ANIMAL KEEPERS' FORUM
The Journal of the American Association of Zoo Keepers, Inc.
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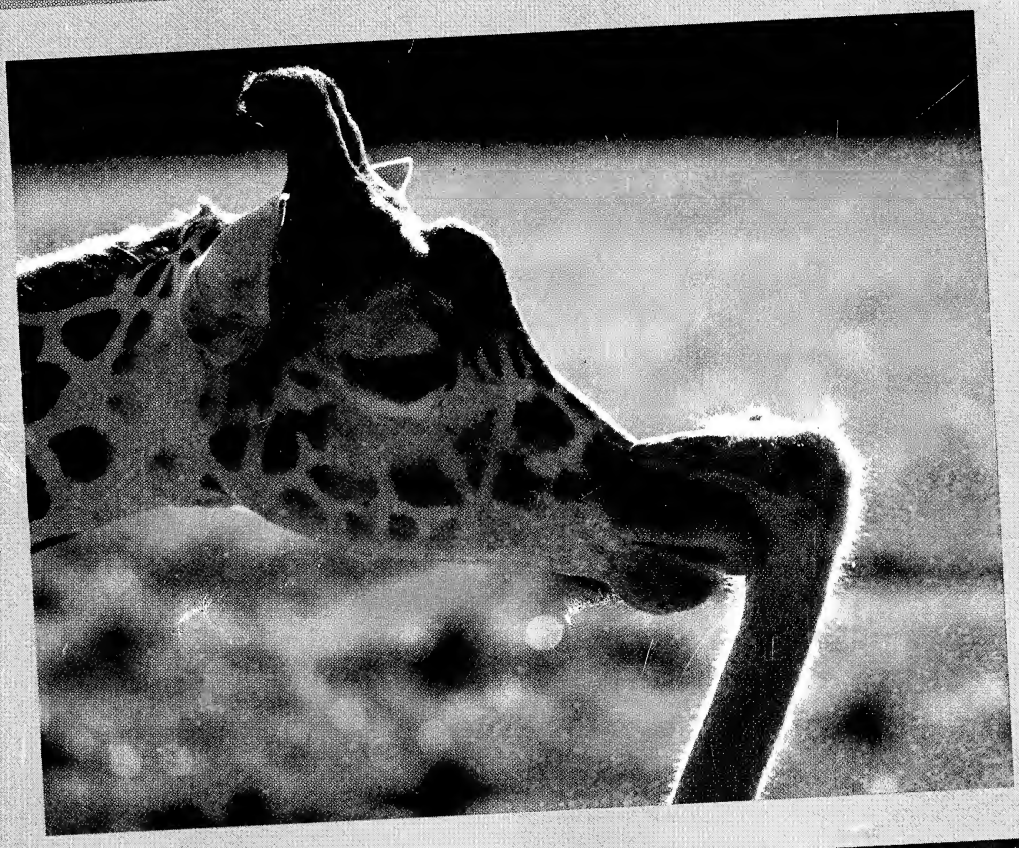

# Bird and Hoofstock Mixed-Species Exhibits

SPECIAL DOUBLE ISSUE

**ANIMAL KEEPERS' FORUM**, P.O. Box 535, Valley City, OH 44280 **April/May 2013**
Phone: 330-483-1104, E-mail: shane.good@aazk.org **Vol. 40, Nos. 4 & 5**

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*Animal Keepers' Forum* is published monthly by AAZK, Inc. Ten dollars of each membership fee goes toward the annual publication costs of *Animal Keepers' Forum*. Postage paid at Topeka, KS.

**AAZK Executive Director**: Ed Hansen, AAZK, Inc., Topeka, KS

# ABOUT THE COVER

This month's cover features a reticulated giraffe (*Giraffa camelopardalis reticulata*) and ostrich (*Struthio camelus*) at the Saint Louis Zoo. The photo is by Chuck Dresner. The *AKF* Editors named this photo "Nuzzle", and we felt that it was a good representation of the positive results that can be achieved with mixed-species bird and hoofstock exhibits. Thank you to all of the authors, sponsors, ASAG, and the Antelope and Giraffe TAG for helping create this special dedicated issue. Your contributions will advance professional animal care and best practice in bird and hoofstock mixed-species exhibits.

Giraffes are long-necked browsing animals that taxonomists place in a separate family, *Giraffidae*, from other artiodactylids. Possessing only seven cervical vertebrae (like other mammals), giraffes, at almost 19 feet, are the tallest of all mammals. Adult males weigh as much as 4,000 lbs. They are characterized by having two knobs, called ossicones, on their head. Unlike antlers on deer or horns on bovids, ossicones are permanently covered by hair and never shed. After a gestation of 15 months, females give birth to a single young; twins occur rarely.

The AZA Ratite TAG is involved in the Adopt-an-Ostrich program to help save the critically endangered desert race of the North African Ostrich (*Struthio c. camelus*). This sub-species inhabits the harsh environment of the Sahara. For more information on how to help, go to: http://saharaconservation.org/?Ostrich-Conservation-Niger.

Articles sent to *Animal Keepers' Forum* will be reviewed by the editorial staff for publication. Articles of a research or technical nature will be submitted to one or more of the zoo professionals who serve as referees for *AKF*. No commitment is made to the author, but an effort will be made to publish articles as soon as possible. Lengthy articles may be separated into monthly installments at the discretion of the Editor. The Editor reserves the right to edit material without consultation unless approval is requested in writing by the author. Materials submitted will not be returned unless accompanied by a stamped, self-addressed, appropriately-sized envelope. Telephone, fax or e-mail contributions of late-breaking news or last-minute insertions are accepted as space allows. **Phone (330) 483-1104; FAX (330) 483-1444; e-mail is shane.good@aazk.org**. If you have questions about submission guidelines, please contact the Editor. Submission guidelines are also found at: **aazk.org/akf-submission-guidelines/.**

**Deadline for each regular issue is the 3rd of the preceding month.**
**Dedicated issues may have separate deadline dates and will be noted by the Editor.**



**To Contact the *AKF* Editor:**
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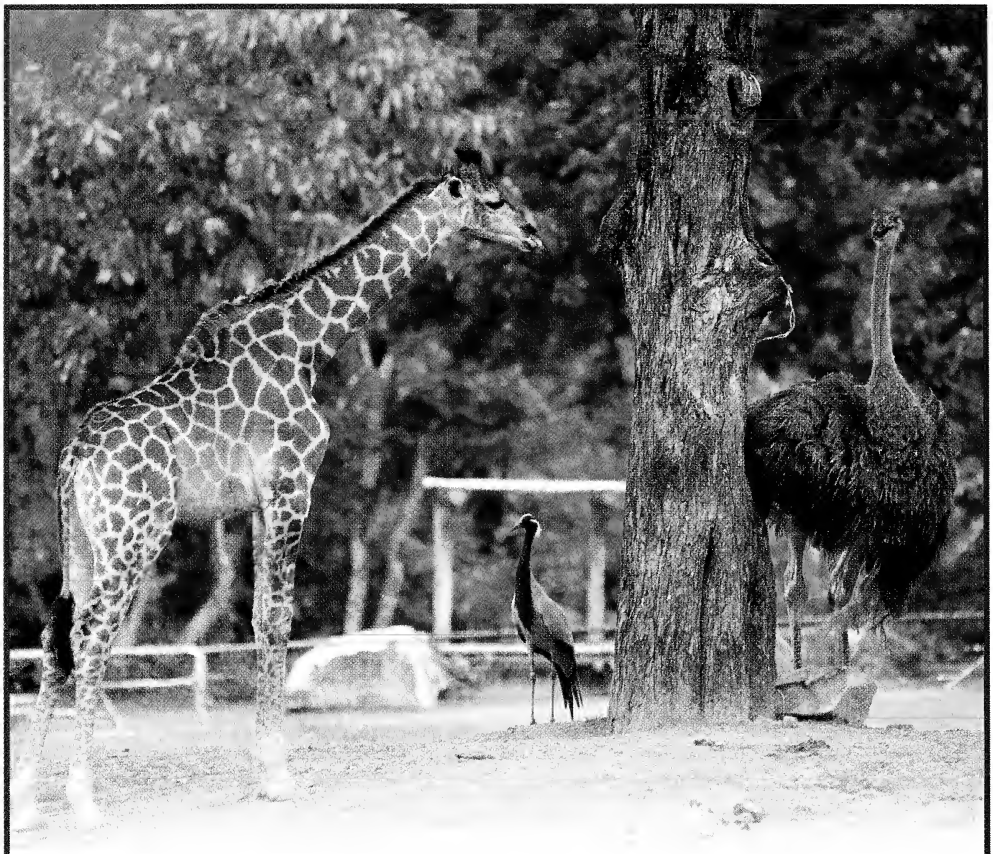

AMERICAN ASSOCIATION of ZOO KEEPERS

*MISSION STATEMENT*
*(Revised April, 2009)*
American Association of Zoo Keepers, Inc.

***The American Association of Zoo Keepers, Inc. exists to advance excellence in the animal keeping profession, foster effective communication beneficial to animal care, support deserving conservation projects, and promote the preservation of our natural resources and animal life.***

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# Herds of a Feather Flock Together

## A Message from the Avian Scientific Advisory Group

In the spring of 2012, at the AZA Mid-Year Conference in Palm Springs, CA, bird and ungulate keepers, managers and curators came together for the first time in a joint workshop aimed at increasing communication to allow for improved management of bird/ungulate exhibits. One of the outcomes of the meeting was a commitment to publishing a series of papers in *Animal Keepers' Forum* on the challenges of mixed-species bird and ungulate exhibits. Recognizing that communication between bird and ungulate keepers and managers must be improved, the workshop and this dedicated issue of *AKF* are a significant positive step towards achieving that goal. Bird and ungulate collections alike face considerable sustainability challenges. Only by working more closely together, can we begin to address the complex and multi-layered challenges facing both groups of animals.

Mixed-species exhibits are popular with both zoo visitors and collection managers for many reasons. Roger Sweeney in his article "*Ten Things Those Birds Walking Around with Your Hoofstock Would Like You to Know*" describes the advantages of mixed-species exhibits as follows: "They provide dynamic, visually interesting exhibits that can effectively illustrate biodiversity themes, increase the activity level of animals in the exhibit and provide a stimulating environment for the inhabitants that is ever-changing; and perhaps most importantly for collection managers, they can maximize the effective use of exhibit space, which works towards trying to resolve one of greatest modern day challenges: How can we provide enough housing space to maintain our SSP populations sustainably?"

As zoos strive to provide increased welfare for their animals, along with bigger enclosures, and inspirational exhibits for visitors, the role of mixed-species exhibits becomes more critical as conservation demands on space increase. Given the great challenges facing population sustainability of both avian and ungulate programs, practical opportunities to increase exhibit and holding space with mixed exhibits must be considered and implemented. Of course not all bird species are suitable to be part of a mixed-species exhibit and likewise for ungulates. Additionally, it is critical to remember that a mixed species exhibit is only successful if it benefits the population objectives of each species that it houses. Ungulate and bird collections have many obvious differences and requirements. But when managed appropriately, and by identifying resources that are likely to create competition and providing appropriate means to minimize conflict between species, these two groups of animals can live together with very positive results.

Although birds and ungulates have been exhibited together for as long as zoos have been around, the need to successfully manage mixed-species exhibits has never been more urgent. If you are involved in the care of a mixed-species bird/ungulate exhibit I hope that you are able to use information contained within this issue to your advantage but most importantly, to the advantage of the animals entrusted to your care.

Sara Hallager
Chair, Avian Scientific Advisory Group

# A Message from the Antelope and Giraffe TAG

In March of 2012, the AZA Ungulate TAGs and the AZA Bird TAGs partnered together for the first time to facilitate a half-day workshop as a part of the AZA Midyear Workshop in Palm Springs, California. This workshop was intended to be the first of, hopefully, many collaborative efforts between the TAGs to bring two incredibly dedicated and passionate groups of professionals, ungulate professionals and bird professionals, together for focused multi-taxa discussions.

The topic of discussion for this inaugural workshop, entitled *Herds of a Feather Flock Together*, was bird/ungulate multi-species habitats. Although we were not entirely sure what to expect when bringing two such diverse groups together, we hoped that this workshop would encourage idea sharing and inspire good discussions about the benefits and challenges of having birds and ungulates living together in the same space. Where would our discussions lead us? We hoped that by sharing our experiences, our knowledge, our concerns, our successes and our failures that keepers and managers would return home rejuvenated and encouraged to pursue new or additional multi-species habitats that ensure safe and successful management of birds and ungulates to the benefit of both taxa.

Much as you would expect a first introduction between a group of ungulates and a group of birds to go, everyone was a little bit tentative at the beginning of this workshop and not quite sure what to make of the other group…however, once the workshop was in full swing, we were very pleased to have full participation from both the bird and the ungulate professionals and we received positive feedback from all who attended.

Not only was last year's workshop a huge success, but also it ultimately encouraged us to pursue another positive collaboration – this time, between the Ungulate TAGs, the Bird TAGs and AAZK. The Ungulate TAGs are proud co-sponsors of this special edition of *Animal Keepers' Forum*. We are pleased with the overwhelming outpouring of fantastic articles covering a myriad of topics related to ungulate/bird multi-species habitats. The important information presented during the workshop last year is reproduced here for those who could not be in attendance. Additionally, this edition also provides new information on the important subject of bird/ungulate multi-species habitats.

Whether you call yourself "a bird person" or "a hoofstock person" - or maybe, like me, you are simply a person who loves both birds *AND* hoofstock – in any case, you will surely find the valuable information included within this special edition of *AKF* to be both interesting and useful.

Thank you for all you do for the care and conservation of animals.

Most Sincerely,

Martha Fischer
Chair, AZA Antelope and Giraffe TAG

# FROM THE PRESIDENT

Congratulations to Shane Good, Elizabeth Thibodeaux, and Becky Richendollar for putting together another successful dedicated issue. The concept of mixed-species exhibits has been around for some time now and in the age of evidence-based husbandry, sharing successes in a measurable and reproducible way helps promote success across the board. That success results from cooperation, collaboration, communication and a common belief from all disciplines, fitting right in with our mission!

Our mission at AAZK is a multidisciplinary effort of its own kind. Board members, Committees and our members strive to do the following:

- Advance excellence in the animal keeping profession
- Foster effective communication beneficial to animal care
- Support deserving conservation projects
- Promote the preservation of our natural resources and animal life

On a National level, AAZK committees are the workforce behind making our mission work for you. Committee members work diligently to bring you products, conferences, workshops, conservation opportunities, advances in behavior and husbandry, and now, distance learning opportunities. Their efforts are progressive, resulting in a modernization of our Association.

Progressive effort and tireless dedication results in great things! For example, our Professional Development Committee has worked diligently since 2008 to provide a standard form of workshop presentations at AAZK Conferences. Their hard work is also responsible for the creation of AAZK Online (P. 259), AAZK's distance learning format. AAZK Online will now make it possible for all members to benefit from our primary mission: advancing excellence in the animal keeping profession.

The Professional Development Committee does their utmost to provide continual resources for professional growth through leadership and educational opportunities for all National AAZK members.

You'll be hearing more about other AAZK committee work, progress and due recognition in the months to come. For now, I'd like to congratulate the Professional Development Committee for accomplishing their greatest goal: AAZK Online, Collaborative Learning Environment. We're moving closer to fulfilling our mission and we're including you.

I welcome your feedback. E-mail me at bob.cisneros@aazk.org ; your voice matters.

Bob Cisneros

# THANK YOU THANK YOU THANK YOU THANK YOU

for supporting this dedicated issue of *Animal Keepers' Forum*

AAZK of Cheyenne Mountain Zoo

www.cmzoo.org/animalsPlantsHealth

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ASAG

Avian Scientific Advisory Group

AAZK

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Antelope&Giraffe TAG

SeaWorld.

COLUMBUS CHAPTER

American Association of Zoo Keepers

VIRGINIA ZOO in Norfolk

QUAGGA

Extinction is Forever

## Dear AAZK Chapters

Congratulations! We are so proud of all the chapters that participated in Bowling for Rhinos in 2012. We asked you to amp up your fundraising and boy did you ever. Because of your work we had a banner year in 2012 raising $337,191.09. This is a considerable amount of money and will go a long way toward supporting this noteworthy cause. Thank you to all the Chapters that participated this year and contributed to our success.

It is a new year and the rhino and all else benefitting from BFR continue to need your support. Our goal for 2013 is again $500,000 and 100% Chapter participation. This can be done but we need your help! We know that we are in difficult times so we have to be creative in our fundraising efforts. Some ideas that have been tried and been successful include: Bowling for Rhinos, Wii Bowling, Rummage for Rhinos, Rock N' for Rhinos, bake sales, reverse raffles, wings and suds, car washes, dances, walk-a-thons, behind the scenes tours of your rhino facilities, personal appeals for donations, to name a few. Clearly your efforts can include more than just bowling. We will be happy to help you come up with ideas if you need help.


Remember …

- The five rhino species are the "Umbrella" species. By saving the rhino's habitat we are saving whole ecosystems including hundreds of species of mammals, birds, insects, reptiles and plants. We protect 1.5 million acres of land in Kenya and 1.4 million acres in Indonesia and support life for the people in the surrounding communities.

- Lewa is home to not only rhino but elephant, lion, leopard, cheetah, the endangered Hirola and 25% of the world's population of Grevy's zebra. The habitat we protect in Indonesia is home not only to rhino but Sumatran tigers, tapir, clouded leopard and siamang, just to name a few. Conservation cannot wait. If we do not act today, it WILL soon be too late. Poaching pressure is the most intense it has been in the past 30 years. There were 65,000 black rhino in 1970. By 1990, there were only 2,000. Today, in part due to organizations such as AAZK, their numbers are back up to more than 4,000. We need everyone's continued support to win this battle against poachers.

- Through Action for Cheetahs in Kenya we are saving the cheetah and wildlife habitat through research, awareness and community participation in various regions including the community conservation areas within the Northern Rangelands Trust that encompasses Lewa Wildlife Conservancy.

- Indonesia's Ujung Kulon National Park is home to the world's only population of Javan rhinos – now numbering no more than 44 animals. Ujung Kulon's boundaries also protect sea turtles, leopard, Javan hawk eagle, Javan gibbons and rich coral and sea grass ecosystems.

- Critically endangered Sumatran Rhinos in Indonesia's Bukit Barisan and Way Kambas National Parks share their ecosystem with Sumatran tiger, elephant, tapirs, sun bear, siamangs and a host of threatened bird species. Bowling for Rhinos helps to protect these species and the habitat they share.

If you would like more info please see the following websites:

- Bowling for Rhinos – AAZK.org or aazkbfr.org
- International Rhino Foundation - rhinos.org,
- Action for Cheetahs – actionforcheetahs.org,
- Lewa – lewa.org.

If you would like help in running a Bowling for Rhinos bowling event, Detroit AAZK has a 'how to' page at AAZK.org. Also, we will be more than happy to help you with ideas or getting you in contact with other AAZK Chapters near you for help.

In 2012 we saw far too many rhinos poached, together we can help to make 2013 a better year for the rhino.

Yours Truly,

***Patty Pearthree***

**Bowling for Rhinos Coordinator**

# COMING EVENTS

**Post Your Upcoming Events here — e-mail shane.good@aazk.org**

**June 5-6, 2013**
**2nd International Symposium on Zoo Animal Welfare, Brookfield Zoo**
For more information: czs.org/symposium

**June 9-13, 2013**
**Shape of Enrichment Workshop**
**Omaha's Henry Doorly Zoo and Aquarium**
Hosted by the Omaha AAZK Chapter
For more information contact: robinfreise@hotmail.com or visit enrichment.org and click under "New Events"

**June 13-16, 2013**
**3rd Seminar on Venomous Animal Safety and Husbandry**
Hosted by Catoctin Wildlife Preserve and Zoo, Thurmont, MD. For more information visit CWPZoo.com,. Registration deadline is May 25, 2013.

**June 17-20, 2013**
**Bear TAG Meeting and Keeper Workshop (Polar Bears and Brown Bears)**
Hosted by Como Zoo, St. Paul, MN.
For more information and to register, contact Laura Bottaro at lbottaro@okczoo.com

**June 23-26, 2013**
**Felid Tag Husbandry Course, plus...**

**June 27-29, 2013**
**AZA Felid TAG Mid-Year Meeting**
Hosted by Jacksonville Zoo and Gardens, Jacksonville, FL. For more information go to: felidtag.org or contact felidtag2013@jacksonvillezoo.org.

**July 8-12, 2013**
**Zoos and Aquariums Committing to Conservation (ZACC),**
Hosted by Blank Park Zoo, Des Moines, Iowa. Registration is available at blankparkzoo.com/index.cfm?nodeID=48429&audienceID=1. Contact Jessie Lowry with questions at jrlowry@blankparkzoo.org.

**August 7-10, 2013**
**11th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles**
Co-hosted by the Turtle Survival Alliance and the IUCN-TFTSG in St. Louis, Missouri. Please visit turtlesurvival.org for more information, or contact Heather Lowe at Hlowe@turtlesurvival.org.

**September 15-20, 2013**
**22nd International Conference on Bear Research and Management**
Hosted by Brigham Young University, Provo, UT.
For more information go to:
ce.byu.edu/cw/bear/

**September 22-26, 2013**
**AAZK NATIONAL CONFERENCE**
Hosted by North Carolina Zoo and North Carolina AAZK Chapter, Asheboro, NC
For more information go to:
ncaazk.com/2013nationalconference.htm

**October 13-17, 2013**
**WAZA Annual Conference**
Hosted by Disney's Animal Kingdom.
For more information go to: waza.org

**October 3-6, 2013**
**Advancing Bear Care 2013**
**Woodlands Wildlife Refuge, Clinton, NJ**
For more information visit bearcaregroup.org

**November 10-14, 2013**
**Zoological Association of America (ZAA) Annual Conference, Phoenix, AZ**
For more information go to zaa.org. Deadline for abstracts is April 1, 2013.

**April 13-18, 2014**
**ABMA's 14th Annual Conference**
Dallas, TX
For more information go to:
theabma.org

# AAZK ANNOUNCES NEW MEMBERS

**NEW COMMERCIAL MEMBER**
Grubco Incorporated, Fairfield, OH

**NEW CONTRIBUTING MEMBER**
David J. Scholes, Aurora, IL

**NEW PROFESSIONAL MEMBERS**
Clinton Doak, Little Rock Zoo, Little Rock, AR
Sarah Sprentall, Reid Park Zoo, Tucson, AZ
Laura Schroeder, Phoenix Zoo, Phoenix, AZ
Sarah Levosky, Phoenix Zoo, Phoenix, AZ
Leigh Ann Fletcher, Los Angeles Zoo, Los Angeles, CA
Daniel Essary, San Diego Zoo, San Diego, CA
Alexandra Cosgrove, The Living Desert, Palm Desert, CA
Rachel Winkler, Oakland Zoo, Oakland, CA
Natasha Marie Tworoski, Oakland Zoo, Oakland, CA
Kimberly Garcia, Los Angeles Zoo, Los Angeles, CA
Grace Enlow, Oakland Zoo, Oakland, CA
Jessica Sheftel, San Diego Zoo Global, San Diego, CA
Ashley Kleam, Fresno Chaffee Zoo, Fresno, CA
Katrina Mehling, Fresno Chaffee Zoo, Fresno, CA
Leslie Rao, Fresno Chaffee Zoo, Fresno, CA
Amanda Preece, Monterey Bay Aquarium, Monterey, CA
Jessica Bella, Randall Museum, CA
Alyssa DeBenedetti, Charles Paddock Zoo, CA
Tara Geiger, Kamloops Wildlife Park, Kamloops, BC, Canada
Jenna Harrison, Assiniboine Park Zoo, Winnipeg, MB, Canada
Megan Desai, Assiniboine Park Zoo, Winnipeg, MB, Canada
Andrea Bryant, Cheyenne Mtn. Zoo, Colorado Springs, CO
Jackie Spicer, Smithsonian's National Zoo, Washington, DC
Chelsea Grubb, Smithsonian's National Zoo, Washington, DC
Nicole MacCorkle, Smithsonian's National Zoo, Washington, DC
Aleksandra Kalenak, Gulf Breeze Zoo, Gulf Breeze, FL
Cindy Hall, Naples Zoo, Naples, FL
Erin Bussom, Central Florida Zoo, Lake Monroe, FL
Matthew Marsicano, Zoo Miami, Miami, FL
Elaine McPherson Andrews, Lion Country Safari, Loxahatchee, FL
Anna Gentry, Busch Gardens, Tampa, FL
Shannon Osterholm, Blank Park Zoo, IA
Brad A. Kennett, Henson Robinson Zoo, Springfield, IL
Racquel Ardisana, Chicago Zoological Society, IL
Mary Haberstich, Topeka Zoological Park, Topeka, KS
Jamie Petrie, Topeka Zoo, Topeka, KS
Bridget Collins-Lyman, Audubon Zoo, New Orleans, LA
Jennifer Carter, Jubilee Zoo, Shreveport, LA
Sarah Fleurent, Buttonwood Park Zoo, New Bedford, MA
Kathryn Harding, Buttonwood Park Zoo, New Bedford, MA
Matthew Stierhof, Franklin Park Zoo, Boston, MA
Lauren Elizabeth Brightman, Salisbury Zoo, Salisbury, MD
Heidi Perez, DEW Animal Kingdom & Sanctuary, Mt. Vernon, ME
Julie Miner, DEW Animal Kingdom & Sanctuary, Mt. Vernon, ME
Cynthia Wagner, Potter Park Zoo, Lansing, MI
Crystal Duval, Kansas City Zoo, Kansas City, MO
Shannon Santangelo, Saint Louis Zoo, St. Louis, MO
Tenley Davis, Kansas City Zoo, Kansas City, MO
Shaina Roskovich, Kansas City Zoo, Kansas City, MO

Kim Montgomery, Zoo Montana, MT
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Jennifer Norman, Omaha's Henry Doorly Zoo & Aquarium, Omaha, NE
Robin Ronnebaum, Omaha's Henry Doorly Zoo & Aquarium, Omaha, NE
Carol Eager, Lee G. Simmons Wildlife & Conservation Park, NE
Erin Sattler, Turtle Back Zoo, W. Orange, NJ
Crystal Dimiceli, Prospect Park Zoo, Brooklyn, NY
Taylor Hann, Columbus Zoo, OH
Robin F. Chambers, Pittsburgh Zoo, Pittsburgh, PA
Eric Kellar, Pittsburgh Zoo, Pittsburgh, PA
Erin Mowatt, Erie Zoo, PA
Cheryl Thome, Elmwood Park Zoo, Norristown, PA
Christina O Donnell, Philadelphia Zoo, Philadelphia, PA
Molly Jorges, Center for Animal Rehabilitation & Education, S. Africa
Christine Blankenship, Charles Towne Landing-Animal Forest, Charleston, SC
Jamie McTyre, Memphis Zoo, Memphis, TN
Kim Callis, Nashville Zoo at Grassmere, Nashville, TN
Kyle Koehler, Nashville Zoo at Grassmere, Nashville, TN
Jaclyn Althauser, Dallas Zoo, Dallas, TX
Shaun Stauffer, The Virginia Zoo, Norfolk, VA
Deanna Edwards, Northwest Trek Wildlife Park, Eatonville, WA
Gwendolyn Schwanke, Ocshner Park & Zoo, Baraboo, WI
Sasha Ripley, Timbavati Wildlife Park, Wisconsin Dells, WI
Brooke Rose, Wildwood Wildlife Park, Minocqua, WI
Susan McCardle, The Good Zoo at Oglebay, Wheeling, WV

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Desert Plastics, LLC, Albuquerque, NM
Premier Tours, Philadelphia, PA

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Donna M. Graham, Dayton, OH
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**RENEWING INSTITUTIONS**

Wildlife World Zoo, Litchfield Park, AZ
Bearizona Wildlife Park, Williams, AZ
Wild Things Inc., Salinas, CA
Oakland Zoo, Oakland, CA
Denver Zoo, Denver, CO
Lemur Conservation Foundation, Inc., Myakka City, FL
Scovill Zoo, Decatur, IL
Columbian Park Zoo, Lafayette, IN
Safe Haven Rescue Zoo, Imlay, NV
Utica Zoo, Utica, NY
Oregon Zoo, Portland, OR
WildCat Haven, Inc., Sherwood, OR
Chattanooga Zoo, Chattanooga, TN
Woodland Park Zoo, Seattle, WA
Point Defiance Zoo & Aquarium, Tacoma, WA
Henry Vilas Zoo, Madison, WI
Calgary Zoo Library, Calgary, AB, Canada

# AAZK Appoints Two Members to Board of Directors

AAZK, Inc. is pleased to announce the appointment of Penny Jolly of Disney's Animal Kingdom and Wendy Lenhart of Philadelphia Zoo to the Board of Directors. Penny is a current member of the Board, serving as our Association's Vice President, and was elected to a second term. Wendy was elected to her first term and will be sworn in at the AAZK National Conference in North Carolina. Congratulations Penny and Wendy!

## Penny Jolly

Penny has been a member of AAZK for 19 years. She became Co-Chair of the newly formed National Conservation Committee in 2007 and helped develop the committee. In 2009 she was honored to become an AAZK Board Member and currently holds the office of Vice-President. "Through the hard work of all the Conservation Committee, we have facilitated several National AAZK workshops including: "Bringing it Home: Participating in Local Conservation", "Green Teams and Green Practices at Your Zoo", "Bushmeat Crisis: local perspectives, global solutions" and "How to Inspire Your Visitors to Conservation Action". She has been a member of the Kansas City and Orlando Chapters, holding the Secretary and Treasurer offices, and participating in fundraisers and conservation projects including BFR and as the 2001 National Conference Treasurer Chair.

## Wendy Lenhart

"A few years ago when the Greater Philadelphia Chapter of AAZK hosted the annual conference, I was able to speak with some visiting kangaroo keepers about the red kangaroos in my care. It's really nice when you can talk to someone else who has a similar task with a different perspective. That was the first conference I had attended in several years and it was invigorating. I found that I took a new pride in my work. After that, I found out that a few of my new kangaroo pals were involved with the AAZK National Conservation Committee, so I decided to apply. Since I've been a member, we've collaborated for articles in the *AKF*, organized a workshop for the Syracuse Conference and I've had the pleasure of assisting with the expansion of Bowling for Rhinos resources. I can't say enough good things about being able to work with other keepers on projects you are all passionate about and for animals we all want to protect. I would encourage anyone with a positive attitude and new ideas to get more involved with national committee work."

# THE SCOOP




**Please join AAZK and PBI in celebrating the achievements of the Chapters participating in this year's Trees for You & Me Challenge — a friendly competition designed to raise funds for local tree planting projects!**

Ready for the results?

Here they are!

Brookfield AAZK Chapter: $3,262.25
Lincoln Park AAZK Chapter: $2,000.00
Milwaukee AAZK Chapter: $656.00
The Greater Orlando Chapter: $650.00
Southern Ontario AAZK Chapter: $375.00
Portland AAZK: $349.15
Greater New Jersey AAZK Alliance: $300.00
Detroit Chapter of AAZK: $250.00
Greater Baltimore Chapter: $250.00
Redwood Coast Chapter: $200.00
Birmingham Chapter of AAZK: $143.70
Orange County Chapter of AAZK: $112.00

**Grand total:**
**$8,547.70**

Funds raised in the competition are used to support tree plantings or relevant greening efforts along with educational events where we hope you'll invite others to join you in additional conservation behaviors. You can coordinate your events with Acres for the Atmosphere or as part of an international tree planting effort through other conservation programs at your institution.

We appreciate your dedication to this conservation program, and we look forward to reviewing your reports about your local plantings by November 2013 in PBI's online community, My Planet, My Part.

Thank you all for your support!

Christy Mazrimas-Ott
AAZK Trees for You & Me Chair

# FAUNA RESEARCH INC.
## Notes from the Field

Fauna Research Inc. TAMER
8 BARD AVE.
RED HOOK, NY 12571
845-758-2549

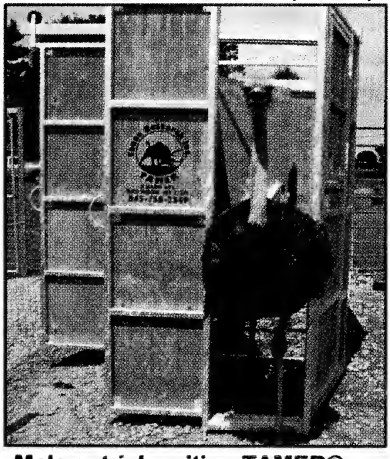
**LOCATION:** Ostrich Pens at Highland Farm, Germantown, NY 12526

**SPECIES:** Common Ostrich, *Struthio camelus sp.* A breeding group of Ostrich consisting of 8 mature females, multiple males and numerous chicks hatched each year are maintained at Highland Farm in several pens on 3 acres.

**DATE:** Summer 2012

**EQUIPMENT:** Portable **OSTRICH TAMER®** with Catch Pen

**NOTES:** The ostrich are conditioned to enter the catch pen and walk through the TAMER® on a daily basis. A wire mesh sweep gate is used to safely move each bird into the TAMER® unit which consists of a solid walled, funnel shaped restraint area with numerous sweep and slide gates for quick, easy and protected access to the head, neck, wings and feet.



Male ostrich exiting TAMER®

"In addition to easily providing health care to the birds on a regular basis, we can also safely separate the breeding male ostrich from the females and move him out of the enclosure so the area can be cleaned and all the birds can be fed and watered daily."
Mike Ruffell, Farm Manager

Easy and protected handling of birds

Deworming with pour on Ivermectin

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# Health Concerns for Mixed-Avian/Hoofstock Exhibits

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Mixed-species exhibits in zoological collections have the potential to enhance both the animals' environment and the visitors' experience. An exhibit with multiple species more accurately depicts the natural environment, providing the zoo guests a more complete appreciation of habitats and their inhabitants. From the animals' perspective, the addition of other species may provide mental stimulation and vary the activity in the exhibit.

Does mixing species in habitats increase disease risk? In recent years much attention has focused on emerging and zoonotic diseases. It is estimated that 2/3 of human pathogens have animal origins, and examples such as Ebola, SARS, Bird Flu and monkeypox have been in the news. An often cited cause for disease emergence is novel exposure; animals and/or humans exposed to other animals and/or humans that they would not typically encounter. In zoological collections 'unique exposure' is practically the definition of the business. Zoos bring animals from a variety of habitats and environments together for conservation, education and entertainment purposes. Does this result in the same sort of disease risk?

There are health risks well known to zoo staff, for example the potential for *Salmonella* to be shed by healthy reptiles. Herpesvirus infections harbored by some macaque species could pose serious health risks to human caretakers. *Chlamydophila* infections in birds, toxoplasmosis infections in cats, and roundworm infections in raccoons (*Procyon lotor*) have all been documented to be zoonotic – transferred to humans from animals.

But what about between animals? We tend to think of infectious diseases within a group. For instance, we vaccinate animals for certain diseases that they can transmit to each other (canine distemper, feline herpesvirus) or get from a common source (rabies, West Nile virus). The risk depends to some extent on the etiological agent. For example, viruses tend to be more taxon specific; for example primate viruses, bird viruses, hoofstock viruses. Parasites tend to have specific groups for hosts and intermediates, with protozoa being the least picky. And bacteria are quite cosmopolitan in their host selection, with no specificity at all.

These generalities do carry over to the specific situation addressed in this issue, that of bird/hoofstock transmission. There are some viral diseases for which birds serve as a reservoir host, such as West Nile virus, Eastern and Western encephalitis virus, and avian influenza. These diseases can be transmitted to mammals. However, all of these require a vector (mosquito), so housing birds and hoofstock together does not increase risk of infection.

Metazoan parasites (nematodes, trematodes) are not transmitted between birds and mammals. However, protozoal parasites such as *Giardia* and *Cryptosporidium* are not species–specific and could potentially be shed by antelope or birds in an exhibit, survive in water, and infect other animals in the same enclosure. While possible, this is very unlikely as long as standard hygiene procedures are followed, such as removing feces and maintaining fresh water.

While bacteria are not very specific in the host that they inhabit, most are not potent pathogens. Enteric pathogens such as *Salmonella* and *Campylobacter* can be shed in feces and potentially infect other animals that contact that material. Bacteria such as *Anthrax* and *Clostridium* may be present in the environment under certain conditions and transmitted to any animals in that exhibit. Once again, good husbandry practices and typical hygiene will prevent nearly all of these potential exposures.

Nutritional aspects should be considered as well. Food items and types commonly eaten by birds or hoofstock are not likely to be dangerous to the other group. However, access to other food items may unbalance the diets. For example, if hoofstock prefer to eat vegetables fed to birds they may consume less hay or pellets which could potentially cause nutritional concerns. In reality, this seems relatively unlikely as the amount eaten would have to be substantial. Another concern would be with meat products in bird diets. Because of the potential of transmission of prion disease, FDA forbids any meat products in ruminant diets. Although this situation would technically not be equivalent to feeding meat to ruminants, FDA has become stricter with zoological parks in regard to feeding practices.

Medicating animals in mixed exhibits may also present challenges. If animals are medicated in preferred food items, it will be important to assure that the targeted animal is consuming the medicated food item. In many cases the effect of medications on non-target species are not known. However, instances of non-target toxicoses have been documented, for instance the fatal renal damage that has occurred in vultures (*Gyps* species) in southeast Asia eating cattle carcasses treated with the anti-inflammatory drug diclofenac. While this drug is safe and approved for ruminants, it is lethal to birds.

The most significant health risk in mixed-species exhibits (regardless of the species) is trauma. Intentional aggression can be avoided by proper species selection. However, situations such as breeding activity, territoriality, nesting, or raising offspring can change behaviors. Traumatic injuries between birds and hoofstock may occur in either direction, but in most cases birds fare much more poorly than hoofstock. In addition to targeted aggression, hoofstock activity in an exhibit may excite birds and cause trauma from walls, moats, and exhibit furniture.

# Successful Management of Jigsaw Puzzle Exhibits

*Sharon Areen Smith*
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*&*
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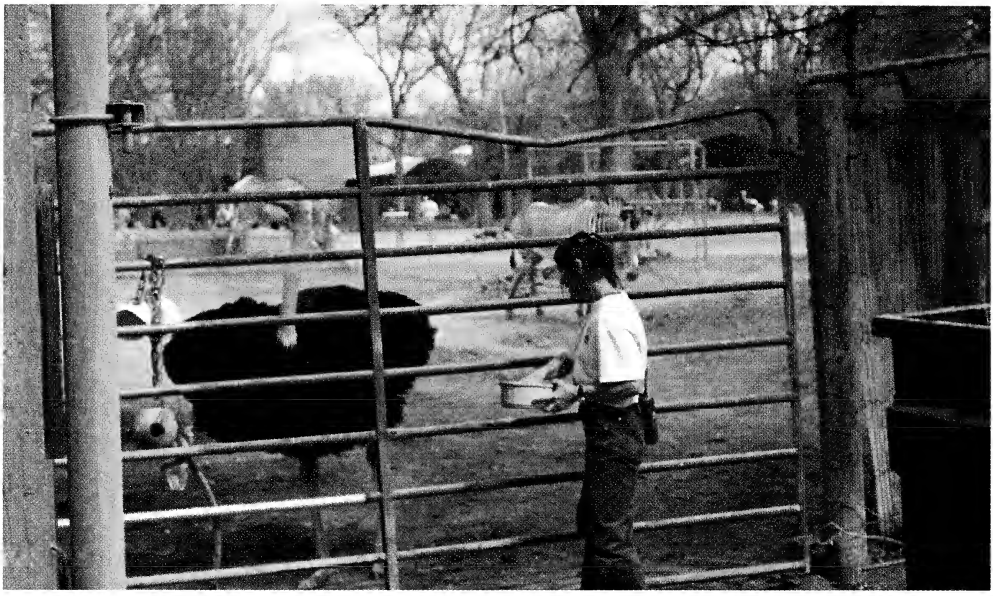

Keeper performing training session with male blue-necked ostrich. *Photo by John Azua.*

Single-taxa exhibits can be interesting, but adding another species can attempt to depict which animals may be seen together in the wild and the inter-relationships between species to the public. Mammals and birds have shared various-sized exhibits for years and there is a body of experience out there that has determined which species work well together and which do not. Attempts at trying mammal and bird species combinations have utilized large-sized exhibits, physical separation within exhibits with the use of deadfall, bodies of water and physical structures in the form of walls and chain link fencing. Climate is an important factor, due to shifting animals into holding enclosures in inclement weather, for zoos in more northern latitudes. At the Denver Zoo, behavioral management and time has provided another tool that helped facilitate multi-species exhibits for successful husbandry management and engaging public programs.

