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Abstract: Established for endangered wildlife, the Center for New Opportunities in Animal Health Sciences, NOAHS Center, is a cooperative program between the Smithsonian Institution's National Zoological Park and the National Institutes of Health, dedicated to advancing biological knowledge relevant to species conservation. With the cheetah, the Center emerged from a successful collaborative project. Screening cheetah blood proteins and DNA, they discovered that the cheetah displayed an extraordinary lack of genetic diversity that severely threatens its survival. NOAHS Center made management recommendations that led to the National Cheetah Research Master Plan and also manages the International Cheetah Studbook.

# NOAH'S Center

New Opportunities in Animal Health Sciences



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At the National Zoological Park's Center for New Opportunities in Animal Health Sciences (NOAHS Center), scientists are developing and applying the latest advances of biomedical research that will ensure a future for many endangered animals around the world. NOAHS Center focuses on the health, management, and reproduction of endangered species and on the maintenance of genetic diversity in zoo and free-living populations.

Three distinguished scientists, each with a special competence in the biology of zoological species, direct the research programs at NOAHS Center.



**Mitchell Bush, D.V.M.**

Dr. Bush received his D.V.M. in 1965 from the University of California at Davis. He became the Chief Veterinarian for the National Zoo in 1972, head of the Department of Animal Health in 1975, and Assistant Director for Animal Health in 1989. He consults regularly with zoos and game parks worldwide and directs one of the most active veterinary training programs in the United States.



**Stephen O'Brien, Ph.D.**

Dr. O'Brien received his Ph.D. from Cornell University in 1966. He serves as Director, Section of Genetics and Laboratory of Viral Carcinogenesis, National Institutes of Health's National Cancer Institute in Frederick, Maryland. His research laboratory leads the fields in human and animal genetics, including studies of population genetics, epidemiology, and genetic action of RNA viruses (oncogenes, AIDS, and feline leukemia) in host populations. His critical work in human biology and his keen interest in the biology of wildlife species allow him to bring to wildlife biology the most critical advances from human biomedical research frontiers.



**David Wildt, Ph.D.**

Dr. Wildt received his Ph.D. from Michigan State University in 1975 and began collaborating with the National Zoo in reproductive physiology in 1976. His work on freezing sperm and embryos of laboratory animals led to his interest in adapting these procedures for exotic species conservation efforts. He joined the National Zoo staff as Head Reproductive Physiologist in 1983 and leads a team of graduate and postgraduate students in state-of-the-art biotechnologies to save endangered species.



Jessie Cotton

*Where it happens: NOAHS Center in the National Zoo's Veterinary Hospital.*



Jessie Cohen

*The giant panda, a living symbol of the wildlife crisis (above). Research scientists from different disciplines agree on the need to collect basic biological information on endangered animals (right).*

**Mission:** Established for endangered wildlife, the Center for New Opportunities in Animal Health Sciences, NOAHS Center, is a cooperative program between the Smithsonian Institution's National Zoological Park and the National Institutes of Health, dedicated to advancing biological knowledge relevant to species conservation. The associated scientists are leaders in their research fields: genetics, reproductive physiology, veterinary medicine, and infectious disease. Their research programs attract high-caliber graduate and postgraduate students. NOAHS provides information for conservationists making management decisions directly affecting species survival. The Center is dedicated to expanding our understanding of the biological factors, including the critical role of biodiversity, that influence animal survival.

World wildlife is now so endangered that active intervention is necessary to save it.

The Center's objectives involve preserving species, advancing basic knowledge about endangered wildlife, and training future conservation bioscientists. Building upon decades of research in human health sciences and biomedical technology, NOAHS Center's

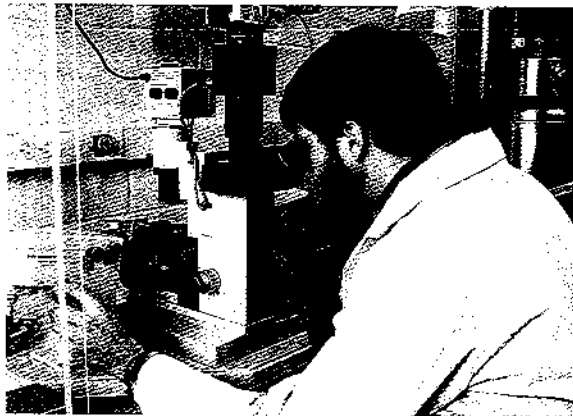


Karl Ammann

Often unknowingly, humans have severely tilted nature's delicate balance. Our generation has witnessed numerous extinctions; several large species survive today only in captivity.

researchers develop and use modern biotechnologies to study, manage, breed, and save endangered species and to ensure genetic diversity in rare animal populations.

