MANAGEMENT AND REINTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td><strong>2. STRESS RESPONSES OF AFRICAN ELEPHANTS (Loxodonta africana) TO WILDLIFE ECOTOURISM ACTIVITIES</strong></td>
<td>8</td>
</tr>
<tr>
<td><strong>2.1 Abstract</strong></td>
<td>8</td>
</tr>
<tr>
<td><strong>2.1.1 Key Words</strong></td>
<td>9</td>
</tr>
<tr>
<td><strong>2.2 Introduction</strong></td>
<td>9</td>
</tr>
<tr>
<td><strong>2.3 Materials and Methods</strong></td>
<td>11</td>
</tr>
<tr>
<td><strong>2.3.1 Study site and animals</strong></td>
<td>11</td>
</tr>
<tr>
<td><strong>2.3.2 Elephant – tourist interactions at Abu Camp</strong></td>
<td>14</td>
</tr>
<tr>
<td><strong>2.3.3 Fecal sample collection</strong></td>
<td>16</td>
</tr>
<tr>
<td><strong>2.3.4 Hormone extraction</strong></td>
<td>16</td>
</tr>
<tr>
<td><strong>2.3.5 Radioimmunoassay</strong></td>
<td>17</td>
</tr>
<tr>
<td><strong>2.3.6 Statistical analyses</strong></td>
<td>18</td>
</tr>
<tr>
<td><strong>2.4 Results</strong></td>
<td>19</td>
</tr>
<tr>
<td><strong>2.5 Discussion</strong></td>
<td>24</td>
</tr>
<tr>
<td><strong>2.6 Acknowledgements</strong></td>
<td>27</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table 2.1 Sex, age class and occurrence of riding by tourists of the eight elephants used in Abu Camp ecotourism activities and the three reintroduced elephants (bold highlight) sampled for fecal glucocorticoid metabolite concentrations .................................................................14

Table 2.2: Fecal glucocorticoid metabolite (FGM) concentrations (ng of corticosterone/g of dry fecal matter) for African elephants by age and herd type .................................................................22

Table 2.3: A generalized additive mixed model (GAMM) used to model elephant fecal glucocorticoid metabolite concentrations in relation to elephant-tourist activities, time of day, season, age class, group, and incident occurrence. Estimation of the coefficients (β) are given with standard errors (±SE), and t-values are used to test the significance of parametric terms..................................................................................................................23

Table 3.1: Tracking periods and number of fixes for two released and two wild adult elephants with satellite GPS collars in northern Botswana. All elephants were female with the exception of Mthondo.................................................................................................................................33

Table 3.2: Results from a generalized linear regression used to fit a Gamma model on factors influencing the home range size (95% BBMM) of three female African elephants (Gika, CH63, CH74) .................................................................................................................................40

Table 3.3: Average home ranges (95%) and core areas (50%) (km²) were estimated for two released and two wild elephants from August 1, 2011 to January 31, 2016 in northern Botswana, using Brownian Bridge Movement Model (BBMM) and fixed kernel (KUD) ..........41

Table 3.4: Results from a generalized linear regression used to fit a Gamma model on factors influencing the home range size of three female African elephants (Gika, CH63, CH74) ........48
LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 2.1: The red and blue lines are average high and low temperatures (°C), respectively, and green bars are average monthly precipitation (mm) from 2013 to 2015 from weather stations at the Maun and Kasane airports in northern Botswana (Botswana Department of Meteorological Services)</td>
<td>12</td>
</tr>
<tr>
<td>Figure 2.2: Fecal corticosterone concentrations (ng/g dry fecal weight) for Abu elephants (white), reintroduced herd (light gray), and wild elephants (dark gray) from May 2013 to August 2014. The lower and upper ends of the box indicate the 25 and 75 percentiles, the line within the box indicates the median value. The ends of the vertical lines are defined as the upper and lower quartiles, respectively ± 1.5 times the interquartile distance. Points outside the lines indicate observations recorded outside this range</td>
<td>20</td>
</tr>
<tr>
<td>Figure 2.3: Concentrations of fecal glucocorticoid metabolite (FGM) (nanogram corticosterone per gram dry fecal weight) for Abu herd elephants 24 h after tourist interactions (none=no activity with tourists, ride=elephant-back ride only by tourists, ride/walk=both ride and walk activities by tourists, and walk=tourists only walked with herd. The lower and upper ends of the shaded grey box indicate the 25 and 75 percentiles, the line within the box indicates the mean value</td>
<td>21</td>
</tr>
<tr>
<td>Figure 3.1: The working Abu herd frequents 26 locations within a 5 km radius of the boma for free-range browsing</td>
<td>34</td>
</tr>
<tr>
<td>Figure 3.2: Gika’s wet season home ranges (95% BBMM) concentrated around Abu and Seba camps post-release from 2011 to 2012, expanded in 2013 and contracted again in 2015. Gika’s wet season home range (95% BBMM) expanded 316%, from 81.1 km² post-release in 2011 to 255.9 km² in 2013</td>
<td>43</td>
</tr>
<tr>
<td>Figure 3.3: Gika’s dry season home ranges (95% BBMM) concentrated around Abu and Seba camps post-release from 2011 (44.2 km²) to 2013, expanded in 2014 (229.7 km²), and contracted again in 2015</td>
<td>44</td>
</tr>
<tr>
<td>Figure 3.4: Mthondo’s wet season home range (95% BBMM) expanded from in 2011 to 2013 and demonstrated heavy usage of areas surrounding PomPom and Xaranna (2011 – 2013), Nxabega Tented (2012 – 2013), and Kanana (2013) safari camps in the Okavango Delta</td>
<td>45</td>
</tr>
<tr>
<td>Figure 3.5: Mthondo’s dry season home range (95% BBMM) contracted from 2012 to 2014 with high use of areas surrounding Xigera, Nxabega Tented, PomPom and Xaranna safari camps in 2012. In the 2014 dry season, Mthondo’s home range shifted northwest and contracted, exclusively using areas surrounding Abu and Seba Camps</td>
<td>46</td>
</tr>
<tr>
<td>Figure 3.6: Released elephants Gika (blue) and Mthondo (green) consistently included the Abu elephant boma in their 95% BBMM home range estimates (bars). Their frequency of visitation to the boma is presented as lines on the secondary y-axis, represented as the number of GPS fixes within a 250 m buffer of the boma. Regardless of season, time since release or home range size, Gika and Mthondo’s fidelity to the boma remained consistently higher than that of wild elephants CH63 (purple) and CH74 (red) who had 0 fixes within 250 m of the boma from 2011 to 2015</td>
<td>49</td>
</tr>
</tbody>
</table>
Figure 3.7: The extent of Gika’s core area of use in the 2015 dry season (50% BBMM; 5.3 km²) mimics her use of space immediately post-release in 2011 (50% BBMM; 2.7 km²). Both estimates included frequent use of areas surrounding the Abu elephant boma, Abu Camp, Seba Camp, and sites regularly used by the Abu herd for daily browsing.

Figure 3.8: Gika’s home range expansion in the 2013 wet season (left) and 2014 dry season (right) exhibited close proximity (within 250 m and 1 km buffers) of several safari camps in the Okavango delta.
ABBREVIATED TERMS

BBMM – Brownian Bridge Movement Model
CITES – Convention on International Trade in Endangered Species of Wild Fauna and Flora
DWNP – Department of Wildlife and National Parks
edf – estimated degrees of freedom
EWB – Elephants Without Borders
FGM – Fecal Glucocorticoid Metabolite
GAMM – Generalized Additive Mixed Model
GIS – Geographical Information Systems
GLM – Generalized Linear Model
GPS – Global Positioning System
HEC – Human Elephant Conflict
KUD – Kernel Utilization Distribution
SE – standard error
WMA – Wildlife Management Area
ELEPHANT EXPERIENCE TOURISM IN SOUTHERN AFRICA: MONITORING TOOLS FOR RESPONSIBLE MANAGEMENT AND REINTRODUCTION

African elephants (*Loxodonta africana*) are the largest living land mammal on earth (Laws 1966, Hanks 1969) and serve vital functions ecologically as keystone species and habitat engineers (Laws et al. 1970, Cumming 1982, Kortlandt 1984, Western 1989). As cultural icons of African heritage, they are known for their intelligence, close family ties and social complexity (Moss 1988) and have become a principle driver of the wildlife tourism industry in southern Africa (Kerley et al. 2003, Mbaiwa 2008).

Elephants once populated the entire African continent, inhabiting a diversity of ecosystems including dense forest, open and closed savannah, grassland, and desert (Mauny 1956, Douglas-Hamilton 1979). African elephants are distributed across 37 countries, but their status varies substantially across their range (Blanc et al. 2008). Recent (2014-15) aerial surveys of savanna elephants were conducted in 18 countries as part of the Great Elephant Census (Chase et al. 2016). Overall, the census confirmed a massive population decline of roughly 30 percent (144,000 elephants) between 2007 and 2014. Carcass ratios in northern Cameroon and Zambia, exceeding 80% of the population, indicate that the population decline is primarily due to poaching but also as a result of habitat loss and fragmentation over the past 150 years (Chase et al. 2016). African elephants have already been locally extirpated in Burundi, Gambia, Mauritania, and Swaziland (Blanc et al. 2008). The southern African region, including Botswana, South Africa, Namibia, Malawi, Angola, Zambia, Zimbabwe, and Mozambique, are the most stable and secure region of the African elephant range.

Botswana currently supports the largest and most stable elephant population of any country, estimated at 130,451 individuals despite significant shifts and declines elsewhere in the
region (Chase et al. 2016). Elephants in Botswana occur in two major regions, the northern range, which is the focus of this research, and Tuli Block in Mashatu Game Reserve (Spinage 1990). Variability in water availability can shift elephant range significantly from season to season and year to year. The wet season range is significantly larger, covering an area of 115,800km² extending from the Boteti River north to the Kwando – Chobe – Linyanti river system, and east-west to the Namibian and Zimbabwean borders. Dry season distributions are noticeably concentrated around perennial water sources in river systems along the Botswana/Namibia border (Chase et al. 2016). Within the elephant range, there are five broad habitat types defined by the dominant tree species -- riverine woodland, Acacia woodland, *Colophospermum mopane* woodland, Terminalia/Burkea woodland, and *Baikeaia plurijuga* woodland. Various combinations of these types also occur, with mixed dominance of the major species. Concern has been expressed over elephant impact on these habitat types, particularly in protected areas and surrounding perennial water sources where high elephant densities alter vegetation structure (Guldemond and Van Aarde 2008, Valeix et al. 2011).

Botswana’s conservation efforts and legislative initiatives have contributed to expansion of the elephant range and maintenance of a stable population within its borders. Initiatives include a ban on sport-hunting (1983 – 1994, Vandewalle and Alexander 2014) and establishment of a highly specialized and trained Anti-Poaching Unit that provides security and legal protection (CITES Prop 11.21, Kidd and Cowling 2003). Further, the elephant range is expanding in northern Botswana into previously un-occupied areas (CITES Prop 12.6), and nearly 80% of Botswana’s elephant range extends beyond the boundaries of formally protected wildlife areas (Chase et al. 2016), increasing the likelihood of human-elephant conflict (Jackson 2008).

Tourism is now the second largest contributor to Botswana’s economy, with more than 2 million international visitors annually since 2006 (Botswana Department of Tourism 2014). Much of this tourism is focused on “wilderness” branding that emphasizes low-impact, high-value
attractions (Mbaiwa and Darkoh 2006, Atlhopheng and Mulale 2009, Duffy 2014). Nature-based tourist attractions are mainly to the north, around the Okavango Delta and at popular protected areas including the Kgalagadi Transfrontier Park, Chobe National Park, Moremi Game Reserve and Makgadikgadi National Park (Moswete et al. 2009, Muchapondwa and Stage 2013). The industry is skilled at marketing new tourism experiences, transforming wilderness into “must see” locations and developing wildlife into “interactive” experiences. This phenomenon includes close encounters with animals, which can be marketed as unique and highly-coveted sensory experiences (Bulbeck 2004, Carr and Cohen 2011).