Managing an animal exhibit can always have a number of issues that require knowledge and different techniques to be successful, but creating an exhibit of mixed species can have new and greater challenges. It can be described as working a jigsaw puzzle. Each animal group has its own needs and behaviors, its individual "shape." All aspects of each species need to be known and understood well enough for the animal managers to be able to fit the pieces together, with minimal conflict, to create a successful mixed exhibit.

Hoofstock and bird collections have many obvious differences, but if done correctly they can have impressive combinations. The number one requirement to attempt this is observations. A keeper must

know the behaviors, habits, and needs of each group of animals, as well as individuals within those groups. This requires constant observations of the animals, learning their habits and personalities. This knowledge will allow keepers to make their management decisions much easier.

**General Considerations**

There are many factors to consider before creating the mixed exhibit:

- What are the behavior dynamics? For example:
  - Are there aggressive or flighty individuals?
  - Are they solitary or grouped together?
  - Are they playful or sedentary?
  - Do they hide or shy away? Easily startled?

- What are their exhibit behaviors?
  - Do they have particular "hang out" areas?
  - Do they move around and are active?

- What are the feeding habits?
  - Do they need food throughout the day?
  - Are they food-aggressive?
  - Is food a shifting motivator?

This information is acquired through continuous observations throughout the day. Also, behavior can be shaped before introductions to decrease potential conflicts.

- If a keeper knows an animal group or individual is territorial around its feeding area, they can establish a feeding area or territory in advance and allow it to be maintained after mixing animals.
- If an animal is slow or difficult to shift inside, arrange for the other animals to come in first. If it is always anxious to come in as soon as possible, then let it be the first to come inside.

**The Animals Will Show You How to Manage Them**

When observing animals, they are communicating their particular behaviors and needs. These observations are key to forming a plan that creates a successful mix. If possible, each animal group should spend time in the exhibit, independent of the other species. The keeper can note where they spend their time, how they spend it (feeding, playing, roosting, pacing, hiding). If an area is overlapped, by knowing what draws an animal group or individual attention, the keeper can attempt to "relocate" one of the conflicting species to a different area or placement.

Of course, animals can, and often will, adjust or change some behaviors when elements around them change. This could be now having a new animal to share an exhibit with, or being in a new exhibit all together. Because of this, it is very important to maintain close observations to identify behavior changes or conflict.

Once again, the animals will communicate what they need or want through their behaviors. By understanding what brings an animal comfort or draws its attention, the keeper will have a greater collection of ideas to implement to decrease stress or conflict. Always remember any management plan will need to be "tweaked" and adjusted as needed.

**Examples of Successful Hoofstock/Bird Exhibits**

**Grevy's Zebra** (*Equus grevyi*) **and Ostrich** (*Struthio camelus*)
A pair (1.1) of adult ostrich was introduced into a group of female zebra.

- They were housed in a studpen with full view of the zebra. Behaviors and interactions were observed.
- No aggression was shown by either species, no fear/flight response behavior.
- Ostrich were given time to be comfortable with their stalls where there was safety and food.
- Zebra group were already a calm herd, easy to work with and keeper serviced yard with them. No history of dangerous aggression, and none seen towards birds through fence.
- Birds became responsive to keeper, no aggression, and calm.
- Dominant zebras kept inside stall, remainder of herd given hay in yard. Birds put into yard (had visual access to yard from pen prior).
- Expected excitement, no fear/aggression. Zebra busy eating hay, distracted.
- After ostrich were comfortable in yard, other zebra released.
- Birds closed inside nightly, followed keeper with grain, a behavior established while housed in stalls/pen.

**Problems/Resolutions:**
Problem – Initially keeper could work around both ostrich in yard. Later male became very aggressive and unsafe to be in enclosure with.

Resolution – Yard serviced prior to him being put into yard for the day and shifted in the stall if keeper needed access to yard.

Problem – Male ostrich became aggressive, excessive courtship with female causing health/behavior problems.

Resolution – Male and female finally were housed separately, but allowed visual access through fence or door space. This allowed keeper to monitor his behavior with her, and the pair to maintain social interaction and familiarity.

Problem – New zebra incited aggressive interaction with male, both traded off aggressive behavior.

Resolution – Kept zebra well-fed, in areas away from where male ostrich spends time. Allow them to settle things (no injury) and monitor for increased aggression. It became more playful, trading off who initiated a "fight", more like entertainment for each.

Problem – Zebra became more aggressive to female ostrich (playful for them, fearful for her) causing her stress and pain.

Resolution – Have her in yard during cleaning with keeper who could keep zebra away from her. Let her in stalls away from herd when unattended.

Problem – Male ostrich was very aggressive and territorial, making him dangerous to work around.

Resolution – Keeper developed a relationship with bird, rewarded calm, friendly behavior. Keeper had numerous unfamiliar people socialize with bird through "window" and reward calm behavior with food.

A combination of constant socialization, rewarding calm behavior and positive interactions made

him a safe, workable bird. Keeper worked with female in pen with male at fence regularly and monitored their behavior together (through fence).

Due to a loss of aggressive behavior and courtship to female and calm social behavior with keepers, birds were again reunited and became inseparable. Observing their behavior over a long period of time allowed keeper to trust the reunion would work. The 1.1 ostrich were successfully put with zebra herd. Zebra instinctively started to go after female, but male intervened and stopped the chase. It did not take long for zebra to quit paying attention to her and for her to be comfortable with herd.

**Okapi (*Okapia johnstoni*), Saddle-Billed Storks (*Ephippiorhynchus senegalensis*), Secretary Birds (*Sagittarius serpentarius*)**

- Okapi were housed in exhibit alone at first. Storks were added (1 pair) and later a pair of secretary birds.
- Each species was allowed to explore yard and observed for behaviors, independent of other species.
- The keeper determined how each would shift, and got each group familiar with their own routine. Attention was made to have ways to adjust shifting routines to not overlap.
- Keepers identified areas in exhibit yard each group spends most time at. Efforts were taken to ensure they stayed in those areas, to not overlap or conflict with others. The animals were reinforced with food items, roosting props, water tubs, etc.
- Introduced animals in shifts, starting with the calmest of birds, the storks.
    - Okapi in yard, storks in pen, visible to okapi, interaction/behavior observed.
    - After familiar with each other, storks given access to yard. Given option to flee into stall if needed.
    - After settled, secretary birds given visual access to storks/okapi.
    - Storks and secretary birds united in yard, monitored close with stall access.
    - Finally all together: okapi in yard first, once settled storks added, once settled secretary birds given access to stall to flee playful okapi as needed.

It is important to give each species what they need to feel safe, content:

- A place to flee or hide when needed.
- Food or enrichment to focus on.
- The feeling they have some control of their situation, not forced (initially allowed to come and go until comfortable with exhibit and company).

The young okapi pair was initially playful and chased the birds. The birds had plenty of space to flee or resort to stall. The excitement wore off in time and each species became settled in its own favorite area of yard. Again, continuous observations and monitoring allowed keeper to identify developing problems or conflicts and adjust the management as needed.

The keeper had become familiar with how each animal shifted best (the animals showed her!) and was able to bring them in each night with no conflict.

- Secretary birds skittish, wanted in first, and came in on their own. Okapi called in by keeper, storks herded in calmly last.

**Successful Enrichment**

Saddle-billed Storks

- Meal worms.
- Fluffed up pile of hay.
- Hay/straw bales to roost on.

- Sticks and dry weeds "planted" in stalls.
- Mice and fish hand-tossed to them.
- Grass sod.
- Stock tank of water – inside "pool".
- Play items in water – wood pieces, chopped carrot or apples, rocks.

Storks really like to roost on top of hay bales. They prefer to see what is going on around them (e.g. use mesh fence instead of solid walls). Secretary birds however, are much more secretive.

Ostrich

- Chopped produce (carrot, apples, and yams).
- Pile alfalfa leaves.
- Lettuce and spinach leaves.
- Noisy "toys", chains to peck and swing, rake heads attached to bars.
- Wood handles (shovel, rake, broom).

It is best to observe what the bird shows interest in; they will let keepers know what they like to play with.

**Ideas**

Feeding/Vet

- Food can be suspended (hay in hay bag).
- Hand-tossed to birds (fish/mice to storks).
- Grain can be put in a feeder only for birds with bills for access.
- Feed birds inside stalls, also incentive to shift in.
- Offer food to the species where it regularly spends most time.
- Medicate animals in a controlled area, inside a stall and not disturbed by others.
- It is easier to manage a mixed exhibit if animals are housed separate overnight, or can be brought in when needed.

Barriers/Fencing

- Deadfall branches around areas in which birds roost. Keep hoofstock feeding areas away from bird roosting areas.
- If possible, do not catch animals on exhibit, transfer to stall.
- Best to have stalls for each species, their "own place" and area to control feeding, and monitor behavior.
- Birds should be brought inside at night if there is chance of night predators (fox, owls). Small gauge fence enclosures for exhibit; monitor fence for holes or defects that allow predators access.

Housing

- Birds should have an inside area for bad weather and colder months. Due to space restrictions, they should be housed away from hoofstock.
- Regular wing clipping to restrict flight.
- To reduce potential conflict and aggression, keep species-specific food and enrichment in areas most used by that species
- Birds can have access to stalls without hoofstock joining them by locking door(s) to stall or pen small enough for only birds to fit through.

Introductions

- Allow each species time to be familiar with the exhibit prior to introduction.
- Allow animals to see each other ("howdy") to monitor behavior and get them used to each other.
- Time of introduction depends on the animals. Some move quickly, others need more time. Do no rush introductions!

Keepers

- Best for same keepers to care for all animals in exhibit.
- Get info from bird or mammal keeper.
- It is up to section keepers to acquire useful information from bird or mammal keepers about unfamiliar animals.
- Bird and mammal keepers can team up for procedures, such as bird keepers assisting mammal keepers with bird procedures (wing trims, physicals). This is a great way to learn more about the "new" species to the keeper.
- It is better if birds can remain in the same housing all year. Keeping them in familiar surroundings with keepers they know and have built relationships with will prevent stress, and provide accurate observations.

**Benefits**

Hoofstock/bird exhibits are very entertaining and educational for zoo visitors, providing a variety of animal behaviors and activities. Often the interactions between the different species gives insight of how they play, defend themselves, communicate, and use their unique assets (horns, wings, bills, and tails).

There have even been different species who seek each other out for play or company:

- Male ostrich and frisky zebra
- Okapi and saddle-billed stork (seen hanging out together, seeking each other).

Saddle-billed stork participating in keeper public program. *Photo by John Azua.*

# Techniques for Introducing Animals to Multi-Species Bird/Ungulate Habitats at Disney's Animal Kingdom Lodge

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**Introduction**

Disney's Animal Kingdom Lodge® (DAK Lodge) is an African lodge-style resort adjacent to Disney's Animal Kingdom® theme park at Walt Disney World®. Guests of DAK Lodge have the unique opportunity to observe exotic animals in a natural setting from the private balconies of their hotel rooms, from special viewing areas, and from picture windows in the hallways throughout the resort. In all, there are 46 acres of animal habitat at DAK Lodge that are broken down into four separate multi-species savannas. The collection of animals consists primarily of African ungulates and birds. In total, the resort is home to 17 species of African ungulates and 17 species of African birds in multi-species habitats. Multi-species bird/ungulate habitat management is our primary focus. At DAK Lodge we use a holistic approach to managing birds and ungulates in our four multi-species habitats. All keepers care for both birds and ungulates and all management decisions are made considering the needs of all taxa. Much of our ability to manage diverse multi-species bird/ungulate habitats at DAK Lodge comes from having a structured process for introducing new animals to these habitats.

**Species Selection, Individual Animal/Group Selection, and Acquisition**

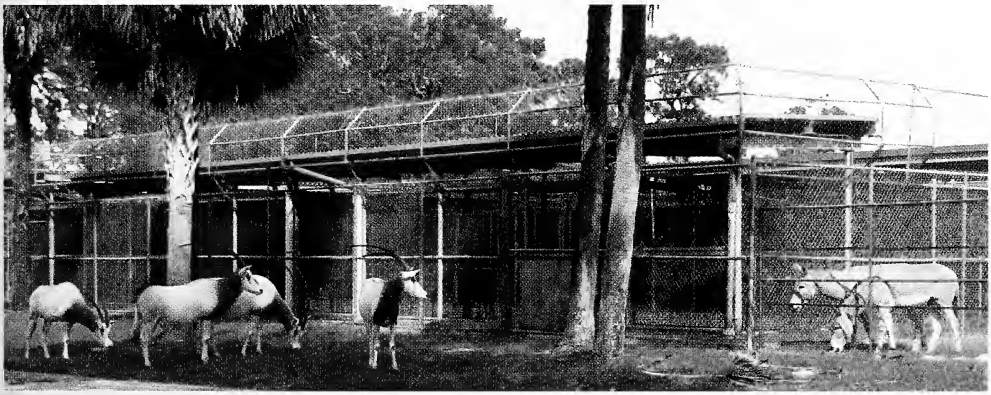
When considering adding a new species to our multi-species habitats at DAK Lodge, we first determine what the parameters of the habitat and holding areas are, what species may work in this setting, and what species may mix well with one another within these parameters. Once we have some ideas around what species may and may not work, it is time to do our research. Our first step is reviewing the various avian and ungulate Taxon Advisory Group (TAG) Regional Collection Plans (RCPs) and Species Survival Plans (SSPs) for guidance. This helps us determine what species are priorities and in need of new institutional participation to assist in achieving sustainability. This narrows our focus to a few species and we can then begin talking with others in the field with experience with these species including SSP coordinators, studbook keepers, and other institutions currently working with these species. There are several questions that need to be asked: Have these species ever been kept in multi-species habitats before? If so, then, with what, and were there any problems? If this species has not been kept in a multi-species bird/ungulate habitat before, then why not? Is there something about this species that does not make it a good candidate for living in a multi-species habitat or is it just that no one has done this before? Is this species similar to other species that have been kept in multi-species habitats before?

Once we have narrowed down what species we plan on adding, we have a few more questions we need to answer: Do we plan on breeding this species or keeping them in a single-sex group of just males or females? This too is determined after having conversations with SSP coordinators, studbook keepers, and animal managers currently working with these species to determine what is available, what is the best thing to do for the populations, and what groupings will work best within our parameters.

Now that we have all of these answers, we need to begin the process of acquiring animals. When doing so, it is very important to ask the institution or institutions with available animals some questions, e.g., what sort of temperament do these individuals have? What is their dynamic within their current group/habitat? Are they flighty, aggressive, hand-raised, parent-raised, etc.? Are they in a smaller zoo habitat or larger, more open range setting? Do they regularly shift off exhibit? Are they trained for husbandry behaviors on a regular basis? Are these animals valuable to the breeding population of this species? All of this helps us determine if the right animals are available of the chosen species to set ourselves up for success. If it is determined that the only available individuals

of this species would not be a good fit for our multi-species habitat management, then it may be necessary for us to look at acquiring a different species entirely or to wait until the right individuals are available. Although generally a species may seem well-suited for multi-species bird/ungulate habitats, problematic *individuals* of this species may not succeed. Whenever possible, we typically have a "plan B" for what we will do if the new animals do not work out in our designated habitat. This secondary plan often includes alternate habitats, moving other species or individuals currently in the habitat to other habitats, off-exhibit holding areas, or placement of animals to other institutions.

An example utilizing this process at DAK Lodge could be seen during our recent addition of 3.0 Somali wild ass (*Equus asinus somalicus*). We were interested in adding another large ungulate to one of our multi-species bird/ungulate habitats and had considered zebras. While attending the various Ungulate TAG meetings in 2012, we learned that Somali wild ass was a red SSP that was in need of additional institutional support. We were able to talk with the SSP coordinator and a few animal managers at institutions that were also working with the species. Through these conversations we found that there were little to no occasions in which this species had been housed in multi-species habitats before, but there didn't seem to be a strong reason as to why they were not. At DAK Lodge we had experience working with Grant's zebra (*Equus grantii*) and Hartmann's mountain zebra (*Equus zebra hartmannae*) in multi-species habitats and thought that this was a good foundation for trying to manage Somali wild ass in a similar way. A young bachelor group of animals was identified by the SSP coordinator as available and after talking with the animal care manager at that institution we determined that these animals would be good candidates for our management style. We were able to acquire the animals, successfully introduce them to this bird/ungulate multi-species habitat, and we are happy to say that they are doing well in this setting where they live alongside of five species of birds and six other species of ungulates. Through this process we were able to add an exciting new species to our collection and assist a red SSP in furthering its goals towards sustainability.



Somali wild ass in acclimation pen meeting the scimitar-horned oryx for the first time.
*Photo by Steve Metzler*

**Planning For and Introducing New Animals to Multi-Species Habitats**

Once the animals have been identified, their histories are known, and it is determined when they will arrive and be available for introduction to the habitat, we sit down with all stakeholders to discuss and plan the process for introducing these new animals to the multi-species habitats. Typically this group includes a curator, zoological managers, and animal keepers. This allows us to discuss timelines, identify any modifications to the existing animal holdings or habitats that will need to take place, and begin to plan the details of the introductions. At this time we identify a core group that will be responsible for the continued planning, communication, execution of the plan, and keeping the team on task. That core group usually includes a zoological manager and a subset of the animal keeper team.

Over the years we've done several introductions of new species to our habitats. We've also introduced new individuals to existing groups, and trained those animals to come into their new off-exhibit holding areas. Each situation is treated a little differently, but we do have a general process which has proved successful. We start by bringing new animals to the off-exhibit holding area that will be the area we will shift them into on a daily basis. We hold them in that area for one to two weeks so they can become familiar and comfortable with this location. We then will give the new animals a "howdy", or visual access, to all of the other animals in that habitat. Our preferred method to howdy animals to their new habitat is to build a temporary pen from the off-exhibit holding area and into the multi-species habitat. For this we use chain link fence panels. The chain link fence panels are the type commonly used to enclose construction sites, control crowd flow at events, etc. The chain link fence panels we use are six feet high and 10-12' wide and are held up with stanchions that the panels slide over. We will then typically zip-tie or wire-tie the tops to add further stability and depending on the species, also reinforce with wooden stakes driven into the ground.

When we are using these for larger birds that may try to jump, we extend the height to eight feet by using fans of wire that spread out on top, to prevent the birds from jumping on or over them. We have had these panels painted a disappearing green so that they blend in with our existing fence lines and do not stand out when they are used in guest view. We refer to this temporary fence panel pen as an acclimation pen. During this time, aggression levels and behaviors of both the new animals in the pen and the other species in the habitat are monitored closely. We will also bait other species to the area of the acclimation pen in order to force close proximity and potential interactions. This allows us to gauge the interest and aggression levels. When we see little interest, we will often move to full introductions rather quickly. If we see a lot of curiosity or aggression, we prolong this howdy period until these behaviors decrease or cease altogether before moving to the full introduction.

When introducing an entirely new species, this process is done more slowly and carefully than when introducing a new animal to an existing group. When introducing the red river hogs (*Potamochoerus porcus*) to our multi-species habitats, this process has taken up to a month or more. The hogs were a considerably different type of animal than what many of the other species had seen before. Many of the animals were much more interested in and apprehensive around the hogs than they had been with other ungulate or bird species.

Once the initial "howdy" process is over and we have reformulated our plans based on the observations during this period, it is time to begin introducing the new animals to the habitat. Whenever possible, we give the new animals some time to explore the new habitat on their own, without the complications

Red river hog in acclimation pen meeting Abyssinian ground hornbill for the first time.
*Photo by Steve Metzler*

of the other species, so they can learn their boundaries, and so they feel more comfortable in those surroundings. Next, we begin to gradually introduce other animals to the habitat. We choose an order of species and individual introduction based on their previous behaviors and we will hold off higher risk introductions until the new animals are established and comfortable in their surroundings. Choosing the order of these introductions comes from those previously mentioned meetings of all of the stakeholders, and particularly from the animal keepers' and zoological managers' experience and knowledge of their animals. We do not proceed to add other species until we are comfortable with how things are going with each new introduction. We typically pull dominant, more aggressive animals out of their habitat for a little while to allow the new animals to get established first before reintroducing them to the habitat. At all times, animal keepers are present and ready to intervene if introductions appear to be seriously threatening the health and well-being of any of the animals involved. We have found it very important to define when we will and will not intervene, and assign a point-person, typically a zoological manager to make this decision. This is important because there is a dominance hierarchy that needs to be worked out between species and individuals, and it is important to allow this to happen.

At DAK Lodge we recently had this discussion around moving 3.0 spur-winged geese (*Plectropterus gambensis*) that were hatched in an off-exhibit area and will soon be old enough to move out to one of the multi-species bird/ungulate habitats. The assistant curator and zoological managers had a meeting to discuss which of the four habitats we have available would be most appropriate. After discussing the challenges and concerns around each of them we decided on one. Some of the animal keepers were then included in the discussion and came up with a rough timeline and action items that would need to be taken care of before we could move them over. Some of the concerns were around the current residents of this habitat and how they may react to the geese, especially considering that the geese would be the smallest animals in this habitat once added. Some of the other primary species of concern in regards to the geese are the 3.0 marabou storks (*Leptoptilos crumeniferus*), as we have seen them show occasional aggression towards some of the native waterfowl that visit the habitat. There was also some concern expressed around some of the larger ungulates in this habitat like zebra. We determined that the best course of action would be to plan on constructing a temporary acclimation pen for the geese surrounding one of our small pools in the savanna. This will give the geese time to become adjusted to the area so they will see this as a home base and hopefully limit their movement around the habitat beyond that. Also, this will allow all of the other animals to see the geese for a while and desensitize to their presence before they have full access to them. We will be able to gauge the aggression level of the marabou storks and other species to determine when it is safe to move towards the full introduction.

**Maintaining Successful Multi-Species Bird/Ungulate Habitats Long Term**

At DAK Lodge, our ability to recall and shift animals out of the habitats may be the most valuable management tool at our disposal. Each day, at a consistent time, all of the ungulate species and many of the bird species are brought into the holding areas to be separated into their appropriate feeding groups and given their diets. Groups of animals of the same species are brought into the same locations and then separated from each other when necessary. For example, male individuals of ungulate breeding groups are typically separated from the females in holding as they tend to be more aggressive in small spaces and may harass females. This practice allows us to perform species specific husbandry i.e., feeding or restraint, in an area that is separate from the multi-species habitats and eliminates the complications that may be caused by other species. Having the habitats clear of ungulate species for 2-4 hours per day also allows animal keepers to attend to any of the bird species that are not brought into holding areas on a daily basis such as the flamingos and cranes. In an effort to avoid conflict, we attempt to shift smaller mammals and birds in one of two different ways: We may bring them in at a different time, or they may enter into a holding space located far from the larger ungulates.

Observation, communication, and adjustment are constant necessities when confronting the challenges and changes of a multi-species bird/ungulate habitat. It also requires a great deal of

Red river hogs, nyala, Abyssinian ground hornbill, blue crane, and wattled crane in multi-species habitat. *Photo by Lindsey Kirkman*

commitment and a determination to see the animals succeed.

**Conclusion**

Since the opening of Disney's Animal Kingdom Lodge in 2001, we have learned a great deal about managing multi-species bird/ungulate habitats. It has been extremely demanding yet rewarding. For many reasons though, all of the hard work is well worth it. Through continuing to expand the diversity of our collection, we have increased the number of species' populations we have been able to support and perhaps inspired other institutions to do the same. As animal care professionals we have been able to broaden our knowledge and experience. Our guests have greatly enjoyed watching and learning about our varied and dynamic mix of species. Most importantly, the animals have benefited from living in these extremely enriching environments.

**Acknowledgements**

I would like to thank the entire DAK Lodge Animal Programs team for their continued hard work and commitment to managing dynamic and taxonomically important multi-species habitats for the delight of our guests and the support of a number of SSPs and TAG goals.

*Table 1: Species currently being managed in mixed-species bird/ungulate habitats at DAK Lodge*

| BIRDS | UNGULATES |
|---|---|
| Ostrich *(Struthio camelus)* | Hartmann's mountain zebra *(Equus zebra hartmannae)* |
| Marabou stork *(Leptoptilos crumeniferus)* | Grant's zebra *(Equus burchelli)* |
| Pink-backed pelican *(Pelecanus rufescens)* | Somali wild ass *(Equus asinus somalicus)* |
| African greater flamingo *(Phoenicopterus roseus)* | Giraffe *(Giraffa camelopardalis)* |
| African spoonbill *(Platalea alba)* | Okapi *(Okapia johnstoni)* |
| Spur-winged goose *(Plectropterus gambensis)* | Common eland *(Taurotragus oryx)* |
| Egyptian goose *(Alopochen aegyptiacus)* | Lowland nyala *(Tragelaphus angasii)* |
| South African shelduck *(Tadorna cana)* | Sable antelope *(Hippotragus niger)* |
| Common shelduck *(Tadorna tadorna)* | Roan antelope *(Hippotragus equinus)* |
| East African crowned crane *(Balearica regulorum gibbericeps)* | Scimitar-horned oryx *(Oryx dammah)* |
| Blue crane *(Anthropoides paradise)* | Common waterbuck *(Kobus ellipsiprymnus)* |
| Abyssinian ground hornbill *(Bucorvus abyssinicus)* | Wildebeest *(Connochaetes taurinus taurinus)* |
| Ruppell's griffon vulture *(Gyps rueppellii)* | Bontebok *(Damaliscus pygargus pygargus)* |
| Lappet-faced vulture *(Torgos tracheliotus)* | Impala *(Aepyceros melampus)* |
| Kenya crested guineafowl *(Guttera puncherani)* | Thomson's gazelle *(Eudorcas thomsonii)* |
| Reichenow guineafowl *(Numida meleagris)* | Ankole cattle *(Bos taurus taurus ankole)* |
| Helmeted guineafowl *(Numida galliformes)* | Red river hog *(Potamochoerus porcus)* |

# A Not So West Side Story

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The Central Park Zoo is one of the Wildlife Conservation Society's five zoos and aquariums. It is a 6.5-acre facility in midtown Manhattan, housing over 150 species. In order to inspire as many of their approximately one million visitors per year as possible, the zoo strives to create a lasting impression with each exhibit. One way to achieve this goal is through mixed-species exhibits. The Central Park Zoo maintains two bird and ungulate mixed-species exhibits with great success. Not only are these exhibits successful in maintaining a healthy physical and mental environment for the animals, it also provides a dynamic exhibit for the zoo guests to learn and grow closer to nature. The goal of this article is to outline some of the benefits of a mixed-species exhibit and encourage that a bird and ungulate exhibit can be achieved without the space requirements of a rhino or giraffe enclosure.

The two exhibits to be discussed are an outdoor exhibit with Reeves's muntjac (*Muntiacus reevesi*), White-naped Cranes (*Grus vipio*) and several waterfowl species; and an indoor walk-through aviary housing over 30 species of birds along with Greater Malayan Chevrotain (*Tragulus napu*). Both of these exhibits have a small footprint, but maintain a collection healthy enough to breed successfully. Let's take a closer look at how these species work together to create an effective exhibit for both animal and guest.

Reeves's muntjac are small ungulates weighing in at about 30 lbs and 3 ft in length. They are an interesting ungulate because in addition to eating grasses, fruits, and seeds, they also eat carrion and eggs. Furthermore, muntjac have a relevant conservation story in that John Reeves, a naturalist who studied them while living in China, sent specimens to England for further study. Some of these deer escaped the park, and a feral population has adapted to live and thrive in Great Britain (Huffman, 2004). Even though the muntjac has all of this to offer, the species is often bedded down during open hours, leaving the guests to wonder what the fuss is all about. In an attempt to create constant movement in the exhibit and engage guests long enough to find the elusive muntjac, white-naped cranes are also exhibited. These cranes are easily found at 4 ft tall with beautiful contrasting colors on their head and body. White-naped cranes have enough gumption to fend the muntjac away from their eggs at breeding season, and a breathtaking presence to catch the attention of the guest. They, too, carry a reverberating conservation story, with loss of numbers due to habitat destruction and pesticides (BirdLife International, 2013).

Though both of these species live on the ground, they serve different niches, making them compatible "roommates". The cranes generally stay close to the water and the muntjacs generally on land. The cranes like to nest near the water's edge and the muntjacs stay close to the brush. Since the species maintain separate territories, feeding and enriching the animals is relatively easy. Furthermore, the presence of each species inherently provides enrichment to the other. Both species have successfully bred in the exhibit. Inherent in this activity are courtship behaviors, nest building, territory defense, egg laying, and the presence of offspring. These natural behaviors bring a new dimension to the animals' environment that would not be present in a single-species enclosure. The behavior dynamic between the two species gives a much better and longer lasting mental exercise than some of the objects keepers can provide. Mixed-species exhibits also allow guests to see a habitat instead of just an animal exhibit. The animals are expressing how they would react to each other if found in a wetland marsh in China. Then if we're lucky, the visitor takes home a better understanding of why it is important to restore habitats and not just individual animals.

The other exhibit mentioned is an indoor aviary. This is a dynamic exhibit with birds as large as Green Peafowl (*Pavo muticus*) and Victoria-crowned Pigeons (*Goura victoria*) to as small as Crested Wood Partridge (*Rollulus roulroul*) and African Pygmy Geese (*Nettapus auritus*), all nest building high

and low. For those guests just passing through, the aviary provides a source of wonder as it ignites enthusiasm for avians of all sizes. For those who stand back and watch, they find themselves immersed in the jungle that surrounds them. There are birds busily weaving nests of grass above, stacking stick nests in the wall of plants at their side, and leaf nests being assembled on the ground below. And amid the bustle around them emerges Peanut, the Greater Malayan Chevrotain. Weighing in at 15 lbs and 2.5 ft long, the chevrotain delights all that see her as she scent marks her territory. When a guest expectantly walks into an aviary, they usually seem quite surprised to find a mammal living inside. Locating an unexpected species often evokes questions about the animal, and conveys a truer sense of a jungle environment than exhibiting birds alone.



(Top) Reeves's muntjac and White-naped Crane Exhibit. (Bottom) Mountain Peacock Pheasant and Greater Malayan Chevrotain mingling in walk-through aviary.

The chevrotain is a fairly docile species, living well with ground birds. Though Peanut lives without a mate, historically several breeding pairs were housed in the aviary with great success. Just like in the outdoor exhibit, breeding behaviors influence territory changes throughout the year and keep the animals' minds occupied. All are enriched by the sounds of the jungle all around them, as well as the influences of guests encroaching on their living space in this walk-through exhibit. The environment is constantly changing due to plants being stripped for nests, shifts in group alliance, the sounds and displays of courtship, and early morning "showers" as the plants are watered. Because the chevrotain diet is very different from the birds and their territory is fairly consistent, it is easy to maintain a healthy diet and visually examine daily. A bird census is done with a bug toss before open hours to get eyes on individuals, as well as see behavioral changes. The bug toss also aids in seeing which individuals are bringing food back to the nest and where the nests with chicks are located. In addition, establishing a positive reinforcement history with the birds makes it easier to catch animals if health issues or transfer recommendations arise.

Both the animals and guests feel the benefits provided by bird and ungulate mixed-species exhibits on several levels. For the animals, the capability for varied, long-term enrichment is inherent in these exhibits. For example, the behavioral changes that are experienced by an animal during different seasons of the year give the other species something new to experience and problem solve. The environment is also constantly changing due to courtship behaviors, nests being built or destroyed, eggs and offspring being produced, and various calls of a different species to name a few. This therefore, provides a more natural environment, which is positive for both animal and guest. Guests spend more time at each exhibit looking for the second species housed within, increasing the likelihood that the conservation message will be seen and understood. In addition, seeing different taxa housed together displays more truly what would be seen in nature, and teaches that conserving a habitat saves not only the attractive, relatable species, but the entire ecosystem.

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# We're All in This Together: The Evolution of Avian Management in African Mixed-Species Exhibits at Blank Park Zoo

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*Jenni Dyar, Avian and Terrestrial Reptile Area Supervisor*
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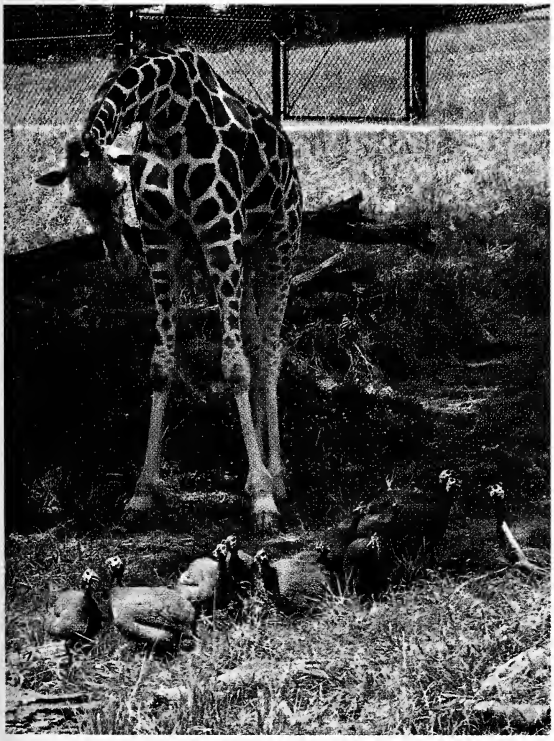
**Introduction**

Blank Park Zoo has a history of displaying hoofstock and birds together in African mixed-species exhibits. Exhibit groupings through the years have included various combinations of reticulated giraffes (*Giraffa camelopardalis reticulata*), lesser kudu (*Tragelaphus imberbis*), Ankole-Watusi cattle (*Bos taurus taurus watusi*), bongo (*Tragelaphus eurycerus isaaci*), plains zebra (*Equus quagga*), scimitar-horned oryx (*Oryx dammah*), waterbuck (*Kobus ellipsiprymnus*), ostrich (*Struthio camelus*), gray crowned cranes (*Balearica regulorum*), Egyptian geese (*Alopochen aegyptiaca*), and guineafowl (*Numida meleagris*).

We have two African-themed exhibits used to display hoofstock and birds. The north yard is ¾ of an acre, and has most recently featured reticulated giraffes, lesser kudu, gray crowned cranes, and guineafowl. This exhibit contains grass, rock, and dirt substrates, trees, deadfall, and features a boardwalk overlook and giraffe public feeding deck. The southern exhibit also has a boardwalk overlook, contains many trees and deadfall, is mainly rock and dirt with some grass, and is ~ ½ acre in size. This exhibit has most recently featured Ankole-Watusi cattle and ostrich, with immediate plans to add a crane species and additional guineafowl.



Giraffe and guineafowl together on exhibit.
*Photo: Lisa Ashburn*

Additionally, we are in the midst of an expansion phase for the zoo which adds new exhibits for eland (*Taurotragus oryx*), black rhinos (*Diceros bicornis michaeli*), Bactrian camels (*Camelus bactrianus*), and several new bird species to the mix (the exact species have not yet been decided). Not only will these species be new to staff, the zoo, and the exhibits, they will be new to each other!

As a smaller zoo, we are often challenged by limited staff, space, time, and resources. This paper will focus on some specific examples of how we've dealt with these issues. Exhibits that were previously managed as one keeper routines are now complex entities that require keepers and other staff working together to find unique solutions and different husbandry techniques to counter challenges which may be encountered.

**Staffing**

About two years ago, the animal care staff at Blank Park Zoo were reorganized into areas to recognize taxonomic expertise.

Previously, we had two animal care teams under two curators which divided the zoo more or less zoogeographically. Now, we have six teams with a specific focus (Aquatics, Avian and Reptiles, Small Mammals, Large Mammals, Primates and Carnivores, Vet Support/Behavior Management), each with an area supervisor, with all accountable to one curator. How do we make this work in a small zoo? Flexibility and cooperation! Initially, we assumed the Large Mammal and Small Mammal teams would be working together frequently to help each other out with staffing and husbandry issues as they arose, but it soon became clear that the Avian team and Large Mammal teams complemented each other. For the first time, hoofstock keepers turned over care of the birds within the mixed-species exhibits to bird keepers. Because of our experiences working together on exhibits, it soon became clear that the Large Mammal team was short on days the Avian team was well-staffed, and vice versa, so the two areas have started sharing a seasonal keeper position. Also, permanent keepers cross-train in different areas, and help each other out as needed. For example, if the bird keepers are tied up with an animal issue in another area of the zoo at closing time, large mammal keepers will help out by bringing the ostrich off exhibit. We also work together on special projects, such as trailer loading/unloading ostrich, facility design, delegating holding spaces, and introducing new species to the exhibits. From a hoofstock keeper standpoint, it's quite nice to have an extra bird keeper in an area on a daily basis to help with husbandry tasks such as exhibit cleaning, and in the process, desensitizing the hoofstock collection to new people.

**Modifying Spaces**

We've increased flexibility in our exhibits and holding by bird-proofing existing structures and adding safe zones for birds. On exhibit, birds have benefited from post and rail fencing designed to keep giraffes back from the public boardwalk, which created a mammal-free area our bird species can easily enter. Additional safe zones have been created by adding deadfall/branch/log piles and perching spots. Making sure there are adequate water sources and shade for each species is also a priority. Separate, remote-controlled access gates for ostrich and Ankole-Watusi cattle were added to an exhibit to better maintain protected-contact handling of these animals, and to avoid species competition while they waited at the same exhibit gate close to closing time.

Flexibility has proven to be key when assigning holding spaces to bird species residing in our older hoofstock barn. We've repurposed storage sheds to serve as guinea coops (add windows, modify doors, add electricity for fans and heat lamps) and crane holding. Sheds and paddocks may be used to hold birds or mammals depending on the year and the collection. Keepers have modified former mammal holding spaces by attaching poultry mesh to cattle panels, which were then connected to each other and existing walls to create portable, temporary, escape proof runs and corridors for guineafowl and cranes to access the exhibits.

**Audio Recall Training**

Because the zoo contains an off-exhibit timbered section and is adjacent to a golf course and county parkland, we have large local populations of raccoons, opossums, foxes, and mink. Unfortunately, despite our trapping efforts on zoo grounds, in the past these animals have occasionally entered the zoo and preyed on birds in the collection. We now take a pro-active approach to avoid this by shifting all birds in our uncovered mixed-species exhibits to secure, indoor holding at night.

To facilitate this, we have utilized audio recalls for all species. Drawing on the success of this strategy at other institutions with multiple species (Kalla & Sevenich, 1999), we have had close to 100% success pulling all birds off exhibit every night. For crowned cranes, mealworms paired with ringing a small bell proved successful for a recall. For ostrich, squeaking a dog toy squeaker paired with feeding romaine lettuce, a handful of grass, a scoop of the normal diet, or even just the curiosity to approach the keeper was a winning combination. For these species it only took a couple of sessions for the birds to make the connection.

In early 2009, the zoo decided to add some interest to our giraffe exhibit by acquiring 26 day-old French guinea keets from a hatchery (this is a variety of helmeted guinea that is a little sturdier/

heavier than "normal" guineafowl). Because guineafowl are renowned for being flighty, escaping/not returning to an enclosure and roaming the zoo at will, not to mention being on the menu of every predator, we decided to implement their conditioning almost as soon as they arrived at the zoo. On Day One they were pinioned. Starting on Day Two, to reduce future flightiness, the keets were gently handled daily by numerous staff, numerous times (this task was often performed by interns, however, due to quarantine concerns within the first thirty days, this was also done by several of our office staff, who would have no contact with the rest of the animal collection during their workday. Thanks to the cute fluffy appearance of the keets, we had no shortage of volunteers to assist with this!). We wanted to make sure these birds felt comfortable approaching us.