As an integral part of the National Zoo, NOAHS Center combines field studies of free-ranging fauna with studies of captive populations in zoological preserves throughout the world. Four sites provide sophisticated biomedical analyses and training: 1) National Zoo in Washington, D.C.; 2) National Zoo's Conservation and Research Center near Front Royal, Virginia; 3) National Institutes of Health's Animal Research Center in Poolesville, Maryland; and 4) National Cancer Institutes' Section of Genetics in Frederick, Maryland.



*Dr. Melody Roelke, left, of Florida's Game and Freshwater Fish Commission and Dr. JoGayle Howard of NOAHS Center collect blood and semen samples from 1 of 50 remaining Florida panthers (left).*

*A graduate student uses state-of-the-art equipment to analyze field samples (bottom left).*

**The Beginning — Cheetah:** NOAHS Center emerged from a successful collaborative project. Drs. Bush, Wildt, and O'Brien sought to solve long-standing puzzles: Why do cheetahs reproduce poorly in captivity, and why are their numbers rapidly declining in Africa?

As the world's fastest land animal, a cheetah can sprint up to 70 miles per hour in pursuing prey. Its respiratory rate climbs from 60 to 150 breaths per minute, but after running only a few hundred yards, a cheetah collapses. As soon as it tires, the cheetah becomes vulnerable to predators. This vulnerability, however, does not adequately explain the cheetah's reproductive problems or its rarity in the wild.

NOAHS Center scientists resolve problems

in wildlife conservation in a new way — biomedical research. Screening cheetah blood proteins and DNA, they discovered that the cheetah displayed an extraordinary lack of genetic diversity that severely threatens its survival. Perhaps 10,000 years ago, and for some unknown reason, the cheetah population declined so much that inbreeding resulted. Inbreeding reduces genetic diversity, producing alarming results including infertility and an inability to combat infectious disease. Today a male cheetah's low sperm count and high frequency of sperm abnormalities account, in part, for poor reproduction. The usually variable genes that defend against invading bacteria and viruses have become so uniform that they make cheetahs particularly vulnerable to certain infectious diseases. As human

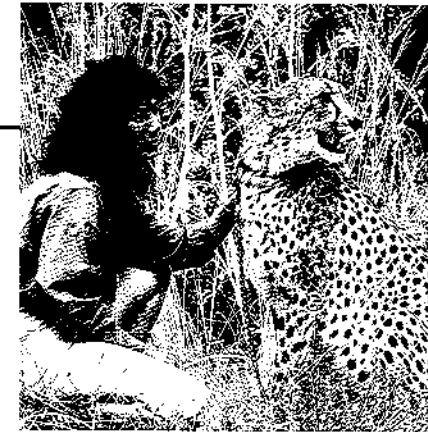
*Collaborative research work on cheetahs led scientists to establish NOAHS. The cheetah and countless other animals from small populations have similar genetic and reproductive problems.*



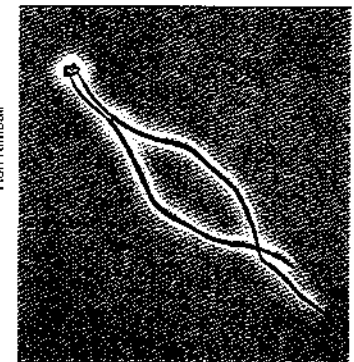
population demands make habitat scarcer and as the animals' environment becomes increasingly stressful, the cheetah's genetic vulnerabilities are compounded.

The research provided additional evidence that a loss of genetic variation threatens species survival and may be a prelude to extinction. NOAHS Center made management

recommendations that led to the National Cheetah Research Master Plan. NOAHS Center continues detailed studies in the medical, reproductive, and genetic health of free-living and captive cheetahs. The Center also manages the International Cheetah Studbook, a record of births, deaths, sires, and dams of all cheetahs in captivity.