The elephant-experience industry in southern Africa employs roughly 215 captive and semi-captive animals at 39 commercial venues and advertises the unique opportunity to observe, feed, touch, walk, or ride atop elephants (Appendix A, Table A.1). The first commercial venue that offered elephant-back rides in Africa opened in Botswana in the late 1990s. Availability of elephant-back rides has expanded to 25 venues throughout Southern Africa, with the exception of Angola, Malawi, Namibia, and Mozambique (Appendix A, Table A.1). Elephants for the tourism industry were sourced from the population of calves and juveniles orphaned by elephant culling operations in South Africa prior to 1995 (Moore 2000, Evans et al. 2013a,b). Individual elephants that could not easily or successfully be returned to the wild were also acquired from zoos, circuses and safari parks internationally.

The development and expansion of the elephant-experience industry in southern Africa has raised ethical concerns about animal welfare and human safety. Locally based practices vary significantly in the number of elephants employed, activities offered, and general management and training of the herds. Critics of the industry call for the development of standards for working elephants so that tour operators and tourists know they are not supporting cruel practices (Duffy and Moore 2011). Furthermore, deaths and injuries of elephant handlers have spurred debate about whether elephant management practices cause undue stress to working animals, causing them to act out in fear or aggression. In a growing number of
countries, higher standards of elephant care are being implemented by identifying welfare parameters (Varma 2008) and developing policies and guidelines that reduce stress and allow elephants to maximize their natural behaviors and social interactions (Olson 2004).

Stress is a physiological and behavioral response that can be used by managers as a parameter to monitor animal welfare. An animal is in a stressed state if extreme adjustments to its physiology or behavior are required to cope with aspects of its environment (Friend 1980). Hormonal secretions can provide the energy required to cope with a limited availability of resources, courtship behavior, or other psychosocial or stressful circumstances (e.g. translocation, culling, human conflict; Garai et al. 2004). However, chronic stress can compromise an animal’s immune function, reduce disease resistance, and provoke uncharacteristic aggression (Romero 2004, Bradshaw and Schore 2007, Teixeira et al. 2007, Twine and Magome 2008, Dickens et al. 2010). Understanding how animals respond to management practices enables tourism operators to better manage human-wildlife interactions, safeguard animal welfare, and ultimately develop more sustainable activities (Jacobson and Lopez 1994, McNeilage 1996, Muller et al. 2004, Ellenberg et al. 2007, Millspaugh et al. 2007, Karp and Root 2009).

Physiologically, stress hormone levels can serve as parameters to evaluate the effect of management actions on animals (Garai et al. 2004, Reefer and Kramer 2005, Santymire et al. 2012). Corticosterone is a steroid hormone released from the adrenal cortex in response to perceived stress (Reeder and Kramer 2005, Santymire et al. 2012, Appendix B, Fig. B.1). Non-invasive sampling (e.g. collection of urine or feces) can be used to obtain biological materials for hormone extraction without subjecting animals to capture and restraint. These methods have been applied successfully to wild and captive study animals including African elephants (Millspaugh and Washburn 2004, Mostl and Palme 2002, Palme et al. 2005, Touma and Palme 2005) under a variety of contexts including physical injury (Ganswindt et al. 2010), long distance translocation (Viljoen et al. 2008, Pinter-Wollman et al. 2009a), zoo-living animals (Mason and
Veasey 2010), hunting pressure (Burke et al. 2008), crop-raiding (Ahlering et al. 2010), reintroduction to the wild (Jachowski et al. 2013) and human-elephant conflict (Ahlering et al. 2013).

Millspaugh et al. (2007) was the only study to report on corticosteroid hormone concentrations in an African elephant-experience operation. They reported that elephants secreted slightly higher concentrations of fecal glucocorticoid metabolites (FGMs) on days when they interacted with tourists compared with days when they did not. The highest hormone concentrations, however, were not associated with tourist activities, but were coincident with episodic loud noises such as thunderstorms and fireworks (Millspaugh et al. 2007). However, this study did not consider differential responses to the variety of activities that elephants routinely participate in at a commercial venue, ranging from non-invasive observation to feeding, physical touch, and riding. To fill this information gap, I quantified the corticosterone hormone concentrations in working animals at an elephant-experience operation (Chapter 2). I compared these values to wild individuals and to elephants previously released back into the wild from the same commercial venue. Second, I evaluated the effect of each elephant-tourist activity on the corticosterone hormone concentrations of the working elephants.

Elephant experience operations are faced with the prospect of releasing captive animals into the wild once they reach adolescence or adulthood. Principal reasons for releasing a captive elephants back into the wild include: lack of sufficient space or resources, closure of a facility, pressure from animal rights activities, and risks to the safety of elephant handlers or other elephants in the captive herd. Captive elephants deemed unmanageable, often adolescent or adult males, have been reintroduced to the wild using both hard and soft release techniques with mixed results, with minimal or no scientific data on release success and long-term outcomes (Grobler et al. 2008).

Satellite GPS collars and ground observations have been used to monitor the status and movements of released elephants. Yet, captive-reared animals often experience transitioning
challenges when released into the wild and success in these endeavors has typically been low or completely unknown (Griffith et al. 1989). Release success and animal welfare can be compromised when captive-reared animals show signs of disorientation or seek human contact (Yeager 1997, Woodroffe and Ginsberg 1999, Letty et al. 2000, Swaisgood 2010, Matějů et al. 2012). Further, little is known about how successfully released African elephants integrate into wild populations, if at all, or whether they pose a threat to human safety. Instances of behavioral aggression have been documented in both male and female released African elephants (Slotow and Van Dyk 2001, Slotow et al. 2001, Fernando 2012). For example, a reintroduction effort in South Africa resulted in aggressive and destructive behaviors by a group of adolescent male elephants that resulted in the goring of >100 white rhinoceroses (*Ceratotherium simum*) and several black rhinoceroses (*Diceros bicornis*) (Slotow et al. 2001). In separate instances, four female elephants released from captivity killed a person (Slotow et al. 2008). Given these outcomes, an examination of post-release elephant movements is needed to increase the success of future releases and to better safeguard the welfare of released animals and humans.

In Chapter 3, I used two methods to estimate the home range size of two elephants released from an elephant-back safari venue in the Okavango Delta, Botswana. I described patterns in the size and distribution of their home ranges over several years and compared their use of space with two wild elephants collared within the study area. I also determined their site fidelity to the safari camps and spatial association to the captive herd from which they were released.

The purpose of this study was to provide managers and elephant handlers with information to better manage elephant experience tourism operations and elephant reintroduction efforts. Furthermore, the stress monitoring protocols developed as a part of this study may serve as a useful tool for elephant managers to track responses to management actions.
This thesis contains two chapters formatted for publication in scientific journals. Chapter 2 discusses research on the stress response of elephants to a variety of tourist activities at an elephant-back-safari enterprise in northern Botswana. Chapter 3 presents the results of research on the post-release movements of two African elephants, one female and one bull, from the same elephant-back-safari enterprise in northern Botswana.
CHAPTER 2

STRESS RESPONSES OF AFRICAN ELEPHANTS (Loxodonta Africana) TO WILDLIFE ECOTOURISM ACTIVITIES

2.1 Abstract

Understanding how African elephants (Loxodonta africana) respond to human interactions in ecotourism operations is critical to safeguarding animal and human welfare and sustaining wildlife ecotourism activities. We investigated the stress response of elephants to a variety of tourist activities over a 15-month period at Abu Camp in northern Botswana. We compared fecal glucocorticoid metabolite (FGM) concentrations across three elephant groups, including: eight elephants in an elephant-tourism operation (Abu herd), three elephants previously reintroduced back into the wild from the Abu herd, and wild elephants. There were no differences in FGM concentrations between the three groups of elephants. The average 1% difference in FGM concentrations between seasons was not statistically detectable in any of the three elephant groups. The highest observed FGM concentrations were associated with episodic events (e.g. loud noise, physical injury, intraherd conflict) unrelated to tourist activities. FGM concentrations differed between the elephant-tourist activities with ride only and mixed ride/walk activities eliciting higher FGM concentrations compared to days when there were no elephant-tourist interactions. No difference was found when tourist activities were limited to walk only and “meet and greet” compared to days with no elephant-tourist interactions. We conclude that elevated stress induced by riding and mixed riding/walking activities is below the biologically meaningful effect size of 20 ng/g, and unlikely to affect the fitness of the animals. Further, surveys indicated that Abu guests found great value in their elephant experiences, considered their interactions with the Abu elephants appropriate, and greatly increased their knowledge about elephants.
2.1.1 **Key words:** Botswana, elephant-back riding, human-elephant interactions, fecal glucocorticoid metabolite, stress response

2.2 **Introduction**


In Africa, elephant experiences are increasing (Mbaiwa 2008, Kerley et al. 2003), providing tourists the opportunity to interact with Earth’s largest land mammal. Most of these elephant-experience operations are located in South Africa, Botswana, Zimbabwe and Zambia (Duffy and Moore 2010), and range from touching and feeding to walking alongside or riding atop elephants. In response to concerns about elephant-experience ecotourism, the South African Department of Environmental Affairs and Tourism established minimum standards for management of captive elephants (Staatskoerant 2009). Under these standards, elephant
managers and handlers are charged with the obligation to avoid undue “stress and disturbance” to the animals while also minimizing potential threat to human welfare.

Corticosteroid hormones, cortisol and corticosterone, have been used as a measure of stress in African elephant serum, urine and feces under a variety of contexts, including long-distance translocation (Viljoen et al. 2008, Pinter-Wollman et al. 2009a), captivity (Mason and Veasey 2010), hunting pressure (Lamoureux et al. 2011), crop-raiding (Ahlering et al. 2011), reintroduction to the wild (Jachowski et al. 2013), and human-elephant conflict (Ahlering et al. 2013). Local and site-specific stressors such as daily and monthly patterns in temperature and rainfall (Gobush et al. 2008), and seasonal variation in the availability of forage (Chinnadurai et al. 2009) and water (Foley et al. 2001, Burke 2005, Woolley et al. 2009) can affect physiological stress responses in elephants. Seasonal climatic conditions (Millspaugh et al. 2001, Huber et al. 2003, Dalmau et al. 2007) such as high daily maximum temperature have been linked to increased stress hormone concentrations in elephant family groups (Pretorius 2004, Burke 2005).

Millspaugh et al. (2007) is the only study reporting stress hormone concentrations in an African elephant-experience operation. They reported that elephants have slightly higher concentrations of fecal glucocorticoid metabolites (FGMs) on days when they interacted with tourists compared with days when there were no interactions. Yet, this study did not consider different types of human interaction or frequencies of interactions. Further, they reported that the highest concentrations of stress were associated with episodic loud noises, such as thunderstorms and fireworks (Millspaugh et al. 2007).

The goal of this study was to determine if human-elephant interactions associated with an elephant-experience operation at the Abu Camp in Botswana caused stress-induced responses in elephants. Our first objective was to determine the stress hormone concentrations, measured by FGMs, in an elephant herd regularly used in an elephant-experience operation in comparison to wild elephants and a group of elephants previously reintroduced back into the
wild from the elephant-experience operation. Secondly, we sought to understand the relationships between FGMs in the safari herd in relation to a variety of elephant-tourist activities. This study of the effects of human-elephant interactions on elephants will help elephant handlers and elephant-experience managers ensure the welfare of elephants used in their operations and minimize stress to elephants caused by tourist activities.

2.3 Materials and Methods

2.3.1 Study site and animals

Abu Camp was the first operator to develop elephant-experiences in southern Africa in the late 1990s, offering tourists the opportunity to get “up close and personal” with elephants and as a more “natural” means of viewing wildlife on safari (Moore 2000). Abu Camp is located in northern Botswana at the southwest corner of the Okavango Delta. The camp is in a wildlife management area designated as NG26, and encompasses about 1,850 km². Formerly used for big game sport hunting, NG26 was converted to a non-consumptive wildlife management area in 2009, and is now used exclusively for photographic safaris. Dominant land covers within NG26 include perennial swamps, seasonally inundated floodplain grasslands, and dry acacia (Acacia spp.) and mopane (Colophospermum mopane) shrublands (de Wit and Bekker 1990). This region of the Okavango Delta undergoes significant changes between seasons and years as a result of variation in the strength and duration of seasonal floods. The highlands of Angola are the water source for the seasonal floods that typically peak in our study area in July/August at the height of the dry season (May – October) when temperatures range between 0 – 35°C and total monthly precipitation can amount to less than three centimeters (Fig. 2.1). The hottest (15 – 39°C) and driest period of the year occurs at the end of the dry season (September to October) when the floods have receded. The wet summer extends from November – April with temperatures ranging between 14 – 39°C and average precipitation can amount to more than 100 mm per month (McCarthy and Ellery 1998, Kinahan et al. 2007, Mendelsohn et al. 2010).
For our study, wet and dry seasons were delineated based on daily rainfall averages from the Kasane and Maun airports in northern Botswana. Following Wittemyer et al. (2004), we designated the beginning of the dry season as the date following 30 days without rain, and the wet season began after 1 week with a minimum of 15mm of rain (the approximate amount of precipitation required to observe a vegetative response).