A little research into the care of domestic guineafowl revealed that white proso millet is a preferred food item (Ferguson, 1999). We selected a soda can with pennies sealed inside to be shaken as the audio cue. On Day 14, while still in a nursery tub set-up, in addition to their regular diet the keets were introduced to a TBSP of white proso millet paired with shaking the penny can. The keets caught on to this quickly; by the third session, every guinea keet was launching themselves in the general direction of the shaking penny can! We conducted these sessions twice daily, continuing with the daily handling.

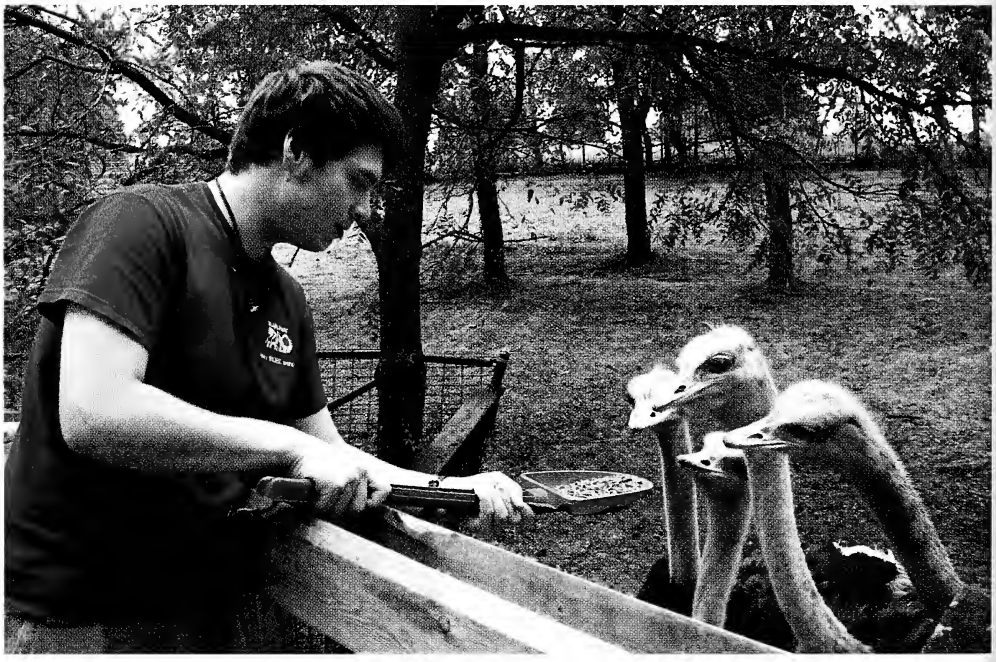
After a week of responding well to the audio cue in the tub, the guineas were released into a small shed located in the general vicinity of their future exhibit. When the keets responded well to the audio cue in the shed, they were released into a small outside area (created by the use of cattle/poultry panels described earlier), but cued back inside the shed at night. At four-weeks-old, they were responding to the cue at a distance of 3-5 m. As the guineas continued to respond well to their recall-training, always returning to their holding shed when cued for their millet treat, their outside area was gradually increased until it stretched to their future exhibit. This allowed the use of a fenceline to howdy with the animals on exhibit. At four months, the guineas were introduced to the exhibit. After a few days of successful recalls back to holding, the giraffes, lesser kudu, and crowned cranes were individually introduced without incident. The guineas have returned to their holding shed every night since.

Guineafowl exploring the area outside their shed. *Photo by Lisa Ashburn*

**Public Ostrich Feeding!?**

Also in 2010, the zoo acquired a group of nine juvenile ostriches from a local ostrich farmer for seasonal display. The initial challenges of shifting to and from the exhibit while managing in protected-contact were quickly overcome with the recall-training mentioned earlier. The ostriches were curious and seemed to enjoy contact with people. We already offered our guests the opportunity to feed the giraffes, so why not public ostrich feeding? There are many benefits we hope to gain from our public feeding programs, such as desensitizing the animals to strangers and giving our guests the opportunity to really connect with an animal they normally wouldn't spend much time observing (who can compete with giraffes?). Maybe we'll even inspire an appreciation for their conservation!

A period of trial and error led us to the right tools for the job; to avoid hand pecking, we found the perfect sized plastic play shovel for the guest to hold and offer the treat (the ostriches' regular diet). The shovels were attached to the boardwalk fence with a clip and cable due to the guests' tendency to drop the shovel. The exhibit fence was modified to allow the ostrich to approach the boardwalk, but still not close enough to take treats without the shovel or harass a guest. Of course, there were a few exceptions to this, brought on by very determined reaching guests, or a very determined, stretching ostrich! A small stool for children to stand on facilitated their participation in the experience. Because the ostrich were just as likely to just peck at the shovel vs. actually eating the grain, a trough was added at the feeding station to catch the grain that inevitably went flying. Keepers trained education staff and interns to staff the experience.



Summer intern Ty Bolte acclimates the ostrich to eating from a shovel. *Photo by Lisa Ashburn*

It didn't take long for the ostriches to catch on to approaching the feeding station for their squeaker cue. The feeding experience was first offered to other keepers, then to other zoo staff before being tried with the general public. Even when the ostriches just pecked at the shovel and grain flew everywhere, our guests certainly had smiles on their faces after participating in the experience!

This experience has led to the creation of a public feeding area designed into our new eland/ostrich exhibit scheduled to open this spring. The ostriches will reach through a post and rail fence on the

Zoo guests take a turn feeding the ostrich.
*Photo by Lisa Ashburn*

exhibit side, and the guest will extend the treat through a fence on the public side (this area will be closed off unless the experience is being offered). This exhibit will also have a gate to split the exhibit to allow us the ability to exclude the hoofstock from the activity.

**Interspecific Introductions-Creating a Cohesive Exhibit**

In 2012, the zoo selected a new species to display in our African section-1.2 Ankole-Watusi cattle. The decision was made to display them with our current 0.3 ostriches in the ½ acre exhibit.

Two of the three cattle came to us from another zoo, so happily they had a clear understanding of shifting for food. The third cow came to us from a local farmer and had no understanding of such things! This took some time to accomplish. After a brief howdy period, she was introduced to the other cattle. After some initial chasing and sparring, we had a cohesive herd ready for exhibit.

The introduction to the exhibit was mostly uneventful, and our seasoned "zoo cows" led the way shifting to/from exhibit. They already knew their names from their previous institution and would come when called, so this was maintained as their audio recall.

The ostrich also came when called and as they were already habituated to shifting in this specific exhibit, we decided to continue with their current gate. A second gate, previously used mostly for keeper and vehicle access, was designated as the watusi gate to prevent the cattle and ostrich from crowding each other while waiting to go inside for the night.

Once the cattle were introduced and getting along well, it was time to start howdying the ostrich. An adjacent "day pen" with a post and rail gate was used as ostrich holding while the animals got used to seeing each other. Keepers observed any interactions, which were few as the cattle were still busy exploring their new exhibit (and pruning the vegetation with their horns). The ostrich however did spend a significant amount of time watching the cattle from behind their fence, especially when the cows were first put on exhibit in the morning.

Then the day came when it was time to put everyone together, and staff were more than a little nervous; Watusi horns could make very large holes in ostrich. Adding to this stress was the fact that none of these animals had ever been displayed with another species, the active nature of our cattle, and the sometimes questionable temperament of our farm-raised cow! We put the ostrich out first, to give them a chance to do their morning laps around the exhibit without the cattle there (who might be tempted to chase them). Once the ostrich were calm, we let the cows out. Keepers and other staff were posted all along the fences and up on the public boardwalk. Cows being cows, they went straight for their hay and ignored the ostrich (and we all breathed a sigh of relief). After watching

On exhibit together for the first time, the Ankole-Watusi and one brave ostrich check each other out. *Photo by Jenni Dyar*

the cows eat from a safe distance for several minutes one of the ostrich got brave and approached. She stood next to the cows and still they ignored her, so she reached out and pecked one of the cows. Nothing happened, so she pecked again. And then something amazing happened. The steer she'd been pecking stopped eating, turned to her (the staff tensed up), and using his horns to steer her, he ever so gently pushed her away. After that, everyone got along. There were days they chased each other, but for the entire summer there was no aggression observed between the two species.

**Looking to the Future...**

These are exciting times at the Blank Park Zoo, as we proceed with our expansion. Bringing in new animals, new staff, performing introductions, and preparing new exhibits all produce varying levels of stress; however, we know we'll get through this by following the approach that works for us; working together, by taking the time to carefully create and follow a plan, adjusting to the animals we have, and predicting and preparing for hurdles we'll face along the way...

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# Interspecific Aggression in a Mixed-Species Exhibit of Ungulates and Birds.

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**Introduction**

The Great Plains Zoo and Delbridge Museum of Natural History in Sioux Falls, SD is home to multiple mixed-species exhibits including an East African savannah environment. Housed in this mixed-species exhibit are: 1.4 reticulated giraffe (*Giraffa camelopardalis reticulata*), 3.2 Grevy's zebra (*Equus grevyi*), 1.3 common ostrich (*Struthio camelus*) and 1.1 East African crowned cranes (*Balearica regulorum gibbericeps*). The demographics of each species group were, comparatively, very different. The number and combination of animals exhibited on any given day varied considerably.

Mixed-species exhibits, while aesthetically pleasing and well-liked by visitors, can cause unique problems, the most common of which is the likelihood of negative interactions between species. Thus, creating a compatible combination of species is essential in maintaining any successful mixed-species exhibit. Many factors have been thought to influence the frequency of negative interspecific interactions. These include taxonomical differences, size differences, species composition, social influences and variations in individual demeanor (Andersen 1992, Forthman and Bakeman 2005, Hammer 2001, Kleiman et al. 2010, Mosley 1999, Popp 1984, Walther 1965).

It was these issues that triggered a study of interspecific social interactions, in particular interspecific aggression and dominance, in the aforementioned African savannah exhibit at the Great Plains Zoo. The purpose of this study was to examine the prevalence of negative interspecific interactions and the effects that variation in habitat and species composition have on these interactions. Both habitat usage (Mosley 1999, Sundaresan et al. 2007[1], Sundaresan et al. 2007[2], Marshal et al. 2008, Kleiman et al. 2010) and species composition (Andersen 1992, Popp 1984) have been shown to influence the amount of negative interspecific interactions in mixed-species situations.

Founded on casual observations and natural history-based assumptions, the following hypotheses were created prior to the study; the Grevy's zebras and crowned cranes will display the most interspecific aggression, the ostriches will be the most submissive in interspecific interactions, there will be an increase in interspecific interactions while animals are in habitat zone 3, and interspecific aggression will be lower throughout the exhibit when the zebras are off exhibit.

The goals of this study were to determine the prevalence of negative interspecific interactions in the study exhibit and identify differences between amounts found in the delineated habitat zones and between varying combinations of animals. This data will be used to propose any needed changes to animal husbandry practices in order to reduce or prevent negative interactions and optimize compatibility and animal welfare.

**Methods**

This behavioral research study was based on focal observation which was used in all data collecting periods. Observation periods lasted fifteen minutes. Observation schedules rotated between species in hopes of obtaining an equal amount of data for each species. Unfortunately, due to a low number of observers and time constraints, observations were done opportunistically and constant variation in species composition made it difficult to obtain an equal number of observations for each species studied. An ethogram (Table 1) was created prior to the study containing all behaviors displayed by each species to allow for easier and more efficient recording of data. Along with behaviors, all interactions were recorded with the zoo-assigned identification number of each animal with which the interactions took place.

In addition to logging behaviors, the habitat each behavior was displayed in was also recorded. Similarly sized habitat zones within the exhibit were delineated prior to study in order to compare behaviors and interactions both within and between varying areas of the exhibit (Fig. 1). This was done in order to gauge the effect habitat had on negative interspecific interactions. Zones were numbered one through six with zones one through four being similar in size and zones five and six

| Notation | Behavior | Description |
|---|---|---|
| Ch+ | Chasing another animal | Focal animal chasing another of any species, include # of animal chased |
| Ch- | Being chased by another animal | Focal animal is chased by another of any species, include # of chasing animal |
| Ac+ | Aggressive contact | Focal animal initiates aggressive contact with another of any species, include # of animal receiving aggression |
| Ac- | Receiving aggressive contact | Focal animal receives aggressive contact from another of any species, include # of animal initiating contact |
| AgD+ | Aggressive display | Animal makes display of aggression, include # of animal receiving display |
| AgD- | Receiving aggressive display | Focal animal receives aggressive display from another of any species, include # of animal initiating display |
| Dis+ | Displacement | The arrival of the focal animal causes other animals in the area to vacate region. Include #s of animals displaced |
| Dis- | Displaced | Focal animal vacates area upon the arrival of another animal to the vicinity. Include # of animal causing the displacement. |

**Table 1.** This table contains the portion of the ethogram describing those behaviors observed during negative interspecific interactions. All behaviors coded with a (+) were entered into the interaction tables as dominant interactions and those coded with (-) as submissive interactions.

being smaller zones accessible only by the East African crowned cranes.

The date, time of day, weather, focal animal and observer were recorded along with the gender ratio of each species kept on exhibit during that observation. This allowed for behavioral comparisons to be made both within and between specific combinations of animals to test the effect of species composition on interspecific interactions. These compositions were coded into four digit numbers for ease in data analysis (Table 2).

Data analysis was accomplished using the statistical analysis program Minitab. Comparisons of averages were analyzed using Two Sample-T tests, proportions Chi-Square tests, and rates Two Sample Poisson rate tests. Linear regressions were used to study correlations and relationships. Differences producing a P value of less than or equal to 0.05 were considered statistically significant. Interaction tables were also established to record different categories of interactions that occurred between specific animals. Dominant interactions included: chasing, displaying aggression, aggressive contact and displacing other animals. Submissive interactions included: being chased, receiving aggressive displays and contact, and being displaced by another animal. Tests were run comparing behaviors and interactions that occurred within each zone with every other zone as well as comparing those performed in specific species compositions with other animal arrangements. Data


Figure 1. An aerial view of the Great Plains Zoo's Savannah Exhibit with boundaries delineated for each of the six habitat zones. Zones 5 and 6 were accessible only by the East African crowned cranes.

| Composition Code | Giraffes | Zebras | Cranes | Ostriches |
|---|---|---|---|---|
| 0024 | 0 | 0 | 1.1 | 1.3 |
| 0124 | 0 | 1.0 | 1.1 | 1.3 |
| 2023 | 1.1 | 0 | 1.1 | 0.3 |
| 2024 | 1.1 | 0 | 1.1 | 1.3 |
| 2124 | 1.1 | 1.0 | 1.1 | 1.3 |
| 2223 | 1.1 | 1.1 | 1.1 | 0.3 |
| 3024 | 0.3 | 0 | 1.1 | 1.3 |
| 3424 | 0.3 | 2.2 | 1.1 | 1.3 |
| 4023 | 0.4 | 0 | 1.1 | 0.3 |
| 4024 | 0.4 | 0 | 1.1 | 1.3 |
| 4223 | 0.4 | 1.1 | 1.1 | 0.3 |

**Table 2.** Gender ratios for each species in the animal arrangements observed on exhibit. First number in composition code is number of giraffes, second is zebras, third cranes, and fourth ostriches. First number in ratio is number of males, second is number of females.

was also combined independently of zone and species composition to gather results on the data as a whole and this data was compared between species to test for overall differences.

**Results**

Behavioral comparisons between each species, regardless of habitat or composition, were analyzed. The rate (number of events per 15 minutes) at which species were involved in negative interspecific interactions was calculated. The ostriches were found to be involved in negative interspecific interactions at a significantly higher rate than the cranes and the giraffes. All of the interspecific interactions involved submissive behaviors displayed by the ostriches towards other species. The ostriches also averaged a significantly higher number of events per observation in which they were displaced by another species compared to the cranes, the only other species displaced during the study. The group of ostriches also submitted to recorded dominant interaction by the focal animal at a significantly higher proportion than the cranes. The cranes were the only other species observed behaving in submission to a recorded dominant interaction. The ostriches also were the species that had the highest proportion of observed submissive interactions by the focal animal. They displayed a significantly higher proportion of the total submissive interactions compared to both giraffes and

the cranes. While the ostriches measured as the species most often receiving negative interspecific interactions, the crowned cranes appeared to be one of the species most likely to instigate such interactions. They exhibited a significantly higher proportion of the total dominant interactions compared to the giraffes and had a significantly higher proportion of those interactions occur with interspecifics compared to the ostriches.

The rate at which negative interspecific interactions occurred in the different habitat zones was calculated: 0.194 interactions every fifteen minutes in zone 1, 0.526 in zone 2, 0.267 in zone 3 and 0.242 in zone 4. The differences between zones were not found to be statistically significant. However, analyzing differences between habitat zones at the species level revealed numerous significant differences. The cranes were involved in negative interspecific interactions while in zone 2 at a significantly higher rate than in all other habitat zones. The East African crowned cranes also proved to have a significantly higher proportion of the submissive interactions displayed by animals directed towards them while in zone 1 compared to while in zone 4. All of these negative interactions were interspecific. However, while in zone 4 the cranes had a significantly higher proportion of the total dominant interactions compared to zone 2. The Grevy's zebras exhibited a significantly higher proportion of the total dominant interactions while in zone 3 compared to both zone 4 and zone 2. They also had a significantly higher proportion of the total submissive interactions directed towards them while in zone 4 compared to in zone 3. Therefore, both the cranes and zebras had contrasting results of negative interspecific interactions in zone 4 depending on the metric utilized. The ostriches had a significantly higher proportion of the total dominant interactions while in zones 2 and 3 compared to while in zone 4 except, unlike the cranes and zebras, none of these interactions were interspecific. The giraffes did not have a statistically significant difference concerning negative interspecific interactions based on variation in habitat zone.

Results were also analyzed for differences in negative interspecific behaviors between species while in each zone. Habitat zone 1 contained no differences in negative interspecific interactions between species. While in zone 2, the ostriches had a significantly higher proportion of the submissive interactions compared to the cranes, the only other species exhibiting a submissive action. Of those submissive interactions displayed by the ostriches, a significantly higher proportion occurred with interspecifics compared to with intraspecifics. The cranes, while in zone 2, were involved in negative interspecific interactions at a significantly higher rate compared to the ostriches. The ostriches had a significantly higher proportion of the submissive interactions while in zone 3 compared to any other species. The giraffes were the only other species to display submission while in this zone. In zone 4, the zebras received a significantly higher proportion of the submissive interactions displayed by focal animals compared to the cranes. The ostriches displayed a significantly higher proportion of the total submissive interactions compared to the giraffes, the only other species to exhibit submissive behavior in zone 4 while being the focal animal. The ostriches also were involved in negative interspecific interactions at a significantly higher rate while in zone 4 compared to the giraffes.

Many significant results were found when comparing negative interspecific behaviors between species compositions (Arrangement coding explained in Table 2). The rates for the studied species compositions were: 0.091 negative interspecific interactions per observation period while in the 0024 arrangement, 3.5 in 0124, 0.357 in 2023, 0.429 in 2024, 0.6 in 2223, 0.238 in 4023, 0.172 in 4024 and 0.25 while in the 4223 species arrangement. It was discovered that animals in compositions featuring the zebras were involved in negative interspecific interactions at a significantly higher rate compared to animals in compositions without the zebras. Along similar lines, animals in compositions consisting of two giraffes were involved in negative interspecific interactions at a significantly higher rate compared to those in arrangements featuring more than two giraffes on exhibit. Continuing with differences in rates, the individuals in the 2223 composition were involved in negative interspecific interactions at a higher rate compared to those in the 0024 combination. Also, those in the 0124 arrangement were involved in negative interspecific interactions at a significantly higher rate compared to every other observed species composition during the study. The pair of cranes displayed a significantly higher proportion of the total dominance behaviors while in the 2024

composition compared to the 4024 arrangement. The ostriches had significant differences regarding submissive interactions with higher proportions of the total submissive interactions while in the 2023 composition compared to the 4023 and 4223 combination of animals. But while in the 4223 composition they had a significantly higher proportion of those submissive interactions occur with interspecifics compared to the 2223 arrangement.

Comparing behaviors between species within the same arrangements also resulted in significant results. While in the 2024 species composition, the cranes were involved in negative interspecific interactions at a significantly higher rate compared to the giraffes. This was the only significant difference using the rate of interaction metric. Other metrics, however, displayed significant results concerning interspecific interactions. The cranes also had a significantly higher proportion of the total dominant interactions that occurred in 2024 compared to the giraffes. The only other significant difference found between species while in the same arrangement was the difference between submissive events in ostriches and giraffes while in the 4023 combination. The ostriches had a significantly higher proportion of the submissive interactions while in this arrangement compared to the giraffes.

Linear regression was utilized in analyzing the correlations between the total number of animals on exhibit and the rate at which negative interspecific interactions were observed. The varying species compositions were grouped according to how many animals were exhibited at once. Within those groups, the total number of negative interspecific interactions was tallied and divided by the

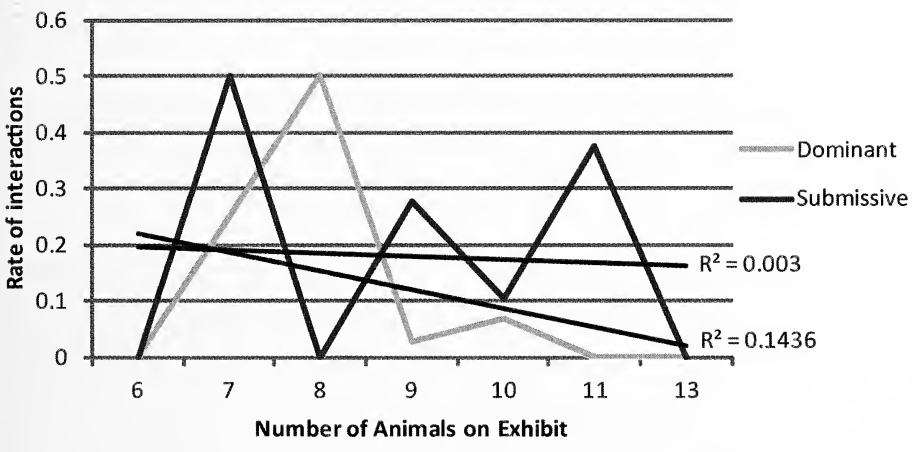


**Figure 2. Relationship between number of animals on exhibit and the rate at which negative interspecific interactions occurred per observation.**

total number of observations within that group resulting in the rate at which negative interspecific interactions occurred during the fifteen minute observations. Linear regression showed little to no correlation between the number of negative interactions between species and the total number of animals on exhibit (Fig. 2). The average number of dominant interspecific interactions per observation declined very slightly with an increase in the number of animals on exhibit ($R^2$=0.1436). The number of animals displayed had virtually no influence on the number of interspecific submissive interactions ($R^2$=0.003).

Regression was also utilized to study the effects varying numbers of animals on exhibit had on

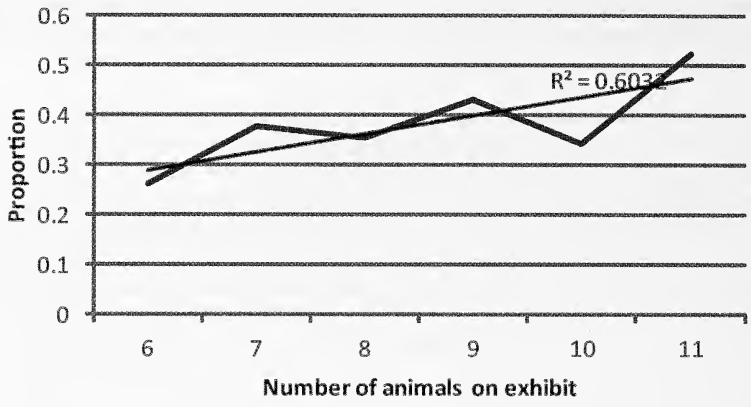


**Figure 3. Correlation between the proportion of proximity events that occurred with interspecifics and the number of animals exhibited.**

the proportion of the proximity events that occurred with interspecifics (Fig. 3). The proportion, according to linear regression, increased positively at a relatively high rate with increasing numbers of animals displayed on exhibit (R2=0.6032).

Studying both regressions cooperatively reveals an interesting trend. While the tendency to be in proximity with interspecifics apparently increases as the total population of animals kept on exhibit increases, the number of negative interspecific interactions decreases slightly.

**Discussion**

Although a large amount of significant data was collected and analyzed during this study, some of the significant differences were skewed due to small or disproportionate sample sizes. Medical situations and issues regarding social dynamics within the herd of Grevy's zebra, coupled with herd management practices used with the reticulated giraffes, made for constant change within the exhibit, which both aided and hindered this research study. The zebras were on exhibit for a relatively small portion of the study making all tests relying on comparison of proportions heavily biased against the zebra population. Certain species compositions also resulted in data of poor quality due to low occurrences or a limited ability to observe animals while these compositions were exhibited. An effort has been made to limit use of this data or make note while discussing the results from these numbers.

After much analysis and many significant differences found displaying the effects of habitat and species composition, the original hypotheses can be revisited. Many of these original hypotheses based on casual observation and natural histories of species were revealed to be accurate. Numerous significant results were discovered verifying the Grevy's zebras and East African crowned cranes to be the species most likely to instigate interspecific aggression and dominance. Conversely, the ostriches were overwhelmingly proven to be the species most likely to receive negative interspecific interactions regardless of habitat or species composition. Hypothesized trends regarding the effect of species composition on interspecific interactions also were verified as arrangements containing zebras were involved in negative interspecific interactions at a significantly higher rate than those arrangements in which zebras were absent. While discussing these trends it is important to note that virtually all interspecific aggression and dominance was directed towards the group of ostriches.

Not all of the hypotheses made at the outset of this study were correct. It was thought that aggression would be most commonly observed in zone 3 of the exhibit. This hypothesis was based on the

presence of a large pool, an automatic waterer, and a shade structure which supports the alfalfa bag used to feed giraffes. The pool and waterer were the only two sources of water in the exhibit, thus making it a limited resource. It has been virtually unanimously concluded that interspecific competition shown to be influenced by habitat has been due to the presence of limited resources over which the competition occurs (Sundaresan et al. 2007[1], Sundaresan et al. 2007[2], Mosely 1999, Marshal et al. 2008, Stensland et al. 2003). Zone 3 is also the epicenter of East African crowned crane nesting behavior and a nest existed in this area during the time of the study. These cranes have been shown to demonstrate fierce protective behavior of their nesting areas, often driving away much larger animals such as cattle (Walkinshaw, 1964). However, zone 3 was not the habitat in which aggression occurred most often; that designation instead went to zone 2. This habitat was seemingly devoid of limited resources, such as water, shelter and higher quality food. Thus it was determined that the higher rate of aggression between interspecifics, though not significantly higher than the other areas, was instead related to a combination of species composition and a potential interspecific dominance hierarchy.

Although the numbers suggest that habitat may influence the rate of aggression, delving into the context of those aggressive interactions within the habitat reveals figures suggesting the other factors mentioned. The ostriches were involved in negative interspecific interactions significantly more often than the other species regardless of the metric used. All of these, as previously noted, were interactions in which the ostriches behaved in a submissive manner. Zone 2 happened to be the habitat in which the ostriches spent a significantly higher proportion of their time compared to the other habitat zones. Therefore the high rate of aggression within this zone is more than likely not a reflection of the affect habitat has on interspecific aggression, but simply the happenstance of the animals with the highest propensity to be involved in such interactions spending a majority of their time occupying the area.

This trend, and the general trend of ostrich involvement in the interactions in question, can further be analyzed by use of species composition comparisons. With no significant, if any, affect of habitat on negative interspecific interactions apparent, the key to the aggression observed may lie in the arrangements in which the animals are kept and the species of which the exhibit is comprised. Many trends were discovered during data analysis which suggested a significant difference in the rates of aggression displayed in certain compositions compared to other arrangements. Those trends included the propensity of arrangements featuring Grevy's zebras to be involved in negative interspecific interactions at a higher rate compared to those compositions in which the zebras were absent. The number of giraffes also influenced interspecific aggression, with those compositions containing two giraffes displaying a higher rate of negative occurrences compared to those combinations containing more than two giraffes. Looking further into specific compositions continued to reveal significant differences as the 0124 and 2223 species compositions featured higher rates of interspecific aggression with 0124 displaying significantly higher rates than all other compositions and 2223 featuring higher rates than shown in 0024. At a species level, the cranes showed higher amounts of negative interspecific aggression while in the 2024 arrangement compared to the 4024. The ostriches were involved in a significantly higher proportion of the negative occurrences while in 2023 compared to 4023 and 4223. Therefore the composition in which species were exhibited was proven to significantly alter the prevalence of negative interspecific interactions. Many previous studies have also shown this to be the case (Andersen 1992, Popp 1984, du Toit and Owen-Smith 1989, Mosely 1999, Marshal et al. 2008).

Now that it is has been established that the role of habitat is minimal or nonexistent in this study exhibit and the affects of species composition appear to be rather high, the question turns to why species composition influences negative interspecific interactions. There have been many theories published on why species composition may have an influence on interspecific aggression. One of these theories is that size disparity between the species influences negative interactions. Although some authors believe that a greater size disparity may result in higher rates of aggression (du Toit and Owen-Smith 1989, Kleiman et al. 2010), others hypothesize that similarity in body size may

trigger higher rates (Marshal et al. 2008). Similarly, contradictory thoughts are prevalent in another common theory; taxonomic relatedness. Popp wrote that the total rate of aggression is higher between two distantly related species due to misunderstandings in aggressive threat behavior (1984), while Walther (1965) believed that interspecific aggression would be higher between closely related species due to similar antagonistic behaviors. Kleiman et al. (2010) agreed with Walther; his findings were based on the thought that physical differences and a reduced competitive overlap would result in less aggressiveness between distantly related species. Trends in negative interspecific interactions have also been shown to exist based on the natural social organization of a species. Stensland et al. (2003) suggested that species living in stable groups may be less likely to accept other species in their areas. Kleiman et al. (2010) believes that males of species which have been known to breed with harems of females are particularly problematic in mixed-species exhibits. These problems are suspected to be due to innate aggression being inappropriately directed towards females of other species. Exhibiting two harem males of differing species was thought to be even more dangerous according to Kleiman. This is especially pertinent to this study as both male Grevy's zebras and ostriches keep harems of females both in the zoo environment and in the wild. Gender differences

***While they may portray the trends shown in their own studies, interspecific aggression does not seem to have one prevailing rule of thumb dictating which species direct aggression towards another species.***

have also been shown to influence interspecific interactions, as species compatibility has previously been linked with male initiated aggression (Popp 1984). Sunderasen and colleagues[1] also showed that male zebras will defend areas with critical resources more vigorously than females (2007). Of course, there are also drastic differences in individual personality that may have significant effects on interspecific social interactions (Andersen 1992).

These theories all could pertain to comparisons between any species on the exhibit. While they may portray the trends shown in their own studies, interspecific aggression does not seem to have one prevailing rule of thumb dictating which species direct aggression towards another species. Instead, these theories may act in combination or across a spectrum of influence specific to each population of mixed-species individuals. Since there was obvious significant effects of species compositions on interspecific aggression, some mechanism, perhaps even a combination of those described above, did appear to be working on the species in this exhibit. Offered as a viable, and likely, explanation for the behavior observed in these species is the existence of an interspecific dominance hierarchy which dictates aggression in this exhibit based on differences in group size, male-initiated aggression, body size, and individual demeanor.

Hierarchies such as this have been found to exist in many different populations of mixed-species (Mosely 1999, Marshal et al. 2008, Stensland et al. 2003). An established interspecific dominance hierarchy in the order of Grevy's zebra>East African crowned crane>reticulated giraffe>ostrich, is thought to have been found in this exhibit. This hierarchy would account for the patterns in aggression discovered during data analysis. The zebras displayed the highest proportion of the dominant interactions as well as having the highest proportion of submissive events be directed towards them. All of these interactions involved the two male zebras exhibited at various times throughout the study, an adult male displayed as the lone zebra, and a male foal displayed alongside his mother. Therefore, the aggression displayed by the zebras, and hence their assumption of the highest standing in the hierarchy, could be said to be based in male-initiated aggression not uncommon for male Grevy's zebras (Sundaresan et al. 2007[1]). The zebras as a group also did not submit to any other animal on exhibit. This is unlike the crowned cranes, which despite instigating aggression at an amount second only to the zebras, did have two submissive behaviors directed towards the giraffes. These interactions did not appear to be aggressive displays by the giraffes, but rather incidental

displacements due to the large size difference, as large species naturally take up more space and more resources displacing other species naturally without need for aggression (du Toit and Owen-Smith 1989). Despite the trends described for large species to be more dominant, there have been instances of smaller species being dominant over large species, thus the cranes displaying dominance over large species is not found to be an anomaly (Kleiman et al. 2010). The giraffes, conversely, being a large herbivore remained true to the trend found by Kleiman and colleagues to be more calm and tolerant compared to smaller herbivores, such as the zebras (2010). The ostriches were the species, by far, relegated to the bottom of the hierarchy, as evident in their high involvement, submissive interspecific interactions and their high usage of habitat zone 2. Zone 2 was an area infrequently used by other species and devoid of any resources that could be viewed as advantageous. Animals such as the ostriches, which were on the low end of dominance hierarchies, showed a behavioral avoidance of habitat used by certain species, a trend described by Marshal et al. (2008). Relative to the amount of interspecific events which did not result in negative interactions, aggression between species was not found to be occurring extremely frequently. Mosely described a previously studied, interspecific dominance hierarchy, as a passive process in which resources were adequate but not abundant enough to ignore the presence of other animals, thus forcing subordinate animals to adjust their habitat use, resulting in low or moderate levels of interspecific aggression (1999). While this exhibit displayed some characteristics similar to that portrayed by Mosely, it also appeared that the zebras and cranes actively sought out ostriches while displaying interspecific aggression. This is evident in the fact that ostriches received a high rate of aggression while in zone 2, where they spent a majority of their time, despite the fact that other species spent comparatively little time while in this zone. Zebras were observed on multiple occasions instigating chase scenes with ostriches by coming from all the way across the exhibit into zone 2. It is noteworthy that in a mixed-ungulate/avian species exhibit the dominance hierarchy appears not to be influenced heavily by taxonomical differences. In fact, both ungulate and avian species were split in the dominance hierarchy with an ungulate and avian species at the top, and both of each at the bottom. Therefore, it is important to monitor the behaviors not only between taxonomic groups, but also within the taxonomic subgroupings found within exhibits featuring multiple ungulates and multiple bird species. Compatibility in this study is determined not only by how ungulates interact with the bird species but also how the bird species interact with each other.

Negative interspecific interactions exist in this mixed-species African savannah exhibit and appear to be most affected by characteristics of species compositions including the gender ratios of other species involved and the number of individuals in each species group. The trends observed regarding the influence species composition has on aggression will have practical implications in creating new management styles that may help to limit interspecific aggression and promote compatibility, thus increasing the welfare of species kept on exhibit. While there is no statistical definition of species compatibility, in terms of the rate of aggression displayed, the current rate has been determined to be problematic. While background aggression will more than likely continue to persist due to natural biological differences, taking advantage of the trends that have emerged will hopefully result in a more acceptable rate of interspecific aggression in the savannah exhibit. The trends observed in this study can be combined with those observed in other studies of interspecific aggression in mixed species exhibits in order to create management practices that may result in more appropriate levels of aggression.

Kleiman and associates (2010) suggests exhibiting species that occupy different environmental niches to reduce competition as well as keeping animals with a wide differentiation in body size and taxonomical relatedness. These recommendations were already in place in the study exhibit and appeared to not offer relief of aggression. They also recommended not displaying males of species which keep harems of females, as previously discussed. These animals are more prone to misplaced aggression, a trend observed, as all of the aggression displayed by zebras was by males. While one male was a foal kept with his mother, the other male is a breeding stallion and may only be able to be exhibited successfully by keeping the ostriches off exhibit. It is also of note that zebras were kept in small groups, either one or two, while on exhibit. Rubenstein, however, noted that aggression in zebras decreases as group size increases (1994). This implies that as the

other zebra female returns to health, and can be exhibited with her colt along with the other mare and colt, this increase in group size may aid in curbing zebra aggression. Thus, a recommendation of an increased group size of zebras, and the limited exhibition of the zebra stallion, only in the absence of ostriches, may be appropriate to aid in limiting zebra aggression towards the ostriches. Another group size-trend that may be taken advantage of is the propensity of species compositions containing two giraffes to exhibit higher rates of aggression compared to those containing more than two giraffes. The only male giraffe was exhibited exclusively with his recommended breeding partner, a subadult female, along with the other species on exhibit. Male giraffes have been shown to be primarily solitary when not actively seeking to breed (Leuthold 2008). As the female he was kept with was not yet reproductive, these animals spent little time in proximity together, compared to groups of female giraffes. As previously stated, du Toit and Owen-Smith (1989) found evidence of large species naturally displacing individuals due to inherently using more resources, therefore it is postulated that two giraffes moving separately consumed a large amount of space and resources reducing those available to other species, creating more opportunities for interspecific aggression over increasingly limited resources, including space. Managing the male giraffe separately from those animals exhibited on the mixed-species exhibit, in similar fashion to the male zebra, may also help reduce aggression between species. Lastly, total group size of all species kept on exhibit showed a correlation with interspecific aggression. Compositions featuring a larger number of individuals correlated with slightly lower rates of aggression despite increasing events in which interspecifics came into proximity with one another. Thus keeping a primary species composition of 4424 (0.4 giraffes, 2.2 zebras, 1.1 cranes, 1.3 ostriches) the maximum number of individuals, excluding the zebra stallion and bull giraffe, may theoretically result in lower rates of aggression. When this composition is unable to be exhibited, either due to weather or medical conditions, careful management of alternatives must take place. If the zebra stallion or bull giraffe are on exhibit, it appears that keeping ostriches off exhibit is the best course of action.

In conclusion, many of the original hypotheses formed before the beginning of this study proved to be correct. While trends regarding the effect of habitat on interspecific aggression were seen, these trends appear rather to be influenced by a combination of species composition, dominance hierarchies, and habitat usage by submissive species. Total group size and the presence of males within the species combination

In this study, the Grevy's zebra males were most likely to instigate interspecific aggression towards the other animals in the exhibit and showed the highest proportion of dominant interactions.
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kept on exhibit proved to be trends on which practical management recommendations could be made. Careful observation of not only aggression between taxonomic groups but also within taxonomic groups should be made in order to make recommendations regarding compatibility. By carefully managing the display of zebra and giraffe males, and exhibiting higher numbers of individual female zebras and giraffes, current trends and previous studies suggest lowering interspecific aggression to a more acceptable level may be possible in the mixed-species African savannah exhibit at the Great Plains Zoo.

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# The Best of Both Worlds: A great visitor experience and successful breeding programs in a mixed-species exhibit at Denver Zoo

*Christina Seely and Loren Berry*
*Large Mammal Keepers; Denver Zoo*

**Introduction**

As you come through the main gates of Denver Zoo and drift to the right, you find yourself starting your journey down "Hoofstock Highway". The first ungulate exhibit you come to is a mixed-species exhibit with 1.2 Gerenuk (*Litocranius walleri*), 1.1 Abyssinian Ground Hornbills (AGH) (*Bucorvus abyssinicus*), and 1.1 West African Crowned Cranes (WACC) (*Balearica pavonina pavonina).* It sounds like a fairly normal mixing of animals and perhaps a group you wouldn't expect much from. However, this exhibit has been a favorite of keepers and zoo visitors alike for the last six years and it's getting more and more interesting!