*Studbook Keeper Laurie Marker-Kraus successfully taught Khayam, born and raised in captivity, to hunt in the African wild (above). High incidences of abnormal sperm signaled that cheetah reproductive problems had a physiological basis (below).*



Riley Caton

Ron Kimball

JoGayle Howard



**NOAHS Center scientists perform research in animals' native habitats:** NOAHS

researchers work differently; they leave their laboratories to travel worldwide, studying and collecting biological materials, including blood samples and sperm from healthy free-living animals. NOAHS scientists interact with other field biologists whose long-term studies form the basis for conservation master plans. This international cooperation addresses important ecological questions about the status and future of wild species.

Back home in the laboratories, analyses of field samples measure an animal's, or animal

population's, health, reproductive state, and genetic status. Recent improvements in endocrine tests of urine or stool samples detect hormones indicating stress, estrus, the breeding cycle, or the time of an expected birth. With these new tests, wild animals can be studied regularly without anesthesia. Test conclusions contribute to definitive management decisions about species

populations. The scientists of NOAHS Center believe that field studies create a basis for successful work with captive animals.

Field research, an integral part of student education, provides key opportunities for international cooperation with host countries also dedicated to wildlife conservation.

*Dr. Howard checks a recently collected sample from a sedated elephant (left). Dr. Bush uses field studies to determine better methods for treating sick animals and better plans for fighting diseases (right).*





Karl Ammann

**Genetic variation is the raw material for evolution; loss of genetic diversity causes problems for any species:** NOAHS Center scientists monitor and help maintain genetic diversity in endangered species. The success of any future wildlife management program hinges on sustaining sufficient genetic diversity to prevent inbreeding and problems such as birth defects, juvenile mortality, infertility, and increased susceptibility to disease.

In ongoing NOAHS projects, state-of-the-art techniques are used to study genetic variability in endangered species such as the orangutan,

Asian lion, African wild dog, black-footed ferret, Florida panther, Alaskan sea otter, and humpback whale. These techniques include direct investigation of DNA itself and electrophoretic surveys of enzymes and other gene products.

Molecular biology techniques, developed by studying humans, determine "genetic distances" among primate, bear, and cat species, thereby reconstructing evolutionary relationships. Genetic tests identify populations or subspecies



Karl Ammann

*The African wild dog, isolated by human encroachment, is a victim of habitat loss, its own limited genetics, and inbreeding. The species has declined drastically (far left). In a mobile laboratory in East Africa, Dr. O'Brien processes carefully collected biological samples for shipment to NOAHS (left).*

at genetic risk. The cheetah, the Florida panther, and the Ngorongoro Crater lions have been so identified.

Recent medical advances isolate and identify life-threatening diseases that spread from population to population. This work will lead to vaccines and treatments to protect small populations, such as protection for the African wild dog from rabies and parvovirus.





*A laparoscope commonly used in human reproductive surgery is now used routinely to improve reproduction in endangered species (above).*

*Dr. Wildt and waking subject in the Ngorongoro Crater (right).*

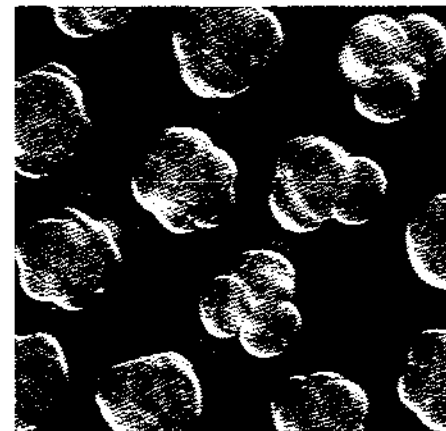


### **Species survival depends upon reproduction:**

Florida panthers, Asian Gir lions, tiny isolated populations of giant pandas, all are in danger because of a lack of reproductive information. Scientists working at NOAHS Center are using the latest reproductive biotechniques to get new facts about the reproductive process and to resolve fertility problems.