**Figure 2.1:** The red and blue lines are average high and low temperatures (°C), respectively, and green bars are average monthly precipitation (mm) from 2013 to 2015 from weather stations at the Maun and Kasane airports in northern Botswana (Botswana Department of Meteorological Services).

The Abu elephant herd was established by Elephants for Africa founder, Randall Moore in 1990 (Moore 2000). The first members of the Abu herd were captive adult elephants from zoos, safari parks, and circuses, later incorporating calves orphaned by herd reduction operations in South Africa and western Uganda. He eventually settled the herd at Abu Camp in Botswana in 1997 where the elephants were trained for elephant-back safari rides, tourist interactions, and film appearances.

For our study, the elephants used in the elephant-experience operation, referred to as the ‘Abu herd’, were comprised of eight African elephants, of which all had been either born or
raised in captivity (Table 2.1). During the night, these elephants are kept unrestrained in a boma (a fenced shelter). The three ‘reintroduced elephants’ used in the study were formerly part of the Abu herd until Nandipa’s reintroduction to the wild in 2008 and Gika and Naya’s reintroduction in 2011, when they were released within NG26 (Table 2.1). The wild elephants used in the study are highly transient with wide-ranging movements within and through the NG26, consequently, we were not able to identify individual elephants. Aerial surveys of African elephants in NG26 prior to our study indicated that wild elephant populations ranged from 3,120 in September 2012 to 440 in February of 2013, reflecting the higher numbers of elephants in the concession during the dry season when herds concentrate to access water from the seasonal floods and their subsequent dispersal during the wet season when seasonal pans are available throughout northern Botswana.
Table 2.1 Sex, age class and occurrence of riding by tourists of the eight elephants used in Abu Camp ecotourism activities and the three reintroduced elephants (bold highlight) sampled for fecal glucocorticoid metabolite concentrations.

<table>
<thead>
<tr>
<th>Name</th>
<th>Sex</th>
<th>Age</th>
<th>Riders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathy</td>
<td>F</td>
<td>Adult</td>
<td>2x Tourist + 1x Handler</td>
</tr>
<tr>
<td>Sherini</td>
<td>F</td>
<td>Adult</td>
<td>2x Tourist + 1x Handler</td>
</tr>
<tr>
<td>Kitumetse</td>
<td>F</td>
<td>Adult</td>
<td>2x Tourist + 1x Handler</td>
</tr>
<tr>
<td>Lerato</td>
<td>F</td>
<td>Sub-Adult/Juvenile</td>
<td>1x Handler</td>
</tr>
<tr>
<td>Abu²</td>
<td>M</td>
<td>Sub-Adult/Juvenile</td>
<td>1x Handler</td>
</tr>
<tr>
<td>Paseka</td>
<td>F</td>
<td>Sub-Adult/Juvenile</td>
<td>1x Handler</td>
</tr>
<tr>
<td>Warona</td>
<td>F</td>
<td>Calf</td>
<td>none</td>
</tr>
<tr>
<td>Naledi</td>
<td>F</td>
<td>Calf</td>
<td>none</td>
</tr>
<tr>
<td>Nandipa</td>
<td>F</td>
<td>Adult</td>
<td>none</td>
</tr>
<tr>
<td>Gika</td>
<td>F</td>
<td>Adult</td>
<td>none</td>
</tr>
<tr>
<td>Naya</td>
<td>F</td>
<td>Adult</td>
<td>none</td>
</tr>
</tbody>
</table>

¹ Died during study on January 11, 2014 due to post-partum complications
² Abu was an adolescent (10 yr old) male elephant who voluntarily left the Abu herd in July 2013 soon after our study began.

2.3.2 Elephant – tourist interactions at Abu Camp

Tourists at Abu Camp have several opportunities to interact with the Abu herd. At the boma every morning at ~ 0630 hrs, the elephants receive dietary supplements and the adult and sub-adult elephants are briefly (< 15 minutes) chained by the fore-right foot while handlers provide positive reinforcement training, necessary medical attention and saddles for elephant-back rides. Only the three adult elephants (Cathy, Sherini, Kitumetse, Table 2.1) are saddled and then ridden by their handler to a nearby elevated platform where a maximum of two tourists board the elephants. The handler sits astride the elephant’s neck and tourists ride on a double saddle. Some tourists choose to walk with the elephants instead of riding. The sub-adult and juvenile elephants (Lerato, Paseka, Abu) are not ridden by tourists, but are ridden without a saddle by a single handler during activities. The two calves (Warona, Naledi) simply follow the herd, interacting with handlers and tourists.
Morning safaris depart from the *boma* at ~0700 hrs and conclude approximately one hour later at a remote location in the bush, where tourists dismount elephants at a platform. At the conclusion of the ride, the elephants are lined up behind a low fence barrier and provided a food reward by the tourists and handlers. After the morning ride has ended, the Abu elephants are allowed to range freely and browse under the supervision of at least two elephant handlers. During this time, the Abu elephants are free to interact with free-ranging wild elephants. The free-range browsing can extend for the next eight to nine hours, except on days when new tourists arrive at the camp. On these days, the Abu herd is reassembled for a “meet and greet” activity, where handlers provide a brief educational introduction and allow interaction with the elephants but no riding or walking with the elephants. The meet and greet activity typically involves tourists touching and feeding of the elephants. After the meet and greet, the elephants continue their free-range browsing. The handlers reassemble the Abu herd in late afternoon (~1530 hrs) to meet tourists for another safari ride or walk-along that ends back at the *boma* by sunset (~1800 hrs).

During the study (May 2013 through August 2014), the Abu herd manager compiled daily reports, detailing the occurrence of tourist activities, number of participants, browsing locations, number of “walkers” and “riders” on morning and afternoon safaris, and the occurrence of “meet and greets” with tourists. Reports also recorded whether there were any tourists in camp and whether or not tourists interacted with the Abu herd. Reports also detailed potentially stress-inducing events, such as encounters with wild elephants, internal conflicts within the Abu herd, medical needs, injuries, or episodic noise events such as thunderstorms or discharge of a shotgun. The occurrence of tourist activities were compiled from reports and used as covariates in the data analyses.
2.3.3 Fecal sample collection

We evaluated the stress response via FGM concentrations in fecal samples in three elephant groups, including: the Abu herd used in elephant-tourist interactions, the three reintroduced elephants, and wild elephants. We collected fresh (<12-h-old) elephant fecal samples between May 2013 and August 2014. Our sampling scheme for the Abu herd encompassed the various activities typical of their daily events. Samples were collected prior to the morning safari, during morning safari, in-between morning and afternoon safaris, during afternoon safaris, and 24-36 h after any potentially stress-inducing “incidents” described in the daily reports. For comparison to the Abu herd, fecal samples were collected regularly (~3 samples per week) from the three reintroduced female elephants, and opportunistically from wild female elephants. Two of the reintroduced elephants (Gika and Naya) had GPS radio telemetry collars that allowed us to track them to obtain fecal samples. Wild and reintroduced elephants were observed from a distance and identified to sex based on body size, tusk length and ear morphology (Chelliah and Sukumar 2013, Rees 2015). Fecal samples were obtained from known individuals for the Abu and reintroduced herds. Once an elephant defecated, the fecal bolus was opened and pieces were subsampled from the interior without mixing (Tingvold et al. 2013). The feces was placed in 50 mL sterile plastic tubes and frozen at -20°C within 2 h. Prior to overseas shipment to the lab for analyses, each sample was treated with 2% acetic acid solution, and later shipped frozen to the San Diego Zoo Institute for Conservation Research. Upon arrival, significant thawing of the shipment was noted. The samples were promptly re-frozen and remained frozen until hormone extraction.

2.3.4 Hormone extraction

Samples were lyophilized for 96 h using a freeze dryer (Flexi-Dry, FTS Systems, Inc. Stone Ridge, NY) prior to hormone extraction. After drying, the elephant fecal samples were pulverized and sifted through a stainless steel mesh to remove debris. A 0.2 g aliquot of dried,
sifted, and homogenized fecal sample was put into a 16 x 100 mm glass tube for hormone extraction. Fecal glucocorticoid metabolites were extracted by adding 5 mL of a phosphate-saline buffer containing 50% methanol, 0.1% bovine serum albumin, and 0.05% Tween 20 (polyoxyethylene sorbitan monolaurate, a surfactant) and rocked overnight for 16 hours at 400 RPM. The next day, samples were removed from the rocker and allowed to settle for one hour. A portion of each extract was pipetted into a different test tube and centrifuged for one hour at 4000 RPM. The extract was then decanted into a new, clean test tube, capped and refrigerated at -4°C until assayed (immediately) or frozen at -20°C until analysis.

2.3.5 Radioimmunoassay

Extracted fecal glucocorticoid metabolites were measured by ³H radioimmunoassay (RIA) using an antibody produced against corticosterone-3-carboxymethylisoxime: BSA (ICN Biomedicals, Costa Mesa, CA). The antibody cross reacts 100% with corticosterone, 2.30% with desoxycorticosterone, 0.47% with testosterone, 0.35% with prednisolone, 0.33% with 17α-hydroxyprogesterone, 0.27% with cortisol, 0.17% with progesterone, 0.14% with 11-desoxycortisol, 0.07% with 20α-dihydroprogesterone, 0.05% with aldosterone, 0.03% with dihydrotestosterone, 0.02% with androstenedione and <0.01% with 20α-dihydroprogesterone, cortisol, estradiol-17β, dihydroepiandrosterone-sulfate and 17α-hydroxypregnenolone.

Samples were brought to room temperature, and tritiated corticosterone (10,000 cpm, PerkinElmer Life Sciences, Boston, MA, USA) was used in the assay to compete with endogenous glucocorticoid metabolites. A 50 µL portion of the elephant fecal extract was pipetted into labeled 12 X 75 mm tubes in duplicate then 300 µL of phosphate buffered saline (PBS) with bovine serum albumin (BSA 0.35%) and 150 µL PBS without BSA was added to each tube. The antibody was added as a final step and the assay was incubated overnight at 4°C. Following incubation, 250 µL of charcoal dextran solution (6.25 g charcoal: 0.625 g dextran in 1 L PBS) was added to end the competitive binding reaction and the assay was incubated for
an additional 30 min at 4°C. Samples were centrifuged at 3,400 rotations per minute (RPM) for 15 min at 4°C and the supernatants decanted into scintillation vials. Finally, 3.5 mL of scintillation fluid was added prior to samples being counted in a Beckman liquid scintillation spectrometer (LS 1801) and final values were calculated in Microsoft Excel®.

A pooled fecal sample was created to assay validation steps for the RIA and the resulting pooled sample was extracted as for the individual samples. The extracted pooled sample was first diluted 2-fold from 1:2 to 1:256 in phosphate buffer saline (PBS) and analyzed in the glucocorticoid assay to determine parallelism against the standard curve. The displacement curve of fecal glucocorticoid metabolites was parallel in comparison to the standard curve \((r=0.999, p > 0.05)\). For further validation, extraction of exogenous corticosterone in the pooled fecal sample was 98.0%. Interference with the sample matrix was assessed by spiking a continuous range of known amounts of exogenous corticosterone hormone \((n=8)\) on top of the extracted pooled sample. The accuracy of recovered spikes was determined to be 97.1% ± 7.8%. Inter-assay coefficient of variation was 3.0% based on duplicates of high binding corticosterone controls and 4.3% based on duplicates of low binding corticosterone controls run within every assay \((n=10)\). Intra-assay variation was reported at 5.5% \((n = 20)\) and assay sensitivity was calculated at 41.2 pg/tube, which reflects %B/Bo at 90% of our lowest standard. Results are presented as nanograms per gram (ng/g) dry fecal weight to control for diet-related changes in hormone excretion rates (Wasser et al. 1993).