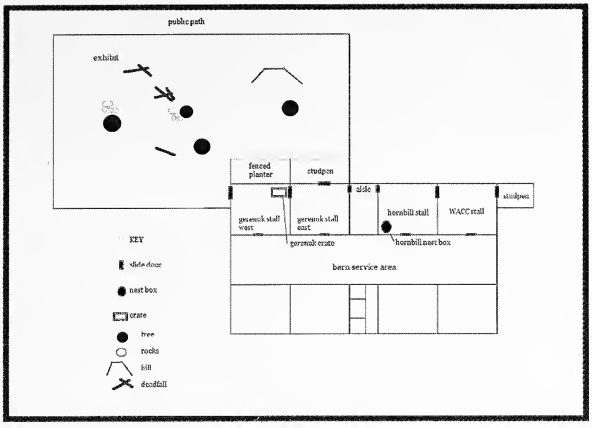
This exhibit is viewed daily by almost every visitor as you have to pass it either entering or leaving the zoo. It is a fairly open exhibit for easier viewing. There are trees for natural shade, and allowing the Gerenuk to show off one of their natural behaviors: standing on their hind legs to forage from the trees. There are dead fall pieces and larger rocks scattered throughout to break up the yard. These areas also double as perching for the birds. The exhibit has natural growing grass, a hill and a slight slope to the front. There is a small framed-in mulch/sand pit in the front as well. The visitor path sits a little higher than the exhibit which helps ensure a better visitor experience by allowing total view of the yard.

What really brings charm to the exhibit though is not its natural open appearance, but the animals that live there and the interactions they have with one another. Some might think a good mixed-species exhibit means having more than one species sharing the space with minimal to no interaction or conflict. All species get along because they have their own "spots" and thus having no real interaction with each other. Sometimes, this is a good thing from a keeper standpoint but it can also be a little boring. Animals not interacting with each other at all, constantly avoiding specific areas of an exhibit may also mean that the individuals may not be comfortable enough in their surroundings to court, build nests, breed successfully, etc. It may also be difficult to allow options for breeding with a mixed-species exhibit, with consideration to housing, nesting, and birthing stalls.

But wait…what if? What if you could have a great looking multi-species exhibit with locations so that each species could have their own "spots" if they wanted but also the rest of the yard was intriguing enough for them to wander and investigate everything all the time? What would happen? Could you get positive interactions between species often enough to call it the norm? Would this create a positive enough experience for visitors and allow the exhibit to double as a location for a successful breeding program(s)?

**Woody**

In May of 2007 the Denver Zoo acquired their current male Gerenuk, Woody. It was already decided which yard he would go into and after quarantine he began being introduced to the exhibit and it's other residents. (For more information on Woody's introduction, please read the 2009 ABMA Conference Proceedings.) At that time, the zoo had their current 1.1 Abyssinian Ground Hornbill, Abby and Bili, and 1.1 East African Crowned Cranes (which have since been replaced with 1.1 West African Crowned Cranes). The cranes and hornbill tolerated each other at best until Abby and Bili decided chasing the cranes around the yard was fun.




**Abyssinian Ground Hornbills**

In 2006, we added our male Abyssinian Ground Hornbill Mbili, or Bili for short. At the time he was a year old and not quite sexually mature, however, the intent was to have Abby and Bili be a breeding pair someday. The introduction between them went great and soon they were being housed on and off exhibit together. They could be seen patrolling the yard and together would chase 1.1 East African Crowned Cranes.

Before Bili was sexually mature he began an interesting relationship with Woody. Woody would be laying in the yard and the young hornbill would bounce around him and bring him sticks and such as if to show Woody what he had found. Soon Bili moved closer, mouth open and hopping, a common play behavior for hornbills. Woody started tilting his head, displaying his horns at him. Bili then would bounce away, and then bounce back towards Woody. Each time Woody would tilt his horns at him, and remain lying down. Before we knew it, the two could be seen bouncing back and forth at each other with a tree between them. Usually one or the other would bounce off, and then return to start playing again. As the relationship progressed, keepers also witnessed Woody tilting his head and Bili, very gently, would begin picking/preening inside his ears and between his horns. This behavior continues today. However, because of this interesting friendship, Bili spent a lot of time with Woody and no time with Abby, his intended mate. Keepers wondered if Bili knew he was a male hornbill with a lady in waiting or if Woody was just too entertaining to leave.

Our question was answered February 2010 when Abby successfully laid a single fertile egg which hatched 39 days later. Unfortunately, the chick only survived a few days, but this didn't stop the hornbills. Bili continued to play with Woody but also continued to court and breed with Abby. Since that first egg, Abby and Bili have successfully laid six fertile eggs and three have hatched. Unfortunately, only one has survived after the decision was made to pull it from the nest and hand-rear it. Abby had laid two fertile eggs in one clutch. One egg stayed with her, and the other went to the zoo's bird propagation center for incubation, hatching and rearing. The chick was determined female and puppet-reared at the zoo's bird propagation center. When the female chick, named Belle, was four-months-old, she was brought to the barn daily for some socialization with the adult pair. She was provided visual access to the adults while they were in the yard and she was in a stud pen. This was all in hopes of showing her how to act like a hornbill. Belle was moved to the barn permanently at approximately five-months-old. She will be here until it is time for her to move with the SSP's recommendations.

She is not housed with her parents, though Abby did show very non-aggressive interest in her, and for a short while was allowed to be with Belle, supervised by keepers, where Bili could not see the two of them. Abby had very good manners and seemed to just want to check Belle out; however, Belle wanted no part in it.

Now Belle is managed completely separate from the pair. As the pair begins showing interest in nest building, it is important to give them plenty of room to roam. When days are nice, the pair has access from their stall and nest box through a connecting hallway, through two Gerenuk stalls, and out to the mixed exhibit. This has been the fairly successful routine during the hornbills breeding season for two years in a row now. It seems the more room you give the male, and things to do, the less he tries to do inappropriate things like join Abby in the nest box (which was a problem the second year of breeding).

So now during breeding season, while Abby sits on an egg or a chick in the nest box, Bili will go out in the yard and find some food, leaf litter, etc for a collection for Abby. He carries it all through two 15X15 foot Gerenuk stalls, through a connecting hallway, and into their stall where she waits for food and additional nesting material. A door is closed enough that only a hornbill can fit through, and not a Gerenuk, which are still on exhibit. Up until this year the cranes where on exhibit as well. This year we have flip-flopped the indoor housing for the cranes and the hornbill, otherwise he would still be traveling through a third 15X15 foot crane stall to reach their nest. This move actually was to benefit the cranes, not the hornbill which you will soon see. (Fig. 1 by Loren Berry)

**West African Crowned Cranes**

In 2011, the Denver Zoo traded out having East African Crowned Cranes and received a 1.0 West African Crowned Crane named Casanova. For about a year he was the only WACC in the exhibit with the 1.1 hornbill and 1.0 Gerenuk. He was not an aggressive bird, but also did not put up with the hornbills attempting to chase him around the yard like the previous crane pair. Though the hornbills chased Casanova, the hornbills seemed less entertained by the new male crane.

In April 2012, the Denver Zoo acquired a young female WACC, Francesca. As with any introduction, precautions were taken with introducing the new female to the yard and her new exhibit mates. First, Casanova and Francesca were in separate stalls with a mesh door between them. Next, was to let her into the stud pen that attached to the yard so she could see all the other animals. She was then introduced to the yard by herself to explore and learn where all her obstacles were. Then our male Gerenuk Woody was added to the yard. He always seemed to not really notice any of the cranes in general so he was a great place to start. However, when we got to the part where Casanova would be in the stud pen and Francesca and Woody were in the yard, Casanova ended the introductions. He "flew" (he is pinioned) over the 6 ft fence between him and the yard. Casanova and Francesca have been together ever since. It was an immediate connection. They were seen preening each other later the same day and refused to be separated overnight.

Due to their young age, (Casanova is 4 and Francesca is 2) eggs are not expected from this pair quite yet, however they are showing all the signs of a great pairing and we are hopeful they will provide offspring in the future. Casanova has been initiating courtship dances with Francesca. They have even begun nest building in their indoor holding. They have been given plenty of sticks, dried reed grass, and grass hay to use as they want. Their choice has been to build a nice, fluffy, 4X3 foot nest incorporating a large black feed tub. Since the hornbills are nesting at the same time, keepers chose to allow the cranes to remain in their holding stall that connects to an off-exhibit, covered, stud pen. They seem very content to have their little private territory. The male has started to get up onto higher perching in the stall between keepers and the nest. He has also stretched his wings out to keepers on this higher spot when they enter. The female still does not seem very protective of the nest site, but she is two years younger.

**And the last piece to the puzzle....More Gerenuk!**

A little after Francesca arrived in April 2012, the zoo received another animal addition to this exhibit with 0.2 Gerenuk named Sushanna (Sushi) and Layla. Sushi is eight-years-old and the mother of four-year-old Layla. The females were an arrival three years in the making and would bring the yard's number of individuals to seven!

The female Gerenuk had a longer than usual quarantine period due to some parasite issues but once they were cleared, the introductions began in July 2012. First, the females were given access from their stall to the attached stud pen. The stud pen is made of small chain link and is connected to the exhibit with about a 90% view of the yard. There they were able to see the 1.1 AGH, 1.1 WACC, and 1.0 Gerenuk they would eventually be housed with. This piece of the introductions was very important because it allowed the female Gerenuk to see how the other individuals moved and interacted in the yard and with each other while allowing them to leave the situation and move to the safety of the stall if needed. The female Gerenuk learned what the norm was for the yard and hopefully what to expect before actually being in the same space with the other species. With the females being in the studpen during the day, it also allowed 1.0 Gerenuk, Woody, to see them for the first time. One fear of introducing male and female ungulates to each other is that some males can get a little too excited the first time with females, and can chase and cause injury to themselves or the female. Therefore, another bonus to this step is that the male can get over some of his "first time" jitters. With this particular introduction method, it seemed to work so well that eventually, Woody could be seen relaxed and laying down either near the stud pen or away from it and the females. Either way, he was clearly not worked up about the females' presence.

Another benefit of the females in the studpen first, was that they were able to get used to the pair of hornbills bringing them gifts. Hornbills being the intelligent creatures they are, enjoy finding treasures. It could be leaves and sticks, a rock, or a large sparkly sombrero that has blown off someone's head on Halloween. After finding these treasures, our hornbills will show each other the item, then run over and show Woody. Therefore, we knew it was only a matter of time (probably minutes) before they would begin bringing objects to the fence to show the females. The first couple of times, of course, the females were a little unsure, but soon they were accustomed to the hornbills and that their antics were just something visually stimulating.

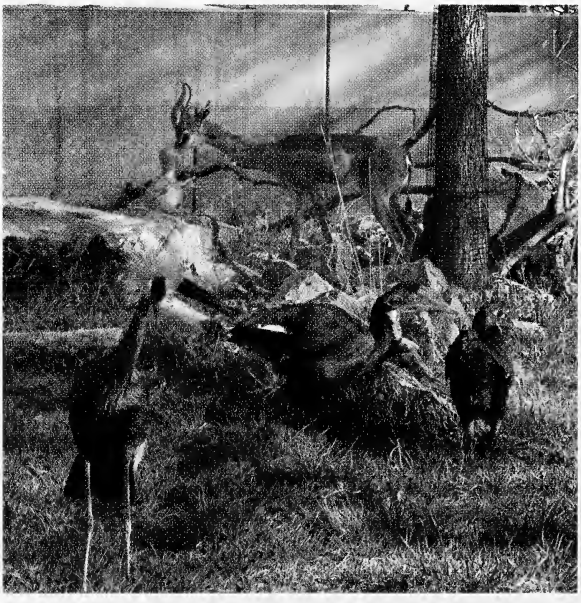
Soon the females were put into the yard on their own to see where the boundaries were and learn where all the perching and other obstacles were at. Next, we decided to introduce 1.1 WACC to the 0.2 Gerenuk. The cranes always seem to run, stretch and flap their wings on their way out of the stalls and into the yard. This was something these females needed to get used to. They had to learn they didn't need to run or spook from everything. After a day or so, the cranes running around and flapping earned a little more than a glance. The crane introduction was followed by 1.1 hornbills to the yard, and finally Woody. Again, due to the fact that we didn't want Woody to harass the girls too much their first time together, we actually introduced them in the stalls first, and once we were sure they were calm and compatible we put them in the yard together. Woody seemed very excited to see the females, but he was very well-behaved. In fact, the females who had not been in a large area for a couple of months, due to their long quarantine, could be seen running laps around the yard in the beginning while Woody stood in the middle of the yard and chewed his cud. He seemed undisturbed by the excitement around him. This in turn helped the females as well. Having another Gerenuk to take cues from seemed to cause them to be calmer over time. They also got to the point that they would not shift in to the barn at night until he shifted in. This presented a fun challenge for keepers at the beginning and still does from time to time.

Woody, now six-years-old, seems to have been such a calming factor for the females, that even though he started out as the Denver Zoo's "star Gerenuk" with his extensive training program, participating in behind-the scenes tours, night events, demonstrations, and even having his own Facebook page (Woody Gerenuk), the females are starting to get a name for themselves. Layla has won the hearts of several visitors as she is more curious and less standoffish then Woody can be sometimes. (Anything for food!). All three Gerenuk are worked in a training program both on and off exhibit. It gets interesting when Woody is in the middle of a session and Layla comes and takes over. Lately, Layla beats him every time and approaches first to participate in tours and training demonstrations. Sushi will usually be close behind but keeping her distance while the hornbills and cranes are there waiting to pick up any scraps of yam or grapes that have been missed.

Sushi has several people taking notice as she seems to have created a similar relationship with Abby, the female hornbill, as Woody has with Bili, the male hornbill. Sushi and Abby can be seen on exhibit initiating play with each other. Sushi will put her head down and bound around while Abby bounces back and forth with her beak open. During breeding season, Abby generally cannot be found without Bili by her side. So when the two girls start playing, Bili tries to play too. Interestingly, Sushi, as of right now, will not play with Bili. On a related note, Abby has never really been seen playing with Woody. They each seem to have their own special relationship that isn't species-specific, but individualized. Layla doesn't seem to have a special relationship with anyone specific. If you have food, you're her friend. Because of this, she is our steady and true girl that you can train for just about anything. She is also the one out of the two females on a breeding recommendation. We have seen breeding behavior between Woody and Layla and hope to welcome the zoo's first Gerenuk calf soon.

**Conclusion**

What really brings charm to the exhibit is not its natural open appearance, but the animals that live there and the interactions they have with one another. Having a mixed-species enclosure can give a lot of great entertainment for visitors and the species that live there. Kathryn Wilson, an Education Logistics Specialist at Denver Zoo recently gave a great visitor summary of her "favorite" enclosure in the zoo. "I love this exhibit for several reasons. One, it allows three different species to be housed in one area. I thoroughly enjoy watching the interaction between these three different species. Another is that it's a great educational tool to talk about and contrast different animals and their similar characteristics and habitats. Finally, there is always something different happening in the exhibit on any given day. You may have Woody and the girls feeding in the trees in the middle of the yard one minute, the cranes in the back corner, and the hornbills chasing squirrels up front and a couple hours later everything has been reversed. It has become one of my favorite places because no matter how long I stand and watch the animals, it is always changing and nothing seems to stay the same long. I believe this makes it an ideal place for the animals to coexist and provide a great and educational tool for the public."



Happy Herd. *Photo by Loren Berry*

Mixed-species exhibits are a great way to utilize land since there is more than just one species in an area as well as give the ability to educate guests on which species could be seen in a given area together in the wild. A problem with mixed-species exhibits is sometimes animals stick to their own areas/ territories meaning they rarely interact, or if they do it isn't always a positive interaction. You may also run into an issue of simply holding animals for exhibit purposes rather than being able to participate in breeding programs.

However, it doesn't have to be that way! With the right animal collection and understanding of not only what your animals need but how they carry out those needs, you can have both a great educational exhibit and a successful breeding program!

# Creative Management: Adapting to Challenges of Multi-Taxa Exhibits

*Michelle J P Handrus, Senior Keeper*
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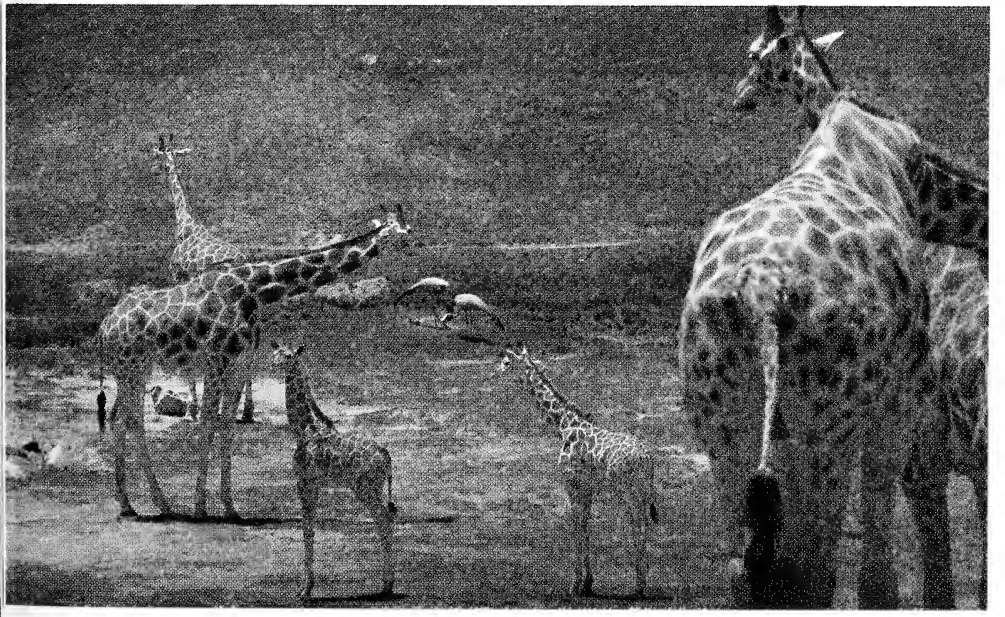
The San Diego Zoo Safari Park (SDZSP) is an expansive wildlife sanctuary that is home to more than 3,200 birds and mammals representing over 300 species. The SDZSP has 40 years of experience in exhibiting mega-vertebrates and birds together. The SDZSP is a unique institution because we have such a wide variety of exhibits. Large 80-acre open exhibits to one-acre covered aviaries, and everything in between. It has been necessary to establish new methods to keep mammals and birds together in flocks and herds, and has resulted in records set in longevity and reproduction programs. Housing techniques, training techniques, breeding/egg/chick management protocols, and overcoming challenges with open communication and creative ideas from the keeper/management/curatorial staff have been integral in the success of the collection.

When designing/maintaining an open exhibit, one needs to take into consideration what all of the animals need to thrive and be safe. Thinking of the particular species, its native habitat, what occurs naturally, and whether or not they can be housed together in the particular space. The size of the animals, both mammal and bird, whether they are herd/flock species, etc. all need to considered. There should always be safe places for both the mammals and birds to go. Whether it is barns/shelters or rock/tree rings, they must accommodate all species in the exhibit. When dealing with multi-taxa exhibits there must be careful consideration, because a lean-to for a guineafowl (*Numididae)* to hide is a toy for a cape buffalo (*Syncerus caffer*), and a small barn for a steenbok (*Raphicerus campestris)* to refuge is a confined space hazard for a crane (*Gruidae*). In large enclosures that house rhinos (*Rhinocerotidae)*, giraffe (*Giraffa camelopardalis*), cape buffalo, oryx (*Oryx sp.*), and sable (*Hippotragus niger variani*), with cranes, vultures, and pelicans (*Pelecanidae*) it is necessary to provide space for all of them to coexist without serious altercation. Constructing an island in a large



Hooves and feathers together at the San Diego Zoo Safari Park. *Photo by Sheila Murphy*

Two birds test a delicate balance.

Rhino and Pelicans. *Photos by Sheila Murphy*

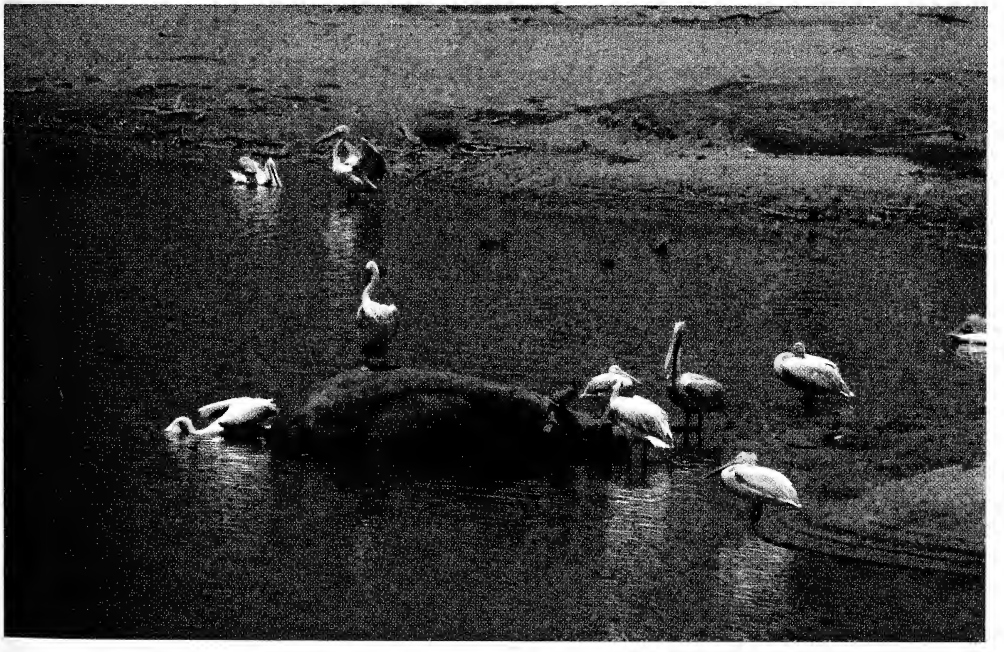
body of water is an ideal design for safety, and a great way to exhibit the multi-taxa species together. Keeping the birds flight-restricted, and on an island, gives the birds a safe place to live among the large herds of large mammals. Pelicans, cranes, Secretary Birds (*Sagittarius serpentarius*), and Saddlebill Storks (*Ephippiorhynchus senegalensis*) have all been housed successfully on islands in large ponds at the SDZSP. If the exhibit does not have a large pond, rock structures can be used. For example, for large flocks of East African Crowned Cranes (*Balearica regulorum gibbericeps*), arranging large rocks in ring format (where it only allows enough space between the rocks where the birds can fit through) will exclude any large mammals; providing a safe place for the birds to escape to. In a mound format, it is a safe refuge for Vultures/Pelicans/Storks (*Ciconiidae*) to roost. These islands also provide a safe place for nesting. When animals are in a breeding mode, it is a whole new set of parameters. Nesting material for birds turns into browse for mammals. (Is the material safe for the mammal to consume?) Nests that are not in protected areas can be destroyed by the mammal herds moving through exhibits.

Keeping the birds safe is not the only concern when dealing with mammals and birds being exhibited together; making sure the correct animals get the correct food can be challenge. There are many challenges to making sure the correct animal receives its food and in a safe environment. Besides the concern from other exhibit animals getting into the diets of the collection birds, is the concern of native birds stealing or contaminating collection bird diets. Training the birds to eat close to the keeper is one way to keep mammals and native birds away. This process takes a lot of time and patience, but once in place is a very good tool. It allows the birds to be up close to the keeper and allows for better assessment. Another method to keep mammals/native birds out of bird diets is to build catch pens that are 'off-exhibit' and train the birds to come into the catch pens. This provides a safe and relaxed atmosphere for feeding. When building catch pens, the natural history needs to be considered. In an exhibit at the SDZSP, we house vultures, cranes, storks, and waterfowl (*Anseriformes*). Because the vultures prefer high ground, we built the vulture catch pen at the top of the exhibit; the catch pens for the others that prefer low ground, at the bottom. This set-up also brings efficiency, allowing all of the birds to be fed at once, rather than having to come back over and over to feed them separately. With catch pens, keepers are bringing the birds into an enclosed area. This requires training and a more applied approach. The keeper needs to be there to bring the birds into the catch pen, lock them in, and needs to: either stay to allow the birds to eat, or return later to put them back on exhibit. This is best for birds that are more crepuscular/gorgers, ideal for storks, pelicans, ground hornbills (*Bucorvinae*), vultures, etc. Another way is to offer diets in excluder feeders. For example, feeding a dry pellet in a 'squirrel excluder' feeder is a great way to feed cranes of all types. This allows the food to be left out over a long period of time, ideal for grazers/browsers. Making sure the birds are fed in a mammal-free, native bird-free, and safe environment seems to be a simple task, compared to having a successful breeding program.

During the breeding season, there is a new dynamic that develops among the birds, among the mammals and among the birds and mammals. Roosting sites change, nest building occurs, mammal

herds relocating, and mammals giving birth and tucking their babies. For birds, breeding season brings courtship behaviors, nest building and protecting, incubation and chick-rearing. This is a time when the birds and eggs are most vulnerable. As previously stated, having safe areas out of the way from 'normal' mammal-traffic areas, is necessary. Although, it must be said, the old phrase "if you build it, they will come" does not necessarily apply to birds. They will often nest wherever they want to; especially, in the most undesirable places (from a keepers perspective). Keepers need to be aware of who is pairing up and where they are thinking about nesting. In multi-taxa exhibits, it is paramount to protect the birds from mammals while they are incubating. The birds are very attentive and will do anything to protect their eggs/chicks. Because the environment is ever-changing and the egg-survival is important, there have been protocols written to ensure chick survival. When eggs are laid in the large multi-taxa exhibits, the eggs are pulled to artificial incubation and dummy eggs are put in the nest to have the parents continue to sit. If the parents sit the entire incubation, the eggs are then returned at pip. When the eggs hatch, the entire family group is caught up and taken to an off-exhibit pen for parent-rearing of the chicks. The off-exhibit pen protects the chicks from native birds, as well as the parents from altercations with mammals. If the parents, unfortunately, do not sit the dummy egg(s) through the incubation; the eggs in artificial incubation are then hand-reared by the keeper staff. There has been great success with many species: waterfowl, cranes, pelicans, vultures, herons (*Ardeidae*) and storks. Every individual and situation is unique. You can base your decisions on previous situations, but keep in mind, every situation is unique, and the animals will determine your decision-making. Learn whatever information is out there, contact other institutions and see what experiences they have had. With open communication and creative ideas, housing mammals and birds together could be a great success.

Having excellent communication skills is one of the most important qualities to have as a keeper; even more important if there are multiple keepers caring for one exhibit. Accurate record keeping and open communication is necessary to ensure the absolute best care of the animals and safety of the keepers. Everything from offering diets, to tossing browse/nesting material in the pen, to providing shelter, all need to be discussed prior to putting into practice. For example, is it a problem if the Gerenuk (*Litocranius walleri*)/Duiker (*Cephalophinae*) eat the crane diet or Kori Bustard (*Ardeotis*



A rhino enjoys a bath in the company of pelicans. *Photo by Sheila Murphy*

*kori*) diet? Yes, it is high in protein/fat, causing excessive weight gain. So, the bird keepers need to be sure to offer the food where the Gerenuk/Duiker cannot get to it. In this instance, a catch pen was installed and the birds were trained to eat in the catch pen. Does the mammal keeper need to know if the scrape in the middle of the exhibit is a Blue Crane (*Anthropoides paradiseus*) nest? Yes, because cranes are very aggressive nest defenders and a keeper that was unaware of nesting could get seriously injured. When adding new structures, it is important to know if it is safe for all animals that reside in the exhibit. Once there is a clear line of communication, it allows everyone the freedom to try new options of exhibiting animals and fulfills responsibility of conservation.

The ability to house 20+ East African Crowned Cranes, 3-4 Marabou Stork (*Leptoptilos crumeniferus*), a pair of Goliath Heron (*Ardea goliath*), a pair of Yellowbill Stork (*Mycteria ibis*), 20+ Giraffe, 8+ Southern White Rhino (*Ceratotherium simum*), and herds of Cape Buffalo, Impala (*Aepyceros melampus*), Oryx, etc. is because the dedicated staff has taken the time to make it work. With educated decisions and creative thinking, mammals and birds can live and reproduce successfully together. Designing new housing with catch pens for feeding and capture, as well as providing safe areas for breeding has increased the success of both mammal and bird collections. Exhibiting mammals and birds together not only uses space to the greatest capacity, but also enhances the guest experience. Birds are not only accessories to exhibits, but main attractions. Offer a different perspective when designing exhibits, try to fill every niche: loud waterfowl, colorful storks/ibis (*Threskiornithidae*), flashy displayers/flyers, etc, will bring the attention to the exhibit, and encourage guests to look further. The success of the SDZSP exhibiting/housing large flocks of birds with large herds of mammals for over 40 years is due to the creative thinking and open communication among all staff involved.

Knowing the location of an aggressive blue crane's nest is important, whether you are a keeper tending to a mixed-species exhibit, or on safari in this South African meadow. ©*Shutterstock*

# Guide to Animal Introductions

*Tammy Sundquist*
*Lincoln Children's Zoo*
*Assistant Animal Curator*

Animal introductions once simply consisted of placing the animals into an enclosure together, which immediately put them into direct contact. Unfortunately, such an abrupt process could result in a high number of injuries and even fatalities. The zoo industry has moved away from this potentially volatile practice to a generally agreed upon path towards reducing aggression, injury and stress. The widely accepted approach to introductions today uses a gradual transition method with three general concepts of increasing proximity: nearby, next to, and with. This allows the animals to become familiar with each other's presence and behaviors before full integration occurs.

Gradual transition introductions begin with the animals being moved into an appropriate area to allow them to be aware of each other's presence nearby through a variety of senses. Once the animals appear to have become accustomed to one another the process then progresses to the animals being moved next to each other. At this time they can have protected contact through a "howdy" door where they are allowed to see and interact with each other via a see-through barrier. A "howdy" door is typically a mesh-type of door that allows for further interaction with the animals being unable to reach through, thus eliminating the risk of serious injury. The material and dimensions of the openings used should be species-appropriate. For instance, it could be chicken wire, chain link, or a welded metal screen.

The tension is expected to ease as the animals become more acquainted with, and better able to understand, each other's behaviors. As this happens and significant signs of aggression, if present, have decreased, the animals are finally allowed into the same enclosure with careful monitoring. The last step for an introduction is removal or opening of the last of the barriers or doors between the animals.

The entire process, and each individual stage involved in animal introductions, do not follow a set time-line. At each step it will take time for hostility to decrease, and acceptance to increase. Not every introduction will be successful and may be stopped at any of these phases. Staff should be encouraged to be patient and allow each step to take the time needed for an overall successful introduction. Violent behavior is expected at the beginning of introductions, when animals are first placed in these unexpected situations. Ultimate compatibility relies on the animals themselves.

Regardless of how well things seem to be going after the introduction is deemed a success, the process doesn't end there. Careful monitoring of interactions will be necessary to determine if there is a need for intervention, and regular assessments of the exhibit-mates' behavior needs to continue in order to ensure their welfare.

Prior to starting animal introductions, having a plan in place is a must. Careful preparation allows those involved to make arrangements for multiple situations that may occur throughout the process. Included here is an Introduction Checklist that can be used as a starting point to explore the possibilities and to allow for appropriate planning. As a resource it can be refined to fit the particular circumstances at an institution and the more often it is used, the more valuable and useful it will become.

In the Introduction Checklist, gathering information on the species and individuals are the first two items, giving an indication of their importance. The best chance for a successful introduction relies on the staff involved conducting this research prior to beginning the hands-on effort. Just as there are variances in behavior between species, individuals have their own idiosyncrasies as well. Each animal has a unique history that may include important information such as their typical response

to stressful situations. This information can prove helpful in predicting the possible reaction of the animal when introduced to another animal and the best course of action for the staff to properly deal with the interactions. The information obtained will be a major factor in determining the plan and progress of the introductions.

In addition to researching the relevant animal data, it is imperative to have clearly developed alternative plans prepared. Strategies should be in place for long-term and future needs that may arise. For example, it may be necessary to prepare additional holding areas in case the introduction was to fail.

There must be staff agreement in advance as to how far to allow aggression to escalate before intervening, prior to initiating the actual introduction. It is also important to name a "point person" to make the final judgment call. This is necessary as circumstances can change quickly and there may not be time to discuss the options in the moment. If the staff interfere with an introduction too soon, before the animals have a chance to work it out in their own way, the new exhibit plan may never have the opportunity to be successful. Opportunities are not limitless, so how much aggression is tolerable should be carefully considered as there have been reports of serious injuries, including deaths resulting from introduction attempts.

When introducing individuals into a social group, staff need to be aware of group dynamics and how the hierarchy is determined. It is best to start by introducing the least dominant or least aggressive individual with the newcomer first. However, if there are two groups of primates to be integrated the most successful method has been both groups at the same time. (Bernstein 1969). Additional researchers have also noted that with primate behavior a slow transitional approach may result in more aggression rather than less. A paper presented at the 2002 AAZK National Conference regarding the process of introducing colobus monkeys stated, "The experiences of other institutions with colobus monkey introductions indicate that, quite often, the less sensory contact the male has with the females prior to the introductions, the better and that prolonged or routine separation between males and females may often elevate aggression." (Wookey 2002).

The following are a few more recommendations that may increase the likelihood of a successful introduction: 1) Those new to the exhibit should be allowed ample time to explore the area by themselves prior to introductions. This will not only alleviate some initial stress, but will allow the new animals to become familiar with potential hiding areas or dead-end spaces. 2) Another way to lower stress levels is to place soiled items from the original area of the animal to be introduced into the new exhibit to help them feel more secure. 3) Animal diets offered need to be considered as there could be a time of day to avoid a new introduction if an animal is more aggressive when it is expecting food, or an animal could be fed extra diet to satiate it prior to an introduction in an attempt to reduce hunger and related tension as variables. 4) The use of enrichment should be discussed, as it can either promote competition, or be a distraction. 5) Hormones affect an animal's behavior, and thus will be a factor in appropriate timing of introduction attempts. These factors should be used to the facility's best advantage depending on the known behaviors of the individuals to be introduced.

In summary, each facility has its own set of circumstances that should be taken into account during planning for animal introductions, such as existing exhibit areas, climate, and staff experience. Therefore, the written introduction protocol should be regarded as a living document to ensure flexibility. Successful animal introductions depend on several factors, including proper planning, staff knowledge, and animal behavior. Being prepared for all contingencies and armed with the most information possible will improve the chance of success. The gradual introduction method works toward the ultimate goal of peaceful coexistence by increasing the animals' proximity to each other over time. As introductions progress, more interaction is allowed and closely monitored to determine when the animals are ready to move on to the next step, if at all, rather than being forced to deal with sharing space immediately. This gradual process allows animals to become familiar with each other, working from awareness to acceptance.

Introduction Checklist

1. Research
    a. Species
    b. Individuals
    c. Contact experts
2. Projected timeline
    a. Contact other internal departments
        i. Inquire about nearby activities planned
        ii. Inform veterinary staff, public relations
3. Step by step introduction plan
    a. Determine final decision-maker
    b. Emergency response for intervention
    c. Appropriate tools/equipment – baffle boards, adequate staffing, $CO_2$ tanks, distraction items, etc.
    d. Schedule observations – ethograms, staffing
    e. Announce start of physical introductions
4. Prepare exhibit
    a. Ensure all aspects in working order
    b. Water, electricity, tools, shift doors
    c. Complete renovations/construction
    d. Escape routes, barriers, round robin
    e. Containment and safety
    f. Appearance – plantings, graphics
5. Husbandry
    a. Staff training
    b. Dietary needs – ordered, in stock, transition
    c. Medical issues – exam schedule, medication
6. Husbandry management protocols
    a. Developed and approved
    b. Trained and posted

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# Mixed-Species Exhibits: A New Phase in Zoo Evolution

*Tammy Sundquist*
*Lincoln Children's Zoo*
*Assistant Animal Curator*

In the early stages of keeping wild animals in captivity, many were regularly housed together in what are now called "mixed-species, or multi-species exhibits". They have been the standard for some taxa for many years, with the emphasis traditionally on social species. The most common example continues to be large aviaries containing a variety of birds. In more recent times, unrelated types of animals can also be seen in the same enclosures, such as birds and ungulates.

As institutional resources become more scarce, yet needs more demanding, mixed-species exhibits are gaining in popularity. They benefit the facility, visitors, and the animals, by maximizing the use of space, attracting and holding the attention of guests, and increasing the animals' interaction within their own environment. As facilities are realizing the numerous benefits of mixed-species exhibitry, it is becoming more frequently utilized.

In today's zoological parks, space is considered prime real estate, and it can be costly to house animals individually. In the case of large hoofstock, they generally require sturdier, and more expensive enclosures, and a larger area, which is usually more expensive to maintain, using additional staff time and other resources. One way to maximize the use of space is to combine more than one species in a single enclosure. Space and resources are critical limitations for zoological institutions and collection planners and managers are continually assessing what is available, suitable and reasonable. Mixed-species exhibits can be a part of the solution by optimizing the use of space, staff time, and tools.

The old-style barren cages have become a thing of the past and have been replaced with more naturalistic enclosures to replicate the wild for the animals and visitors. This step increased natural behavior and mixed-species exhibits extend this concept further, thus creating a new phase in zoo evolution, by showing animals how they might be found in the wild, sharing the same habitat. It is also a form of enrichment, which alleviates boredom, stereotypical behaviors and provides positive, beneficial challenges to the animals. No matter what the other species is, what area of the habitat it uses, or the length of time it is present in the same area, the presence of another species in the same enclosure will cause the others to be more alert and engage in different activities (Deleu 2003). Animal welfare still needs to be monitored as interactions could be deemed too stressful, with the risk outweighing the benefit. Animal collection managers designing mixed-species exhibits must attempt to establish the best arrangements according to species and individual needs.

An important role captive animals play is to educate the public as representatives of their wild counterparts and ecosystems. To encourage positive behavior changes from the public for the good of the environment, zoo exhibits must capture guests' attention long enough to deliver key messages. Some of the best combinations occur when the animals use different parts of the exhibit, and have different activity patterns, thereby maximizing the use of the space even further. A good example of this is an enclosure where the birds inhabited high branches, monkeys could be found in the middle, and the agouti was located on the ground (NWMTAG 2008). If the animals are active during different times of the day, there's a better chance of seeing active animals at the exhibit throughout the day, which enhances the zoo visitor experience (NWMTAG 2008). Guests are more likely to stay longer at an exhibit if an animal is visible and more active (Bitgood 1987), resulting in an increase in educational opportunities. In current zoo philosophy, there is an emphasis in exhibit presentation on realism to further education, rather than simply providing an unusual sight. In exhibit design the focus has shifted to encompass entire ecosystem communities rather than an individual species (Johnson 1996), thus ultimately allowing organizations to show the public's connection with nature and encouraging stewardship.

The positive aspects of mixed-species exhibits have been discussed, but there are negatives to consider as well. A health concern is the risk of cross-contamination of diseases or parasites between species. There is also the potential for injury, and even death. An important way to reduce this possibility is to remove as many variables for competition as possible, such as food and shelter access. Stress is a natural part of everyday life for both captive and wild animals. However, there is a difference between occasional stress and chronic stress. The latter can be detrimental and manifest itself in stereotypical activities such as over-grooming, or manifest itself in health problems such as reduced reproductive success (K. Carlstead, and D. Shepherdson 2000). Monitoring the balance for animal well-being is an important key.

There are a number of species that have been successfully incorporated into mixed-species displays, and seem to be well-suited for them, such as crested screamers (*Chauna torquata*), rheas (*Rhea sp.*), and tapirs (*Tapirus sp.*) (Hjordt-Carlsen 1997). In contrast, those that are easily stressed or highly aggressive are not recommended. A single instance of a negative outcome does not mean all attempts will encounter the same result. Each animal has a unique background, experiences and personality. There can also be variances in behavior within species and between groups of the same species. These all need to be taken into account and can affect an animal's expected species-specific behavior. "Just because one example of a mixed-species exhibit failed or was successful, that should not mean it can't ever be tried again, nor does it guarantee success." (OWMTAG 2007).

