May 8th, 12:30 PM - 2:00 PM

Room to Roam: Using GPS to Determine the Effect of Exhibit Size and Herd Size on Zoo Elephant Movement

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Room to Roam: Using GPS to determine the effect of exhibit size and herd size on zoo elephant movement

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GPS & wildlife

- Minimal researcher effort
- Large quantity of data
- Diverse applications
- Lowered costs
- Improved accuracy
Movement and zoo elephant welfare

• Limited opportunities for exercise
• Condensed diet
• Skeletal anatomy & foot health
• Historical considerations
Movement and elephant management

• How big are the enclosure?
• How many elephants share the space?
• How do these factors affect movement?
RESEARCH ARTICLE

GPS Determination of Walking Rates in Captive African Elephants (Loxodonta africana)

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The movements of elephants in captivity have been an issue of concern for animal welfare activists and zoological professionals alike in recent years. In order to fully understand how movement rates reflect animal welfare, we must first determine the exact distances these animals move in the captive environment. We outfitted seven adult female African elephants (Loxodonta africana) at Disney’s Animal Kingdom with collar-mounted global positioning recording systems to document their movement rates while housed in outdoor guest viewing habitats. Further, we conducted preliminary analyses to address potential factors impacting movement rates including body size, temperature, enclosure size, and social grouping complexity. We found that our elephants moved at an average rate of 0.409 ± 0.007 km/hr during the 9-hr data collection periods. This rate translates to an average of 3.68 km traveled during the observation period, at a rate comparable to that observed in the wild. Although movement rate did not have a significant relationship with an individual’s body size in this herd, the movements of four females demonstrated a significant positive correlation with temperature. Further, females in our largest social group demonstrated a significant increase in movement rates when residing in larger enclosures. We also present preliminary evidence suggesting that increased social group complexity, including the presence of infants in the herd, may be associated with increased walking rates, whereas factors such as reproductive and social status may constrain movements. Zoo Biol 28:16–28, 2009. © 2008 Wiley-Liss, Inc.

Keywords: animal movement; welfare; exercise; enclosure size

Grant sponsor: NSF; Grant number: NSF-0326395.

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Received 27 June 2007; Revised 3 December 2007; Accepted 20 May 2008

DOI 10.1002/zoo.20199
Published online 9 July 2008 in Wiley InterScience (www.interscience.wiley.com).
Developing the plan

- Anklets > collars
- 5 days of data per elephant (24 hrs/day)
- GPS coordinates every 5 seconds
- Simultaneous tracking of functional exhibit & herd size
Let’s do it!
(but wait – what about GPS technology?)
Challenge: GPS technology
Challenge: GPS technology
Challenge: GPS technology
Challenge: GPS technology
Challenge: GPS technology
Let’s do it!
(but wait – what about understanding spatial analysis?)
Challenge: GIS and Imagery

Integrated Solutions for GIS

Satellite & Aerial Imagery
- 3D Terrain Modeling
- Stereo Imagery
- Multi & Hyper-Spectral
- Ortho-Imagery
- Film
- Digital (DSS or ADS)
- Thermal

Digital Surface Model
GIS Implementation
Derived Products
Bare Earth DEM/DTM

What projection are you using?
Challenge: GIS and Imagery
Challenge: GIS and Imagery
Challenge: GIS and Imagery
Let’s do it!
(but wait – what about a pilot study?)
The effects of GPS collars on African elephant (*Loxodonta africana*) behavior at the San Diego Zoo Safari Park

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1. Introduction

African elephants have been in North American zoos for over 200 years (Schulte, 2000). The current AZA studbook for the African elephant, a comprehensive database of each individual animal under human care, states that there are approximately 171 females and 33 males exhibiting in U.S. institutions across North America (Olsom, 2011). While 36 of these animals were born on-site at zoological institutions, the vast majority of the adults were caught in the wild as juveniles during the ivory trade of the 1970s and 1980s (Olson and Weave, 2003). The maintenance of elephants in zoos requires that careful consideration given to exhibit size, compatible social grouping, diet and health (Gall and Mason, 2003; Mason and Veasey, 2010; Veasey, 2006). There is an increased interest in the activity budgets of zoo elephants as it relates to both physical well-being (i.e., obesity, degenerative joint disease, foot health; Cape, 2003; Rozeveld, 2003).
Challenge: Pilot Study

Training and Desensitization Protocol

IMLS Elephant Welfare Study: GPS

Step 1. Train foot presentation
The same behavior is used to attach front leg chains and perform routine foot work; it’s likely that your elephant is already trained for this.