### 2.3.6 Statistical analyses

Wasser et al. (2000) reported a 24-36 h lag from the time of a stressful event to the detection of increased FGMs in elephant feces. Thus, we considered tourist activities and potential stressors 24-36 h prior to sample collection in our evaluation of FGM concentrations.

All statistical analyses were performed using RStudio V.3.10.1 (R Development Core Team 2015). We used the generalized additive mixed model package ‘gamm4’, which fits a
Gamma distribution to each response using REML (R Core Team, 2014), to examine the effects of elephant-tourist activities (ride only, walk only, mixed ride/walk, no interaction, and “meet & greet”) on elephant FGM concentrations. The model furthermore compared mean FGM concentrations between the Abu herd, wild, and released elephants. There are three components to a GAMM model: the fixed effects, random effects and the smooth terms (Wood 2006). The random effects structure was a generalization over individual elephants (random =~1|elephantID) to take into account the pseudo replication affiliated with multiple points from an individual animal. Furthermore, a correlation structure was included in the model to account for the dependence between consecutive sampling days. Date of sample collection was included as a continuous covariate to be smoothed. The model estimated the degree of smoothing. The fixed effects structure included covariates for activity type (ride only, mixed ride/walk, walk only, “meet and greet”, and no interaction) as well as age class, season, and incident occurrence. An incident was considered any atypical and potentially stress-inducing event observed by the elephant management team. We were cautious in accepting any model, balancing the significance of the fixed effects and their t value, with the confidence intervals about the smoothed terms. We placed great emphasis on model performance using gam.check and vis.gam and supplementary box plots on the fixed effects using vis.reg. Throughout, P values on the 0.05 boundary were treated with some skepticism as to their true significance (Zuur et al. 2009).

2.4 Results

We collected a total of 434 fresh (<12-h-old) elephant fecal samples over 160 days between May 2013 and August 2014, encompassing one wet (n=149) and two dry seasons (n=285, Table 2.2). Overall, there were no differences in the mean FGM concentrations between the Abu herd, reintroduced herd, or wild elephants (Fig. 2.2, t=0.59, p=0.55). The highest FGM concentrations occurred in the Abu herd with FGM concentrations > 90 ng/g
occurring on 11 occasions (range 95.0 to 140.6). Although FGM concentrations averaged
0.07% higher during the dry versus the wet season for all three elephant groups combined, we
did not detect a notable difference in FGM concentrations between wet (X=46.43, SD=19.29,
n=149) and dry (X=49.61, SD=18.74, n=285) seasons (t = 1.76, p=0.08). Adults expressed
higher FGM concentrations than calves in the Abu herd (t = -3.55, p=0.00).

![Figure 2.2](image)

**Figure 2.2:** Fecal corticosterone concentrations (ng/g dry fecal weight) for Abu elephants
(white), reintroduced herd (light gray), and wild elephants (dark gray) from May 2013 to August
2014. The lower and upper ends of the box indicate the 25 and 75 percentiles, the line within
the box indicates the median value. The ends of the vertical lines are defined as the upper and
lower quartiles, respectively ± 1.5 times the interquartile distance. Points outside the lines
indicate observations recorded outside this range.

Fecal samples (n=315) were collected from the Abu herd on 129 days over the 412-day
study period. There were no interactions with tourists on 101 days, accounting for 32% of fecal
samples collected. The number of tourists that participated in elephant-tourist activities with the
Abu herd on any one day averaged 6 (range 1 to 12 people). Abu elephants most frequently
engaged in mixed ride/walk activities with tourists on 133 days, representing 42% of fecal samples), followed by walk only (n=41 days and 13% of fecal samples), and ride only (n=39 days and 13% of fecal samples). “Meet & greet” interactions occurred on 165 days, and occurred on 52% of the days when tourists interacted with the Abu herd.

FGM concentrations differed between the elephant-tourist activities (Table 2.3). Ride only and mixed ride/walk activities produced significantly higher FGM concentrations compared to days when there were no elephant-tourist interactions (‘none’) (Fig. 2.3). No differences were found when tourist activities were limited to walk only and “meet and greet” compared to days with no elephant-tourist interactions. We found no difference in FGM concentrations between morning and evening activities.

Figure 2.3: Concentrations of fecal glucocorticoid metabolite (FGM) (ng/g dry fecal weight) for Abu herd elephants 24 hrs after tourist interactions (none=no activity with tourists, ride=elephant-back ride only by tourists, ride/walk=both ride and walk activities by tourists, and walk=tourists only walked with herd. The lower and upper ends of the shaded grey box indicate the 25 and 75 percentiles, the line within the box indicates the mean value.

High (> 90 ng/g) FGM concentrations were associated with records of potentially stress-inducing “incidents” in the Abu herd’s daily reports (t=2.96, p=0.00). Although incidents were
grouped for the analyses, incidents included altercations between elephants within the Abu herd, mating by wild bull elephants of Abu herd females during free-range grazing periods, displays of aggression to the Abu herd by wild bulls in musth, the birth of a calf (Naledi), the death of an adult (Keitumetse), the departure of an adolescent male (Abu) from the herd, physical injury of foot, tusk, and tail, conflicts between Abu herd elephants and handlers, thunderstorms and severe weather events, and changes to the herd’s schedule or daily operations. We were able associate 5 of the 11 records of the highest FGM (> 90 ng/g) concentrations to specific incidents, including: two interactions with an aggressive bull in musth (99.2, 130.5 ng/g), a lacerated fore-right foot (121.1 ng/g), a broken tusk (112.6 ng/g), and internal herd conflict (109.9 ng/g). We were not able to associate the other six high FGM concentrations with any specific elephant-tourist interaction or incident.

**Table 2.2**: Fecal glucocorticoid metabolite (FGM) concentrations (ng of corticosterone/g of dry fecal matter) for African elephants by age and herd type.

<table>
<thead>
<tr>
<th>Elephant</th>
<th>Herd</th>
<th>n</th>
<th>Mean FGM (ng/g)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult females</td>
<td>Abu</td>
<td>243</td>
<td>52.9</td>
<td>26.8 - 156.8</td>
</tr>
<tr>
<td>Adult females</td>
<td>Wild</td>
<td>97</td>
<td>46.4</td>
<td>27.2 - 110.6</td>
</tr>
<tr>
<td>Adult females</td>
<td>Reintroduced</td>
<td>23</td>
<td>50.1</td>
<td>30.3 - 75.9</td>
</tr>
<tr>
<td>Calves</td>
<td>Abu</td>
<td>71</td>
<td>29.8</td>
<td>4.2 - 68.0</td>
</tr>
</tbody>
</table>
Table 2.3: A generalized additive mixed model (GAMM) used to model elephant fecal glucocorticoid metabolite concentrations in relation to elephant-tourist activities, time of day, season, age class, group, and incident occurrence. Estimation of the coefficients ($\beta$) are given with standard errors ($\pm$SE), and t-values are used to test the significance of parametric terms.

| Fixed effects          | $\beta$     | $\pm$SE   | t-value | Pr(>|t|)   |
|------------------------|-------------|-----------|---------|------------|
| Intercept              | 3.81535     | 0.10275   | 37.132  | <2e-16     |
| AM/PM                  | -0.03617    | 0.03593   | -1.007  | 0.314760   |
| Ride only              | 0.14499     | 0.06250   | 2.320   | 0.020883   |
| Mixed ride/walk        | 0.13709     | 0.05359   | 2.558   | 0.010920   |
| Walk only              | 0.08148     | 0.05596   | 1.456   | 0.146268   |
| Age class “Calf”       | -0.61734    | 0.17364   | -3.555  | 0.000427   |
| Grp:“Released”         | 0.11787     | 0.16749   | 0.704   | 0.482017   |
| Grp: “Wild”            | 0.02788     | 0.22543   | 0.124   | 0.901647   |
| Meet&Greet “Yes”       | -0.01494    | 0.04154   | -0.360  | 0.719309   |
| Incident “Yes”         | 0.16709     | 0.05638   | 2.964   | 0.003238   |
| Season “Dry”           | 0.07069     | 0.04026   | 1.756   | 0.079973   |

Adjusted $R^2 = 22.4\%$, scale est. =0.097, n=434

2.5 Discussion

Overall, the FGM concentrations were similar between the Abu herd, reintroduced and wild elephants in the Abu concession, suggesting that the elephant-tourist activities for the Abu herd do not cause higher stress concentrations than experienced by wild elephants. Further, our results indicated that FGM concentrations for elephants reintroduced back into the wild exhibit normal stress concentration ranges as wild elephants, at least for elephants using an area that is used for photographic safaris and where elephants do not interact with local communities. Further, our FGM profiles of the Abu herd were similar to the FGM profiles for elephants used in an elephant-experience operation in South Africa reported by Millsbaugh et al. (2007).
FGM concentrations across all elephant groups were on average 1% higher in the dry season than the wet season. This difference was not statistically detectable. Slightly higher FGM concentrations during the cooler, dry season suggest that lower availability of water and browse in our study area may be more stressful to elephants than higher temperatures in the wet season. Yet, daytime ambient temperatures during the hot, wet season often exceed the core body temperature of an elephant (Tyrrell and Cole 1988). Other studies reported that increased stress hormone concentrations in elephant family groups were associated with high daily maximum temperatures (Pretorius 2004, Burke 2005). Additionally, behavioral and physiological thermoregulation are well documented (Wright 1984, Phillips and Heath 1992) in the African elephant in relation to daily and monthly weather conditions (Gobush et al. 2008), seasonal variation in availability of forage (Chinnadurai et al. 2009), and access to water (Foley et al. 2001, Burke 2005, Woolley et al. 2009).

Although FGM concentrations were relatively higher on days when ride only and mixed ride/walk activities occurred for the Abu herd, the question remains, “Do these two elephant-tourist interactions pose an unacceptable stress risk to the Abu herd elephants?”. Based on adrenocorticotropin (ACTH) challenge tests, Wasser et al. (2000) considered a FGM concentration of 90 ng/g to be high and indicative of a stressed elephant. They also considered a FGM concentration of 150 ng/g an acute stress threshold. Although we recorded FGM concentrations > 90 ng/g in the Abu herd on 11 occasions (range 95.0 to 156.8), five records were associated with “incidents”, and we were unable to associate these incidents and any of the other six high FGM concentrations with elephant-tourist interactions. Further, the increase in average FGM concentrations was relatively small (4.0 ng/g) for the Abu herd on days with ride and mixed ride/walk activities versus days when these activities did not occur. Wasser et al. (2000) and Millspaugh and Washburn (2004) considered a 20 ng/g increase in FGM concentrations as biologically meaningful based on their ACTH challenge results with elephants. This relatively small 4.0 ng/g difference in FGM concentrations between the various elephant-
tourist activities suggests that tourist activities probably have little to no effect on the biological welfare of elephants used in the elephant experience at Abu Camp. Furthermore, we consider the possibility that the physical exertion required to perform the elephant-back riding activity activates the hypothalamic-pituitary adrenal axis and results in increased levels of stress hormone as a mechanism of active coping (Stranahan et al. 2008; Chong et al. 2017). Inquiries into exercise induced stress may provide further insights and promote our understanding of the fine line between beneficial and detrimental stress in wildlife. Finally, we reiterate the finding that the FGM profiles of the Abu herd were similar to wild elephants in NG26. Subsequent to our study, elephant-back riding was discontinued at Abu Camp in August 2016 based on the assumption that elevated stress levels incurred by riding, albeit low, could be alleviated if the riding activity was stopped.