Despite the odds against it occurring after an initially successful introduction, there is always the possibility that animal behavior may change, rendering the new exhibit unsafe or unsuitable for an individual or species. Careful monitoring of interactions will be necessary to determine if there is a need for intervention, and regular assessments of the exhibit-mates' behavior needs to continue in order to ensure their welfare

Animal care managers must weigh the benefits with the risks prior to initiating a mixed-species exhibit plan. Further on is a Management Checklist to facilitate necessary discussions and decisions regarding this type of animal management. It certainly does not cover all possibilities, but it will initiate productive discussions among zoo managers interested in creating these dynamic displays. It is recommended to use it as a starting point. Hopefully it will eliminate or reduce surprises after plans have already been set in motion. An exhibit is far more likely to succeed when potential problems can be foreseen and avoided.

Mixed-species enclosures are a continuing trend due to the benefits of optimizing space and providing both animals and visitors with a stimulating environment, thereby increasing the facilities' guest experiences and educational messaging. When considering creating one, take into account all of the possibilities, gather as much information as you can, and assess special needs and unique traits of individuals. Every circumstance is unique, and should therefore be investigated with these constraints in mind. The mixed-species exhibit concept is a win-win-win situation for the staff, animals and viewing public alike.

Crested Screamers are a bird species often used in mixed-species exhibits with a South American theme.

1. Animals
    a. Establish purpose
        i. How species fit into collection plan
    b. Assess availability and cost
        i. Number of individuals and species
            1. Present and future capacity
    c. Consider natural history
        i. Climate, social groupings, niche, heating/cooling needs
    d. Contact population program managers
    e. Seek expert advice
    f. Establish alternative holding areas
    g. Consult Veterinarian
        i. Testing, vaccination needs, communicable diseases
    h. Plan for nutritional requirements
        i. Obtain samples from former institution, pre-order, transition
2. Facilities
    a. Evaluate space availability - number of individuals and species
    b. Identify needed modifications/additions/renovations to exhibit
    c. Ensure availability of appropriate alternative housing
    d. Reserve and prepare quarantine space
    e. Consider new building, construction vs utilization of existing area
    f. Plan and secure signage
3. Finances
    a. Animal acquisition – moves, price, transportation, permits, fees
    b. Initial investment – materials, tools, exhibit changes, staff training
    c. Long-term costs – additional keeper staff, food and medical supplies
    d. Source of funding – now and in future
    e. Perform cost analysis
4. Staffing
    a. Level of keeper experience
        i. Is additional training needed
    b. Is additional staff required
        i. Is it in budget
        ii. Who is responsible for what
    c. Protocols and policies – established prior to animal introductions
5. Timeline
    a. Facilities – design, construction, renovations
    b. Animal acquisition – permits, transport
    c. Contact program managers for future plans – when would animal be available
    d. Introduction plan
    e. Exhibit considered temporary, permanent or replacement
6. Future topics
    a. Breeding – young dispersal, den and off-holding areas
    b. Considerations for geriatric/aging animals
    c. Considerations for injured, outcast, introduction failure
    d. Exhibit maintenance costs
7. Evaluations
    a. Conducted at each phase - Before, during, after, and long-term check-in

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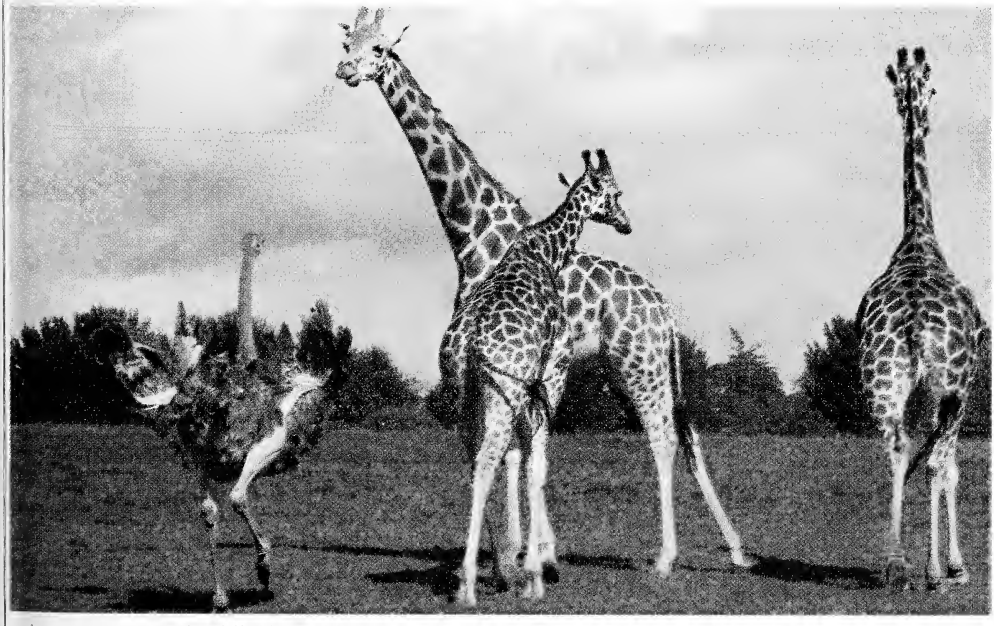


A management checklist in the planning stages can help create an exciting mixed-species exhibit.

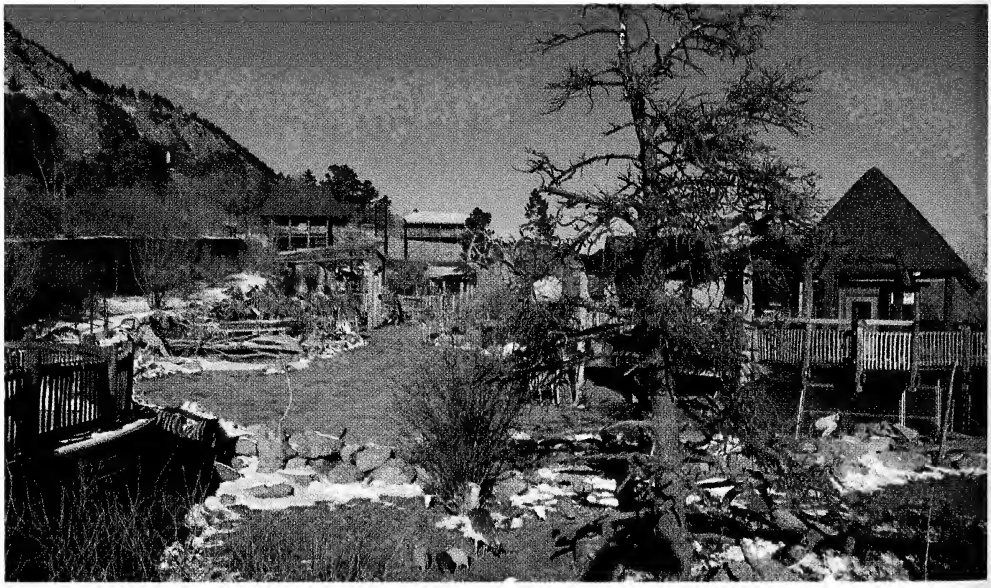
# Hooves and Feathers Together

*Roxanna Breitigan*
*Animal Care Manager*
*Cheyenne Mountain Zoo*

Be adaptable. Be flexible. Be creative. Be innovative. Be resourceful. Think Outside the Box. We have all heard these phrases and been expected to use them in our daily lives in one way or another. In our industry, this seems to happen more often than not. Animals are living, breathing and ever-changing. As our horticulture teams like to remind us, so are their exhibits.

So when we start thinking about tearing down old exhibits, designing new ones, and deciding on species for enclosures, we need to think about all of these things with an open mind, knowing that at some point things will change. Adding to that complexity is creating space not just for the animals on exhibit, but using the space as efficiently as possible to maximize the number of species being exhibited. Especially in the hoofstock and avian worlds, we are all too aware of the tendency to eliminate exhibits and species from an institution for the sake of creating larger exhibit spaces for other species. Which species will stay and which will go? It seems that, as space gets more scarce in most of our institutions, we are now, more than ever, asking which species can be exhibited together. We want more space for our animals, but that space comes with a price. So, we and our animals, find ourselves adapting, being flexible, and needing to think outside the box.

This is what happened to us at Cheyenne Mountain Zoo when we opened African Rift Valley. We thought we could put certain animals together…in theory it should work. But as we often learn, what looks great on paper does not always work in real life. The space we thought would be enough for the species we had was just not enough. We quickly had hooves meeting up with feathers and that does not usually end well for the feathers. We assessed the challenges and made changes. Years later, we still have a safe and highly functioning exhibit. In fact, it's one of our guests' favorites. The hooves and feathers live together and it works for both.



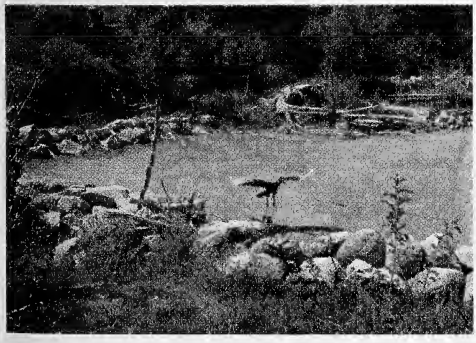
African Rift Valley at Cheyenne Mountain Zoo. *Photo by Roxanna Breitigan*

For us, the hooves are the easy part. We consistently have a herd of up to 20 reticulated giraffe (*Giraffa camelopardalis reticulata*) which guests get to get up close to, feed, and get slobbered on. It is often said that the giraffe exhibit is the happiest place at the Zoo because of this unique connection they can have with guests. We started out with lesser kudu (*Tragelaphus imberbis*) also in this exhibit, but over time had to adapt again. The kudu were phased out and Grant's zebra (*Equus quagga boehmi*) took their place. These are not usually easy decisions and when the last one loads onto a truck and drives away, there is sadness knowing another amazing species has left our collection to make room for someone else.

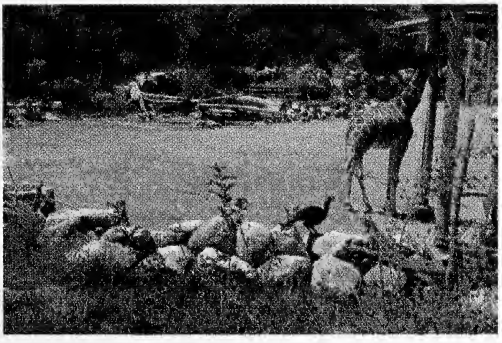
Aside from the kudu situation, one of our main challenges in this exhibit was keeping the birds safe while keeping the aesthetics of the exhibit the same. We did not want the birds to be meshed in; we wanted to continue to have an open feeling for the exhibit. We also knew we wanted to be able to showcase the birds so guests could truly appreciate them. So again we adapted, changed some species, and made exhibit modifications. Once we knew the birds could be on exhibit safely, we began focusing on how we could showcase them better.

The thought of a bird show intrigued everyone but we are not set up to have a traditional zoo bird show in an amphitheater. Flat space real estate is nearly non-existent on the mountain. During this time we had a visit from Steve Martin (NEI). He looked at the yard and in his wisdom said to us, "Why don't you just do the show from the yard?" It was one of those moments where you look around at each other and say "Why didn't we think of that?" This is one of the ways we started getting creative by looking at exhibits differently. We have unique challenges and opportunities on the mountain. We started looking at our animals' natural behaviors and how we could use their exhibits as the backdrop to showcase those behaviors. Once again, adapting to how we used to look at our animals and their exhibits and now how we may need to change things up to create a new experience. Today, we have a Birds of Africa Show, where vultures, kori bustard (*Ardeotis kori*), egrets, Abyssinian ground hornbills (*Bucorvus abyssinicus*) and even guineafowl (*Numididae*) can display their natural talents with a beautiful backdrop of giraffe, mountains and the city skyline.

Animals will be added to our collections, be shipped out, have babies, grow up, not get along with each other. Master plans will change, and the vision for our exhibits will take a turn. When these things happen we need to adapt and get creative. Looking at animals and exhibits differently so we can provide more room for a species we didn't have before or researching which mixed-species might work are just a couple of ways we can be resourceful and creative. We are the voice for our animals, exhibits and areas, so if we want to keep moving forward, making the most of what we have, we need to speak loudly for them. If we are creative in our thinking, you never know what spaces we can create so that there is room for the hooves and feathers to herd and flock together.



Abysinnian Ground Hornbill flying into Wings of Africa Bird Show. *Photo by Roxanna Breitigan*



Safe landing and looking up at his tall friend. *Photo by Roxanna Breitigan*

# Multi-Species Habitats: Weighing the Benefits Against the Challenges

*Kim Downey, Senior Keeper/Antelope Area*
*Saint Louis Zoo, St. Louis, Missouri*

During my early years as a zoo keeper, I worked with a variety of birds and ungulates. However, most of these animals were managed in single-species habitats. In 2009, I joined the Antelope Area team at the Saint Louis Zoo and found out that I had a lot to learn about caring for birds and ungulates in a multi-species environment. The Antelope Area currently cares for seventeen birds in six different bird/ungulate habitats, and over the years has tried many more combinations. Now, housing them together seems a logical thing to do after realizing many of the benefits and overcoming some of the challenges.

One of the first benefits I noticed was the possibility for social interactions between the birds and ungulates. When thinking about their natural environment, it seems obvious that ungulates will encounter birds on a daily basis and vice versa. Why not give them similar situations in zoo settings? These interactions can stimulate natural behaviors which are key components to their physical and psychological health. One of the best examples at the Saint Louis Zoo is the habitat that houses our reticulated giraffe (*Giraffa camelopardalis reticulata*) and ostrich (*Struthio camelus*). Our ostrich appear to be particularly interested in giraffe calves and can be seen interacting with them in the habitat. We have observed the giraffe and ostrich lying next to each other or following each other around the habitat, particularly when new animals are introduced (Figure 1).

Another advantage of bird/ungulate multi-species habitats is the potential for increased visitor interest and the opportunity to educate our guests. As keepers we are often in view of visitors when we are

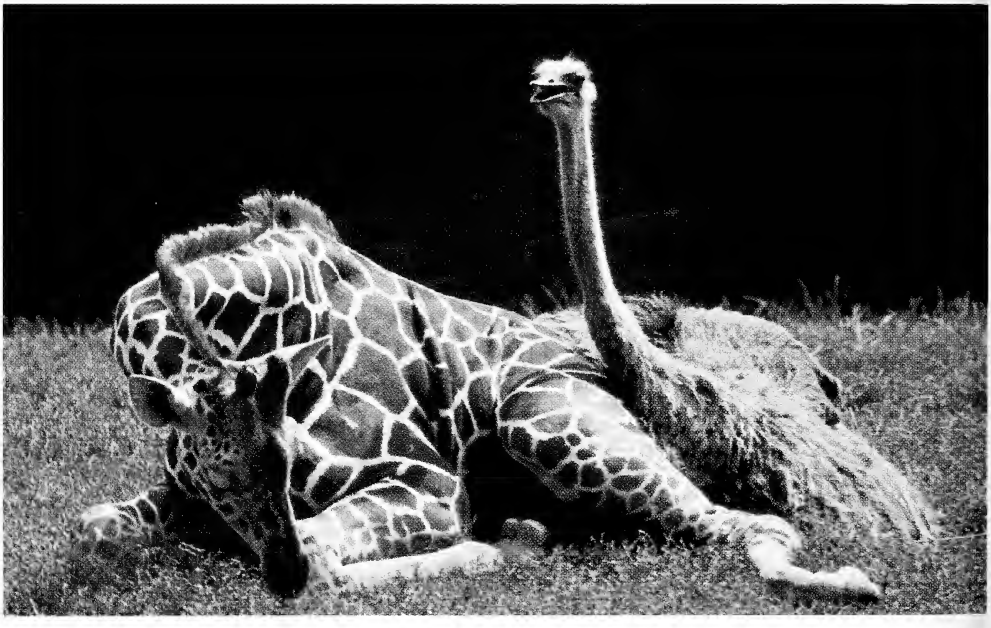


Figure 1: Giraffe and ostrich enjoying their multi-species exhibit together.
*Photo by Antelope Area keepers*

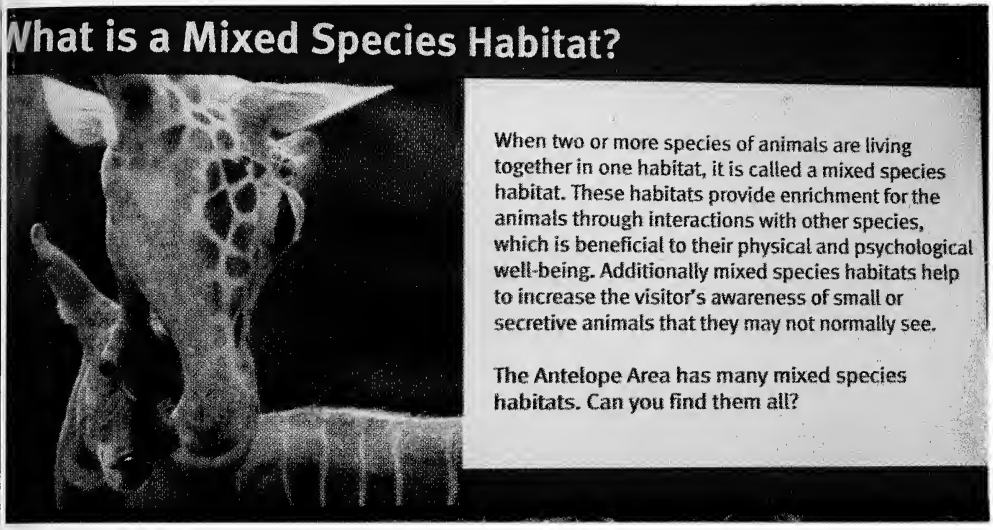



Figure 2: Graphics help complement a multi-species exhibit. *Photo by Kim Downey*

servicing habitats, conducting training sessions, giving keeper chats, or checking on our animals. During these times we can hear visitors commenting on the fact that there are birds in the same habitat as the ungulates. Many times questions are directed our way about the reasoning behind this, which serves as a perfect opening for education. We also have graphics located in front of our multi-species habitats to serve as an additional resource for information (Figure 2).

A third benefit of bird/ungulate multi-species habitats is a more stimulating work environment for keepers. Our problem-solving skills are regularly put to the test when figuring out the challenges of shifting, feeding, training, and enriching both birds and ungulates. We are required to not only know how an ungulate may react in any given situation, but also how a bird might react in the same situation. If you have worked with birds and ungulates, you know that those reactions can be quite different! Training and enrichment questions have sometimes led us to seek advice from keepers in the bird department which has given us fresh ideas and new perspectives. By learning the natural histories of the birds in our care we have expanded our bank of animal knowledge.

While the benefits of a bird/ungulate multi-species habitat do outweigh the challenges, there certainly are some challenges to consider. The first relates directly to the husbandry of the animals in the habitat. The birds and ungulates in our care receive different diets, which led us to develop different feeding strategies. If the ungulates in the habitat are secured into a holding area at night, we can simply offer the birds their diets in the evenings. However, some of our ungulates have access to the habitat (and therefore the birds' diets) at night as well. In those situations we have been able to create areas that birds can access but ungulates cannot, allowing us to feed both groups of animals at the same time. In the same manner, any enrichment items offered must be approved for all species in the habitat if they can all access them. Otherwise, species-specific enrichment items are offered when the birds and ungulates are separated.

In addition to feeding and enrichment, shifting animals can be a challenge. One of our popular multi-species habitats includes saddle-billed storks (*Ephippiorhynchus senegalensis*) and lesser kudu (*Tragelaphus imberbis*) (Figure 3). Due to his aggressive tendencies towards keepers, we do not share space with our male saddle-billed stork. Therefore, we must shift him into a holding area before servicing the habitat or walking the lesser kudu inside. After several brainstorming sessions and trying a few options, we were able to devise a training plan that accomplished this task. We now use clicker training, with his diet of fish and mice as a reward, to ask him to voluntarily walk into a

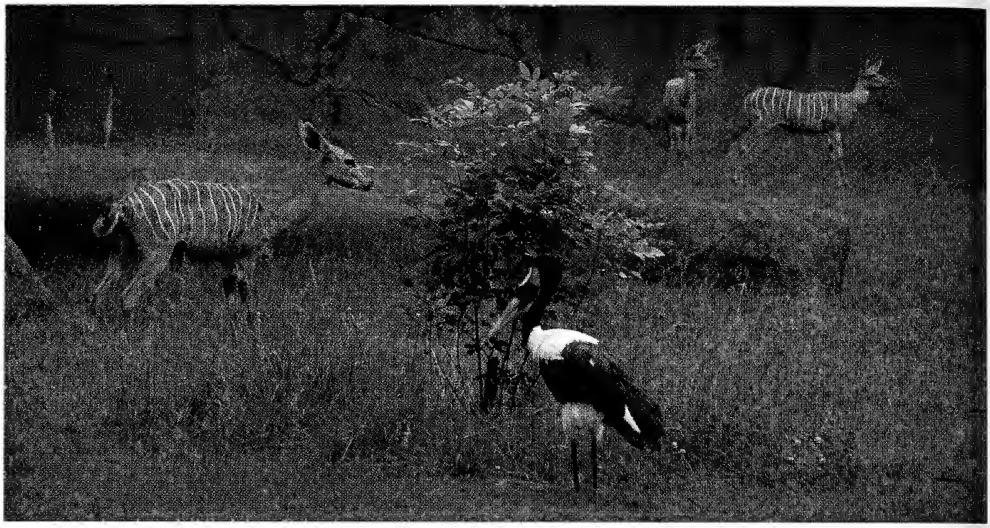


Figure 3:Saddlebilled storks and lesser kudu create an exciting mixed-species exhibit at the Saint Louis Zoo. *Photo by Antelope Area keepers*

holding corral. Shifting is also an especially important aspect should an emergency arise. If you need to quickly examine a bird but do not share space with the ungulate in the habitat, will the ungulate shift into a holding area reliably? At the Saint Louis Zoo, our animals are positively reinforced for shifting (typically with a food reward) and the sound of the door opening acts as a cue for the animals to shift. Over time we have seen our ungulates shift more quickly and reliably than before.

Potential aggression issues are another factor to consider when working with multi-species habitats. These can include negative ungulate-bird interactions as well as antagonistic behavior by birds or ungulates towards their human caretakers. At the Saint Louis Zoo, we have experienced both situations. We currently house 1.1 wattled cranes (*Bugeranus carunculatus*) with 1.4 addra gazelles (*Nanger dama ruficollis*) and have seen the birds act in a negative manner towards the ungulates when shifting the gazelles into the habitat in the morning. We have implemented several solutions to this challenge including distracting the birds, not allowing the birds into a smaller space with the gazelles, and using an extra keeper to keep the birds away from the doorway while another keeper shifts the gazelles outside. In some situations where we have experienced bird-human aggression, we have found that it helps to take two keepers into the habitat. One keeper can watch the bird while the other services the habitat or focuses on the ungulates. This worked well for managing an aggressive male marabou stork (*Leptoptilos crumeniferus*) housed with 1.0 lesser kudu and 1.0 gerenuk (*Litocranuis walleri)*. The gerenuk and lesser kudu had to be walked into their holding area at night, and the stork was very focused on the keeper during this procedure. Having a second person in the habitat allowed one keeper to focus solely on the bird while the other walked the ungulates inside. While it may seem more time-consuming at first to use two keepers, it quickly becomes routine. In some other situations where we see negative interactions between the bird and its keeper, we have been able to shift the bird into a holding area while the keeper completes the necessary work.

While there are some challenges to consider, the benefits of bird/ungulate multi-species habitats are worth a little extra time and effort. These include benefits to the animals, the staff, and the visitors. Overall, my experience in the past four years with bird/ungulate multi-species exhibits has been overwhelmingly positive and I would definitely recommend adding them to your collection.

# Where the Deer and the Antelope (and the Birds!) Play: Setting your bird/hoofstock multi-species habitats up for success

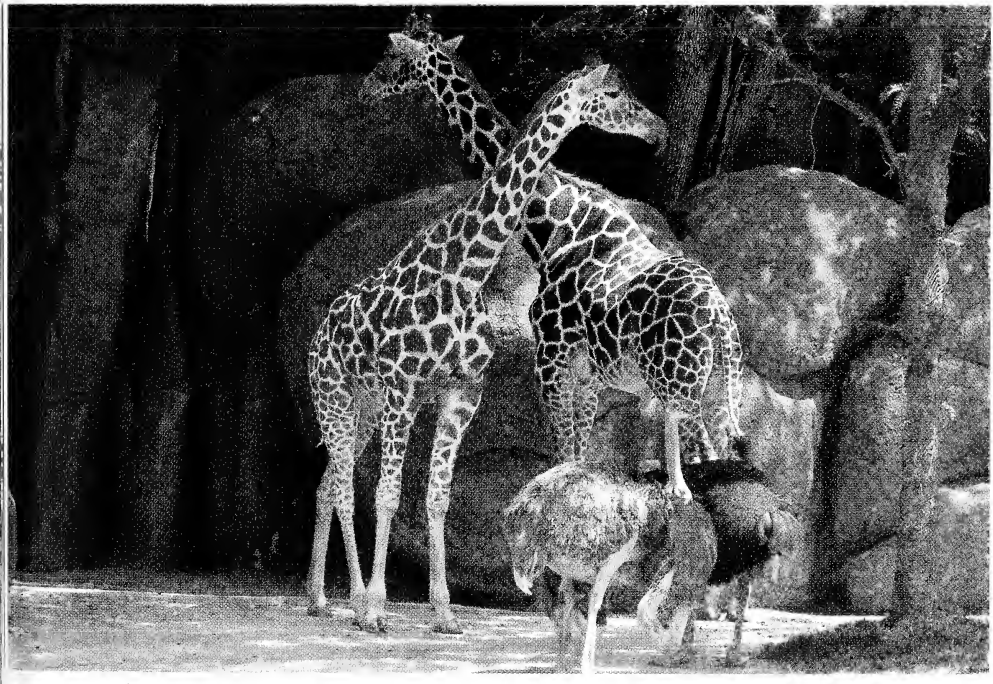
*Martha Fischer, Curator of Mammals*
*Saint Louis Zoo*
*Chair, AZA Antelope and Giraffe TAG*
*Saint Louis Zoo*

*(First presented as a PowerPoint at the 2012 AZA Midyear Workshop in Palm Springs, CA during the AZA ASAG/Ungulate TAGs joint workshop on management of bird/hoofstock multi-species habitats, Herds of a Feather Flock Together).*

So, I hear you're toying with the idea of trying a bird/ungulate multi-species habitat at your zoo? Congratulations! The benefits of multi-taxa habitats are numerous. Before you get started, though, there are many things to consider in order to set yourself, your team, and most importantly, your multi-species habitat up for success.

**Teamwork**

Starting a new multi-taxa habitat is an excellent opportunity for bird and ungulate care teams to work together. It is important that both groups are involved in the development and implementation of this new habitat to benefit from the taxa-focused expertise of both groups, and also benefit from the new, fresh perspectives that can be gained by asking your teams to think outside of their taxa-focused box. When managing a habitat as a team, it is important to figure out early-on what will be expected of both teams throughout the process of developing the multi-taxa habitat and eventually maintaining the habitat once it is established. Communication and flexibility are key to the long-term success of any team-managed multi-taxa habitat.



Giraffe and ostrich are commonly exhibited together in mixed-species habitats.
*Photo courtesy of the Saint Louis Zoo*

A Saddlebilled stork and lesser kudu at the Saint Louis Zoo. *Photo by Chuck Dresner*

**Do your homework!**
It is important to do your homework when thinking about establishing a new bird/ungulate multi-species habitat. Fortunately, a lot of zoos have experience with multi-taxa habitats, and there is a wealth of information available on this topic. Spend time talking with colleagues about what has worked and, just as importantly, what hasn't. Review the available resources on this topic, such as the AZA Antelope and Giraffe TAG Mixed Species Resource Manual. Attend bird and ungulate TAG meetings to find out which species are available, which species are good candidates for sharing space with other taxa and which SSPs are in need of additional space and support.

**Facility evaluation**
Not every outdoor habitat will be appropriate for mixing ungulates and birds. Depending on the species you are hoping to manage together, you will need to closely evaluate the outdoor facilities to be certain that they will contain the species of birds and ungulates you are hoping to manage together and will be safe for all of the animals involved. This close evaluation may illuminate the need for modifications to accommodate all species, such as a higher containment barrier, a bird-only feeding area, additional shade structures, etc. Additionally, any indoor holding spaces that might be used to support this multi-taxa habitat should be evaluated for both birds and ungulates, as well.

**Seasonal needs**
Seasonal needs for all species should be considered and, as needed, modifications should be made to make sure all animals' needs are met all year-round. Are there enough weather shelters available in the habitat for all individuals, both ungulates and birds, to escape the sun, wind, rain and snow? If you are hoping that your ungulates and/or birds will reproduce, do the facilities allow for this to occur in a manner that optimizes reproduction and rearing of young without disturbance from the other taxa sharing the habitat and without disturbance from your keepers maintaining the habitat?

**Daily routine**
As you are doing your homework early-on, you should think through the daily routine for all of the habitat's residents and decide how all of the animal care and habitat maintenance duties will

be performed each day. This is also a good time to consider which duties will fall to which keeper team – and split the animal care and habitat maintenance tasks between the bird department and the ungulate department in a way that works well for everyone.

**Proper training**

Anytime a new exhibit is initiated, it is important to provide adequate animal care and management training to your teams. If you are adding a new bird species to an ungulate habitat, it is important to familiarize your ungulate team with that species so that they can make sure they have the correct tools and skills to care for the species. On the flipside, if you are acquiring a new ungulate species for a bird habitat, it is important that your bird team be familiar with that species so that they can make sure they are prepared to manage that species appropriately. Cross-training on bird behavior and/or ungulate behavior is essential to make sure that the keepers who are responsible for managing a bird/ungulate habitat are knowledgeable about both taxa.

**Tools of the trade**

If you are adding birds to your ungulate area for the first time, it will be necessary to stock up on bird care equipment such as nets, appropriately-sized crates, gloves and safety glasses if those tools are not already present in the area. Additionally, specific tools for bird care, such as tools to trim wings, beaks, and nails should be available.

**Guidelines**

To be certain that all animals in a multi-taxa habitat – both birds and ungulates – receive the care they need and deserve, it is important to provide guidelines for their care up front. Be sure to provide guidelines not only for the basic day-to-day care that they receive, but also provide guidelines for enrichment and training, manual restraint and temperature that have been discussed and agreed upon by all involved in the team management of the bird/ungulate habitat.

**Looking ahead**

A certain amount of proactive management is required for managing birds and ungulates together in the same habitat. If the habitats are open, as many are, and if the birds are full-winged, a protocol and schedule for wing-trimming will need to be decided upon. Additionally, routine weighing and deworming will need to be scheduled to monitor the birds' health throughout the year. It is important to discuss not only when these procedures will occur each year, but also which team will be responsible for scheduling and performing them.

**What if...**

If all of the above steps have been methodically followed, then most of the time the bird/ungulate habitat will work well. However, what if it doesn't? If you attempt enough bird/ungulate combinations, at some point there will be a species:species mix that doesn't work or an individual bird or an individual ungulate that turns out to be a poor candidate for sharing space with others. It may be that the habitat that you thought would work perfectly doesn't actually work well for managing birds and ungulates together. Though you cannot predict the future and know what will and won't work, you can give this a bit of thought in advance and have a plan on the back burner just in case something doesn't work out.

**Herds of a feather**

Whether your first love is ungulates or birds, we are all facing similar challenges when it comes to maintaining sustainable populations and developing exhibits that our visitors will enjoy. Ungulate/bird multi-species habitats aren't the answer for every ungulate and bird species, but with good planning and teamwork, it can be a good option for many species. By working together and managing our birds and ungulates in shared spaces, we can maximize the use of our limited zoo space. By being flexible and communicating frequently, bird and ungulate teams will find that managing bird/ungulate multi-species habitats can be a hugely rewarding answer to some of the challenges that both taxa are facing in zoos today.

# Benefits of Ungulate/Bird Multi-Species Habitats

*Martha Fischer, Curator of Mammals*
*Saint Louis Zoo*
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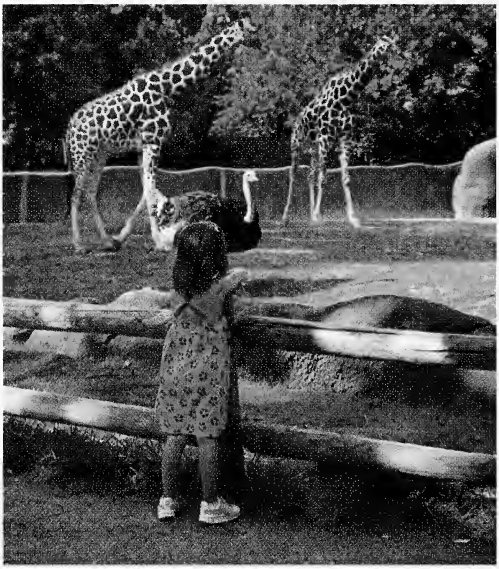
*(First presented as a PowerPoint at the 2012 AZA Midyear Workshop in Palm Springs, CA during the AZA ASAG/Ungulate TAGs joint workshop on management of bird/hoofstock multi-species habitats, Herds of a Feather Flock Together).*

Whether their focus is ungulates or birds, curators, managers and keepers of these taxa face similar challenges when it comes to maintaining sustainable populations for the future and creating dynamic exhibits for zoo visitors. Though ungulate/bird multi-species habitats are not appropriate for all ungulate and bird species, there are many species for which this style of management is an option. And, when this style of management is an option, there can be many benefits to caring for ungulates and birds in shared habitat space.

**Maximizing limited space to create more room for our managed programs**

If you ask any AZA Species Survival Plan® (SSP) coordinator what they most wish for, he/she will probably tell you "More space!" – and this will be true whether you are talking to an ungulate or a bird program leader. It is a fact that in order to sustain zoo populations long-term, SSPs often need to maintain a large number of animals and, as a result, it is not uncommon for an SSP to have more animals than it has available spaces. It is also a fact that AZA's animal programs compete for zoos' limited space.

Whenever possible, it is critical that we optimize the use of the limited space that is available to us, and for some species, creating multi-species ungulate/bird habitats is one good way of doing so. If we can care for multiple species and/or multiple taxa in single exhibits, it will make better use of the limited space that we have available to us. Even if only a few additional spaces are gained, those few spaces can be tremendously helpful to an SSP coordinator who is trying to accommodate all of the needs of his/her managed program.

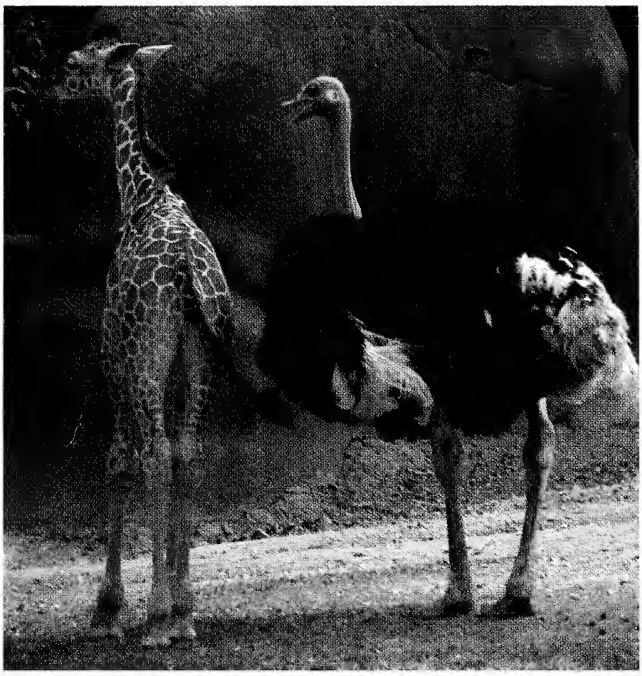


Young zoo visitor enjoying giraffes and ostrich.
*Photo courtesy of St. Louis Zoo*

**Increasing activity, visibility, diversity and beauty within our habitats**

Every keeper knows that our animals enjoy moving about in the cool morning hours and they are active again when the cooler evening temperatures arrive, but when the sun is high, they all have a tendency to move around less, rest in the shade and wait out the hot part of the day, and who can blame them? This is a great schedule for the animals - - however for the large number of visitors that enjoy our zoo during the middle part of the day, it is not so great if all they see are resting ungulates and birds. By showcasing more than one species in each habitat, the chances that our visitors will see an active and interesting habitat are automatically higher.

Some of the ungulate species in our zoos, like the large and vibrantly-colored giraffe, zebra and bongo, do not have to do much of anything to catch the attention of our visitors. On the other hand, some of our ungulate species are shy and not-so-flashy, and in fact some might even describe them as drab. These species are secretive and neutrally-colored specifically to camouflage them so they are *not* easily seen. The timid and the brown need conservation attention and space in our zoos too, so they definitely have a place in our collections, but let's be honest – sometimes these less-than-flashy ungulates are overlooked by our visitors. There is no doubt that adding birds to the habitats with our ungulate species adds beauty to that habitat. It is often the tall, colorful bird that first captures our visitors' attention as they pass a shared ungulate/bird habitat.



Giraffe and ostrich providing excitement at the Saint Louis Zoo. *Photo by Chuck Dresner*

And this works both ways – some of our visitors favor the mammals over the other taxa and might not typically enjoy visiting bird exhibits. By presenting ungulates and birds together, we are encouraging our visitors to appreciate all of the taxa represented in our collections.

The bottom line is – no matter whether their first preference is mammals or birds, if we can get the visitors to linger in front of our habitats, even if just a tiny bit longer, we have greatly increased the chance that they will notice and appreciate *both* the feathered and the hooved species in the habitat.

**Enhancing visitor learning**

Educational services are an integral part of every zoo's commitment to conservation. Zoos offer engaging programs, exhibits and materials to educate our communities about wildlife, help visitors feel more connected to animals, and motivate them to take action to preserve the natural world.

To that end, increasing the number of habitats that tell stories about whole bio-communities rather than of a single featured resident is beneficial to visitor learning. Since all living organisms exist in communities made up of different plants and animals, modern zoo professionals are increasingly combining species to create a more realistic, natural experience for their animals and, in turn, a more exciting one for zoo visitors. Visitors that are more engaged by active, beautiful animals will spend more time enjoying a habitat, and thus will learn more from observing multi-taxa interactions.

**Encouraging natural behaviors and social interactions**

As previously noted, multi-species ungulate/bird habitats can enhance program sustainability and enhance our habitats for the visitors. It is also important to note that this style of management can enhance the welfare of our animals. Ungulates and birds share the same habitats and interact on a regular basis in nature, and so it makes sense that some of our ungulate and bird species should

be able to share space in our zoos, too. When given the option of sharing space with other taxa, our animals are provided with enrichment through species interactions that would not be present otherwise if the species were managed separately.

**Management similarities between ungulates and large birds**

When managing multi-taxa habitats, animal care teams must be very diverse in their skill sets as they may be charged with managing exhibits that may include mammals, birds, reptiles and plant life. Ungulate keepers already possess some of the specialized skills required to care for larger birds like cranes, storks and ratites, such as patience, calm demeanor and manual restraint experience. For those important bird-care skills that your ungulate keepers may not yet possess, ungulate/bird habitats offer an opportunity to cross-train ungulate keepers and include bird care into their repertoire of keeper skills. Additionally, ungulate keepers can learn other key skills from the bird experts at their zoo through ungulate/bird department team management of multi-taxa habitats.

In closing, though multi-species habitats are not the answer for every ungulate species and every bird species cared for in our zoos, it is an option to consider for many of our species to enhance population sustainability, visitor experience, education, animal welfare and professional development. This type of management system should be considered when developing your zoo's collection plan.