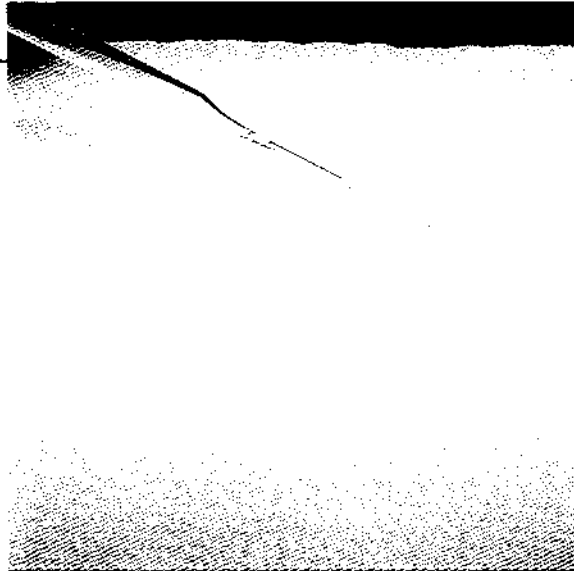
Knowledge accumulated from decades of reproductive research in humans and domestic

livestock is being applied to endangered species. The Center is pioneering methods for evaluating reproductive abilities of many species including the cheetah, the Siberian tiger, and the giant panda. It is testing new approaches for artificially breeding the black-footed ferret and the Florida panther. Scientists at NOAHS Center are leaders in developing artificial insemination methods to improve captive breeding of endangered species. Recently NOAHS scientists achieved a first by producing tiger cubs by *in vitro* fertilization.



*Using in vitro fertilized embryos to assist wild cats was demonstrated first with the successful birth of domestic cats and then in April 1990 with the birth of tiger cubs (above).*

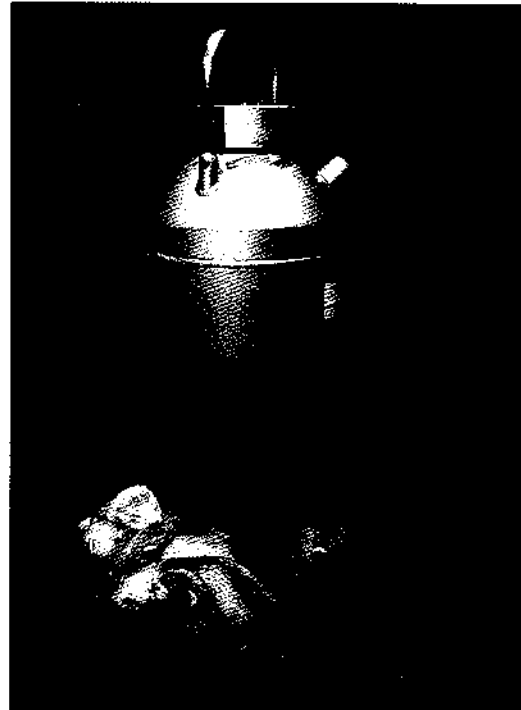
Stephen O'Brien



*Frozen sperm—a way of keeping gene pools alive indefinitely.*

A critical task for NOAHS is preserving sperm and embryos. Advances in livestock production have shown that frozen sperm can be held for decades and then used to produce live offspring. Similar methods can provide young from rare animals years after their death. To prevent inbreeding crises in zoo populations, the scientists are developing methods for freezing sperm from free-living wild populations, thereby boosting the genetic diversity of captive species.

Jessie Cohen



Jessie Cohen



Wyoming Game & Fish Dept.

*Domestic ferrets were born from frozen sperm stored in this liquid nitrogen tank. NOAHS scientists expect the very endangered black-footed ferret to benefit from this research (left and above).*

**NOAHS Center scientists are exploring new medical frontiers to diagnose, treat, and prevent disease:** Maintaining vast biodiversity so precious to our fragile biosphere is a challenge to the exotic-species veterinarian. Each species differs dramatically. Each species experiences distinct diseases and responds uniquely to medicines.

Decades of trial and error experiences and, in recent years, data from applied research studies on wild species have formed NOAHS' extensive clinical database. Ongoing clinical research involving medicines, antibiotics, and anesthetics will further expand this database.

Zoological medicine has become an exact and organized science. Yet the gaps in medical knowledge remain vast. New developments in human and domestic animal medicine allow the dedicated veterinarians to focus constantly on resolving wildlife health problems.



JoGayle Howard

*Dr. Bush, left, leads a team of doctors and students who provide the finest animal care possible. The National Zoo's giant pandas are their two most famous patients.*



Stephen O'Brien

*Determining proper medication and dosage for wild animals is always difficult, particularly with a giant like a giraffe (above).*



*NOAHS interns—conservation biologists of the future—participate in biomedical research projects.*

#### **NOAHS Center — an institute for learning:**

Wildlife biomedical research has developed into a new field. NOAHS Center's multidisciplinary research offers students and visiting scientists a unique and fascinating perspective for preserving biodiversity and benefiting wildlife. The training program is affiliated with several universities in the Washington, D.C., area.