Although elephants have been used in wildlife tourism for decades, there is much controversy concerning this practice (Millspaugh et al. 2006). Elephant-back riding has been criticized and actively campaigned against in South Africa by the International Fund for Animal Welfare (IFAW) as “an irresponsible form of tourism that should not be supported…has no conservation value and is cruel and exploitative” (IFAW 2006; IFAW 2013, IFAW 2014). Yet, guest surveys at Abu Camp (Appendix D) and our stress hormone results suggest an alternative view. Based upon guest surveys (n=126) conducted at Abu Camp during this study, guests believed that the elephants were healthy and well cared for by the handlers. The vast majority of Abu guests (91%) believed that elephant back rides by guests were appropriate and did not want to be restricted to simply walking with the elephants (82%). Yet, walking with the elephants was the favorite activity for guests. Most all Abu guests greatly increased their knowledge about elephants. Less than 5% of guests agreed with the statement that “Abu elephants should be returned to the wild”, while over 65% of respondents believed that the Abu elephants should not be returned to the wild and 30% of respondents neither agreed nor disagreed with the statement. Admittedly, engaging tourists who actively sought out a unique elephant experience
heavily biased our guest survey, but this group found great value in their experiences and did not consider their Abu experience as “cruel and exploitative”.

There is also much variation in the practices and the living and working conditions of elephants used in the elephant-experience tourism industry. For example, Abu Camp and many elephant experiences operations in Namibia and Zimbabwe permit elephant riding by tourists. In contrast, Baines Camp and Stanley’s Camp elephant experience operations in Botswana are centered exclusively on walking with elephants (Duffy 2014). Further, Abu Camp has a strong commitment to elephant welfare. For example, the Abu elephants spend much of their time during the day “out in the bush” browsing, with the herd taken into the boma at night to protect them from wild elephants and potential predators. Female elephants in the Abu herd mate freely with wild bulls. Additionally, the adult Abu elephants are not chained except for a brief period in the morning for conditioning and to attend to health needs. Further, it is the policy of Abu Camp to allow elephants to leave the herd if they choose. This occurred in 2013 for a 10-year-old male named Abu. For several months, Abu would remain in the bush after the rest of the herd had returned to the boma in late afternoon. In the early weeks, he would regularly return to the boma late at night and be let in by the handlers. With time, this adolescent male elephant started to spend multiple nights away from the boma and eventually joined the released herd and stopped returning to the boma.

Based upon our stress hormone results, we offer the following observations to those managing African elephants for interaction with tourists: 1) monitoring stress using FGMs is a useful diagnostic tool in understanding elephant responses to tourist activities, 2) external stressors, such as conflicts with wild elephants and loud noises, should be minimized, and 3) the stress induced by elephant-back safari riding and mixed ride/walk activities while detectable, is relatively modest, and is unlikely to affect the biological welfare of the animals.
2.6 Acknowledgements

We would like to thank the Paul G. Allen Family Foundation for funding and support, as well as the Botswana Ministry of the Environment, Wildlife and Tourism and the Botswana Department of Wildlife & National Parks (DWNP) for permission to do this work. We thank Elephants Without Borders research assistants and staff including, Kelly Landen, Tempe Adams, and Robert Sutcliffe. We thank the Elephants Without Borders research station for their endless support and hospitality, with special thanks to Gagoope Tsukotsuko, Kabo Kakana and Ronnie Ndjavera. Stress hormone analyses were carried out by Senior Research Associate, Corinne Pisacane, of the San Diego Zoo Institute for Conservation Research. We are grateful to the Abu Camp managers for accommodating our research needs and providing logistical support, with special recognition to Elizabeth Parkin and Aaron Gjellstad. Lastly, the most sincere thanks to all of the Abu Elephant handlers for their efforts with special recognition to elephant managers Wellington Jana and Brett Mitchell and team manager Boago Poloko.
CHAPTER 3

POST-RELEASE MOVEMENTS OF AFRICAN ELEPHANTS FROM AN ELEPHANT-BACK SAFARI CAMP

3.1 Abstract

The elephant experience tourism industry faces challenges in managing elephants who’s aggressive or unpredictable behavior makes them ill-suited to captivity, training, and interaction with handlers and tourists. Reintroduction of these elephants back into the wild may be a favorable solution if the welfare of released individuals, recipient wild animal populations, and human populations can be ensured. We describe the post-release movements of two African elephants, one female and one bull, from an elephant-back-safari enterprise in the Okavango Delta, Botswana. We compared the movements of the female with that of two wild females collared in the same wildlife management concession. We assess their home range size, proximity to human dwellings, and fidelity to their former home range as former members of their semi-captive, working herd from which they were released. We found that the average home range (95% BBMM) used by our released female was 40 - 80% the size of those used by the two wild elephants. Additionally, the released female and released bull occurred more frequently in close proximity (within 250 m) to tourist lodges throughout the Delta. The released elephants also frequented sites used by the working Abu herd with greater frequency than the wild elephants, and that this visitation rate did not decline significantly over their respective four- and two-year post-release monitoring periods respectively, despite the positive growth in home range size.
3.1.1 **Key Words:** reintroduction, post-release, movement, elephant, home-range, safari, ecotourism

3.2 **Introduction**

Captive or semi-captive animals are released into the wild for a variety of reasons (Stuart 1991) including: lack of sufficient space or resources due to a successful breeding program, closure of a facility (Gales and Waples 1993), pressure from animal welfare groups (Waples and Stagoll 1997), and as a conservation measure for threatened or endangered species (Beck et al. 1994, Bright and Morris 1994). Such releases involve the placement of an animal, either born in captivity or maintained in captivity for an extended period of time, into the wild where it is no longer under human care or supervision (Waples and Stagoll 1997). Criteria for a successful release can include integration into a local wild population, survival without human aid, and permanent cessation of interaction with humans (Seddon 1999, Fischer and Lindenmayer 2000, Kleiman et al. 1993). Both hard and soft releases have been used with mixed results; yet, there is minimal scientific data on release success or long-term outcomes (Grobler et al. 2008). Telemetry and ground observations are commonly used for post-release monitoring to ensure the welfare of released individuals, the recipient wild population and human populations near release site (Evans et al. 2013a). For example, signs of disorientation or seeking human contact can compromise release success and the welfare of the animal (Swaisgood 2010, Woodroffe and Ginsberg 1999, Yeager 1997, Letty et al. 2000, Matějů et al. 2012). Despite precautionary monitoring, captive-reared animals often experience challenges when transitioning to life in the wild, and success in these endeavors has typically been low or completely unknown (Griffith et al. 1989).
Beginning in the 1960s, intensive management of elephant populations in eastern and southern African parks dictated stocking rates and removal quotas of elephants via translocation and culling, leaving behind a population of young orphaned elephants. Orphaned calves were moved into captive, semi-captive and free-ranging herds, including those working in the elephant-experience industry in southern Africa (Child 2004, Slotow and Van Dyk 2001, Whyte 2005, Dickson and Adams 2009). New challenges arose as calves aged into adolescents and adults with some elephants in captive settings posing significant risks to the safety of other elephants and their handlers. Additionally, the release of “unmanageable” elephants into the wild could also pose risks to the well-being of recipient wildlife populations, and the safety of people near the release site (Evans et al. 2013a). Instances of behavioral aggression and evidence of limited social functioning (Shannon et al. 2013) were reported in male and female African elephants released into the wild (Fernando 2012, Slotow and Van Dyk 2001, Slotow et al. 2001). For example, a reintroduction effort in South Africa resulted in aggressive and destructive behaviors by a group of young male elephants, leading to the goring of >100 white rhinoceroses (*Ceratotherium simum*) and several black rhinoceroses (*Diceros bicornis*) (Slotow et al. 2001). Aside from Evans et al. (2013a,b), little is known about the integration of released African elephants into wild populations or whether they pose a threat to human safety. Given these challenges, a better understanding of post-release movement and behavior is needed to increase success of future releases and to better safeguard the welfare of released elephants.

In this paper, we describe the post-release movements of one female and one bull elephant released from an elephant-back safari enterprise, Abu Camp, in northern Botswana’s Okavango Delta. We assess their home range size, proximity to human dwellings, and fidelity to their former home range as former members of their semi-captive, working herd from which they were released. Our analyses aim to quantifiably
describe the gradual acclimation of two elephants to life in the wild, and to provide
criteria for judging their progress and the success of their releases. As a comparative
measure, we also analyzed movements exhibited by two wild female elephants collared
in the same wildlife management area. We predicted that the released female (Gika)
would (i) utilize smaller home ranges than wild females. Further, both Gika and the
released male (Mthondo) would (ii) expand their home range sizes over time post-
release, (iii) exhibit high fidelity to sites regularly used by the semi-captive Abu herd, and
(iv) interact frequently with the Abu herd from which they were released.

3.3 Materials and Methods

3.3.1 Study area

We conducted the study in NG26, a wildlife management area of 1,850 km² at
the southwest corner of the Okavango Delta in northern Botswana. Formerly used for big
game sport hunting, NG26 was converted to a non-consumptive wildlife management
area in 2009, and is now used exclusively for photographic and wildlife ecotourism
safaris based out of two luxury safari camps, Seba Camp and Abu Camp. Established in
1997, Abu Camp was the first elephant-back safari enterprise in southern Africa (Moore
2000).

Dominant land covers within NG26 include perennial swamps, seasonally
inundated floodplain grasslands, and dry acacia (Acacia spp.) and mopane
(Colophospermum mopane) shrublands (de Wit and Bekker 1990). This region of the
Okavango Delta undergoes significant changes between seasons and years as a result
of variation in the strength and duration of seasonal floods. The highlands of Angola are
the water source for the seasonal floods that typically peak in our study area in
July/August at the height of the dry season (Mendelsohn et al. 2010, McCarthy and
Ellery 1998) when temperatures range from 0 and 35°C and total monthly precipitation
can amount to less than three centimeters. Seasonal pans persist into August during the latter part of the dry season, some remaining until the wet season begins in late October. As the floods recede, the region is characterized by high heat and little water availability. Daily temperatures range from 15 – 39°C and average monthly precipitation typically declines to <5 mm. October to April brings temperatures ranging from 14 to 39°C and average precipitation amounting to more than 100 mm per month. From 2011 to 2015, total annual rainfall for the region averaged 471 mm (Okavango Research Institute Monitoring and Forecasting 2015).

### 3.3.2 Study animals

The elephants in our study fall into three groups -- eight elephants in the captive herd at Abu Camp, two released elephants, and two wild elephants (Table 3.1).

#### Table 3.1: Tracking periods and number of fixes for two released and two wild adult elephants with satellite GPS collars in northern Botswana. All elephants were female with the exception of Mthondo.

<table>
<thead>
<tr>
<th>Elephant</th>
<th>Group</th>
<th>Start</th>
<th>End</th>
<th>Weeks tracked</th>
<th># of fixes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gika</td>
<td>Released</td>
<td>1 Aug, 2011</td>
<td>27 Apr, 2015</td>
<td>195</td>
<td>25,797</td>
</tr>
<tr>
<td>♂Mthondo</td>
<td>Released</td>
<td>9 Jan, 2012</td>
<td>31 May, 2014</td>
<td>125</td>
<td>16,864</td>
</tr>
<tr>
<td>CH63</td>
<td>Wild</td>
<td>3 Oct, 2012</td>
<td>8 Apr, 2014</td>
<td>79</td>
<td>12,224</td>
</tr>
<tr>
<td>CH74</td>
<td>Wild</td>
<td>11 Jul, 2013</td>
<td>31 Jan, 2016</td>
<td>133</td>
<td>5,185</td>
</tr>
</tbody>
</table>

#### 3.3.3 Abu herd and released elephants

The Abu elephants are trained to obey verbal commands and physical cues, and adults are trained to carry a handler and two tourists on elephant-back rides. Tourists may also walk, feed, and physically interact with the herd twice daily at scheduled activities. During our study, the Abu herd was comprised of eight elephants, all females and their offspring, clustered into two distinct family groups. During the day, the Abu
herd maintains a relatively consistent schedule centered on tourist activities and free-range browsing at one of 26 routine locations (Fig. 3.1). All browsing locations were located within a 5-km distance of the Abu boma, a fenced shelter roughly 260m northwest of the Abu Camp lodge. Tourists participate in a morning activity, typically a ride or walk with the herd, after which the elephants are free to browse under the supervision of their handlers and interact freely with wild herds. Free-range browsing takes place for the next eight to nine hours, followed by an evening ride or walk-along with tourists back to the boma. From dusk until dawn, the herd remains enclosed in the boma to protect the herd from wild elephants and predators. Boma reports are daily summaries of the Abu herd whereabouts and interactions with tourists and handlers. Interaction between the Abu herd elephants, released elephants, and wild elephants are a critical piece of daily reporting.
Figure 3.1: The working Abu herd frequents 26 locations within a 5-km radius of the boma for free-range browsing.
The released female (23-year-old, Gika) and released male (34-year-old, Mthondo) were part of the captive elephant herd at Abu Camp, and employed frequently in elephant-experience activities with tourists and handlers. Gika arrived at Abu Camp in 1988 along with two other elephants orphaned by a cull at Kruger National Park in northeastern South Africa (Moore 2000). Due to unmanageable behavior and concerns for human safety, Gika was separated from the Abu herd on August 1, 2011. Her 8-year old adolescent female, Naya, who was born at Abu Camp on March 30, 2003, accompanied her. Upon separation from the Abu herd, Gika and Naya were relocated 15 km from the boma in a temporary boma, and GPS satellite collars were attached to both elephants. During the day, elephant handlers guided Gika and Naya to browse outside their temporary boma, returning to the boma at night. After three weeks in the temporary boma, a wild bull broke through the enclosure. Thereafter, the elephant handlers left Gika and Naya to move freely throughout the NG26 concession and daily monitoring by was concluded. However, they were tracked via VHF telemetry and sporadically monitored via ground observations thereafter. Further, after release, the Abu elephant handlers discouraged Gika and Naya from interacting with the captive Abu herd during their free browsing periods. The two elephants remained together post-release and due to the similarity of their movements, only Gika’s movements were selected for analysis in this study.