Mhorr gazelle (*Nanger dama mhorr*) and wattled crane (*Bugeranus carunculatus*).
*Photo by Chuck Dresner*

# Ten Things Those Large Birds Walking Around with Your Hoofstock Want You to Know About Them

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Southern ground hornbills (*Bucorvus leadbeateri*).
*Photo by Roger Sweeney*

*(First presented as a powerpoint at the 2012 AZA midyear meeting in Palm Springs during the ASAG/Ungulate TAG joint workshop on management of birds/hoofstock mixed exhibits).*

**Introduction**

Mixed-species exhibits are popular with both zoo visitors and collection managers for many reasons; they can provide dynamic, visually interesting exhibits that can effectively illustrate biodiversity themes, they can often increase the activity level of animals in the exhibit and provide a stimulating environment for the inhabitants that is ever-changing; and perhaps most importantly for collection managers, they can maximize the effective use of exhibit space, which works towards trying to resolve one of our greatest modern day challenges. How can we provide enough housing space to maintain our SSP populations sustainably?

**Words of caution**

While the benefits of mixed-species exhibits are clear, we must also add some words of caution in regards to potential risks that need to be considered and managed. In addition to the obvious questions about exhibit aesthetics, and the practicality of exhibit and livestock management considerations; from the avian management point-of-view we should ask ourselves the following questions when considering a new mixed-species exhibit proposal.

***Is this creating additional space that will improve SSP populations?*** Many of our SSP species are in need of enlarging their current population size. Creating new holding space by inclusion of birds into mixed exhibits can be a benefit to many avian populations, but we should ensure that this represents new opportunity rather than diminishing value of current resources.

***Are the individual animals involved well-represented in their populations?*** In any population there is variation among individuals in regards to mean kinship value; as well as a need sometimes to

manage a gender-bias or unbalanced age classes effectively. Individual animals considered of high value for demographic stability of the population with low mean kinship should probably be assigned accommodation space to maximize potential for breeding, but there are often animals in a population where housing in a mixed-species exhibit would have benefits to managing the population.

***Have birds been considered in the exhibit design?*** Whether birds are being introduced to a hoofstock yard, or whether hoofstock are being added to a bird enclosure, a collection manager should ask themselves whether the requirements of each new species have been covered in the original design of the exhibit. If not, then they should be taken into account with adaptive management prior to an intended introduction.

***Is the introduction process well-planned?*** As will be discussed in this article and throughout this special edition of *AKF*, careful preparation for introductions makes a huge difference in successful mixed exhibits. A carefully planned introduction process builds confidence in the staff team and ensures a greater chance of success.

***Is there a contingency plan?*** Knowing in advance the "when, where, who & how" of how to step in when things don't go well not only builds staff confidence towards managing mixed-species exhibits, but also ensures that when an intervention is required, that intervention can be swift and effective to ensure safety for both animals and staff. A good contingency plan not only plans for intervention and separation options, but also considers potential future needs for husbandry & medical resources, holding space and future collection planning options for any animals which may be separated and designated as not suitable for the mixed exhibit situation.

***Are all the staff members involved supportive and understand the plan?*** The best prepared plans are only as effective as how well they are communicated to all concerned. The level of consensus and confidence within the staff team is critical to successful implementation.

***Has the behavior and welfare of all species been considered?*** A simple question, but one which needs to be asked, at all stages of the process, for each species included into a mixed-species exhibit system.

Having considered these points, let's return to trying to think of ten things those birds would like you to know about them if you have not worked with large birds in mixed exhibit situations before.

**1) Size doesn't always matter**

While there is an obvious correlation between larger, stronger birds being better-suited to living with large ungulates; this is not always true. Some large birds are just sensitive, nervous or more accident prone when it comes to mixed-species exhibits. Bird species that are most successful are usually either regarded as being 'tough' and able to easily stand up for themselves (i.e. large vultures, large storks, ground hornbills etc.), or being agile and very mobile with an ability to easily move out of the way quickly (such as cranes, etc.). There are some species however that may look large and robust, such as kori bustards (*Ardeotis kori*), which in fact are quite sensitive and delicate. So always check in with the program leader about the suitability for mixed exhibits if it is an SSP program, otherwise contacting the TAG chair or posting a question on the one of the AZA listserv groups is always a good idea.

**2) Landscape for success**

Careful planning of the exhibit landscape before introductions can make a big difference in how successful birds will fit into a mixed-species community, as well as making husbandry management routines for the staff much easier. Start by considering the species of birds you intend to include in the mixed exhibit and think about how to landscape for areas that allow for retreat from larger animals and provide separation distance if they need it. This is important not just to provide a retreat from actual aggression, but also to help create increased comfort and confidence in some species. Retreat

areas can be created by using different types of fencing, tree trunks, large branches, large rocks or even hot wire depending upon the types of animals that are planned to pass through or be excluded from a particular area. There are many successful examples of good techniques that can be seen in zoos so be sure to reach out to colleagues for ideas if needed.

Next, consider the courtship display and nesting behavior of the bird species you want to include in a mixed-species community; what are their space and environmental needs for courtship display, mating and nesting locations. In many cases the same type of landscaping that creates exclusion opportunities can also include areas for nest sites as well. Also consider that you may need an excluded location where nesting material can be provided for the birds to use for nest-building without ungulates passing through and consuming nesting materials such as cut branches as browse.

Finally, consider that not only bird nesting material may be attractive for mammals to investigate, many ungulates find pelleted bird food to be extremely tasty. Exclusion feeders should be designed into the landscape to allow birds to access the correct type of food for them in areas where mammals cannot block access. Also, the location of these exclusion feeders should provide easy & safe access for staff to reach. In any situation where multiple animals are housed together, the ability to closely monitor food and body weight is important, but in more diverse mixed-species communities it is essential to try and keep species eating the correct diet and monitor food supply closely.

**3) Behavioral quirks**

It is often said that the greater the knowledge a keeper has of the behavior for the species that they work with, then the greater the level of successful management that can be achieved. Zoo keepers develop specialist knowledge of the species they work most closely with, so being confronted with the husbandry management of a mixed bird/hoofstock exhibit for the first time can require a new learning curve with very different sets of animal behavior for new species.

Conversations with bird keepers can often provide a solid background for general bird behavior, but it is always worth exploring species-specific information once you know what bird species may be added to your exhibit. Many species of birds can have unique behavior, which can be easily misunderstood until experience is gained. Ground hornbills are fascinating birds and provide a great example. Unlike other hornbill species, ground hornbills do not practice nest sanitation and instead the male will regularly bring fresh nesting substrate while the female occupies the nest. This behavior is often extended to the male frequently carrying around a beak full of leaves, sticks or even clumps of soil; for some birds this could be viewed as a risk for foreign object ingestion, but for male ground hornbills this is normal behavior. Also the displaying, passing or withholding of food items between male ground hornbills and their mate (or family members), are behaviors that form a central part of the social organization for these species; but this behavior can also be misread. I have heard from keepers intending to separate ground hornbills because of concern that the male was stressed in the presence of the female; his behavior was described as constantly running along the exhibit fence line to get away from the female and that he would appear to snatch food items and just run away, holding them in his beak for a long time rather than eat. It is more likely that the male was displaying the food item and walking the boundary lines of his exhibit to maintain his social position but it is easy to see how such species-specific behaviors can be misunderstood.

**4) Social system implications**

Social systems can matter just as much in birds as they do for mammal species. While a majority of bird species live and will breed as a conventional monogamous pairing; for some bird species social requirements such as group size, polygamy mating systems and even cooperative breeding systems will need to be considered in order to successfully manage them to their display and breeding potential.

When looking to add a bird species to a mixed exhibit to provide variety, activity and color; some of the most attractive species that might come to mind sometimes include species such as flamingos or scarlet ibis (*Eudocimus ruber).* If the exhibit does have a pond area then this might be an attractive

option, which can be seen in many of our zoos. But it is important to consider what size of social group these birds will be happy and comfortable living in, and avoid the temptation to only add a few of these colorful birds to 'accent' the exhibit display. During the 2012 ASAG workshop on maximizing red & yellow SSP bird programs held at the AZA midyear meeting in Palm Springs, scarlet ibis were highlighted as a species where we should avoid the temptation to keep a few birds just to enhance display; we should remember the colonial social system of these birds and always try to keep them in sufficient group size to allow natural behaviors and social systems to be maintained.

For species that do not use a monogamous mating system, we should consider adapting holding space and plan both the number and gender of birds to be held to allow for lek courtship opportunities where possible. While for species that naturally live in an extended family cooperative breeding system, such as the southern ground hornbill (*Bucorvus leadbeateri*), we should plan for any offspring produced to potentially remain with the parents for several years to act as nest helpers.

**5) Training: A universal language**

One of the best opportunities that curators and collection managers have to generate increased staff enthusiasm and consensus for venturing into mixed-species exhibits, are the animal training opportunities that these situations create. Training is a universal language for modern day zoo keepers; whatever types of animals most interest you, training methodology is pretty consistent and applicable. Zoo keepers who start working in mixed ungulate/bird exhibits for the first time not only face new challenges, but also great opportunities for professional development and to increase their training skills in new directions.

Training programs for birds to be introduced into a mixed-species exhibit not only provide a new challenge for staff to enhance their training skills with, but the training done can dramatically improve the chances of successful introductions, the safety of all animals involved and the staff. This will also increase the confidence levels for staff who are charged with managing this new project. Even training very simple behaviors like shifting, stationing, and targeting dramatically increase the ability to manage these birds at time when direct access is limited by the presence of other larger species.

**6) Enrichment challenges**

Enrichment strategies and approval processes are often written at an individual species level. When managing a mixed-species exhibit the affect of enrichment strategies between different species needs to be more carefully considered. Mixing birds and ungulates species, which can each access the enrichment designed for other species, requires a good level of specialist knowledge of all species involved in order to assess safety implications of different enrichment offered in a shared communal space. By knowing as much as we can about the behavior and activity patterns of all the different species housed in the mixed exhibit, we can then consider strategies for the location, placement, sequencing and timing of when certain enrichment is provided so that we can manage risk to the greatest degree possible.

**7) Crazy things that birds eat**

Certain foreign objects seem to draw the attraction of many animals, regardless of species and are obvious hazards; but it is also true that certain species can be more problematic for foreign body ingestion than others. One aspect of mixed-species exhibits is that in addition to mixing species into situations where they might encounter objects and enrichment that is unfamiliar to them, often mixed exhibits can bring certain species into closer proximity of the public where foreign objects can be dropped or even thrown into contact distance.

Among bird species that will eat the most unexpected of things, the kori bustard deserves special mention. These large, robust birds look as though they would fit very well in a mixed exhibit, but few other avian species have accumulated such a unique inventory of records of unexpected objects ingested. Included in that list of strange objects that have been ingested by kori bustards include an adult T-shirt knotted five times and swallowed completely until the bird was blocked up; a full length

pencil, a children's plastic happy meal toy, bottle caps and plastic bags. It can also be common for them to eat rocks until they become blocked too.

Think ahead and plan for how diets can be separated for the different species in the exhibit. Use exclusion feeders to make sure birds with specialized diets are able to access their food without competition and to minimize any cross-contamination issues. Carefully review what food is used to provide any foraging activity to ensure that it is safe for all species in the exhibit and is not likely to put the diet of any specialist feeders out of balance.

**8) Changes to exhibit routines**

When birds are being added to an established ungulate exhibit, a good first step would be to review the exhibit perimeter, as birds are often more vulnerable to predation risks such as foxes and raccoons, compared to ungulates. Fence lines and gates should be checked for gaps and any trees or plants adjacent to the exhibit boundaries should be assessed as to whether they might facilitate predator entry.

Feeding times and locations will have to be considered for each species in the mixed exhibit to closely manage 'who is eating what'. The use of exclusion areas, exclusion feeders and sequencing the times of feeding may all play a part in keeping the right animal eating the right diet in a mixed-species community.

Planning the location and shifting sequencing of animals from exhibit to holding areas can play a huge part in determining how successful the mixed exhibit will be. In an ideal situation, birds and ungulates will have holding facilities in different locations so that when they shift, they go in different directions, therefore reducing the risks of collision or trauma from birds & ungulates funneling into the same direction. Remember to ensure that different cues are used for different species to prevent confusion and allow for more effective sequencing of how animals are shifted. Finally, the amount and quality of behavior training that can be undertaken early in the process can play a part in how successfully the birds can be routinely shifted and recalled, if needed to be moved to a safe area if problems arise.

**9) Setting up for success**

There are many things that we can do in advance to increase our chances of success with managing mixed bird/ungulate exhibits. Careful landscaping and allowing areas for retreat and exclusion have already been mentioned, as have the benefits for establishing shifting systems and recall training to allow different species to be recalled to different locations, without confusion of cues and/or competition for access passageways. But what else can be done?

Choose birds with the greatest chance of success! In addition to working with a program leader to ensure that the individual birds you plan to add to a mixed exhibit do not have very high demographic or genetic value, also consider what additional factors might contribute to your success when selecting birds. Would the age, rearing type, gender ratio, past social experience or past training history make a difference to your chances for success?

Be sure to work through contingency planning in advance so that if things do not go as planned you already have a 'plan B' ready to be implemented; it also doesn't do any harm to also have a plan C, D and even E thought of in advance if you are dealing with a particularly large mixed exhibit. Try to think through all the different complications that might occur and how you could change the environment as required to counter these, and always plan ahead about different ways to recall, separate or retrieve each of the different species if aggression should emerge as a problem.

It is really important to ensure all members of the keeping staff team have good communication and are all fully aware of the introductions processes that are being followed and are all fully aware of the contingency plans to be implemented if a problem occurs. Some mixed exhibits can be controversial so it is important that all members of the staff team reach a consensus that they are comfortable with

the safety levels of the plan being followed; involving everyone in contingency planning in advance is a great way to build consensus and the comfort level of all that a well-thought plan will safely be followed.

As mentioned earlier, planning the exhibit landscape to allow for the needs of each species in regards to display, breeding, retreat and separation is very important and helps to build in increased options for problem solving and managing any inter-species problems that may arise. Remember to consider keeper access if animals need to be separated or recaptured and recall shifting is not possible.

When possible, start training of basic behavior such as stationing and targeting in advance of the birds actually arriving to the new exhibit area. Obviously some situation-dependent behaviors like shifting have to be trained using the actual exhibit and holding facilities, but ensuring that the birds are already responsive to some basics like targeting will allow for a quicker transition into their new accommodation.

Once the exhibit space and access to holding facilities have been set up as well as possible, start the introductions process as carefully as possible; introductions should be conducted at a time when there is sufficient staff presence to control and observe the process to be as safe as possible. Allow limited visual and auditory access between animals before full contact introductions take place. Many animals are naturally curious and allowing new inhabitants to be introduced in an exclosure area, where current inhabitants can get close enough to look, smell, listen and become comfortable with new animals they have not seen before can often remove the risk of chasing and harassment once the full introduction takes place. Observation and record keeping should be a strong commitment, not only to provide initial safety support but to also start to establish behavior records from which developing behavioral trends may start to emerge and be monitored.

Always assess risk in advance, plan to manage risk through contingency planning, observe carefully to spot potential for problems developing, if problems do occur then try to problem-solve before giving up and no matter what the outcome try to quantify relative success against problems and look for opportunities to refine situational management for the future.

**10) Space: Our greatest limitation**

We need to remember that the majority of our animal populations (especially with bird and ungulate programs) will benefit from increased population size and more animal holding space. It is against this background that we should consider more opportunities for mixed-species exhibits as long as we carefully assess the increased costs against benefits. Less than perfect situations can still be considered if we take the time to assess risks and plan carefully with contingency plans for all conceivable events. Safety of all animals and staff should always be our first decision filter as we move through this process.

If things do not go smoothly we should try problem-solving before giving up. Different ideas to improve the chances of success should continue to be tried as long as this continues to fall within a well-prepared plan with proper contingency planning. Many behavior problems can be individual-specific, so sometimes it can be one individual animal that is not suitable for the mixed exhibit environment rather than a species. We need to be open-minded and try to achieve success while assessing actual progress at the individual animal, group, species and exhibit operational levels.

**Summary**

As a community we already have many successful examples of mixed exhibits containing birds and mammals in North American zoos. Given the challenges of population sustainability that both the avian and ungulate programs face, then practical opportunities to increase exhibit and holding space with mixed exhibits should be considered. It is essential however, to always plan in advance for all contingencies, and make sure that all staff members involved share good communication and are fully aware of all aspects of the plan. We should always remember that a mixed exhibit is only successful if it benefits the population objectives of each species that it houses.

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When considering a species like scarlet ibis for an exhibit, remember the colonial social system of these birds and always try to keep them in sufficient group size to allow natural behaviors and social systems to be maintained. ©*Shutterstock*

# Welfare of Ratites and Marabou Stork in Mixed Mammal/Bird Exhibits

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**Key words:** Emu, interspecific interactions, marabou stork, mixed-species exhibits, ostrich, rhea.

**Abstract**
Mixed or multi-species exhibits are increasingly popular and common in zoological parks. Many zoos have successfully mixed ratites and marabou stork (*Leptoptilos crumeniferus*) with various mammal species but there are also many anecdotal reports of poor welfare and excessive aggression in some exhibits.This project investigated the behaviour and space use of ratites and marabou stork housed with and without mammal species in various zoos to identify possible welfare effects of mixed-species exhibits and identify mammal/bird combinations that may be particularly suitable or unsuitable for mixing. The results show that mixed-species exhibits are very variable but not necessarily good or bad for ratite or stork welfare. Species, individuals and enclosure design impact on behaviour. In all cases, social interactions of all types are much more common between conspecifics than inter-species pairs and overall no more aggression was observed in mixed than in single-species exhibits. It appears that some of the most suitable combinations are rhea-deer and rhea-mara, as these species seem to actively form associations, whereas ostrich-giraffe was the least suitable combination, resulting in relatively high aggression and active avoidance.

**Introduction**
Mixed-species exhibits have a number of advantages, making them increasingly common in many zoos (Veasey and Hammer 2010). In addition to maximizing the use of available space, these include a more enriched environment for the animals, with increased interaction opportunities both directly (social interaction, active avoidance) and/or indirectly (sniffing at urine, faeces or other scents left by the other species) (Backhaus and Fradrich 1965; Baer 1998; Coe 2001; Coe 2004; Croke 1997; Richardson 1999). They can also be more stimulating and educational for visitors due to the potential to increase the amount of time at least one species is active and visible (Probst and Matschie 2008; Xanten 1992) and the opportunity to present naturally occurring sympatric species together (Baker 1992; Croke 1997; Harrison 1986) or to provide species to compare in terms of physical and behavioural adaptations (Muller 1975; Thomas and Maruska 1996). Additionally, mixed-species exhibits can be an invaluable resource for research (Freeman and Alcock 1973), allowing observation both of interactions between species and effects of inter-specific interactions on behaviour (Buchanan-Smith and Hardie 1997; Cave-brown 1986).

On the other hand, potential health and welfare problems associated with mixed exhibits include injuries as a result of interspecific aggression, transmission of disease between species, and nutritional issues if species have access to diets provided for others in the enclosure (Gupta et al. 2007; Lowenstine 1999; Mcaloose 2004; Wortman et al. 2002). Thus, it is important that the design of mixed-species exhibits and the selection of species reduce the risk of these potential health and welfare problems. One of the greatest concerns with mixed-species enclosures is negative interactions between species, but there are few quantitative studies into how frequent these are and what form they take. Ratites have been kept and bred with varying degrees of success in mixed-species enclosures (Rees 2011); ostrich (*Struthio camelus*) are often held in mixed-African savannah-style exhibits with species such as plains zebra (*Equus quagga*), giraffe (*Giraffa camelopardalis*) and various antelope,

emu (*Dromaius novaehollandiae*) are often exhibited with various types of Macropod and rhea (*Rhea sp.*) with various South American species such as capybara (*Hydrochoerus hydrochaeris*), mara (*Dolichotis sp.*) and giant anteater (*Myrmecophaga tridactyla*). Marabou stork are increasingly also housed in mixed-African savannah-style exhibits (King 1993) but seem to suffer high mortality rates possibly due to inter or intraspecific aggression, although there is little definitive evidence on the effects of hoofstock on marabou storks (Nogge and Pagel 2001).

This project investigated the behaviour and spacing of ratites and marabou stork housed with and without mammal species in various zoos to investigate possible welfare effects of mixed species and determine possible suitable and unsuitable combinations of species.

**Materials and Methods**

*Study sites and subjects*

A total of 60 ostrich (*Struthio camelus)*, rhea (*Rhea americana, Rhea pennata*), emu (*Dromaius novaehollandiae*) and marabou stork (*Leptoptilos crumeniferus*) were observed in 17 different enclosures in five UK zoos between May and July 2012 (Table 1). All ratites were observed in at least one single-species exhibit and one exhibit mixed with mammals. Due to time, visa and financial restrictions, no marabou stork/mammal mixed enclosures were available, so storks were only observed held as single-species or mixed with other birds. Observer effects were minimized by viewing only from public areas and during normal opening hours.

*Data collection*

Instantaneous scan sampling was used to note the behaviour and location of each study subject every 10 minutes for five hours per day (11:00-16:00) for two days per enclosure. Behaviour was classified using an ethogram developed during preliminary observations (Table 2). For location, each enclosure was divided into zones using the modified Spread of Participation Index method (Plowman, 2003). In addition, every 30 minutes for each study subject, the distance to the nearest individual of the same and each other species in the enclosure was noted. These were recorded in four categories: < 1 metre, 1- 5 metres, 5-10 metres and >10 metres.

In this study, aggression amongst rheas was particularly high, especially at feeding time. It is suggested that additional feeding stations might help alleviate the problem.

**Table 1:** Study subjects and enclosures observed in a comparison of behaviour of birds in single and mixed-species exhibits in UK zoos.

| Enclosure number | Zoo number | Study subjects | Mixed with | Brief Enclosure Description |
|---|---|---|---|---|
| 1 | 1 | 1 Emu | 5 Kangaroo | Large size, grass and dirt, shelter, bushes, tree, |
| 2 | 1 | 2 Marabou | - | Small size, grass and dirt, pond, shelter, bushes, tree |
| 3 | 1 | 2 Rhea | - | Small size, grass and dirt, shelter, bushes, tree, |
| 4 | 1 | 1 Emu | Mixed birds | Medium size, grass and dirt, pond, shelter, bushes, tree |
| 5 | 1 | 3 Ostrich | 3 Zebra | Large size, grass and dirt, shelter, bushes, tree, |
| 6 | 2 | 3 Ostrich | 12 Lechwe<br>1 Waterbuck<br>Mixed bird | Large size, grass and dirt, shelter, bushes, tree |
| 7 | 2 | 7 Rhea | 2 Tapir<br>10 Capybara<br>Mixed birds | Large size, grass and dirt, pond, shelter, bushes, tree |
| 8 | 3 | 9 Rhea | 3 Tapir<br>35 Mara<br>9 Alpaca<br>2 Agouti<br>6 Capybara<br>Mixed birds | Large size, grass and dirt, pond, shelter, bushes, tree |
| 9 | 3 | 8 Emu | - | Large size, grass and dirt, shelter, bushes, tree, |
| 10 | 3 | 4 Ostrich | 3 Giraffes<br>4 Zebras | Large size, grass and dirt, shelter |
| 11 | 4 | 2 Rhea | Mixed birds | Medium size, grass and dirt, shelter, bushes |
| 12 | 4 | 2 Rhea | Mixed birds | Medium size, grass and dirt, shelter, bushes, tree |
| 13 | 4 | 3 Rhea | 5 Muntjac deer<br>Mixed birds | Large size, grass and dirt, pond, shelter, bushes, tree, |
| 14 | 4 | 2 Emu | Mixed birds<br>2 Wallaby | Medium size, grass and dirt, pond, shelter, bushes, tree, |
| 15 | 4 | 2 Marabou | 1 Bird | Small size, grass and dirt, logs, shelter, bushes, tree |
| 16 | 5 | 6 Ostrich | - | Large size, grass and dirt, shelter, bushes, tree, |
| 17 | 5 | 3 Emu | 5 wallaby | Small size, grass and dirt, shelter, bushes, tree, |

**Table 2:** Ethogram used in scan sampling for ratite and marabou stork behaviour

| Welfare indicators | Definition |
|---|---|
| Activity related behaviours | |
| Waltzing | Twirl around, often until dizzy. Sick birds rarely twirl. |
| Sleep | The bird holding its neck raised or with the bird lying prone with its neck outstretched straight in front of it. |
| Thermoregulatory | Bird will open-mouth breath and open their wings, or bed down covering their legs with their wings. |
| Trembling | Resembles shivering. |
| Social behavior | |
| Threat | In a typical threatening posture, the bird will stand tall with tail erect, hissing, wings slightly open, and feathers puffed up, especially around the neck. |
| Vocalization | Bird makes a distress call and booming. A distress call, which is somewhat similar to that of a pigeon's prolonged throat call. Booming is a sound produced by mature males; serves to establish territorial boundaries, warn other birds |
| Submission | Run away from an aggressive bird or drop to the ground without defending itself. |
| Sexual behavior | |
| Clucking and fluttering | Rapidly opening and closing her beak, may flutter wings by dropping them low and forward, and vibrating in sequence. |
| Kanteling | The bird drops to his hocks, and fans both wings forward and backward while hitting his head on each side of his spine. |
| Abnormal behavior | |
| Feather-picking | A bird will aggressively peck feathers from the back and tail area of penmates. |
| Toe and face pecking | Excessive toe and face pecking |
| Behavioural stargazing | A bird will continually lift its head up and back to the extent that it eventually touches its spine. |
| Pica | The ingestion of faeces |
| Aggression | Bird will intensely pursue and attempt to kick another bird. |

*Ad libitum* sampling was used during the same time period to record all occurrences of inter-specific and intra-specific interactions. For all interactions, the type of interaction (Table 3), along with the direction of the interaction (initiator and responder species) and the type of response were recorded. Moving towards and away from other individuals was included as an interaction to calculate maintenance of proximity.

**Table 3:** Definitions of intraspecific and interspecific interactions.

| Interaction type | Definition |
|---|---|
| **Actor(s)** | |
| Threat display | Actor(s) engages in non-vocal aggressive behaviours toward member(s) of the other species. |
| Vocalization | Actor(s) makes a call. |
| Play | Actor(s) plays with member(s) of the other species or attempts to elicit play or attempts to join in intraspecific play. |
| Moving together | Individuals of both species travel in the same direction in close proximity (1m), include foraging or exploration behaviours. |
| Curious approach | Actors moves toward member(s) of other species at a slow pace and does not display any aggressive behaviour, but shows interest in other individual or initiates interaction. |
| Close proximately | Actor(s) moves to 1 metre of individual(s) of other species but shows no interest in interacting, and does not touch. |
| Unclear | An interaction occurs between two or more individuals of different species, but it is difficult to discern the type of interaction. |
| **Recipients** | |
| Vigilant-ignore | Recipient(s) appears aware of behaviour of the actor(s) but does not move from area. |
| Vocalization | Recipient(s) faces the actor(s) and makes a call. |
| Approach | Recipient(s) moves to 1 metre of actor(s) |
| Moving away | Recipient(s) retreats from actor(s) and the area they were previously occupying. Includes moving short distances away or leaving enclosure. |
| Segregate into species group | Members of the two species move toward their own species members to form a cluster. |
| Aggression | Recipient(s) behaves in an agonistic way toward the actor(s), moving into closer proximity and making threatening displays toward another individual. |
| No reaction | Recipient(s) does not respond to the behaviour of the actor(s), for example, does not look in direction of actor or respond in any way |

*Statistical analysis*

Prior to analysis, some behaviour categories were pooled leaving six categories that were subjected to analysis; locomotion (walking and running), foraging, feeding (including drinking), standing, threat and vocalisation, and others (preening, body shaking, wings expanding, leg scratching). Generalized linear mixed models (GLMMs) were performed for each behaviour category and each nearest neighbour distance category using species and exhibit type (mixed or single-species) as main factors. Zoo and enclosure number were included as covariates. Following the initial model non-significant covariates and factors were removed in a stepwise method from the model to leave a final model only including those variables that significantly affected the number of times the behaviour or distance category was observed.

The total number of aggressive, neutral and friendly interactions between all possible species-species combinations were counted. The expected number of such interactions for each species pair combination was calculated based on the total number of possible dyads of that combination

observed and assuming that interactions would happen evenly across dyads. Observed frequencies were compared with expected using chi-squared tests.

Frequency of each enclosure zone was used to calculate the Spread of Participation Index (SPI) (Plowman 2003) to determine the use of available space. Maintenance of proximity describes the extent to which proximity is due to the movements of one member of the dyad rather than the other. It was calculated for all possible species dyads using the following formula:

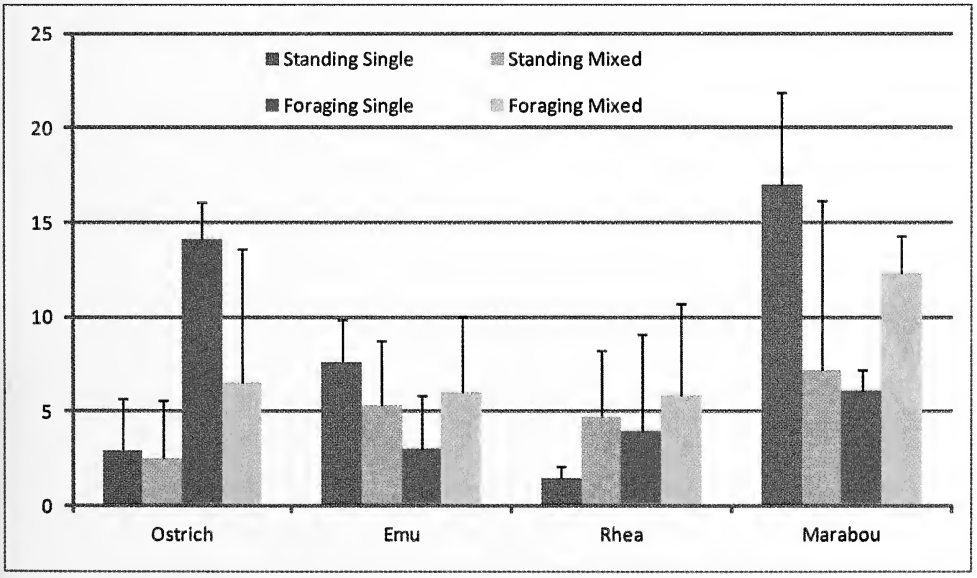
*Maintenance of proximity* = $U_A / (U_A + U_B) - S_A / (S_A + S_B)$

Where $U_A$ is the number of occasions when a pair were united by species A's movements; $U_B$ is a number of occasions when a pair were united by species B's movements; $S_A$ is the number of occasions when a pair were separated by species A's movements; and $S_B$ is the number of occasions when a pair were separated by species B's movements. The index ranges from -1.0 (B totally responsible for maintaining proximity) to + 1.0 (A totally responsible) (Martin and Bateson 1993).

**Results**

Bird species had a significant effect on the time spent performing all behaviour categories, except threat and resting. Overall, emus and rhea tend to move most and marabou stork least, whereas marabou tend to stand more than the other species and also perform more other behaviours. Emu and rhea tend to spend more time feeding and foraging. In addition, the covariates zoo and enclosure also had significant effects on most behaviour categories. However, despite the effects of these other variables it was possible to detect some overall effects of exhibit type (mixed or single-species) on behaviour. Exhibit type had a significant effect on the time spent standing ($x^2_{[1]} = 9.07$, $P = 0.003$) and foraging ($x^2_{[1]} = 7.23$, $P = 0.007$) by birds overall but no significant effect on locomotion ($P = 0.61$), threat ($P = 0.38$), feeding ($P = 0.55$), resting ($P = 0.62$) or others ($P = 0.95$). Generally birds in single species exhibits spent longer standing and more time foraging than birds in mixed exhibits (fig. 1).

**Figure 1:** Mean observation time spent standing and foraging by birds in single-species and mixed-species exhibits in five UK zoos.

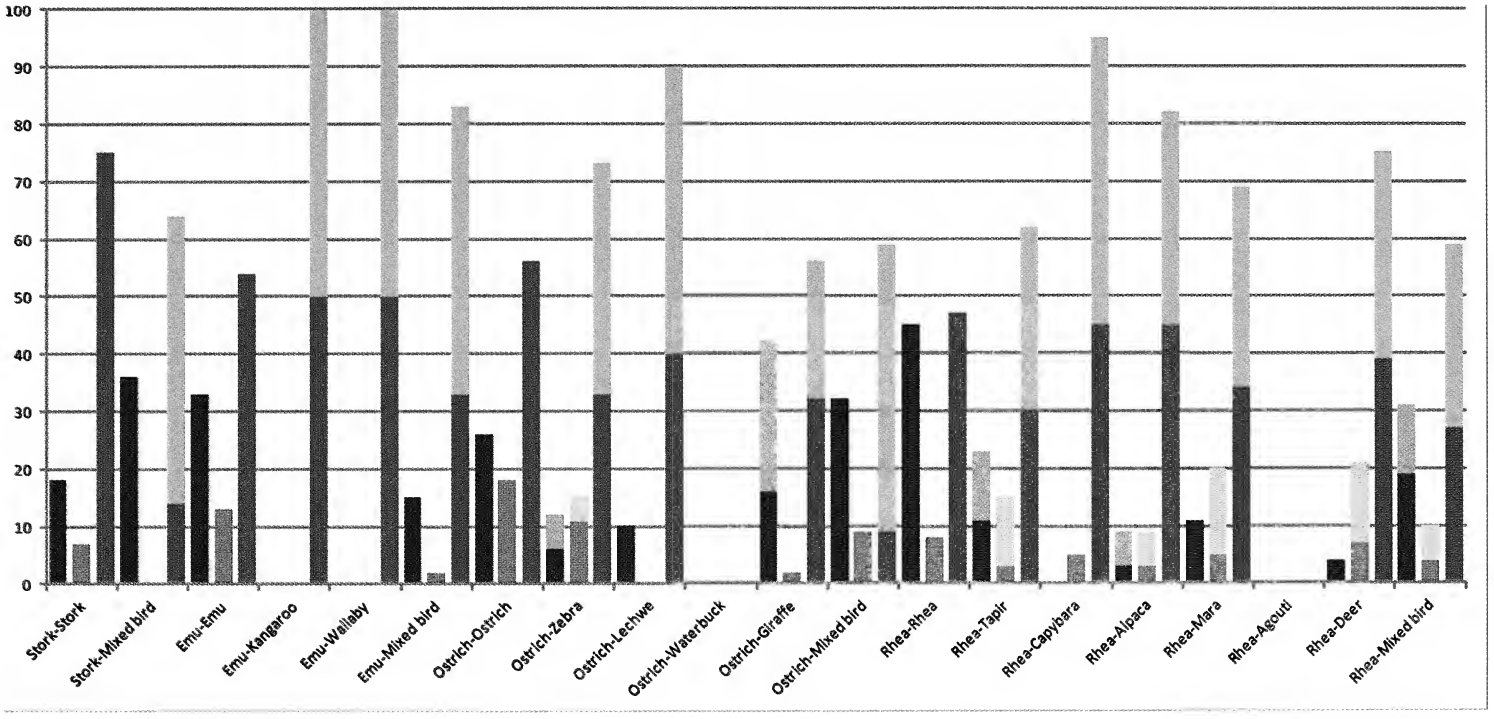


In addition, there was a significant interaction between species and exhibit type on locomotion ($x^2 = 16.57_{[4]}$, P = 0.002), standing ($x^2 = 26.003_{[3]}$, P = 0.000), foraging ($x^2 = 12.17_{[3]}$, P = 0.007) and others ($x^2 = 17.23_{[4]} = 0.002$). Although generally birds stand for longer in mixed exhibits, rhea do so in single-species exhibits, ostrich are the only birds that foraged more in single-species exhibits, marabou stork and rhea perform more locomotion in mixed-species exhibits, whereas emu perform less.

There were significant differences between species pairs in the frequency of aggressive ($x^2= 284_{[11]}$, $P < 0.05$), friendly ($x^2= 538_{[11]}$, $P < 0.05$) and neutral interactions ($x^2= 966_{[11]}$, $P < 0.05$). Ostrich-zebra pairs tend to interact significantly more often than other species pairs for all three types of interaction. Emu-wallaby pairs tend to perform significantly more neutral interactions than other species pairs and rhea-deer pairs perform more than expected friendly and neutral interactions. Aggressive interactions were found mostly in rhea-rhea pairs and no aggression was seen at all between emu-kangaroo, emu-wallaby, ostrich-waterbuck, rhea-capybara and rhea-agouti pairs. Aggressive interactions were much more often initiated by the ratite/marabou than the other species (fig. 2). Most aggression towards ratites/marabou was seen in giraffe-ostrich pairs and in rhea–mixed bird and rhea-tapir pairs, with small amounts in ostrich-zebra and rhea-alpaca pairs (fig. 2). Friendly interactions were found mostly in ostrich-zebra, rhea-mara and rhea-deer pairs, but very infrequently in ostrich-giraffe pairs, and not at all between emu-kangaroo, emu-wallaby, ostrich-lechwe, ostrich-waterbuck and rhea-agouti pairs. Neutral interactions were the most common type between most pairs and were seen particularly often in emu-kangaroo, emu-wallaby, emu-mixed bird, stork-mixed bird, ostrich-lechwe, ostrich-mixed bird and rhea-capybara pairs.

In this study, emu were found to perform less locomotion in mixed-species exhibits, while other bird species performed more locomotion.

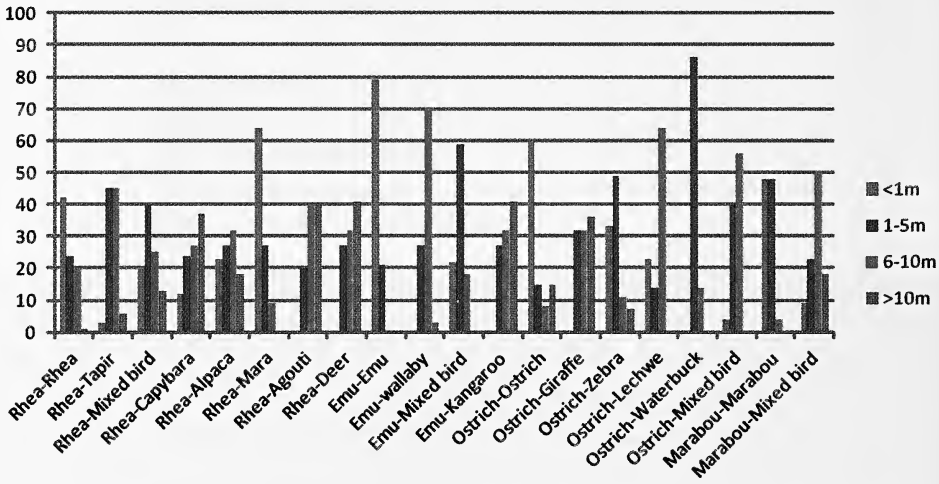
**Figure 2**. Percent interactions for all species pairs that were aggressive (red), friendly (blue) and neutral (green). Dark colours indicate that the ratite/marabou initiated the interation, pale colours indicate that the other species initiated the interaction.



The SPI values varied from 0.35-0.61, indicating uneven distribution of space use in all enclosures but none with extremely biased use of only small enclosure areas (SPI = 1). There was no difference between the SPI values of birds in single-species (mean SPI = 0.50) and mixed exhibits (mean SPI = 0.48)

Exhibit type and the interaction between species and exhibit type both had significant effects on the frequency of nearest neighbours being in each distance category. Nearest neighbours of all species were much more often in the closer distance categories in single-species exhibits, especially so for ostrich and emu. Conspecifics spent more time in close proximity (<1 metre apart) compared with all bird-mammal species pairs (figure 3).

Figure 3: Percent of observations for which the nearest neighbour fell in each distance category.