Step 2. Introducing a prop
A prop is a device used to get your elephants used to wearing anklets. Most foals will start with a length of chain slipped inside a piece of flesh, attached on the ends with a shackle. Practice putting the prop on and taking it off until the elephant gets used to the procedure. When putting on the prop, the safest method is to first position the prop over the bar, and then ask the elephant to present their foot (similar to image at left showing ankle-measuring procedure). Alternately, ask her to present her foot first, then reach around the leg to affix the prop.

Step 3. Beginning training
To properly desensitize your elephant to wearing the anklet, you need to employ traditional DRI (differential reinforcement of incompatible behavior) techniques. Begin by asking the elephant to perform behavior that takes her attention away from her anklet (e.g., ask for her trunk, ask for behaviors that she likes). The goal is to keep her occupied doing behaviors that are difficult to complete if she is also fussing with her anklet. Slowly lengthen the amount of time she wears the anklet while also desensitizing her to varying environmental and social situations. In all of the above situations you are trying your best to have her nor play with the anklet.

Step 4. Anklet training
If possible, work with a handy staff member or a local tack shop to develop your own training anklet. If this is not possible, don’t worry. When you receive your kit from us, you will have 1-2 weeks of training time. Use the steps described above to desensitize your elephant to the new anklet before beginning data collection. During training, keep theottebox in the pouch, but do not put the electronic equipment inside. Good luck and thank you!

Have a problem elephant or need training advice?
Contact Jeff Andrews at jandrews@sandiegozoo.org or (760) 728-5063

Have questions about the project or want to find brummel books, etc.?
Contact Matthew Holdgate at mholdgate@gmail.com or (613) 815-4810
Challenge: Pilot Study
| Zoo | Name | ID   | Total Fixes | # | % | # | % | # | % | # | % | # | % |
|-----|------|------|-------------|---|---|---|---|---|---|---|---|---|---|---|
| San Diego | Swazi | 113067 | 0 | 0.0% | 292 | 0.3% | 1835 | 1.6% | 514 | 0.5% | 1321 | 1.2% | 1401 | 1.2% |
| San Diego | Lungile | 111257 | 5 | 0.0% | 326 | 0.3% | 1745 | 1.6% | 569 | 0.5% | 1176 | 1.1% | 1430 | 1.3% |
| Calgary | Rani | 14756 | 0 | 0.0% | 308 | 2.1% | 48 | 0.3% | 10 | 0.1% | 38 | 0.3% | 81 | 0.5% |
| Calgary | Swarna | 14588 | 0 | 0.0% | 138 | 0.9% | 91 | 0.6% | 43 | 0.3% | 48 | 0.3% | 134 | 0.9% |
| Fresno | Kara | 40810 | 0 | 0.0% | 163 | 0.4% | 2216 | 5.4% | 839 | 2.1% | 1377 | 3.4% | 7799 | 19.1% |
| Fresno | Shaunzi | 43812 | 3 | 0.0% | 280 | 0.6% | 2723 | 6.2% | 806 | 1.8% | 1917 | 4.4% | 6717 | 15.3% |
| Fresno | 46517 | 0 | 0.0% | 157 | 0.3% | 442 | 1.0% | 78 | 0.2% | 364 | 0.8% | 399 | 0.9% |
| Fresno | 432014 | 8 | 0.0% | 2056 | 0.5% | 9492 | 2.2% | 2919 | 0.7% | 6573 | 1.5% | 18328 | 4.2% |

**Challenge: Pilot Study**
Let’s do it!
(okay!)
We did it!

- Target population: 500 days of data from 100 elephants at 50 zoos
- Actual population: 386 days of data from 80 elephants at 43 zoos
Data Processing

- 86,400 data points/elephant; 6,912,000 total
- Inclusion criteria, GPS filters, spatial analysis
- Elephant survey data (species, age, body condition, health history, reproductive status, exercise)
- Zoo survey data (exhibit sizes, substrates, temperature, disturbance)
- Calculations of functional exhibit size and herd size
Research Questions

What are the factors that affect zoo elephant movement?

• Emphasis: exhibit size
• Emphasis: herd size
How does movement affect zoo elephant welfare?
  • Emphasis: body condition score
  • Emphasis: foot health

What factors affect zoo elephant recumbence?
  • Emphasis: substrate
The elephants and I would like to recognize...

- Debbie Ethell, data intern
- Tim Alder, GIS intern
- Institute of Museum and Library Services
- Pittsburgh Zoo and PPG Aquarium’s Conservation and Sustainability Fund
- Forbes-Lea Research Fund
- Marie Brown Travel Award
- Zoo visitors!
Literature Cited