Similarly, the released bull elephant, Mthondo, was separated from the Abu herd due to unmanageable and aggressive behavior and released in January 2010. Mthondo was born in Zimbabwe and translocated as a calf to Pilanesberg National Park in South Africa. Following a period of aggression and unmanageable behavior in adolescence, Mthondo was transferred from South Africa to the Abu herd in 1993, and subsequently released into the wild in 2010. For this study, we analyzed GPS collar data from Mthondo’s from January 2012 until his death in May 2014.
3.3.4 Wild elephants

Wild elephants using NG26 are highly transient, ranging widely within and across the boundaries of the concession. Aerial surveys of African elephants in NG26 prior to our study indicated that wild elephant populations ranged from 3,120 in September 2012 to 440 in February of 2013. Elephant abundance in NG26 is high during the dry season when herds concentrate to access water from seasonal floods and subsequently disperse during the wet season when seasonal pans provide water sources throughout northern Botswana (De Beer and Van Aarde 2008). To compare the movements of the two released elephants to wild elephants, we collared two wild adult females with satellite collars from two different herds, one on October 3, 2012 (CH63) and the other on July 11, 2013 (CH74). Both of these wild females were older members of their herds and were located via a helicopter. They were immobilized using ethiorphine hydrochloride (M99) administered by darts fired from a modified .22 caliber rifle from the helicopter. Once the elephant was recumbent, it was fitted with a satellite collar around the neck. The effect of the immobilizing agent was reversed using diprenorphine (M5050).

3.3.5 GPS satellite tracking

The duty cycle of the GPS satellite collars (African Wildlife Tracking, Pretoria, South Africa) on Gika, Mthondo, and wild female CH63 were set to download one GPS fix every hour. The unit on wild female CH74 was programmed to obtain a fix every four hours. Fixes were downloaded via satellite through ORBCOMM (USA) and data were transmitted through Skygistics (Gauteng, South Africa). The geographic accuracy of GPS locations was <15 m for collars we field-tested prior to deployment. Each unit was also equipped with a VHF transmitter, allowing periodic tracking in the field and ground observation of each elephant.
3.3.6 Home range estimation

We used two methods to estimate home ranges of the two released and two wild elephants from 1 Aug, 2011 to 31 Jan, 2016; however, tracking periods varied between the four elephants monitored (Table 3.1). We used a Brownian bridge movement model (BBMM) and a Kernel Utilization Distribution (KUD) for comparison with previous studies. Location data for all analyses were input as Universal Transverse Mercator (UTM) coordinates and categorized by year and season (wet vs. dry). Following methods from Wittemyer et al. 2004, the beginning of the dry season, typically in May, was marked by 30 d without precipitation according to rainfall data compiled by Okavango Research Institute Monitoring and Forecasting (Wolski et al. 2006, Okavango Research Institute 2016). The start of the wet season, typically in November, was determined by the first week with a minimum 15 mm of rainfall also determined by local weather data (Okavango Research Institute 2016). Home range area was reported in km² (mean ± SE), and we used ArcGIS 10.4 (Environmental Systems Research Institute, Redlands, CA) to map locations, landscape features and the extent of home ranges.

3.3.7 Brownian bridge movement model (BBMM)

We used the BBMM package (http://cran.opensourceresources.org) in R (R Foundation for Statistical Computing, Vienna, Austria) to estimate the path of an animal’s movement probabilistically from locations recorded at brief intervals. This differs from home range estimators, such as Minimum Convex Polygon or Kernel Utilization Distribution, in that BBMM assumes locations are not independent. The BBMM requires 1) sequential location data, 2) estimated error, and 3) an assigned grid cell size for the output. Movement between locations is assumed to be random and conditioned on the
pairing of start and end locations. However, this assumption becomes less realistic as the time interval between fixes increases (Horne et al. 2007).

### 3.3.8 Fixed-kernel home range

Kernel analyses were used to identify centers of activity and for comparison to previous studies. We calculated 50% and 95% Gaussian utilization distribution kernels (KUD) following Seamen and Powell (1996) to estimate the core area and overall home range for each animal. We used the fixed kernel method because it incorporates the density of locations and is considered more accurate at determining outer boundaries than the adaptive kernel (Worton 1995, Seaman et al. 1999). All home range estimates were fitted in RStudio Version 3.1.2 (R Foundation for Statistical Computing, Vienna, Austria) using the ‘adehabitatHR’ package, and the amount of smoothing was determined by the reference bandwidth ($h_{\text{ref}}$).

### 3.3.9 Statistical analyses

Autocorrelation of elephant movements is long-term, temporally complicated, seasonally variable, and closely linked to patterns in rainfall (Cushman et al. 2005). Swihart and Slade (1997) argued that regular sampling intervals resulting in autocorrelated data will not invalidate many estimates of home range size as long as the study time frame is adequate. Based on this rationale, we chose not to subset our data, and to use the full set of GPS locations collected from 1 August, 2011 to 31 January, 2016 to estimate home ranges using BBMM and KUD. We identified and removed erroneous data points (e.g. outliers, missing coordinates, multiple records) and excluded Naya from the analyses because she remained with Gika and their movements were nearly identical.

Home ranges for elephants Gika, Mthondo, CH63 and CH74 were calculated based on a minimum of one annual cycle encompassing the full extent of wet and dry
season periods. Home range estimates for wild elephant CH63 met these criteria, but were based on a shorter than expected transmission time (79 weeks, Table 3.1) from October 3, 2012 to April 8, 2014 as the result of GPS collar failure.

We used generalized linear regression to compare home range estimates and GPS fixes recorded in close proximity to the Abu Camp lodge, Seba Camp lodge, Abu herd boma, Abu herd browsing sites, and safari camp lodges in the southwestern Okavango Delta (n=34). For this analysis, we created 250 m and 1 km buffers around each location of interest in ArcGIS 10.4 and calculated the sum of fixes registered within each buffer by season. The 250 m buffers were selected for the Abu Camp lodge, Seba Camp lodge, Abu herd browsing sites, and the Abu elephant boma. The 1 km buffer was used for each of the 34 safari camp lodges in the study area.

3.4 Results

3.4.1 Seasonal home ranges

Dry season home ranges, estimated using BBMM and KUD, were smaller than wet season home ranges for wild and released elephants, but not statistically given the wide variation in range sizes (Table 3.2, t=-1.218, p=0.241). Seasonal home ranges estimated by BBMM (95%) were much smaller and less variable than those estimated as fixed kernels for both wild and released elephants (Table 3.3). Prediction (i), that Gika would utilize smaller home ranges than her wild counterparts was partially supported. The average BBMM (95%) home range used by Gika across five dry seasons was roughly 2.5 times smaller and far more variable than wild female CH63, and roughly 80% the size and twice as variable as wild female CH74 (Table 3.3). Similarly, core areas (BBMM 50%) used by Gika were roughly half the average size of the two wild females in both wet and dry seasons (Table 3.3).
Table 3.2: Results from a generalized linear regression used to fit a Gamma model on factors influencing the home range size (95% BBMM) of three female African elephants (Gika, CH63, CH74).
Formula: glm(Home Range ~ Individual Elephant + Season, family = Gamma)

| Covariate      | Estimate  | Std. Error | t value | Pr(>|t|) |
|----------------|-----------|------------|---------|---------|
| Intercept      | 0.0104422 | 0.0019884  | 5.252   | 7.91e-05|
| CH63           | -0.0047860| 0.0020103  | -2.381  | 0.030   |
| CH74           | -0.0004477| 0.0025723  | -0.174  | 0.864   |
| Season = “Wet” | -0.0022524| 0.0018492  | -1.218  | 0.241   |
Table 3.3: Average home ranges (95%) and core areas (50%) (km\(^2\)) were estimated for two released and two wild elephants from August 1, 2011 to January 31, 2016 in northern Botswana, using Brownian Bridge Movement Model (BBMM) and fixed kernel (KUD).

<table>
<thead>
<tr>
<th>Group</th>
<th>Elephant</th>
<th>BBMM</th>
<th>Dry [min, max]</th>
<th>Wet [min, max]</th>
<th>KUD</th>
<th>Dry [min, max]</th>
<th>Wet [min, max]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release</td>
<td>Gika</td>
<td>50%</td>
<td>2.7, 18.2</td>
<td>7.9, 23.4</td>
<td>50%</td>
<td>5.7, 237.2</td>
<td>21.6, 416.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95%</td>
<td>32.9, 229.7</td>
<td>76.7, 255.9</td>
<td>95%</td>
<td>43.2, 1152.7</td>
<td>166.5, 2678.0</td>
</tr>
<tr>
<td></td>
<td>Mthondo</td>
<td>50%</td>
<td>5.7, 11.1</td>
<td>7.9, 27.5</td>
<td>50%</td>
<td>12.0, 54.3</td>
<td>18.5, 100.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95%</td>
<td>65.2, 107.6</td>
<td>200.8, 324.4</td>
<td>95%</td>
<td>121.8, 561.9</td>
<td>130.1, 599.9</td>
</tr>
<tr>
<td>Wild</td>
<td>CH63</td>
<td>50%</td>
<td>20.2, 22.5</td>
<td>28.6, 34.2</td>
<td>50%</td>
<td>237.2, 401.8</td>
<td>115.2, 228.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95%</td>
<td>207.0, 208.9</td>
<td>100.4, 149.1</td>
<td>95%</td>
<td>1396.4, 1856.9</td>
<td>487.5, 1861.2</td>
</tr>
<tr>
<td></td>
<td>CH74</td>
<td>50%</td>
<td>15.9, 27.7</td>
<td>16.5, 28.8</td>
<td>50%</td>
<td>28.4, 48.9</td>
<td>48.0, 48.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95%</td>
<td>69.8, 133.8</td>
<td>73.1, 94.6</td>
<td>95%</td>
<td>116.7, 175.1</td>
<td>197.8, 227.5</td>
</tr>
</tbody>
</table>
Prediction (ii), that Gika and Mthondo’s home ranges would expand over time, is partially supported. Gika exhibited growth in overall wet (Fig. 3.2) and dry season (Fig.3.3) home range size (95% BBMM) from her release in 2011 until 2014. At its largest, Gika’s wet season home range size expanded from 81.1 km² post-release in 2011 to 255.9 km² in 2013 (Fig. 3.2). Gika’s dry season home range also expanded from 44.2 km² post-release in 2011 to 229.7 km² in 2014 (Fig. 3.3). Mthondo’s home range size (95% BBMM) exhibited similar growth across wet seasons from 2011 (73.1 km²) to 2013 (94.6 km²; Fig. 3.4). Despite these expansions, Gika’s dry season home range (95% BBMM) shrunk by 70% between 2014 (229.7 km²) and 2015 (67.9 km²; Fig. 3.3), and her wet season home range (95% BBMM) declined by 41% from 2013 (255.9 km²) to 2014 (152.3 km²); with an additional 49% reduction in 2015 (76.7 km²; Fig. 3.3). Mthondo’s dry season home ranges showed a similar decline, shrinking from 107.6 km² in 2012 to 65.2 km² in 2014 (Fig. 3.5).
Figure 3.2: Gika’s wet season home ranges (95% BBMM) concentrated around Abu and Seba camps post-release from 2011 to 2012, expanded in 2013 and contracted again in 2015. Gika’s wet season home range (95% BBMM) expanded 316%, from 81.1 km² post-release in 2011 to 255.9 km² in 2013.
Figure 3.3: Gika’s dry season home ranges (95% BBMM) concentrated around Abu and Seba camps post-release from 2011 (44.2 km$^2$) to 2013, expanded in 2014 (229.7 km$^2$), and contracted again in 2015.
Figure 3.4: Mthondo’s wet season home range (95% BBMM) expanded from in 2011 to 2013 and demonstrated heavy usage of areas surrounding PomPom and Xaranna (2011 – 2013), Nxabega Tented (2012 – 2013), and Kanana (2013) safari camps in the Okavango Delta.
Figure 3.5: Mthondo’s dry season home range (95% BBMM) contracted from 2012 to 2014 with high use of areas surrounding Xigera, Nxabega Tented, PomPom and Xaranna safari camps in 2012. In the 2014 dry season, Mthondo’s home range shifted northwest and contracted, exclusively using areas surrounding Abu and Seba Camps.
3.4.2 Fidelity to sites regularly used by the semi-captive herd