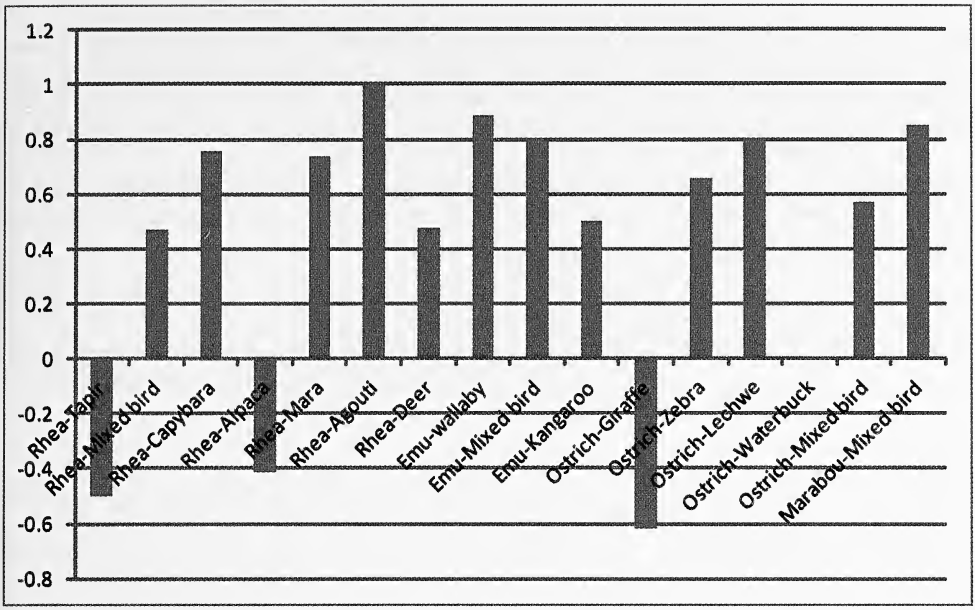



Maintenance of proximity indices (fig. 4) show that the role of the ratite/marabou in maintaining proximity to other species varies considerably. For example, rhea were totally responsible for maintaining proximity to agouti (+1.00) but much less so for proximity to tapir (-0.50). Emus, are most responsible for proximity to wallaby (+0.89) but less to kangaroo (0.50). Ostriches, are most responsible for maintaining proximity to lechwe (0.80) but very little to giraffe (-0.62).

Figure 4: Maintenance of proximity of all possible species pairs, values above zero indicate that the first species is predominantly responsible for maintaining proximity, values below zero indicate that it is the second species.

**Discussion**

None of the birds observed in this study showed any stereotypic or other abnormal behaviour and all performed a range of normal activities of daily living such as, locomotion, foraging, preening, resting, and socialization as typically expressed by all members of their species. Although there were some significant differences in time spent on various behaviours across zoos and enclosures and between species, it was still possible to detect some overall effects of single or mixed-species exhibits. For example, overall birds in single-species exhibits spent longer standing and foraging than birds in mixed exhibits. However, no effects of exhibit type were found on time spent performing behavior that might be indicative of poor welfare.




Aggressive interactions such as chasing, biting, or competition over food were seen but resulted in no serious consequences during the study. All types of interactions including aggressive and friendly were seen more often between conspecific pairs than between any interspecific pairs. Veasey and Hammer (2010) illustrated that intraspecific aggression is more likely than interspecific aggression, because competition for resources will be more intense within a species as individuals compete directly for identical resources, including shelter, food, and mates. Aggression between rheas was particularly high, usually in the form of chasing during feeding time, resulting in the aggressee running away. The highest interspecific aggression was seen between ostrich and giraffe, both species often being the aggressor, in a large open enclosure. Instances occurred most often near feeding stations and it is suggested that more feeding stations could be used and that the introduction of visual barriers (bushes and trees) might be of benefit.

Most friendly interactions were seen between conspecifics which tend to forage or move together but this was also true of some interspecific pairs such as ostrich-zebra. Neutral interactions were seen in almost every pair except ostrich-waterbuck and rhea-agouti. Many birds showed no interest when other species approached which may reflect habituation since most had been in the same enclosure for a long time. On the other hand, no interactions between rhea-waterbuck and rhea-agouti may reflect that these pairs avoid each other.

Many zoo animals do not use all of the space available to them, this may indicate that there is something within the enclosure to which the animal is attracted or trying to avoid. The lowest SPI score (indicating greatest enclosure use) in this study was for ostriches in a large enclosure mixed with zebra and giraffe. All species have free access to the whole enclosure which is open grassland and provided enough space to allow avoidance of contact with other animals or with people, although this was also the enclosure with the highest rate of ostrich-giraffe aggression. In contrast, the lowest enclosure use was by nine rhea housed with mara, agouti (*Dasyprocta sp.*), tapir (*Tapirus sp.*), capybara, alpaca (*Vicugna pacos*) and mixed birds. Although this enclosure is large and little aggression was seen, it contained a large pond which was not used by the rhea. Therefore, it seems that in most cases enclosure use was determined mostly by enclosure design rather than the effects of other animals. One exception was the two emu held with wallabies and mixed birds which appeared to be limited in their enclosure use by an aggressive goose who chased them whenever they approached a particular shelter.

Ratites/marabou in single-species exhibits tend to be closer to their nearest neighbour than in mixed exhibits even though the nearest neighbour is still likely to be a conspecific. Rhea also tend to be in relative close proximity to mixed birds, mara and alpaca and with the exception of alpaca are primarily responsible for maintaining this proximity. Emus do not tend to be in close proximity to other species but are primarily responsible for maintaining proximity suggesting that mixed birds, wallaby and kangaroo (*Macropus sp.*) may actively avoid emus. Ostrich tend to stay relatively close to zebra and lechwe (*Kobus leche*) and are primarily responsible for maintaining this proximity whereas they appear to avoid giraffe.

The results presented here are preliminary and should be interpreted with caution since they are based on a limited sample of enclosures, particularly for marabou stork for which a mixed-mammal enclosure could not be included. In addition, all the exhibits had been established for some time so by definition could be judged as successful, thus it is not surprising that no major welfare issues were detected.

**Conclusions**

Mixed-species exhibits are variable but not necessarily good or bad for ratite or stork welfare. In many exhibits the opportunities for interspecific interactions seemed to be enriching, enclosure use was not restricted and little aggression was seen. However, some species pairs such as ostrich-giraffe and some individuals (the aggressive goose) may be less suitable resulting in more aggression and active avoidance of each other. Conversely, rhea-deer and rhea-mara seem particularly suitable, actively forming associations in mixed exhibits.

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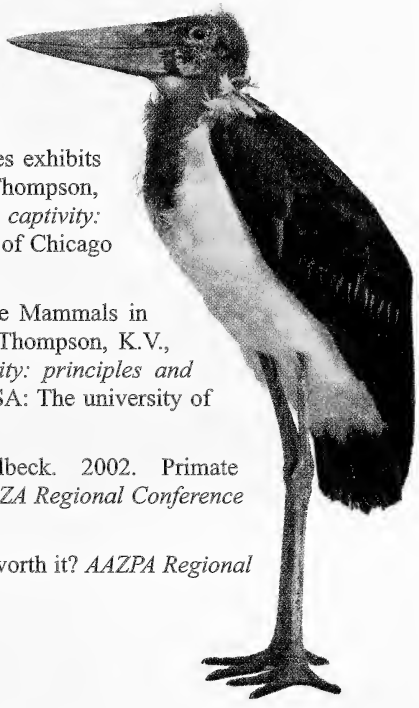

# Keeping Ground Hornbills in Mixed Zoo Exhibits with Ungulates and Other Birds

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Southern ground hornbills at Virginia Zoo. *Photo courtesy of Virginia Zoo*

**Introduction**

When considering bird species to be featured in an African mixed-species savanna exhibit, ground hornbills can be an excellent choice. Ground hornbills are large impressive birds, which are typically very active and highly visible in mixed-species exhibits. There are two species of ground hornbill, the Abyssinian ground hornbill (*Bucorvus abyssinicus*) and the southern ground hornbill (*Bucorvbus leadbeateri*); both live on African savannas and lead a mainly terrestrial existence. Ground hornbills

differ from true hornbills by having an additional neck vertebra, by having elongated tarsi and with a special tendon between pelvis and femur that allows them to be able to walk and run with a long stride, enhanced by long legs and the ability to walk on the tip of the toes. Ground hornbills also differ from most other hornbills in being predominantly carnivorous. They have black plumage over most of the body, except for white primary feathers that are hidden except when they take flight or extend their wings to jump. The tail is relatively short, nares are covered tuft of bristly feathers, eyelashes are well developed and flattened to form screen above the eyes. They breed in rock or tree cavities, not sealing the nest, showing no nest sanitation, but with the female being fed at the nest while incubating and brooding. Food is carried to the nest, often as a bundle of several items held in the bill that can include nest litter material as well as food. The female does not molt flight feathers simultaneously while breeding. The chick's skin turns from pink to black a few days after hatching, and chick is often left alone in the nest well before fledging. Both species of ground hornbill are currently managed by the AZA under Species Survival Plans (SSP's).

**Abyssinian Ground Hornbill**

Also known as the northern ground hornbill, it ranges through sub-Saharan African savannas north of the equator, inhabits areas with poor to good grass cover, including rocky outcrops. Generally occupies drier savanna and steppe compared to the southern ground hornbill. Range extends in a band across Africa from Senegal, Gambia, Guinea and Sierra Leone, and the west coast; across the continent to Sudan, Somalia, Ethiopia and Kenya on the east Coast.

The male and female have similar black plumage but are dimorphic in coloration of the bare skin patch on the throat and upper neck, this is entirely blue in the female while the male has red coloration, with a blue area at the front of the throat. Length is 90-100cm with weight up to 3,500 grams. Casque is pronounced in both sexes, rising above the skull at base of bill in short, high cowl-like curve, with two ridges along each side and ending abruptly with the anterior end open. Eyes are dark brown, legs and feet are black. Immature birds are similar to adults but plumage is browner, primaries have some irregular black marks, bill is greyer with only small pale yellow spot at base. The casque is only slightly raised on base of upper mandible, and the facial skin in pale grey.

Usually found living in the wild as adult pairs, sometimes with current offspring living with them. Breeding appears to be initiated by nest-site inspection, courtship feeding, and beak slapping between mates. Vocalization consists of a series of deep booming notes that may continue for lengthy periods.

**Southern Ground Hornbill**

The southern ground hornbill was formerly widespread across African savannas south of the equator. Common in open woodland, savanna and grassland habitat, which extends into short scrub with a few trees, such as agricultural areas or montane grasslands but does not occur in more continuous woodland or forest, hence it is uncommon through much of central African woodlands. Range of the east coast of Africa extends from lower Kenya all the way down to South Africa; and extends west through Rwanda, Botswana, Zambia, Zimbabwe; into eastern regions of Angola and Namibia on the West coast.

The male and female have similar black plumage but are dimorphic in coloration of the bare patch of skin on throat and upper neck, in the adult male this is completely red while in the adult female this is mostly red but with patch of violet blue on the throat. Length is 90-100cm with weight up to 4,000 grams. Bill is black, with casque only having a low ridge at the base. Eyes are yellow, legs and feet are black. Immature birds have sooty-brown plumage with flecks of black in their white primaries. Bill is noticeably smaller than adults, eyes are grey and facial skin is pale grey-brown.

Southern ground hornbills live in extended family cooperative breeding units, where juvenile males can stay with the parents living as a family social group and acting as 'nest helpers' for up to 20 years. Female juveniles by comparison usually stay with the family for only 1-3 years after fledging before they leave. In the wild they are usually found in family groups ranging from 2-11 birds. All members of the family unit coordinate their activities and remain closely together throughout the day. Social organization is maintained by allopreening and complex interactions involving giving

and withholding food. Vocalization consists of a main loud call that is a deep, resonant, four-note booking, accompanied by three body contractions, the last of which produces a double note. This call is given by all family group members throughout the day, but most frequently at dawn and dusk. Adult males and females will often "duet", with the male calling at a lower pitch than the female, but any family member may call at either pitch.

**Husbandry**

Ground hornbills are large, active birds that live predominately a terrestrial lifestyle. As such, they need sufficient room to remain active in an enriched environment with plenty of space to explore, forage and express social behavior. In many cases this makes them good candidates for mixed-species exhibits given that a good mixed-species exhibit helps to create a more stimulating and ever changing environment for our animals. In the case of Abyssinian ground hornbills, usually an adult pair or two individuals are housed together, but the southern ground hornbill has a more complex social system based around a cooperative-breeding extended family group that can have between 2-11 individuals in the wild. Three AZA institutions have built up family groups as large as five birds in recent years. Ground hornbills are very social birds. In both species a well-bonded pair of adults will spend the majority of the day in close proximity to each other. In the case of southern ground hornbills, when they are allowed to form a family group then all members of the family will spend the majority of the day in close proximity to each other. The only circumstances when it should be assumed that individual birds will need more space for the ability to separate from con-specifics, is when a new pair is being formed and two birds are being introduced to each other that have not yet formed a strong pair-bond and demonstrated compatible behavior. In the case of introductions, potential mates should be housed in adjoining enclosures with the ability to interact visually and vocally. Only once the birds have started to clearly demonstrate courtship behavior (as shown by duet vocalization, regular proximity to other bird in adjoining enclosure, passing of food item and other courtship display) should the birds then be introduced to the same enclosure area.

Barriers for ground hornbills need to reflect the strength of these large birds and the power of their strong beaks. Chain link fence, solid fencing or any other suitable sturdy equivalent can be used for the sides of the enclosure. Ground hornbills are mainly terrestrial in lifestyle but do have flight ability and so they must either be flight restricted by flight feather trimming or housed in covered enclosures. It is recommended that doors to ground hornbill exhibits always have secondary containment as the confident behavior of these birds means that they will often approach the doorway area as animal care staff attempt to enter. Exhibit furnishings should be robust and enhance the lifestyle and behavioral enrichment of these birds. Ground hornbills are predominantly terrestrial and love to explore logs, rocks, branches and other objects they can explore, climb over or destroy. Some horizontal perching or logs upon which the birds can climb are appreciated as they often like to perch above ground level. If live plants are included within the exhibit then they should be checked to ensure that they are non-toxic and safe to be used with birds that might damage, beat or even swallow pieces.

Ground hornbills vary from most other true hornbills by being almost exclusively carnivorous in their diet. Wild ground hornbills have been observed capturing and eating a wide variety of reptiles, birds, small mammals and even carrion (Kemp, 1995). Hornbills are among the least understood families of birds when it comes to comparative avian nutrition (Kirk Klasing, pers. comm.); further research is required in this area. In captivity, ground hornbills have shown some interest in consuming occasional vegetable matter, but they are mainly carnivorous as they are in the wild. A nutritional philosophy that bases the diet upon whole food (prey) items with proper supplements, or which uses balanced formulated diets, is the best approach until further knowledge is available. It is recommended that ground hornbills should be fed a minimum of once a day, with two feeding periods each day being preferred in order to ensure the freshness of any meat products being presented in the diet. The nutritional requirements of ground hornbills are not thought to vary seasonally, although the composition of the diet should be changed when breeding and rearing of offspring is taking place. Opportunities to provide food in ways that stimulates behavior and activity, such as foraging strategies, are encouraged as long as the quality control of food items can be maintained.

**Breeding Management**

Ground hornbills are long-lived birds that form long-term monogamous pairs. They have been known to remain fertile and reproductively active up to an age of 50 years. The social systems between the two species of ground hornbills vary. The Abyssinian ground hornbill normally lives in monogamous pairings, with juveniles staying with the parents for between 6-18 months after fledging before being encouraged to leave once the parents begin to prepare to nest again. With the southern ground hornbill, they live in a family cooperative breeding social system of between 2-11 birds, with juvenile birds (usually males) staying with the parents for up to 20 years to act as 'nest helpers' when the parents breed in subsequent years. Ground hornbills are cavity nesters, but unlike other true hornbill species, the entrance to the cavity is not sealed while the female is nesting inside. Abyssinian ground hornbills seem to prefer a cavity at ground level, often excavating into soil banks, using low tree cavities or even using cavities in rock formations. Southern ground hornbills generally prefer a more elevated nest site, with tree trunk cavities above ground level being the norm.

In the wild, reproductive behavior seems to generally be initiated in a well-established pair by nest site inspection once the pair has located a suitable nest site, courtship-feeding, and beak-slapping between the pair (Kemp, 1995). Clutch size is usually 1-2 eggs, although only one chick will typically be fed and cared for by the parents. Incubation period is 37 days and after hatching the chick will spend up to 90 days in the nest cavity before fledging. Maturity and age at earliest reproduction has been established with Abyssinian ground hornbills as five years for both male (age at first fertility) and female (age at first egg-laying). With the southern ground hornbill, further research is needed to establish maturity parameters as lack of success with breeding first generation birds in captivity has not yet supplied us with enough data to establish reliable estimates. Current anecdotal observation suggests a later maturity age than is the case with the Abyssinian ground hornbill. Breeding pairs of ground hornbills should remain together as an established social unit throughout the year and through the breeding period without any seasonal or management separation required of these birds. Producing parent-reared birds is considered much more important for the population than producing artificially-reared birds.

Egg-laying can occur within a few days of the female consistently spending prolonged periods of time within the nest. Clutch size is usually 1-2 eggs, which are laid in 2-3 day intervals. Only one chick will be cared for and fed by the parents. The incubation period is 37 days, with hatching taking approximately 6-72 hours after raw-down and internal pip commences. Establishing successful parent-rearing is considered very important for these populations so the nest site should not be disturbed unnecessarily. Pairs breeding for the first time may require a learning curve, with early attempts being unsuccessful, but these birds have a very long reproductive life (40+ years) and definitely show learning ability from life experience, so young pairs should be allowed several attempts to perfect parent-rearing before artificial rearing is considered (except as a response to an abandoned chick). If hand-rearing is attempted then it is interesting to note that at least two zoos working with southern ground hornbill have had very good success with introducing hand-reared birds back to living with the parents (or family group) at weaning age by using a protocol developed at San Antonio Zoo.

**Training and Enrichment Notes**

Ground hornbills are very active birds that usually investigate and interact with new objects in their environment, so they are usually highly responsive to both enrichment strategies and training plans. With ground hornbills, behavioral training techniques that are considered particularly advantageous include the following:

**Shift Training**: Facilities moving a bird(s) between the main exhibit and a holding area by means of positive reinforcement rather than forcing the bird(s) to move between areas against their will. This promotes easier maintenance and a better working relationship with the bird(s). In mixed-species exhibits it greatly improves the ability to recall birds to a secure area when you need to have close contact with them.

**Scaling**: Encourages birds to stand upon a scale so that voluntary weights can be collected without the need to capture and contain them so that a weight measurement can be acquired.

**Kenneling**: Encourages a bird(s) to voluntary enter a transport kennel on a routine basis so that when

restraint or movement of a bird is required it can be accomplished voluntarily without stress to the bird and with time efficiency for the animal care staff.
**Targeting**: Encourages a bird to approach an object, the target, upon cue; this allows the bird to be voluntarily moved to different locations within the exhibit, or targeted towards objects that are part of different training management (scale, kennel, etc.).
**Stationing**: Encourages a bird to go to and stand at a specific location within the exhibit, and remain there as long as the trainer reinforces the bird to stay. The ability to station a ground hornbill, which is a large and potentially aggressive bird, can assist in easy cleaning and maintenance of the exhibit as well as potentially help in achieving simple voluntary medical procedures.

Primary reinforcers are typically the birds preferred food items from its diet; bridges can be verbal or clicker devices. Standard principles for avian training management apply. However, with southern ground hornbills it is important to remember that these birds live in socially complex family units and any behavioral management should seek to compliment the natural social system of these birds rather than work against it. It is important to work with southern ground hornbills within the social group rather than trying to separate them.

In terms of enrichment strategies, ground hornbills are active and inquisitive birds that enjoy tactile objects that can be examined, destroyed or dragged around. Their natural history supports a wide range of food foraging opportunities or devices, where food items can be distributed in puzzle feeders, forage trays or packed with layered containers where the bird has to work to acquire the food item. The social nature of ground hornbills also supports the use of auditory (recordings of vocalization) or visual stimulus (mirrors outside of direct contact from their beaks, etc.) that provide social stimulus and enrichment for the birds. All enrichment strategies and devices used should be reviewed for safety and that they promote behavior goals for the species. Typical safety risks can be posed by objects that could be swallowed, which could pose a tangle risk for the bird or which might have sharp edges that could become exposed as the bird destroys the exterior.

**Ground hornbills in mixed-species exhibits**
In early 2010, I sent out a cage space and husbandry survey that 37 North American zoos responded to. This data is now slightly dated, with two of those zoos no longer housing Ground Hornbills and others having made some changes, but it still provides an interesting snapshot look at how ground hornbills are being housed in North American zoos. Of the 37 zoos that responded, 17 zoos held Abyssinian ground hornbills and 23 housed southern ground hornbills (3 zoos housed both species). Of the 17 zoos holding Abyssinian Ground hornbill, a majority (71%) held them in mixed-species exhibits; with the breakdown being 12 zoos holding then in mixed-species exhibits compared to 5 zoos holding them as a single-species exhibit. By comparison, the opposite was true for the southern ground hornbills. Of the 23 zoos holding southern ground hornbills, a majority (61%) held them as single-species exhibits, with the breakdown being 9 zoos holding them in mixed-species compared to 14 zoos holding them as a single-species exhibit. Breeding success does not have a clear correlation as both species of ground hornbills have bred in both exhibit situations, although keeping ground hornbills in designated cage space is generally more successful for breeding, there are several other variables which can have a greater impact on breeding success rather than whether they live in a mixed-species exhibit.

It is worth noting that the difference in social system between the two species should be considered when considering adding ground hornbills to a mixed-species exhibit. Abyssinian ground hornbills generally live in pairs and a pair of ground hornbills is usually a good balance in a mixed-species exhibit situation. Southern ground hornbills can develop into a larger family group and as family group size increases so might their potential for aggression towards other species. It is also worth noting that southern ground hornbills have a higher conservation status and an active field conservation program in progress, providing several strong conservation education messaging points as a single-species exhibit, in addition to the fact that they can be kept as a larger family group. So it is probably a good trend that Abyssinian ground hornbills are more frequently kept in mixed-species situations while southern ground hornbills more often have designated exhibit space.

From the 2010 survey information collected, the following tables show the species that were housed with ground hornbills in the survey replies.

**Table 1:** Species mixed with Abyssinian ground hornbills in North American zoos.

| Name of Zoo | Species mixed with Abyssinian ground hornbills |
|---|---|
| Denver Zoo | Crowned Crane; Gerenuk |
| Disney's Animal Kingdom | Nyala; Okapi; Stanley Crane; Spur-winged Goose; Impala, Waterbuck; Red river hog |
| Ellen Trout Zoo | Masai Giraffe; Bontebok; Griffon Vulture; various waterfowl |
| Fort Worth Zoo | Lesser Kudu; Gerenuk |
| Living Desert | Cuvier's Gazelle |
| Maryland Zoo | Crowned Cranes; White Storks; Sitatunga |
| Montgomery Zoo | Reticulated Giraffe |
| Omaha's Henry Doorly Zoo | Yellow-backed Duiker; Crowned Cranes; Okapi; Egyptian Goose |
| Riverbanks Zoo | Crowned Cranes; Cinereous Vultures; Ruppell's Griffon Vulture |
| Safari West | Springbok |
| Sedgwick County Zoo | Bontebok; Warthog; Slender-horned Gazelle |
| White Oak | Lesser Kudu |

**Table 2:** Species mixed with southern ground hornbills in North American zoos.

| Name of Zoo | Species mixed with southern ground hornbills |
|---|---|
| Brevard Zoo | Crowned Crane; Klipspringer; Marabou Stork |
| Houston Zoo | Okapi; Yellow-backed Duiker |
| Jacksonville Zoo | Bongo; Speke's Gazelle; Impala; Stanley Crane; Egyptian Geese |
| John Ball Zoo | Bongo; Yellow-backed Duiker; White-backed Vulture; Egyptian Geese; Guineafowl |
| Lowry Park Zoo | Steenbok; Lesser Kudu; Bay Duiker; Crowned Duiker |
| Oregon Zoo | Reticulated Giraffe; Speke's Gazelle |
| Santa Barbara Zoo | Giraffe; Crowned Cranes; Sulcata Tortoise |
| Toronto Zoo | Kudu; Impala; Cranes; Vultures |
| Virginia Zoo | Masai Giraffe; Ostrich; Grant's Gazele |

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* Improving Your Photographic Images
* Constructing Wood Shipping crates for Zoo Animals Such as Impala and Birds
* High WBC w/ Increased Ratio of Eosinophils...What the?.. Understanding Vets
* Keeper Talks Can Be Fun...Seriously!
* North Carolina Zoo Horticulture and Browse Program
* Management Adjustments to Address Ageing Animals
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* Guest Presentations Made Easy

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# Ten Things Those Hoofstock Walking Around with Your Birds Want You to Know About Them

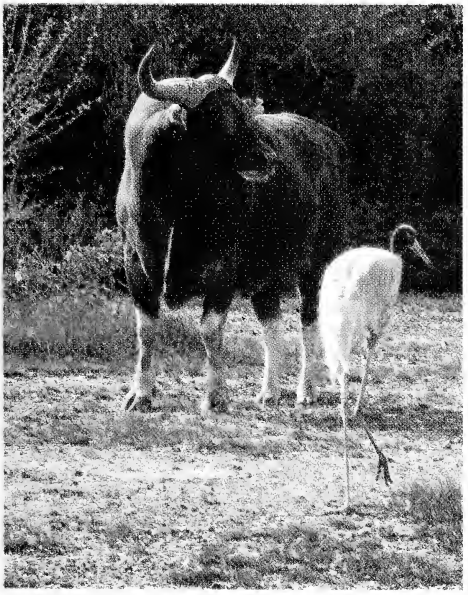
*Tim Thier, Zoological Manager/Antelope*
*Saint Louis Zoo, Saint Louis, Missouri*

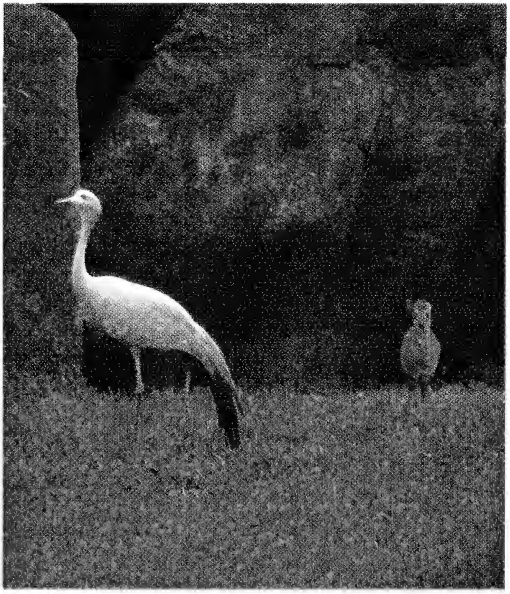
There is a great variety of hoofstock species that work well in multi-species habitats and although they may look very different from each other, they are typically managed and behave in very similar ways. This article will provide you with ten tips that will allow you to better understand the hoofstock species in your multi-species habitats which will allow you to manage them with greater success.

**1. Flight Response**

Hoofstock species are prey animals, and as such, their first instinct when they feel threatened is to run. The flight distance will vary greatly from species to species and will even vary for individuals of the same species. Animals that tolerate our presence in a large area may not be as tolerant in a smaller area, such as their indoor holding. Care must be taken when working in a habitat with hoofstock species. Ideally one should move slow at all times and avoid walking an animal into a corner where it may feel trapped. If the animal feels it has no other option it may run directly at you or jump to try to escape. The animal should always have a flight path that it can use at any time to move away safely.

Flight response can also be used to properly manage hoofstock species. Many smaller species of hoofstock are secured inside at night and staff members can use the flight response to safely encourage the animals inside if they choose not to walk inside on their own. The flight response can also be used in the manual restraint of small to medium-sized hoofstock species. Typically two staff members enter the stall giving the animal a flight path along each wall. The animal will use the flight path along the wall rather than stay in the back of the stall, and as the animal passes by, the staff members can safely restrain the animal.





(left) Banteng and a Sarus crane (right) Stanley crane and a Red-flanked duiker

**2. We Don't Care For Surprises**

Most hoofstock species startle easily and care needs to be taken when working around them on a daily basis. It is beneficial to move slowly and talk softly to the animals when entering a barn or rounding a corner in order to alert them of your presence. It is also important to monitor any construction work that may be taking place around the habitats and barns that could potentially startle the animals. Playing radios inside the barns provides background noise that will help keep the animals calm if there is a sudden, loud noise.

Providing hoofstock species with new exhibit furniture or a new enrichment device may also elicit a negative response. The temperament of the animals should be considered before introducing new items and the animals should have plenty of room to move away from the item until they have time to acclimate to its presence.

Before introducing a hoofstock species to another mammal or bird it is beneficial to give the animals visual access to each other. This allows the animals to see, smell and acclimate to each other before the physical introduction takes place and allows for a safer and more predictable introduction. If visual access is not possible through a mesh or "howdy" door, another option is to house the animals in adjacent habitats, which will also allow for the initial investigation to take place prior to the introduction.

**3. Routine, Routine, Routine**

Hoofstock species are easy to care for and manage once they understand what is expected of them. It is recommended that keepers follow the same routine at approximately the same time every day. If the habitat is serviced the same way every day the animals will know what you are going to do and will adjust to your movements accordingly. It is also recommended to move the animals on and off exhibit the same way every time. The animals will quickly learn that the opening/closing of the door is their cue to shift inside or outside and this will make managing them much easier.

Hoofstock species can also acclimate to items such as scales and mechanical restraint devices by making it part of their daily routine. Acclimation typically begins by shifting the animal over the scale platform or through the restraint device on their way out to the habitat. Over time, as this becomes part of their normal daily routine, the animals are easily weighed or secured in the restraint device.

**4. Each Animal Is Unique**

Just like humans, each individual ungulate is unique and one should never generalize the behavior or temperament of a species based on an individual animal. Hoofstock species managed in the same way and in the same environment can behave completely different from each other. Knowing the history of the animals in your care can also aid in their proper management. Often times hand-reared animals will behave differently towards their caretakers than parent-reared animals. Individual animals will also respond differently to different staff members and as such one should not base their "knowledge" of an animal on how it interacts with coworkers.

Not all animals of a given species will work well in a multi-species habitat. Careful consideration should be given to the temperament and history of the individual animal before introducing it to a multi-species habitat. Over time animals that have successfully lived in a multi-species habitat may change and they too should be evaluated on a regular basis to ensure they are still a proper fit for this type of habitat. This is especially true if an animal has been taken out of the multi-species habitat for some time and is being re-introduced.

**5. Females With Offspring**

Females with offspring are a special case and should be observed closely for changes in their behavior after giving birth. They may not be as tolerant towards their caretakers and will often become more

aggressive, even without a history of aggression. They may also challenge herdmates as well as other species housed in their habitat if they feel their baby is threatened. The females will often return to a more normal behavior after being back with their herd and a normal routine for a few days.

**6. Body Language**

Animals can sense when you are nervous and this may affect their behavior. You must be confident when working around hoofstock and it is advisable to move slowly and deliberately at all times. If they "test" you and get a reaction they will continue to do so on a regular basis.

**7. Learn To Read Our Cues**

There are several signs that hoofstock species will give you to let you know that they are uncomfortable in their current situation, including pacing and alert body posture. For some animals, slow pacing can be a normal behavior, but typically as an animal becomes excited or agitated the rate of the pacing will increase and may eventually lead to the animal rearing up on its hind legs or jumping. A vigilant animal in the alert position will have its head up, ears pointing forward and the entire body will be rigid. This shows that something has gotten the attention of the animal and that its next move may be unpredictable.

Equids will often have rapid tail swishing with their ears back to let you know that they are upset and these behaviors are often closely followed by a kick. Many suid species will vocalize loudly and peccary species will use teeth clacking as a warning sign. Many species will also use a foot stomp behavior as a warning sign and typically the head toss and horns down behavior is closely followed by a charge.

**8. Horns, Hooves and Teeth**

Hoofstock species do have the potential to cause injury to those that share space with them and it is important to respect their strength. In most situations, proper positioning by staff members will avoid any injuries. Maintaining a safe distance from the animal to ensure that you are out of horn and hoof reach is all that is needed. Depending on your facilities, on the species in your care, and on the personalities of individual ungulates, it may be inappropriate to share space with some ungulates.

Additional skill is required when hoofstock species are mechanically or manually restrained and staff members are forced to work in close proximity to the animals. In most situations, it is key to gain control of the head first as that will protect those handling the animal from the horns and teeth. This should be followed closely by controlling the legs, so the animal does not have the opportunity to injure itself or the handlers.

**9. Bird Food is Awesome**

Most hoofstock species prefer bird food over their own food and management practices that allow for the safe feeding of both hoofstock and bird species is something that needs to be considered. Competition at a single feeder can lead to negative interactions between the bird and hoofstock species. If the hoofstock species are secured indoors overnight the birds can simply be fed late in the afternoon. In other situations exclusion areas may be required to provide the animals ample time to feed.

**10. Safety Considerations**

Exhibit design should be carefully examined when selecting a species for a multi-species habitat. First and foremost is there proper containment? Is there sufficient cover for the animals? Do the species require seclusion areas from the other species that will be sharing the habitat? Is there sufficient and safe access to bring the various species indoors?

The safety of enrichment items also needs to be considered. Are the bird enrichment devices safe for the hoofstock species and vice versa?

Staff members should always be alert and should take note of any special circumstances that may affect the behavior of the animals. One should never turn their back on the animals and it is also advisable to carry a broom or a stick when working around medium to large hoofstock species. When working around hoofstock species, you should always be aware of your surroundings and possible escape routes in case a dangerous situation arises.

Multi-species habitats are a fantastic opportunity to enrich both the animals and the staff members that care for them and also provide a more interesting experience for our visitors. The great variety of hoofstock species ensures that there is one that will work in almost any multi-species habitat and there is a wealth of knowledge among your colleagues in this field. For more on hoofstock species feel free to contact any of the Ungulate TAG Chairs and they would be more than willing to provide you with information regarding these charismatic animals. You can get additional information on hoofstock species by joining one of the several listservs at AZA.org.

Gerenuk are popular ungulate choices for mixed-species exhibits. ©*Shutterstock*

# What We Have Learned From a Shifty Ibis (shift training for sacred ibis)

*Rebecca Heisler, River's Edge Senior Keeper*
*Saint Louis Zoo*
*Saint Louis, MO*

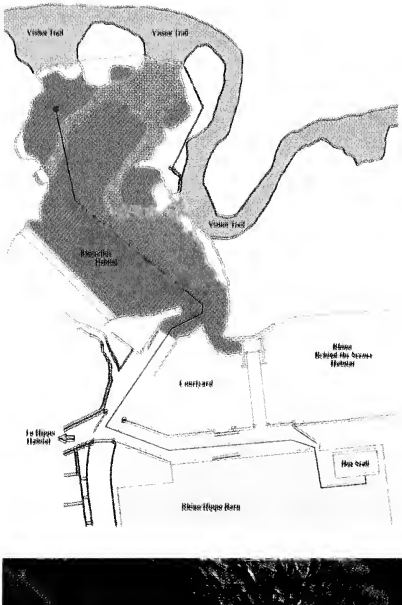
The River's Edge department of the Saint Louis Zoo has had great success with training a flock of sacred ibis (*Threskiornis aethiopicus)* to shift between their indoor area and their outdoor multi-species habitat. The training has helped reduce stress on the birds as well as the keepers. This paper will outline the basic tools and steps used to achieve this result.

**Basic information**

The Saint Louis Zoo houses 2.1 black rhinos (*Diceros bicornis*), 0.4 Nile hippos (*Hippopotamus amphibius*) and 4.1 sacred ibis within one barn. The barn has eight stalls for rhino or hippo use with solid concrete or steel bollard pass-through walls. The rhino and hippo shifting pathways to the habitats are designated with steel bollard pass-through or cable barriers. Between the barn and the rhino/ibis habitat is a small grassy area for keeper access that we call the courtyard. The rhino/ibis habitat has one remotely-operated electric sliding gate for rhino access and a larger swing gate for keeper and ibis access. The rhino/ibis habitat includes a waterfall that flows into a small wading pool that then turns into a meandering stream down the front of the habitat. There are two concrete feed pads, a mud wallow and significant space for the rhinos and ibis to roam. The majority of the habitat is surrounded by lush vegetation and themed gunnite walls.

Our current flock of 4.1 sacred ibis came from a full flight enclosure and arrived as juveniles. Indoors, the five live together in a large common area with an adjacent stall for shifting during cleaning. They are shifted into the rhino/ibis habitat and share the same space with the rhinos during the day as weather permits, and they are shifted indoors at night. The ibis are shifted indoors overnight not only due to weather but to also avoid any potential ibis/predator conflicts. We currently use 50°F, sunny and dry as their minimum weather conditions. The ibis are fed indoors once daily in shallow rubber

The ibis spend a large portion of their time in the outdoor multi-species habitat probing through the pool shallows. *Photo by Rebecca Heisler*

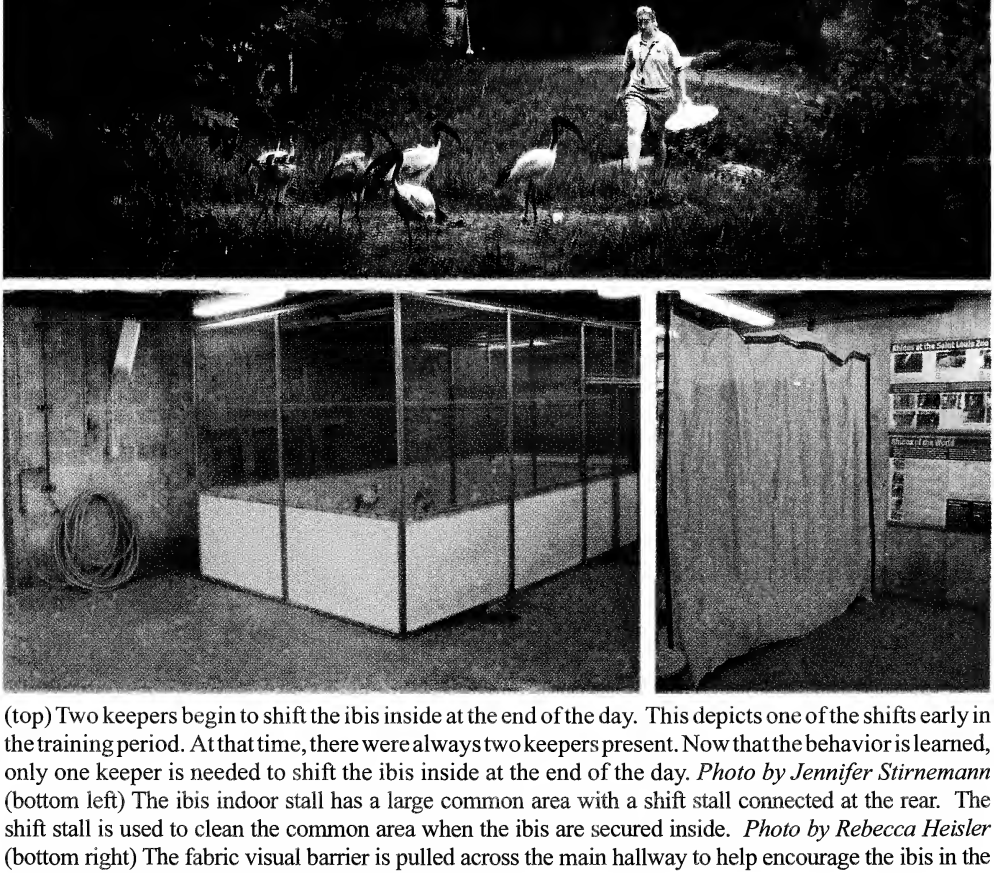


tubs. Their diet consists of Milliken Meat 10% feline diet, capelin, flamingo chow, lake smelt and thiamin E paste. Some of their more preferred enrichment items include live insect tosses and live fish in tubs of water.