Students and research scientists work in the National Zoo's excellent facilities in Washington,

D.C.; its Conservation and Research Center near Front Royal, Virginia; and the National Cancer Institute in Frederick, Maryland. Collaboration with the National Institutes of Health, the Johns Hopkins University, and other local medical centers, as well as NOAHS' many international connections, makes the veterinary, reproduction, and genetic training programs among the best in the world. NOAHS trainees will be the preeminent conservation biologists of the future.

*Working with the Serengeti Lion Project, NOAHS research directors and graduate students are involved in a long-term lion study.*





*The NOAHS Center team (above). At the Sakkarbaug Zoo in India, Drs. Wildt, center, and O'Brien, background, share their knowledge of new techniques and research results with colleagues (right).*



**Preserving life is what it is all about:** NOAHS Center has identified problems in the fight to save endangered species. Its research in genetics, reproductive physiology, and veterinary medicine will offer solutions to conservation problems.

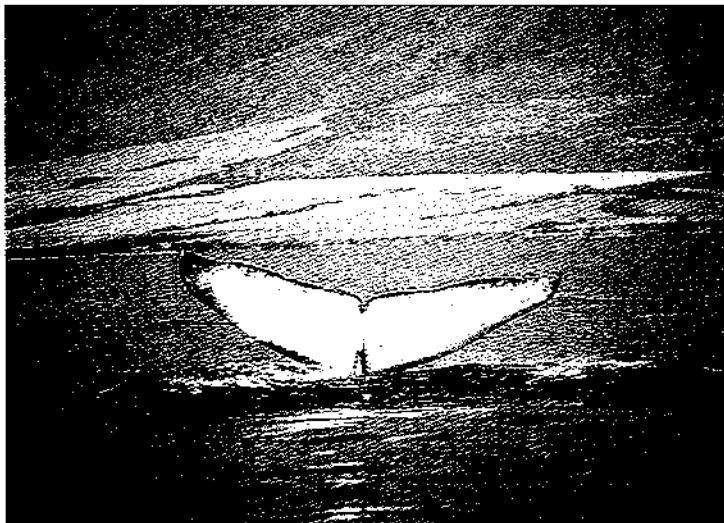
Humankind needs to give back to the wild what it has taken. Researchers at NOAHS Center are finding new and creative ways of fulfilling this obligation. The Center plays an active role in advising wildlife managers around the world.

NOAHS Center is dedicated to preserving life by better understanding the biology of endangered species. Rescuing a species from extinction does not simply mean confining it to a safe place. It means propagating a healthy population so that viable offspring can be returned to the wild where the species can live, roam, hunt, and thrive in freedom. This is the ultimate goal of NOAHS Center.

*Species preservation  
—what it is all about!*



Laurie Marker-Kraus



Scott Baker

*Genetic studies of the exploited  
humpback whale yield greater  
understanding of the  
consequences of small  
populations (left).*

*The first tiger cubs produced by in  
vitro fertilization are held by  
NOAHS graduate student Annie  
Donoghue who led the research  
group that adapted the technique  
for tigers (right).*





Daniel Kraus

*Extinction is forever; endangered  
means there is still time.*



### **Our Responsibility**

We all are responsible for protecting the biodiversity of our natural heritage and for ensuring this heritage for future generations.

These responsibilities are almost overwhelming as we struggle to resolve the conflicts and deal with the consequences of our industrial, urban lives and our decreasing natural resources. We face a challenge as daunting as any our civilization has yet confronted.

As citizens of this world, we must meet this challenge if we value the quality of life as we have known it. Accepting the challenge means investing in the future.

NOAHS Center is a way to meet the challenge. The Center's scientists, through painstaking research, are developing techniques to ensure a future for many endangered species. Although it works through the facilities of the Smithsonian's National Zoo and the National Institutes of Health, NOAHS provides essential private funding to supplement this vital research.

### **How to Meet the Challenge**

Investing in NOAHS Center is a way you can accept the challenge of saving our varied and wonderful natural heritage for the future.

Gifts may be made in the form of cash, securities, or property. Donations are tax-deductible to the fullest extent of the law.

Checks should be made payable to

NOAHS Center/Smithsonian Institution

For additional information, please contact  
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# NOAHS<sup>Center</sup>

New Opportunities in Animal Health Sciences

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