Although the home ranges of both Gika and Mthondo generally expanded post-release, both elephants continued to exhibit high fidelity to the Abu boma and browsing sites regularly used by the Abu herd (Table 3.4, $t = -0.41, p=0.69$). Our hypothesis (iii) that Gika and Mthondo would continue to exhibit high fidelity to these sites and (iv) interact frequently with the captive Abu herd were supported. Regardless of home range size, season, or time since release, the boma and browsing sites used by the Abu herd remained part of Gika’s core area of use (50% BBMM) from 2011 to 2015 and Mthondo’s core area of use from 2012 to 2014. Gika’s GPS unit recorded 751 fixes within 250 m of the Abu boma over the course of this study, most frequently (n=218 fixes) in the 2011 dry season, soon after release (Fig. 3.6). Over time, Gika’s frequency of visitation to the boma fluctuated, but remained consistently higher than wild elephants ($t = 3.73, p=0.002$, Table 3.4). Two years post-release during the 2013 wet season, Gika recorded the fewest number of visits to the Abu boma (n=11; Fig. 3.6). However, this decline in visits was reversed in the 2015 dry season (n=108), and Gika’s 50% BBMM home range included locations frequented by the Abu herd, and closely resembled her early post-release movements (Fig. 3.7). Mthondo’s GPS unit recorded 129 fixes within 250 m of the Abu boma between 2011 and 2014, most frequently (n=92) in the 2013 dry season (Fig. 3.6). In comparison, from 2013 to 2015, wild elephants CH63 and CH74 were never recorded within 250 m of the Abu boma. CH74, the wild elephant with the most similar home range size and overlapping extent as Gika, occasionally frequented browsing sites visited by the Abu herd, whereas CH63 never utilized these browsing sites. These sites were less frequently visited by Mthondo but remained within his 95% home range (BBMM) post-release. Mthondo’s core area of use (50% BBMM) during the wet and dry season contracted significantly from 2011 to 2014. Familiar browsing sites used by the Abu herd remained within his core area of use between 2012 (10.9 km$^2$) and 2014 dry seasons (5.7 km$^2$, Appendix C, Fig. C.1).
Table 3.4: Results from a generalized linear regression used to fit a Gamma model on factors influencing the home range size of three female African elephants (Gika, CH63, CH74).

Formul$a$: `glm(Visits ~ Herd + Season + Home Range, family = Gamma)`

| Covariate       | Estimate | Std. Error | t value | Pr(>|t|) |
|-----------------|----------|------------|---------|---------|
| Intercept       | 1.917e-03| 9.527e-04  | 2.012   | 0.06134 |
| Herd:Wild       | 9.974e-01| 2.676e-01  | 3.728   | 0.00183 |
| Season:Wet      | 2.310e-03| 1.599e-03  | 1.444   | 0.16790 |
| Home Range      | -2.751e-06 | 6.791e-06 | -0.405  | 0.69077 |
Figure 3.6: Released elephants Gika (blue) and Mthondo (green) consistently included the Abu elephant boma in their 95% BBMM home range estimates (bars). Their frequency of visitation to the boma is presented as lines on the secondary y-axis, represented as the number of GPS fixes within a 250 m buffer of the boma. Regardless of season, time since release or home range size, Gika and Mthondo’s fidelity to the boma remained consistently higher than that of wild elephants CH63 (purple) and CH74 (red) who had 0 fixes within 250 m of the boma from 2011 to 2015.
Figure 3.7: The extent of Gika’s core area of use in the 2015 dry season (50% BBMM; 5.3 km$^2$) mimics her use of space immediately post-release in 2011 (50% BBMM; 2.7 km$^2$). Both estimates included frequent use of areas surrounding the Abu elephant boma, Abu Camp, Seba Camp, and sites regularly used by the Abu herd for daily browsing.
3.4 Proximity to Okavango Delta safari camps

Post-release movements by Gika and Mthondo included high use of areas immediately surrounding the Abu and Seba camps with 1,967 and 266 fixes, respectively, within 250 m buffers of these camps over the course of this study. The frequency of visitation to the two camps was much higher than that of wild elephants \( t = 3.73, p = 0.002; \) Table 3.4.

Further, both Gika and Mthondo frequently visited (< 250 m) other safari camps in the Okavango Delta (Fig. 3.4; Fig. 3.5; Fig. 3.8). Soon after his release in 2011, Mthondo’s core area included high use of areas surrounding PomPom and Xaranna camps. More than 30 fixes were recorded within a 250 m buffer of these two camps in the 2011 wet season. Mthondo continued to frequent areas within a 1 km buffer of PomPom camp over the course of this study, totaling of 780 GPS fixes, reaching a peak of 175 occurrences in 2012. Additionally, Mthondo’s 95% and 50% utilization distributions included 1 km buffers around Xigera, African Horseback Safari, Nxabega Tented, and Kanana camps from 2011 to 2013. Similarly, Gika’s home range expansion in the 2013 wet and 2014 dry seasons reflected a pattern of heavy usage surrounding Nxabega and Kanana camps, with additional fixes recorded <1 km from African Horseback Safari, Baine’s Camp, Stanley’s Camp, Eagle Island, Xigera and Xaranna camps (Fig. 3.8). This high rate of camp visitation by Mthondo and Gika differed greatly from the wild elephants CH63 and CH74, who were never recorded within 1 km of any Okavango Delta camp, including Abu or Seba camps.
Figure 3.8: Gika’s home range expansion in the 2013 wet season (left) and 2014 dry season (right) exhibited close proximity (within 250 m and 1 km buffers) of several safari camps in the Okavango delta.
3.4.4 Herd integration

Within 72 h of release, Gika and Naya joined Nandipa, another adult female elephant released from the Abu herd and her three wild-born calves. Nandipa had been released from the Abu herd in 2003 (Evans et al. 2013b). These six elephants formed a herd, which were typically seen together, and occasionally observed interacting with released bull elephant, Mthondo, as well as another adult bull, Mafunyane, released from the Abu herd as an adolescent (age 14) in January 2002 (Evans et al. 2013a).

The daily boma reports compiled by elephant handlers from May 29, 2013 to September 20, 2014, reported 42 incidences when the released elephants (Gika, Naya, Nandipa, Mthondo and Mafunyane) interacted with the Abu herd. Reports described released elephants browsing alongside the Abu herd, following along on elephant-back safari rides, and following the captive herd to the boma. On 16 of these occasions, the elephant handlers took action to separate the Abu herd elephants from the released elephants. Additionally, 22 interactions were reported between wild elephants and the Abu herd over the same period, during which handlers purposefully attempted to separate the Abu herd elephants from wild herds on 14 occasions by shouting, clapping hands, positioning vehicles, and on rare occasions discharging warning shots from a firearm. Physical touch between Abu elephants and wild individuals was not reported.

Both released female elephants successfully birthed calves sired by wild bulls after their release. Gika gave birth to her first wild-born calf in August 2013, indicating that she mated with a wild bull within her first month post-release. In late December 2015, Naya, who was released with Gika as an adolescent in August 2011, also gave birth to her first calf at age 12.

3.5 Discussion

The elephant experience tourism industry will continue to face challenges in managing elephants whose aggressive or unpredictable behavior makes them ill-suited to captivity,
training, and interaction with handlers and tourists. Reintroduction of these elephants back into
the wild may be a favorable solution if the chosen methods of reintroduction and post-release
monitoring can ensure the welfare of released individuals, recipient wild animal populations, and
human populations.

Settlement distance is common indicator of translocation and reintroduction success
(Pinter-Wollman 2009b, Armstrong et al. 1999). Despite exhibiting exploratory behavior in the
2013 wet and 2014 dry seasons, Gika’s home range was much smaller compared to the ranges
of the two wild females tracked in our study. Although we had no concurrent data on the
movements of wild bull elephants to compare to Mthondo’s post-release movements, his home
range (mean 95% KUD: 324.7 km$^2$ ± 213) was much smaller in comparison to the average
home range of five wild adolescent bulls (95% KUD: 1,794.8 km$^2$ ± 1,034.5) and three
adolescent bull elephants previously released from the Abu herd (95% KUD: 987.3 km$^2$ ± 332)
reported by Evans et al. (2013a). This relatively near post-release settlement distance suggests
that the released elephants in our study were reluctant to disperse and resettle long distances
from those areas they were most familiar.

Avoidance or cessation of interactions with humans is considered a hallmark of a
successful reintroduction to the wild (Kleiman et al. 1993, Fischer and Lindenmayer 2000,
Russon 2009). Yet, both of our released elephants spent much time in close proximity to the
Abu and Seba camps and often came in contact with the working Abu herd from which they
were released. Similarly, Evans et al. (2013a) reported that three adolescent male elephants
previously released from the Abu herd also spent much time in close proximity to the Abu and
Seba camps. However, Gika and Mthondo also frequently visited (<250 m) other, unfamiliar
safari camps in the Okavango Delta, and this behavior differed greatly from the wild elephants
we tracked. The frequent visitation of both familiar and unfamiliar safari camps exhibited by the
released elephants in our study is uncharacteristically bold compared to wild elephants and is a
serious concern, posing a potential safety hazard to tourist and staff at lodges.
Social integration and reproductive success are considered hallmarks of a successful reintroduction to the wild (Gusset et al. 2006, Evans et al. 2013a,b). Both Gika and Naya integrated into Nandipa’s breeding herd, and produced calves sired by wild bulls. In contrast, there have been relatively few occurrences of successful reproduction by adult females in the Abu herd between the establishment of Abu Camp in 1997 and the end of our study in 2015. Only three of eight adult females in the Abu herd [Kitty (n=2), Sherini (n=4), Gika (n=1)] produced seven calves while living in semi-captivity as working members of the Abu herd. Although Gika produced a single calf during her 23 years in the Abu herd, giving birth to Naya in March 2003, she produced two calves over a six-year period post-release (thru early 2017). Nandipa produced no calves during her 13 years in the Abu herd, giving birth to three calves over a 10-year period post-release (thru 2013). Despite some opportunity to mate with wild bulls during free-browsing, the calving frequency of Abu herd females appears much reduced while a member of the Abu herd. In contrast, the calving rate of released Abu females was high post-release, suggesting that herd management practices probably restrict access of wild bulls to Abu herd females during their relatively short period of ovulation (n=4 days) over the course of a 14-16 week estrous cycle (Allen 2006).