**Preparations for training**

Once the ibis were moved to the rhino/hippo barn, our team encountered the challenge of how to get the ibis from the inside area safely to the outside habitat in a consistent and time efficient manner. The path the ibis would need to shift was a lengthy 340 feet! There were several steps to take before we could start this training.

This diagram (left) illustrates the ibis shifting route. The ibis shift from their indoor stall, through the rhino/hippo barn, down the rhino/hippo gangways, through the keeper courtyard and out into the multi-species habitat.



(top) Two keepers begin to shift the ibis inside at the end of the day. This depicts one of the shifts early in the training period. At that time, there were always two keepers present. Now that the behavior is learned, only one keeper is needed to shift the ibis inside at the end of the day. *Photo by Jennifer Stirnemann* (bottom left) The ibis indoor stall has a large common area with a shift stall connected at the rear. The shift stall is used to clean the common area when the ibis are secured inside. *Photo by Rebecca Heisler* (bottom right) The fabric visual barrier is pulled across the main hallway to help encourage the ibis in the correct shifting direction. *Photo by Rebecca Heisler*

Since the ibis had come from a full flight area, they required wing trims. We needed to ensure that the ibis would remain in designated ibis areas and not fly way. All primary feathers were trimmed from one wing of each bird.

In order to begin training the ibis, we needed to find some type of reinforcer to motivate them. Food items such as insects were difficult for the ibis to pick up and eat quickly. The other portions of their diet were not favored food items. Therefore, food was not going to be an optimal reinforcer. We researched their natural history and common behaviors to find other motivation ideas. Sacred ibis tend to hang out in large flocks. So we simply picked "being outside" as their reward and began shifting them as a group. As one ibis would move, the others would naturally follow. At the end of the day, the ibis were again encouraged to move as a group and were fed their diet once shifted inside. The next challenge was how to designate the actual shifting route to the birds. Since portions of the shifting route to the outdoor habitat were not solid walls, we needed to create temporary barriers to help the ibis learn their shifting route. We hung large blue tarps with twine in front of all pass-through gates and cable barriers. These temporary tarps were easily and quickly put up and taken down for each ibis shift. We also ordered more permanent fabric barriers that we hung like curtains and pulled shut just outside the habitat gates. This visual barrier helped to keep the ibis away from the entrances/exits of the habitats and was also convenient for keeper use. These barriers were always placed out of the rhinos' reach.

(top left) During the first few rhino/ibis introductions in the habitat, the adult male rhino would only watch the ibis from a distance. *Photo by Stephanie Richmond*
(top right) The ibis tend to stay together in a group. Here they are resting on perching placed in the multi-species habitat for their use. *Photo by Rebecca Heisler*
(bottom) As the two species became more comfortable with each other, the adult male rhino would approach the ibis; the ibis would simply move out of his path. *Photo by Stephanie Richmond*

Occasionally, the ibis enrich themselves by catching native tadpoles and frogs. *Photo by Roger Brandt*

A typical picture of the black rhino habitat as seen from the public trail. The rhinos eat their hay as the ibis watch from their perches across the stream. *Photo by Stephanie Richmond*

In order to create "safe zones" and prepare the rhino habitat for the ibis, we added some branches for perching in areas of the habitat that the rhinos typically choose not to utilize. This way the ibis had sections of the habitat to remove themselves from rhino presence. We also trimmed all vegetation away from the perimeter walls to discourage ibis from leaving the habitat if spooked.

**Shift training**

We used a very slow pace as we began training to ensure ibis comfort. We had one keeper designated as the primary trainer to keep the training progress consistent. One keeper would enter the inside ibis area. The flock of birds automatically moved away from keeper presence. Therefore, the primary keeper simply placed his/her body behind the birds and encouraged them forward with slow steps toward the shifting route. At first, we needed extra keepers positioned along the shifting route to help guide the ibis in the right direction and prevent them from straying. This was very simple, as the ibis would always move away from all keepers. A slight shoulder turn or a step to the side could position and direct the flock.

All keepers carried a net in the beginning for emergencies. The same path was used during every shift. With repetition, the ibis learned their route and we needed fewer keepers for positioning. With time and practice, the birds started walking along the path with less encouragement and we were able to eliminate the time-consuming task of putting up and taking down the temporary tarps every time the birds were shifted (this was one of the keeper team's favorite steps!). Eventually, only one keeper was needed to encourage the birds from behind with subtle body position changes. We continue to evaluate the shifting process from time to time and make adjustments as necessary.

**Introductions to rhinos**

The ibis flock's first few trials in the outdoor habitat were without the rhinos present. We wanted to give the ibis some time to acclimate to the habitat on their own. We walked the flock of ibis by the rhinos as often as possible so the rhinos could see them and get accustomed to their presence. The rhinos showed very little interest in the ibis. Next, we began short rhino and ibis introductions within the habitat with our most calm rhino. The ibis were walked to the far end of the habitat and then the rhino was shifted out. There was still very little interest in the ibis by the rhinos. The adult male rhino tried to approach the ibis a couple of times, but the ibis avoided him by walking away. The rhinos never pursued more ibis interaction and the ibis preferred to stay in the areas of low rhino use.

**Improvements**

We needed to make modifications to the rhino habitat due to an impending rhino birth. The fabric ibis visual barriers just outside the rhino gates were replaced by plywood boards on the gates themselves. This improvement was an unexpected surprise as it helped make the ibis shifting more time-efficient since there were now fewer steps. One of the fabric barriers was moved within the barn and that eliminated the use of several tarps inside as well (another keeper team favorite step).

**Ibis life in the habitat**

The ibis flock seems to enjoy the time in the outdoor habitat. They practically run to the habitat every morning. It is a very enriching environment and they show many natural behaviors while in the habitat. They wade in the stream and pool shallows and are often found catching native tadpoles and frogs. They dig in the grass and probe in the soil for insects. Sometimes they even build nests out of twigs and leaves. The ibis bathe in the stream and then sun on the perches. Sometimes they wander near the rhinos, but usually return to the area across the stream. They will occasionally split into smaller sub-groups since they have so much space to utilize. When in the habitat, the ibis are always visible to the visitors. Overall, the shift training for the ibis was very successful for every keeper (and ibis and rhino) involved!

# The Training and Introduction of a Male Ostrich With Greater Kudu

Tom Mortimer, Tulsa Zoo Bird Supervisor

Tulsa, OK

Our male ostrich "Rodney" and our male greater kudu "ZooK"

The ostrich (*Struthio camelus*) is a large flightless bird from parts of Africa. They can be found all over the world where they are farmed for their feathers and meat. They tend to be nomadic and like to live in large groups, since there is safety in numbers. With their very large eyes they can see from a great distance away. This gives them an advantage to run away from predators. In the wild they can be seen with zebra, both animals working together, the ostrich using its vision to look for predators and the zebra using its hearing and sense of smell. Both animals share a symbiotic relationship, where each makes up for the other's deficiency. When an ostrich is threatened it runs, if cornered they will use those two powerful legs to kick, and it doesn't hurt that they have a four inch claw on each toe. So it makes sense that you will see them pairing off with hoofstock in the wild. It may be more common to see them with zebra or gazelle but why not greater kudu (*Tragelaphus strepsiceros*)? Pairing the largest bird in the world with one of the largest antelope sounds crazy. But that's just what we wanted to do.

Our 20-year-old male ostrich was a bachelor who had his own yard. During winter he had an open structure that he could go into. He was provided bedding and a heat lamp. When winters were bad he was moved to a barn or enclosed area, always taken back to his yard by spring time. As time went on he started showing signs of aging. We realized he was getting cataracts and his right eye was almost completely blind. He also used to be aggressive, especially towards men and he wasn't the same bird

that would chase after keepers, although he would still occasionally hiss at us.

In the winter of 2010 we moved him to our Africa hoofstock barn. He did very well for keepers. We did not have a training protocol for him at the time. We would call him by name or go in and have him follow us into the barn using free-contact. We could then close the shift door, locking him into a stall while we cleaned. It was during that time that we realized it would be nice not to have to move him around during the cold seasons. Bird staff, hoofstock staff and vet staff began talking about the possibility of putting him in with our male and female greater kudu on exhibit.

It was in 2011 that the Tulsa Zoo implemented a training program to integrate our male ostrich with our male and female greater kudu. The ostrich had two small reserve yards outside, a large inside stall and a smaller inside stall beside it. Our goal in the beginning was to get him inside his larger stall. Have him station at a small window, then shift into another stall, closing the door behind him. Once inside his stall he would have access to food, water and a bed of hay. Bird keepers, hoofstock keepers and the behavior/enrichment curator worked together to make a training protocol that would fit him best. Several meetings took place before we started working with him. Vet staff was included since they knew his history and in case of any unforeseen injuries they would be aware. We wanted to have a way to call him that was routine and sounded the same way every time. We also needed a command to get him to shift from one reserve while stationing at a window to another that had his food, water and bedding. We also wanted to positively reinforce his good behavior. In the beginning we used a small shallow bowl with a couple of pieces of apple to reward him. Over time we moved to using a dowel rod with a piece of apple on the end.

Our hoofstock keepers were already using bells to call in hoofstock from the exhibits. We did not want to use anything that might confuse them. So we used a standard lifeguard whistle. Two short blows would be used to call the ostrich inside the barn. Once inside we used a dowel rod that had a piece of apple on the end, this was put through the window to give him his reward (we could also medicate him this way, by putting pills in the apple and handing them to him). We would give him two to four pieces of apple using the word "good" after he took each piece. Once he was finished with his apple the keeper would open his shift door and give the command "over". On this side of the shift was his water and food bowl. We had his ratite (grain) inside with a little fruit to reward him for shifting over. Once inside the word good was given and the door was closed. This allowed us to go in his reserve yard and clean. It also allowed us to keep him inside due to storms or cold temperatures.

In the beginning we had to use free-contact to get him to come inside. We initially blew the whistle twice and tried calling him by name. Even if we were not doing a session with him and he was in the inside reserve we would blow the whistle twice and try to give him pieces of apple for being where we wanted him. We did go into his reserve in the beginning to bring him in, blowing the whistle twice when he was in or near the inside reserve. He quickly associated the whistle with the reward. As time went by we were blowing the whistle twice and calling him by name, only occasionally having to go in and get him. He eventually was coming in at the sound of the whistle blowing and having his name called once or twice. We also learned that in the morning we should close him out of his stall where his food and water was. This kept him more focused and food-driven to get back into his stall. Shifting from one inside stall to the other was something he became very good at. It didn't take too long for him to shift over with ease. As soon as the command "over" was given he shifted. Once the door was closed keepers could clean or lock him in. After husbandry duties were completed his shift door would be open and he could go back to his reserve.

So this is how a normal day would have gone; Two whistle blows at the window of the inside stall, calling his name once or twice. Once he was inside we would say "good" or 'good boy", giving him pieces of apple on the end of a dowel rod. The shift door between the stalls would be opened, and the command "over" was given. Once inside the next stall the word "good" or "good boy" was given and the door would be closed. Inside his stall was already cleaned, he was given fresh water, and food.

Once we felt he had a handle on this we started working him out of his reserve yard and into the

lane that would eventually lead to the greater kudu exhibit. At first we opened his gate and gave him access to the lane for a couple of hours a day. Allowing him to acclimate himself into the lane without being asked or forced. We wanted him to come and go in the lane as he pleased. While we rarely saw him move down the lane we did notice footprints in the dirt and feces in the lane. After a couple of weeks we started opening his gate and calling him down the lane; it was about fifty feet from his reserve yard to the exhibit. We fed him pieces of apple from the other side of the chain link fence, slowly walking down the lane with him. There were times that he would end the session by turning around and going back to his yard. After a while we started closing him off from going back to his reserve yard. There were times in the beginning that we went inside the lane and walked him down to the neutral area (an area right before the exhibit that could be closed off). While in the neutral area we allowed him to stay and familiarize himself. We would then walk him back to his reserve. Now that we were confident he knew how to get to the exhibit and back we started looking at the exhibit for possible issues. Once the exhibit was ostrich-proof we decided on a date to put him on exhibit for the first time, without the kudu.

We decided on February 9th, 2012. We made sure to communicate with all of the appropriate departments including vet staff in case there was an injury while out on exhibit for the first time. That morning, the greater kudu were shifted off and the ostrich was given the lane. He made it all the way down the lane but would not shift through the last roll gate into the yard. We gave the command "over" and still nothing. After several attempts he made his way back up the lane to his reserve yard. Although he did not shift on exhibit we felt we had made great strides in getting him this far. We continued to work on getting him in the lane and down into the neutral area over the next two weeks. On February 23rd we made a second attempt at shifting him on exhibit, without the kudu. All of the same personnel were contacted in case of any injuries or emergencies. Although he was a little hesitant, he shifted. It took us going into the yard and calling him out into the exhibit. We gave him several hours on exhibit; he mostly stayed within 20 feet of the lane. When the time came to call him

The first meeting between our male ostrich "Rodney" and our female kudu "Kiya"

in we tried two short whistle blows to call him back to his reserve. After many failed attempts to call him in we finally had to go in and walk him to the lane using free-contact. We knew that in time this would become routine, that we needed to just be patient. On February 24th we shifted him back into the kudu exhibit. He was still hesitant to go through the last roll gate, although he did eventually go. While on exhibit he did well, although he did not venture through the whole yard. At the end of the day we attempted to shift him off exhibit. He was still needing assistance to get through the gate, but once he was through he made it back up the lane to his reserve with no problem.

The one benefit we had with the introduction of the ostrich and greater kudu was that they were being housed next to one another. Every day the kudu were shifted on or off exhibit they had to walk by the ostrich. Any time the ostrich was outside in his reserve they would see him. This howdy process made the transition much easier. I still remember the first day we brought the ostrich over. When the kudu first saw him they became very vocal, it almost sounded like barking. Now they accepted him being beside their reserve yard and had shown no signs of aggression.

We decided to put the ostrich and greater kudu together on February 25th 2012. Vet staff was notified and on standby should they become aggressive towards one another. The kudu were on exhibit that morning, at 10:00 AM we shifted the ostrich on exhibit. He was still hesitant at the last gate into the exhibit but eventually made it through. Once through, the female kudu showed interest and walked up to him. She put her nose up to his beak, he hissed at her but showed no other signs of aggression. While the female kudu was showing interest in the ostrich, the male kudu couldn't care less. He was on the other side of the exhibit lying down. The ostrich moved around the exhibit foraging at grass and leaves on the ground. At different points of the day, they were all grazing, lying down, and walking by each other. We never witnessed any aggression. At one point the ostrich was sitting within a short distance of their water source and the male kudu walked around him to get a drink. You would have thought they had been on exhibit for years together. At the end of the day our hoofstock keeper shifted the kudu off. The ostrich needed a little assistance to get through the gate but made it back to his reserve. As we shifted him on and off exhibit it became more routine. You could tell he was getting the hang of it. On March 1st he stayed on exhibit overnight for the first time. He seemed to be exploring more of the yard each time he was out there. There were even times when you could see the three of them sitting within a short distance of each other.

We always shifted the kudu off exhibit first. Once they made their way into the lane the roll gate was closed. When they made it back to their reserve the ostrich was at the gate waiting on his turn. The whistle was no longer being used outside to call him off exhibit. When he saw the kudu shift he came up to the gate. Since he was behind chain link we were able to reward him for coming close to the roll gate and stationing there. From that point the gate was opened and he went through. We would walk back to the barn blowing the whistle twice for him to come inside his reserve stall.

I want to say thank you to the Bird Department, Hoofstock Department, Vet Staff, and the Curator of Behavior/Enrichment. It was the combined effort of all of you that made this work.

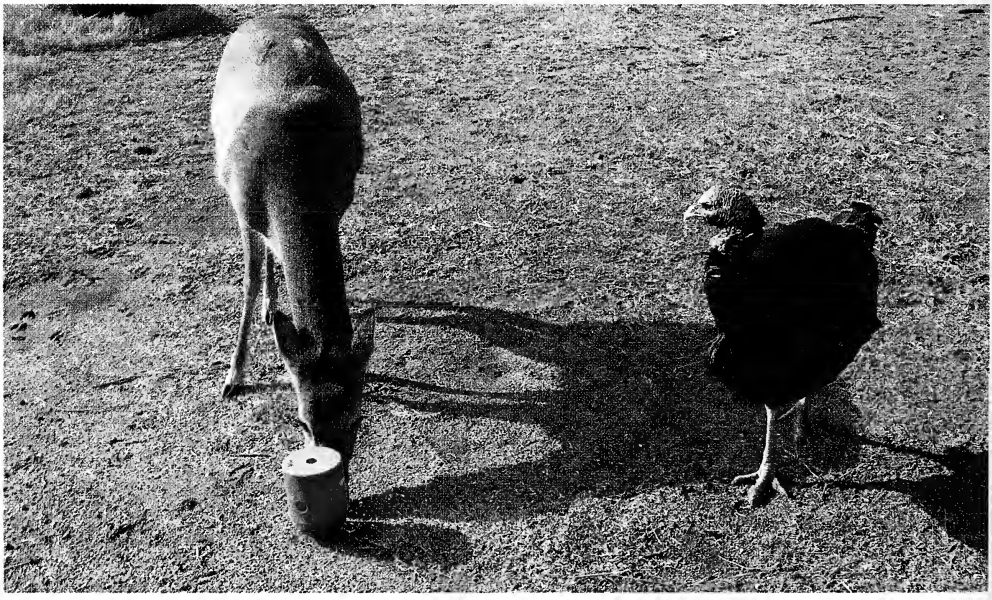
# Bird/Hoofstock Mixed-Species Enrichment Safety Notes

Enrichment E O Options

Imagine this: You get a call on the radio that one of your hoofed animals is in distress and seems to be tangled in something. You get to the scene to find that, while sparring with a log in the habitat, he got tangled up in the hose running a mister bath used by the birds in the same habitat. Because this is a dangerous, large male in rut, a field anesthesia is necessary to free him. Fortunately, everyone works quickly and professionally to get him back on his feet in minimal time, and he recovers without further incident.

Mixed-species habitats are enriching to the animals that inhabit them, but providing additional enrichment to the individuals in a mixed-species habitat requires additional planning for all species and individuals exposed to that enrichment. A very important consideration for all enrichment is safety. When mixing diverse taxa, such as birds and hoofstock, it is important to imagine how each could interact with the enrichment in addition to the intended use by the targeted species.

**Bird Safety Considerations for Hoofstock Enrichment:**
**Holes/Handles/Mesh:** Birds like to stick their heads in things, and if it's just the wrong size, angle or material, they could injure themselves. If the enrichment has holes perfectly-sized for hoofstock to use their tongue to manipulate, consider whether the birds housed with them could poke their heads



Wild Turkey and White-tailed Deer with enrichment item.

inside for a look around and then not be able to get out. If a bird has a particularly long beak, this danger can be reduced by ensuring the depth of the hole, from all angles, is such that they can stick their beak in but not far enough to put their head in danger. Birds also can get their feet or toes stuck in holes, handles or mesh. This is more probable with enrichment given on the ground, but don't discount foot dangers with enrichment presented at higher levels. By managing the depth, shape and size of holes, as well as ensuring smooth edges of materials, we can reduce these potential dangers to birds.

**Rope/Netting:** Bird toes or heads getting tangled in frayed rope or fabric material is a real enrichment danger. When using enrichment that has any fabric component, it is advised that you frequently check the seams and edges to ensure that age or wear has not created a potential danger. This includes rope that might be used for hanging or fastening enrichment.

**Hardware:** Birds like to peck at things, and shiny, small things seem to catch their attention even more so. Any small parts, mounting hardware, or other possible fragments can pose a risk to birds that may ingest them. Birds are susceptible to metal toxicity as well as gastrointestinal blockage if they ingest loose, small parts from enrichment.

**Hoofstock Safety Considerations for Bird Enrichment:**

**Holes/Handles/Mesh:** A danger also exists for hoofstock species, particularly those with horns or antlers, when enrichment has holes, handles or mesh. Many hoofed animals will rub on or head-butt enrichment. This is highly probably with males in rut, and if the holes are large enough and deep enough they can get their horns or antlers stuck. This danger can be compounded with anchored enrichment because then the male hoofstock will continue to spar with this new enemy, with hormonal vigor, until he frees, medically exhausts, or injures himself. At best, it could result in a potentially harmless hornament (horn + ornament) that you wait for the animal to remove on its own, and at worst the animal could expire due to capture myopathy.

**Rope/Netting:** Many hoofed animals incessantly chew and/or lick everything; therefore access to rope or fabric material can pose ingestion hazards in addition to entanglement or accidental hanging risks. Animals with horns or antlers should have minimal access to enrichment with these components. As with all enrichment, these types of materials should be closely observed when animals first have access to them and frequently checked for signs of nibbling or wear. This includes rope that might be used for hanging or fastening enrichment.

**Hardware:** Hoofstock, particularly giraffe (*Giraffa camelopardalis*) and okapi (*Okapia johnstoni*), can be very adept at using their tongues to unscrew, unhook, or unlatch any hardware holding enrichment together or mounting it for use. They can also be relatively tough on enrichment so durability is an important factor.

**Meat:** Another safety issue to consider when enriching avian species is the use of the bird of prey diet (BOP) in mixed-species habitat. Hoofed animals that cohabitate an exhibit with bird species who consume BOP are subject to particular precautions. When giving this type of diet in an enrichment device, it must be done in a way which ensures only the bird species have the ability to gain access to the diet. If enrichment is given to a bird that allows hoofstock access to the BOP diet, it can possibly create serious health issues. Hoofstock that consume mammal protein have been directly linked to contracting Bovine Spongiform Encephalopathy (BSE) and Creutzfeldt-Jakob Disease (CJD). The U.S. Food and Drug Administration (FDA) has strict regulations and legislation prohibiting the consumption and use of most mammalian protein by hoofstock (U.S. Food and Drug Administration, 2010). If there is any doubt that a hoofstock species can gain access and consume the bird of prey diet, then use of that enrichment delivery system should be avoided.

Examples of enrichment items.

**Options:**

Just because an enrichment idea is not safe for all inhabitants of a mixed-species habitat does not mean the intended animals cannot ever have it – we must manage the situation to maximize appropriate enrichment options for all individuals while also minimizing safety concerns. One management option would be to offer enrichment that may not be "bird safe" to the hoofstock species while they are in the barn for the night and vice versa if your birds are brought inside. Another management option may be to incorporate "creeps", where only animals of a certain size (or physical capability) can access a region of the habitat and the enrichment options specific to that species can be given there. Also, using animals' natural abilities can give us options to maximize enrichment diversity and safety – for example, using the height advantage of giraffe to offer their enrichment above the reach of bird species (be sure your birds' flight/loft/jump capabilities are considered and, if applicable, when their last wing trim was done). Using locking nuts and/or Loctite® to secure mounting hardware, routinely checking hardware and minimizing access to these components can greatly enhance the safety of enrichment. When using rope or chain, housing it inside of PVC, as well as limiting the length and/or animals' access to these potential dangers can mitigate the hazards.

**Enrichment Safety Resources:**

For real-life enrichment safety scenarios, check out the Shape of Enrichment's Safety Database at: http://www.enrichment.org/Safety.php. Please help contribute to this valuable resource by sharing any safety incidents with their safety editor who will ensure it is posted with institutional and contributor anonymity.

**Reference:**

U.S. Food and Drug Administration. 2010. Animal Proteins Prohibited in Ruminant Feed-Code of Federal Regulations. Retrieved From: http://www.fda.gov/AnimalVeterinary/GuidanceComplianceEnforcement/ComplianceEnforcement/BovineSpongiformEncephalopathy

# Savannah Exhibits: Developing a New Formula

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Savannah exhibits continue to be popular, and the number of savannah exhibits in European zoos keeps on growing - several have been completed in recent years and more are in progress. Generally these savannah exhibits constitute large, fairly open and flat enclosures, sometimes with a few hills or cliffs. Vegetation in and around the enclosure usually consists of acacia and/or similar trees, and closely cropped grass if the grass has a chance to grow at all, given the intensity of its use. The larger fauna often includes some combination of white rhino (*Ceratotherium simum*), eland antelope (*Taurotragus oryx*), springbok (*Antidorcas marsupialis*), wildebeest (*Connochaetes sp.*), blesbok (*Damaliscus pygargus phillipsi*), impala (*Aepyceros melampus*), zebra (*Equus sp.*), addax (*Addax nasomaculatus*), giraffe (*Giraffa camelopardalis*), waterbuck (*Kobus ellipsiprymnus*) and ostrich (*Struthio camelus*). Cranes (often grey crowned cranes *Balearica regulorum*), storks (usually marabou *Leptoptilos crumeniferus* and/or white storks *Ciconia ciconia*), guineafowl (*Numididae*) and even sacred ibises (*Threskiornis aethiopicus*) frequently serve as accent pieces or "fillers". Other "flying" avian species (non-ratites) that regularly end up in savannah exhibits include flamingos (*Phoenicopterus sp.*), pelicans (*Pelecanus sp.*), geese and ducks (*Anatidae*). Termite mounds frequently appear in the landscape as well. The educational graphics generally refer to the incredible numbers of migrating mammals that appear on the savannah during the wet season when vegetation is bountiful, leaving again when the dry season commences and their food sources wither away.

This is the formula, sometimes with twists. Obviously it is seen as a successful formula, as it has been replicated so frequently over time. But perhaps it is now time to change this formula - to take

A close encounter between a marabou female and gelada baboon (*Theropithecus gelada*) at the Dresden Zoo, Germany. This may not fit our "Bird/Hoofstock" theme, but it certainly falls within the category of unique mixed-species exhibits. *Photo by Rolf Veenhuizen*

Newly fledged marabou in an aviary in Paignton Zoo, Devon, England. *Photo by Ray Wiltshire*

the "flying" birds out of the savannah. You are probably thinking that then the exhibit would not look as natural, or so full; that the visitors would not like it as well. But picture it - visitors gazing out at a savannah with only ostriches and/or local birds that can come and go at will in addition to those big mammals. Would their reactions really be "it would be a fantastic exhibit if only it had a crowned crane" or "where are all those storks I see on the documentaries?" Is it instead possible that the mega-vertebrates which so clearly dominate the landscape, the vegetation and the non-living accent pieces, wisely and creatively used, can be enough for the visitors to absorb? Visitors do not expect to see lions (*Panthera leo*) or hyenas (*Hyaenidae*) kept with hoofstock, why should they expect to see birds?

The reality is that most savannah enclosures just do not do justice to the birds, which are usually seen at a distance. If visitors notice them consciously at all, they don't get the chance to appreciate the uniqueness of the mighty marabou or to glimpse the true character of the elegant crowned crane. This can only happen when the birds are seen close up, in surroundings more similar to what they really have in their natural environment. Picture a group of marabous or crowned cranes foraging, loafing and interacting with each other in long grass, rich in insects that is not eaten by hoofstock; probing in, bathing in and nesting near a wetland not trampled by hoofstock; roosting in trees not hot-wired to keep hoofstock at bay. Some of my most prized photos are a sequence showing a saddle-billed stork (*Ephippiorhynchus senegalensis*) capturing and eating a snake in its marsh-like enclosure that were taken by a fellow visitor at the Kansas City Zoo, as we stood just a couple of meters away. Such an intimate experience is unlikely to happen near a savannah exhibit. I have now seen full-flighted marabous in several large aviaries, and watching these great birds perching above me, then using their immense wings to make a short flight or glide to the ground, is certainly awing. Zoo visitors and other zoo professionals must have the same reaction, given the current popularity of marabous in zoo educational presentations.

As time passes, and birds have become more valuable, both monetarily and conservation-wise, the variety of avian species exhibited on savannahs has declined - rarely do you see saddle-billed storks, wattled cranes (*Bugeranus carunculatus*) or blue cranes (*Anthropoides paradiseus*) among the antelope nowadays. But even those common, large species such as marabous and grey crowned cranes are becoming increasingly valuable, in light of the EU bird ban and US wild bird ban that has made acquiring them from the wild more difficult. Furthermore, some of the species that we have always assumed to be common in the wild may not be so in the future, or even now - their status can change quickly. The grey crowned crane was deemed of Least Concern in 2008, than as Vulnerable in 2009, and Endangered in 2012 in the IUCN Red List of Threatened Species. The uplisting of this species to Endangered was because of threats such as habitat loss and the illegal removal of birds and eggs from the wild (IUCN, 2013). The International Crane Foundation is leading a campaign, including the production of a short video which can be viewed on YouTube, to make people more aware of the illegal trade problem, and to encourage holders of grey crowned cranes to house them suitably and participate in breeding programs (C. Mirande, pers. comm.).

Unfortunately, savannah enclosures are usually not suitable to breeding birds or in many cases even keeping them alive for an extended period of time. Zoo managers tend to view injuries and deaths of birds at the hands (or rather heads and feet) of large mammals and ostriches as exceptions: "the bird was new to the enclosure, the bird got between the mother and its young, *the bird was defending its nest...." The problem is that these exceptions add up to substantial numbers, and as* the ESB keeper for marabou storks, I have tried to make European holders aware of this problem. Because ESB participants are usually quite cooperative in letting me place their surplus birds, and there is a waiting list for marabou storks, I have been largely able to avoid sending marabous to zoos planning to hold them with large hoofstock in recent years. This may be part of the reason why traumatic non-chick deaths of marabous due to other animals (excluding predators) dropped from 11 between 2006-2008 to 3 between 2009-2011, even though overall levels of mortality were comparable during these two three-year periods. While there are no data for cranes or other large flying birds in similar situations in Europe, it seems likely that they suffer the same problem to the same degree.

In the ideal world, and most certainly the ideal zoo, marabous and all the other birds now kept in hoofstock enclosures would not only be housed separately from hoofstock, they would also be housed in covered enclosures, i.e. aviaries. A list of reasons why aviaries may be preferable for housing birds is shown in Table 1. This list was compiled from discussions on the EAZA Bird TAGs list serve, with input from a number of people. Of course, the relevancy of the potential reasons can vary with the situation, and we acknowledge that not everyone will agree with all the reasons suggested. There are two reasons that I want to go into in more depth here. One is that only when birds are kept full-flighted can they carry out a reasonable representation of their behavioral repertoires, including being able to roost in trees, in the case of crowned cranes and marabous. I wonder how many zoo people are even aware that these birds usually roost in trees. Presumably the reason why they roost in trees is for protection from potential predators. Is it stressful for a bird to be unable to select where it roosts, not to be able to go where it feels safe? Many birds held in aviaries do seek the highest perches that they can use, presumably because it makes them feel safer. This can become a problem when keeping tropical birds in temperate climates, as the birds may choose for height of the roosting perch outdoors over warmth of an indoor area or outdoor heat lamp, and can suffer negative effects from cold if not forced to go indoors.

An important reason for housing species that are notoriously aggressive to conspecifics, including their mates, such as marabous, in aviaries is that it provides opportunities for the birds to space themselves vertically as well as horizontally. This possibility is known to be important in reducing aggression in primate social systems, and could help reduce intraspecific killings of marabous. Disturbingly, intraspecific killings constituted 46 (40.7%) of the 113 non-chick deaths between 2006-2011 in the ESB population (C. King, unpubl. data). Females are at much higher risk than males, and the EAZA population is thus male-skewed, numbering 167.138.23 marabous on 31 December 2011 (King, 2012). While I do not yet have enough data to say this conclusively, my impression is that marabous are indeed less likely to kill each other when held in aviaries, and they also seem to form breeding pairs faster and breed more quickly than in open enclosures.

The need to encourage zoos to hold more birds across taxa and different TAGs in aviaries to promote breeding was recognized at the Bird Oriented Persons (BOP) Meeting held during the EAZA Annual conference in Montpellier, France in 2011. It was acknowledged that there are some hurdles to overcome: covered enclosures are often viewed as expensive, and unsightly. Clearly though there are many different ways to build a covered enclosure, and these come in different price categories. Another deterrent is that each zoo must research the options themselves, which costs much time and duplication of effort. Therefore the EAZA Ciconiiformes and Phoenicopteriformes TAG offered to research the possibilities for making a compilation of different existing aviary designs, materials, costs and other relevant information that zoos wanting to make an aviary could refer to. Two students recently undertook a pilot project to study how best to acquire this information (van den Heuvel and Ludwig, 2012) and Andrea Bracko, the EAZA Ciconiiformes and Phoenicopteriformes TAG Vice-chair, is heading up a project being carried out at Zagreb Zoo to make a web-based version of an aviary data base for general use.

So possibly it is time to review your current savannah or future savannah plans, and see whether presentation of the savannah animals you want to exhibit could not be considerably improved by developing a new formula: one savannah mega-vertebrate enclosure plus one savannah bird enclosure is far greater than one mixed-savannah enclosure. And of course, the same philosophy can be applied to other mixed-species enclosures, not just savannahs. Additionally, as time goes on, other problems may be signaled. For example, while ostriches are compatible with many hoofstock, they may be "pronged" by others. Jo Gregson, vice-chair of the EAZA Ratite TAG, together with her colleagues at Paignton Zoo, has developed a project for assessing ostrich behavior in different mixed exhibits and single-species exhibits. Hopefully this will shed light on the severity of this problem, and how it can be overcome if it is a problem. As zoo professionals, we strive to ever improve the well-being and presentation of the animals that we work with, and hold them as naturally as possible. In the case of "flying" birds, this includes letting them use their wings, which conveys a far more important educational message than housing them with hoofstock does.

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**Table 1.** A list of 23 reasons for why aviaries can be the best solution for housing birds

| | |
|---|---|
| 1 | Predators should not be able to enter the enclosure |
| 2 | Birds can retire to safer (higher) places if predators do enter |
| 3 | Local egg thieves cannot reach eggs or disrupt breeding |
| 4 | Loss of food to local birds can be reduced or entirely avoided |
| 5 | Potential for disease transmission from local birds is reduced |
| 6 | Hybridization with indigenous or domestic species can be avoided |
| 7 | Potential for adding to the invasive species problem (e.g. waterfowl production) is reduced |
| 8 | Use of space is more efficient (more enclosure space per surface area) |
| 9 | Three dimensional use of space makes a more interesting exhibit for visitors |
| 10 | Three dimensional use of space gives a more accurate educational message |
| 11 | Three dimensional use of space decreases competition and aggression between individuals |
| 12 | Three dimensional use of space allows a greater diversity of species to be held together |
| 13 | Three dimensional use of space allows birds to carry out behaviors that are part of their natural history, e.g. roosting and/or nesting in trees |
| 14 | Protection of an aviary enables the visitors to see parent-rearing of chicks that would otherwise have to be hand-reared because of predation problems (e.g. waterfowl) |
| 15 | A full-winged bird is more attractive than one with part of its wing missing; asymmetry is known to have a negative influence on mate choice generally |
| 16 | Full-flighted birds have better balance, which can reduce traumatic injuries |
| 17 | Full-flighted birds have better copulation abilities, especially long-legged birds that copulate standing |
| 18 | Full-flighted birds can perform species-specific ritualized behaviors better because they have full use of the wings and better balance |
| 19 | Aviaries can more easily be turned into temporary quarantine/holding areas when necessary. |
| 20 | Flying in an aviary, even short distances, allows birds to develop muscles normally |
| 21 | Flying is energy consuming, and can help birds to avoid becoming fat, which can negatively influence reproduction and health |
| 22 | There is no reason to repeatedly capture birds for wing-clipping to keep them from leaving if pinioning is not practiced because of the legal and ethical considerations of this practice |
| 23 | When capture is necessary there is less stress to the keepers and birds than in a large open area |

# CITES Announces Suspension of Crowned Crane Trade

**March 4, 2013**

An announcement, detailing the suspension of trade in Black Crowned Cranes from Guinea, Sudan and South Sudan and trade in Grey Crowned Cranes from Rwanda, Uganda and Tanzania, has just come out of the CITES Conference of the Parties 16 currently underway in Bangkok, Thailand.

Tanzania, Rwanda, Uganda, Guinea, Nigeria, Sudan and South Sudan all underwent a full review, conducted by the CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna) Significant Trade Review Process, of their wild caught Black and Grey Crowned Crane trade in order to determine the impact of this trade on their wild crane populations. This CITES suspension is in place until the country in question can prove that export will not be detrimental to the wild population and that they are able to successfully monitor export permits granted and actual exports, with the goal of limiting exports in order to maintain the species.

Nigeria was included in the final review, and has been removed from the CITES Significant Trade Review process as the Management Authority of Nigeria has not issued an export permit for commercial trade of the species since 2005. The reason for this course of action is due to the fact that there is no reliable population data for the Nigerian species. Furthermore, the Management Authority has not, to date, registered or recognized any captive-breeding facility for any wild animal species. Therefore, until further notice, any permit originating from Nigeria for captive-bred species of wild animals is illegal and should not be accepted.

The Endangered Wildlife Trust (EWT) and the International Crane Foundation (ICF) were instrumental throughout Trade Review Process as they supplied CITES with crucial data about the state of trade in cranes on the African continent.

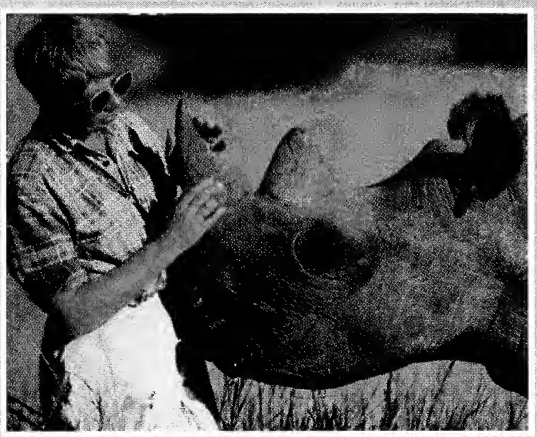
Said Kerryn Morrison, Manager of the ICF/EWT Partnership's African Crane Conservation Programme: "We welcome the decision from CITES as these species of cranes are under very real threat from live trade, partly because they are in high demand – they are unique looking, iconic of Africa, and tolerate being displayed in groups and with other species – but also because there are fewer effective controls in many of their countries of origin. In addition, many of the players involved in the demand and supply sides of this trade still believe that these species are plentiful. Without urgent attention, this trade could lead to loss of these birds from much of Africa."

The cranes are removed illegally from the wild, usually as chicks, for the captive trade market. In some cases, this involves domestication where cranes are kept in private gardens, around homesteads and in hotel gardens. There is however, a big demand for the species in captive facilities around the world where they are either placed in private breeding facilities or in mixed exhibits in captive facilities open to the public where they add value to savanna exhibits.

"Nowhere in the world are captive crane populations managed sustainably at this time. The African Crane Trade Project is, however, working with formalized zoo associations in Africa, North America, China and Europe to create managed programmes that aim to develop and manage sustainable populations of Grey Crowned Cranes, thus alleviating the need for wild caught cranes to supplement captive stock. Note though, that only 1,200 zoos of the 12,000 estimated captive facilities around the world belong to these formalized zoo associations. Therefore, it is clear that more urgent attention must be paid to communicating to, and educating a far wider stakeholder group involved in the captive trade," commented Morrison.

*Source - International Crane Foundation*

# Farewell Anna



**The Lewa Wildlife Conservancy deeply regrets to announce the death of Anna Merz, one of the Conservancy's iconic founders and renown conservationist. 82-year-old Anna passed away in a South African hospital, further details pertaining to her death will be communicated later.**

**Anna, along with the Craig family, founded the Ngare Sergoi Rhino Sanctuary, which would later on be established as the Lewa Wildlife Conservancy. It is by her vision, dedication and desire to save the rhino from extinction that Lewa stands as the proud organization that it is today.**

**The entire Lewa fraternity is devastated to lose the most passionate 'mother of rhinos', its greatest supporter, and its source of endless inspiration. Anna proved to us all that one person's dream and love for wildlife can create the most significant impact, far beyond our deepest imagination.**

**Rest in peace Anna. You will forever be missed and engraved in all of our hearts.**

**To read Anna's April 2012 letter to the AAZK Membership, written for the *AKF* issue dedicated to rhino conservation and Bowling for Rhinos, go to:**

**http://aazk.org/category/akf/viewpoint/**

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