Long-term survival is another common indicator of translocation and reintroduction success (Sarrazin and Barbault 1996, Warren et al. 1996, Richard-Hansen et al. 2000, Clarke et al. 2003, Reynolds et al. 2008, Bright and Morris 1994). Using this measure, the reintroduction of Abu herd elephants Gika, Naya (6 years post-release), Nandipa (14 years post-release) and Mafunyane (15 years post-release) have been successful. Released bull elephant, Mthondo, was killed in NG26 in May 2014 (5 years post-release), when he posed unacceptable risk to human safety and to the safety of the Abu herd. Additional reintroductions from the Abu herd and from other elephant-back safari enterprises have resulted in similar outcomes due to human-elephant conflict. Adolescent male elephant, Seba, was released from the Abu herd in 2003 at age 9, and he was killed by a rancher in 2010, in connection with damaging cattle
fences. He had moved 140km from the release site, outside the protection of formally
designated wildlife management areas in the Okavango Delta (Evans et al. 2013a). However,
Evans did not attribute Seba’s destructive behavior to familiarity with “human presence,”
reasoning that nine wild-born bulls were shot as well. Adolescent male, Pula, was released from
the Abu herd in 2008 and later shot for damaging property and endangering human safety at an
Okavango Delta safari camp (Kate Evans, pers. comm. 2016). Chase (2010) reported on the
release of four captive elephants (3 adult males and 1 adult female) into western Zimbabwe with
two bulls released into Hwange National Park shot within one month of their release for causing
damage to property and threatening human life, and the third bull shot three years after release
for harassing school children near the town of Victoria Falls. As of 2011, the released female
reintroduced into a large fenced area was still alive and had produced one calf. These limited
records on the fates of released elephants suggest that male elephants are particularly
susceptible to engaging in destructive or threatening behaviors with humans and are more likely
to be killed post-release, sometimes many years after release. Further, these human-elephant
conflicts occurred despite the release of these male elephants into large parks or wildlife
conservation areas quite distant from human settlements.

Reproduction and long-term survival are ultimately the best measures of success for the
reintroduction of elephants back into the wild from elephant-experience tourism operations. A
wide variety of factors, such as sex, age at release, release method, site selection, and
experiences with humans prior to release, all presumably will affect the success of elephant
reintroductions. Although we were not able to fully assess these factors from our limited sample
of released elephants and those reported by Evans et al (2013 a,b), we offer the following
conclusions. First, the probability of reintroduction success is much higher for female versus
male elephants because male elephants range farther post-release and are more likely to come
into conflict with humans, increasing the likelihood that they pose a risk to human safety and be
killed. While releases into large protected areas may reduce the potential of both female and
male elephants to interact with people, the greater dispersal behaviors of released male elephants may counteract the advantage of releasing male elephants in large protected areas. Further, both female and male elephants tend to continue their association with humans post-release, posing potential safety hazards for tourists and staff even at remote safari camps. Given these uncertainties and risks associated with elephant reintroductions, it is imperative that all elephants reintroduced back into the wild from elephant experience tourism operations be monitored via telemetry for many years so that resource managers can intervene if the safety of elephants or humans is at risk.

Finally, our dual utilization of Brownian-bridge (BBMM) and Gaussian utilization distribution kernels (KUD) estimators for calculating home range and core area provided us insight into the performance of these estimators for future studies. The two methods produced significantly different results for both the home range (95%) and core area (50%) ranges. Much of the variability in seasonal home ranges was due to the long-distance exploratory movements of the elephants. We believe that the BBMM estimator intuitively fit movement trajectories better than KUD estimates, with the latter tending to “fill-in” gaps between clusters of locations (Appendix C, Fig.C.2). The ability of the BBMM estimator to account for long movements across the landscape during exploratory periods provided us important insights into how both Gika and Mthondo’s used areas surrounding unfamiliar safari camps in the Okavango Delta. In contrast, the KUD estimator using $h_{ref}$ tended to over-smooth and over-estimate the extent of home ranges (Worton 1995; Seaman et al. 1999). Thus, the ranges estimated with KUD were 2-10 times larger than those estimated via BBMM at the 50% and 95% levels. We suggest that the traditional fixed kernel and bandwidth selection commonly used in home range estimation software may not be as useful as BBMM estimators for animals that migrate or conduct long-distance movements across large geographical extents. Nevertheless, these KUD estimates, along with the traditionally used Minimum Convex Polygon (MCP) do provide comparative measures across studies.
3.6 Acknowledgements

We thank the Paul G. Allen Family Foundation for funding and support. Thanks to the Botswana Ministry of Environment, Wildlife and Tourism and the DWNP for permission to do this work, as well as Elephants Without Borders research assistants and staff, Dr. Larry Patterson for veterinary support, and pilot Andrew Baker. Additional thanks to Abu Camp managers Elizabeth Parkin and Aaron Gjellstad, and elephant managers Wellington Jana, Brett Mitchell, and Zenzo Sibanda for their support.
APPENDIX A

ELEPHANT EXPERIENCE TOURISM IN SOUTHERN AFRICA

Table A.1: We identified 38 commercial venues for elephant-experience tourism in the southern African region. Twenty-five of these venues offer elephant-back riding as a tourist activity. Abu Camp in Botswana’s Okavango Delta discontinued elephant-back riding in August 2016. Operational changes at other elephant-experience venues are noted.

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<th>Rides</th>
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Figure B.1: The hypothalamus, pituitary gland and the adrenal cortex regulate production of corticosteroid hormones in response to perceived stress.
**Figure C.1:** 50% BBMM home range estimates (km²) for released elephants Gika and Mthondo and wild elephants CH63 and CH74 by year and season.
Figure C.2: Comparison of 95% estimates of Gika’s home range during the 2013 wet season derived from a) kernel density estimation with $h_{ref}$ bandwidth selection (light blue) and b) a Brownian bridge movement model (dark blue) with GPS locations (yellow) in the foreground.
Abu Camp pioneered elephant back safaris, providing Abu guests with a unique opportunity to experience the life of elephants up-close in a natural environment. To better understand how the “Abu Experience” contributes to instilling a shared vision for elephant conservation and training of captive elephants, Abu guests were invited to share their attitudes and perceptions about their interactions with the Abu elephants via a paper survey. The survey was left in each guest’s room on their final evening in camp. This preliminary report summarizes the responses of 126 surveys completed from June 2013 through January 2014.

Overall, Abu guests felt very safe around the Abu elephants (Fig. D.1) and believed that the elephants were healthy (Fig. D.2) and well cared for by the handlers (Fig. D.3). The vast majority of Abu guests believed that elephant back rides by guests were appropriate (Fig. D.4) and did not want to be restricted to simply walking with the elephants (Fig. D.5). Yet, walking with the elephants was the favorite activity for guests (Fig. D.12). Although most Abu guests indicated that they had enough time to interact with the elephants (Fig. D.6) and that they "got to do everything they wanted with the elephants" (Fig. D.7), about half of the guests expressed the desire to spend more time with the Abu herd (Fig. D.8). Most all Abu guests greatly increased their knowledge about elephants (Fig. D.9), and only 15% of the guests indicated that they wanted more information about elephants during their stay at Abu Camp (Fig. D.10). Less than 5% of guests agreed with the statement that “Abu elephants should be returned to the wild”, while over 65% of respondents believed that the Abu elephants should not be returned to the wild and 30% of respondents neither agreed nor disagreed with the statement (Fig. D.11). The favorite activity of guests was walking with the elephants followed by elephant observation time, sundowners with elephants, and elephant back rides (Fig. D.12). The three least favorite
activities were the Star Bed, having a meal with the elephants, and the “Meet & Greet” (Fig.D.12). Overall, 100% of the Abu guests “loved their Abu Experience” (Fig.D.13).
Fig. D.3 The elephant handlers take excellent care of the Abu elephants (n=125)

- Strongly Agree: 114
- Agree: 10
- Neither agree nor disagree: 0
- Disagree: 0
- Strongly disagree: 1

% of Total Responses

Fig. D.4 Guests should NOT be allowed to ride the elephants (n=123)

- Strongly Agree: 6
- Agree: 9
- Neither agree nor disagree: 17
- Disagree: 32
- Strongly disagree: 59

% of Total Responses
Fig. D.5 Abu guests should ONLY be permitted to walk with the elephants (n=120)

- Strongly Agree: 9
- Agree: 8
- Neither agree nor disagree: 21
- Disagree: 40
- Strongly disagree: 42

% of Total Responses

Fig. D.6 I had enough opportunities to interact with the Abu elephants (n=124)

- Strongly Agree: 74
- Agree: 40
- Neither agree nor disagree: 5
- Disagree: 5
- Strongly disagree: 0

% of Total Responses
Fig. D.7 I got to do everything I wanted to do with the elephants during my stay at Abu camp (n=121)

- Strongly Agree: 55
- Agree: 55
- Neither agree nor disagree: 8
- Disagree: 3
- Strongly disagree: 0

% of Total Responses

Fig. D.8 I would have liked more time with the Abu elephants (n=123)

- Strongly Agree: 15
- Agree: 33
- Neither agree nor disagree: 43
- Disagree: 25
- Strongly disagree: 7

% of Total Responses
Fig. D.9 My Abu experience greatly increased my knowledge about elephants (n=125)

Fig. D.10 More information about the Abu elephant herd should be provided to guests (n=118)
Fig. D.11 All of the Abu elephants should be returned to the wild (n=122)

- Strongly Agree: 1
- Agree: 5
- Neither agree nor disagree: 36
- Disagree: 47
- Strongly disagree: 33

% of Total Responses

Fig. D.12 Mean ranking for favorite elephant activity (n=88)

- Walk with elephants: 4.4
- Elephant observation time: 4.3
- Sundowners with the elephants: 4.2
- Elephant back ride: 4.1
- Feeding the elephants: 4.1
- Star bed: 4.0
- Breakfast, Lunch or Dinner: 4.0
- Meet & Greet: 3.9

Least Favorite to >> Most Favorite
Fig. D.13 I loved my Abu elephant experience \((n=124)\)

- Strongly Agree: 106
- Agree: 18
- Neither agree nor disagree: 0
- Disagree: 0
- Strongly disagree: 0
Abu Camp requests your help. Please complete the following Abu Elephant Experience Survey regarding your experiences with the Abu Elephant Herd. This information will help guide our planning for the elephant management program at Abu Camp. Thank you for your time.

1. I feel very safe around the Abu elephants.
   - Strongly agree
   - Agree
   - Neither agree nor disagree
   - Disagree
   - Strongly disagree

2. The elephant handlers take excellent care of the Abu elephants.
   - Strongly agree
   - Agree
   - Neither agree nor disagree
   - Disagree
   - Strongly disagree

3. Guests should NOT be allowed to ride the elephants.
   - Strongly agree
   - Agree
   - Neither agree nor disagree
   - Disagree
   - Strongly disagree

4. I had enough opportunities to interact with the Abu elephants.
   - Strongly agree
   - Agree
   - Neither agree nor disagree
   - Disagree
   - Strongly disagree

5. The Abu elephants are in good health.
   - Strongly agree
   - Agree
   - Neither agree nor disagree
   - Disagree
   - Strongly disagree

6. I would have liked more time with the Abu elephants.
   - Strongly agree
   - Agree
   - Neither agree nor disagree
   - Disagree
   - Strongly disagree

7. More information about the Abu elephant herd should be provided to guests.
   - Strongly agree
   - Agree
   - Neither agree nor disagree
   - Disagree
   - Strongly disagree

8. Abu guests should ONLY be permitted to walk with the elephants.
   - Strongly agree
   - Agree
   - Neither agree nor disagree
   - Disagree
   - Strongly disagree

9. I got to do everything I wanted to do with the elephants during my stay at Abu Camp.
   - Strongly agree
   - Agree
   - Neither agree nor disagree
   - Disagree
   - Strongly disagree

10. My Abu experience greatly increased my knowledge about elephants.
    - Strongly agree
    - Agree
    - Neither agree nor disagree
    - Disagree
    - Strongly disagree

11. All of the Abu elephants should be returned to the wild.
    - Strongly agree
    - Agree
    - Neither agree nor disagree
    - Disagree
    - Strongly disagree

12. I loved my Abu Elephant Experience.
    - Strongly agree
    - Agree
    - Neither agree nor disagree
    - Disagree
    - Strongly disagree
REFERENCES


